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U.S. COMMISSION ON OCEAN POLICY PRELIMINARY REPORT

HEARING

BEFORE THE

COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED EIGHTH CONGRESS

SECOND SESSION

MAY 5, 2004

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U.S. COMMISSION ON OCEAN POLICY PRELIMINARY REPORT

WEDNESDAY, MAY 5, 2004

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
Washington, DC.

The Committee met, pursuant to call, at 10:10 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Sherwood L. Boehlert (Chairman of the Committee) presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

U.S. Commission on Ocean Policy Preliminary Report

Wednesday May 5, 2004

10:00 AM – 12:00 PM
2318 Rayburn House Office Building (WEBCAST)

Witness List

Admiral James D. Watkins, USN (Ret.) is the Chairman of the U.S. Commission on Ocean Policy. Admiral Watkins is also President Emeritus of the Consortium for Oceanographic Research and Education, was formerly chief of naval operations for the United States Navy, and was Secretary of Energy under President George H. W. Bush.

Dr. Andrew Solow is the Director of Marine Policy Center at Woods Hole Oceanographic Institution. Dr. Solow was a member of the U.S. Commission on Ocean Policy Science Advisory Panel Governance Working Group.

Dr. Shirley A. Pomponi is the Acting Managing Director of the Harbor Branch Oceanographic Institution. Dr. Pomponi was a member of the U.S. Commission on Ocean Policy Science Advisory Panel Research, Education and Marine Operations Working Group.

Dr. Leonard J. Pietrafesa is the Director of External Affairs at the College of Physical and Mathematical Sciences at North Carolina State University. Dr. Pietrafesa is chair of the National Oceanic and Atmospheric Administration (NOAA) Science Advisory Board.

Dr. Michael H. Freilich is the Associate Dean of the College of Oceanic and Atmospheric Sciences, at Oregon State University. Dr. Freilich is a member of the National Research Council's Space Studies Board and chair of that Board's Committee on Earth Studies.

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HEARING CHARTER

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

U.S. Commission on Ocean Policy Preliminary Report

WEDNESDAY, MAY 5, 2004
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On May 5, 2004 at 10:00 a.m., the House Science Committee will hold a hearing on the key findings and recommendations of the Preliminary Report of the U.S. Commission on Ocean Policy. In response to pressures on ocean and coastal ecosystems from increased coastal development, over-fishing, pollution, and a confusing patchwork of federal and State legal authorities for ocean and coastal activities, Congress passed the Oceans Act of 2000. It required the President to establish a nonpartisan, diverse commission of experts in ocean policy and charged that commission to establish findings and develop recommendations for a new comprehensive ocean policy, including in research and development (R&D). The Report is the first comprehensive review of national ocean policy in more than 30 years.

The Committee plans to explore the following overarching questions:

1. What are the current problems in our nation's ocean and coastal ecosystems and why has federal policy been unable to effectively deal with them?
2. What are the recommendations from the Report and should they be implemented?

Witnesses:

Admiral James D. Watkins, USN (Ret.), Chairman, U.S. Commission on Ocean Policy. Admiral Watkins is President Emeritus of the Consortium for Oceanographic Research and Education, was formerly Chief of Naval Operations for the United States Navy, and was Secretary of Energy under President George H.W. Bush.

Dr. Andrew Solow, Director, Marine Policy Center, Woods Hole Oceanographic Institution. Dr. Solow was a member of the U.S. Commission on Ocean Policy Science Advisory Panel Governance Working Group. He will discuss the Report's recommendations to establish a National Ocean Council to coordinate federal efforts with respect to oceans.

Dr. Shirley A. Pomponi, Acting Managing Director, Harbor Branch Oceanographic Institution. Dr. Pomponi was a member of the U.S. Commission on Ocean Policy Science Advisory Panel Research, Education and Marine Operations Working Group. She will discuss the implications of the Report's recommendation for increased funding for ocean research.

Dr. Leonard J. Pietrafesa, Director of External Affairs, College of Physical and Mathematical Sciences, North Carolina State University. Dr. Pietrafesa is chair of the National Oceanic and Atmospheric Administration (NOAA) Science Advisory Board. He will discuss the Report's recommendations to strengthen NOAA.

Dr. Michael H. Freilich, Associate Dean, College of Oceanic and Atmospheric Sciences, Oregon State University. Dr. Freilich is a member of the National Research Council's Space Studies Board and chair of that Board's Committee on Earth Studies. He will discuss the Report's recommendations to transfer some programs from the National Aeronautics and Space Administration (NASA) to NOAA.

Background:

The last comprehensive review of U.S. ocean policy took place more than 30 years ago when a governmental panel, the Stratton Commission (named for its chair, Julius Stratton), issued its report *Our Nation and the Sea.* This report led to the creation of the National Oceanic and Atmospheric Administration (NOAA) by executive order in 1970.

Since that time, more than 37 million people, 19 million homes, and countless businesses have been added to coastal areas. The country is more dependent on marine transportation of goods, and coastal recreation and tourism have become more significant elements of the national economy. These increased and sometimes competing uses of the ocean and coasts have caused dramatic declines in fish populations and increased pollution. In addition, a confusing patchwork of federal and State legal authorities for ocean and coastal activities has evolved to attempt to deal with these problems.

Four years ago, Congress passed the Oceans Act of 2000, establishing the U.S. Commission on Ocean Policy. The Commission, consisting of 16 members from diverse scientific and political backgrounds, was charged to establish findings and develop recommendations for a new comprehensive national ocean policy. (A list of the members of the Commission is provided in Appendix A.) The Preliminary Report of the Commission (referred to as the Report for purposes of this document) was delivered to the Governors of the all states and U.S. territories on April 20, 2004. The Governors and the general public can provide comments on the Report through May 21, 2004 and in the summer of 2004 the Commission will release its final report. The law requires the President to submit a formal response to the Commission's recommendations 90 days after the final report is released. The Administration has remained silent on the preliminary report, pending the President's formal response.

Key Recommendations of the Report:

The Executive Summary of the Report is provided in Appendix B. The complete report is available at www.oceancommission.gov.

Ocean and Coastal Research Funding

Problem: Scientific understanding of the oceans is still fairly limited. While it is difficult to determine the precise amount of money the Federal Government has invested in ocean research, because it spans so many fields and agencies, spending on ocean research appears to have been virtually flat (even without adjusting for inflation) for the past two decades or so. The Report notes that in the 1960s and 1970s ocean research represented seven percent of the federal research and development budget; today it represents only 3.5 percent because other fields have increased at a faster rate.

Report Recommendation: The Report recommends gradually doubling the level of federal funding for ocean and coastal research so that it would increase from the FY 2004 level of $650 million to $1.3 billion in FY 2009. (The Report estimates that if all of its recommendations were implemented (not just those related to R&D), federal spending on oceans would increase by $1.3 billion in the first year, and by $3.2 billion by the third year, and then by inflation after that.) The Report recommends the research spending increases be used for such purposes as expanding NOAA's Sea Grant program and expanding ocean exploration efforts. The Report recommends that funding for ocean exploration increase from the current level of $13 million to $110 million. The Report recommends financing all of the increases by tapping the royalties the Federal Government receives from off-shore oil and gas drilling. The Report calls for those funds to be placed in a "Trust Fund" for ocean programs, but the Report is unclear about whether spending from the Trust Fund would be mandatory or subject to annual appropriations.

Issues: A major question is whether Congress should allocate as much money as the Report recommends and whether Congress should establish a Trust Fund for these activities. A related question is whether a Trust Fund would be subject to appropriations (such as the Land and Water Conservation Fund) or should guarantee a mandatory spending level (such as the Highway Trust Fund). Also, the Report does not provide any guidance as to which areas of research should be priorities, leaving that question to the National Ocean Council that it recommends creating (see below).

Earth Observing Systems

Problem: Both NOAA and NASA operate civilian, space-based Earth environmental observing programs. NOAA's program focuses on sustained operational observations for weather and climate purposes, while NASA's program is meant to advance research and sensor development. NASA's missions are generally short-lived and NASA often plans its research missions without considering whether its satellites could also contribute data to meet the longer-term climate and weather interests of NOAA. When NASA does develop a sensor of interest to NOAA, it often takes a long time to transfer the technology to NOAA.

Report Recommendations: The Report recommends that operation of all civilian, space-based Earth environmental observing systems be managed by NOAA to provide smoother transition of research to operations. NASA would retain the research,

engineering, and development roles for the research programs, but NOAA would be responsible for operations. The next generation of polar-weather satellites at NOAA, known as NPOESS, is cited as a model attempt for this idea.

Issues: The Report is somewhat unclear in its delineation of new roles for NASA and NOAA. Regardless of the details, it is unclear whether transferring money and staff between agencies is the most efficient way to increase coordination for Earth observation systems, especially since the Report assumes that some satellite responsibilities would continue to be divided between the two agencies. Transferring people between agencies is complicated, and often Congress does not agree to move all funding along with a program. An additional complicating factor is the President's proposed new vision for NASA which uses cuts in NASA's Earth Science programs to fund the mission to land an American on the Moon.

Ecosystem-based Management

Problem: Currently, each ocean and coastal problem tends to be addressed in isolation, for example increasing populations of a single fish species, or improving water quality for a particular purpose, such as swimming. This single-issue focus sometimes results in unintended consequences. For example, when government agencies began restoring the rockfish population in the Chesapeake Bay, the number of rockfish became so high that the number of juvenile crabs—which rockfish eat—began to decrease, causing problems for the crab industry.

Report Recommendation: The Report recommends that U.S. ocean and coastal resources should be managed using "ecosystem-based management." The goal of ecosystem-based management would be to manage an ecosystem as a whole, rather than dividing a problem along the lines of political or agency jurisdictions. To obtain the data needed to inform an ecosystem-based approach to management, the Report recommends (among other suggestions) creating the Integrated Ocean Observing System, which would use satellites, planes, buoys, ships and other means to collect data. Federal agencies have already put together a plan for such a system, which would draw, in part, on existing capabilities. The Report recommends making implementation of the system a priority, and estimates it would cost $290 million in the first year, rising to $650 million annually by the fifth year. The Report recommends that NOAA operate the System, which would be split among a variety of agencies under current plans.

Issues: The Report does not lay out how to implement ecosystem-based management in any detail. However, any approach is likely to require much better understanding of the oceans (and their interactions with land and the atmosphere, and of ecology) and much more data about them than is currently available. As a result, the success of such an approach will depend in large measure on how much money is invested in ocean science and observation.

Government Organization: National Ocean Council

Problem: According to the Report, more than 60 Congressional committees and subcommittees oversee 20 federal agencies and permanent commissions that are charged with implementing at least 140 federal ocean-related statutes. There is no clearly articulated national system of ocean and coastal governance.

Report Recommendation: The Report recommends that Congress establish a National Ocean Council in the Executive Office of the President, composed of all the cabinet secretaries and independent agency directors with ocean-related responsibilities and chaired by a Special Assistant to the President. The Report also recommends that Congress establish a Presidential Council of Advisors and that the Special Assistant would also run a new an Office on Ocean Policy to provide staff support to these entities. The Report describes this reorganization as an initial step in a long-term process that should culminate in the creation of a single Department that would bring together NOAA, the Environmental Protection Agency, the Interior Department and other related natural resource agencies and programs.

Issues: White House entities have a mixed record of being able to foster interagency cooperation. Moreover, existing White House offices already try to coordinate some ocean issues across agencies. For example, the Council on Environmental Quality deals with ocean issues from an environmental perspective, and the Office of Science and Technology Policy deals with ocean science across agencies. In addition, in 1997, Congress created the National Oceanic Partnership Program (NOPP), headed by a National Ocean Research Leadership Council, to coordinate national ocean research and education policy. The Council is made up of the heads of 14 federal agencies with ocean research responsibilities. The Report argues that NOPP has not been successful because it lacks a mechanism to require agency participation.

Government Organization: NOAA

Problem: NOAA was established by Executive Order in 1970. Since that time new responsibilities have been added to the agency on an issue-by-issue basis, resulting in a complex organization where communication across office lines is difficult. Also, many other agencies perform work related to ocean and coastal issues, and there is not always a clear lead for civilian ocean issues.

Report Recommendation: The Report recommends "strengthening NOAA" by clearly making it the lead agency for ocean issues; by giving it additional responsibilities, such as managing the Integrated Ocean Observing System; and by "restructuring" the agency "consistent with the principles of ecosystem-based management." The Report recommends gradually moving all federal civilian ocean and coastal activities into NOAA. The Report also recommends that Congress pass an organic act for NOAA to give the agency clear authority and organizational lines.

Issues: Congress needs to decide what should be in a NOAA organic act and to what extent it should make statutory decisions about NOAA's organizational structure. Over the long-term, moving all ocean and coastal programs into NOAA would be a massive undertaking that could cause dislocations in many agencies without necessarily improving coordination or oversight.

Education

Problem: Currently each ocean-related agency performs its own education and outreach activities on a program-by-program basis. There is no coordinated, comprehensive ocean education and outreach program or plan.

Report Recommendation: The Report recommends that the new National Ocean Council establish a national ocean education office to strengthen ocean education and coordinate federal efforts. Education programs should be addressed to students from kindergarten through graduate school and to the general public.

Issues: The recommendation assumes that the Council will be created and that money will be available to augment existing programs. (The Report does not consider using any existing White House office with science education responsibilities for this purpose.) The Report recommends that the Council create the program, but that it be funded through NOAA, which would then distribute funds to other agencies. Other agencies might object to receiving funding through NOAA.

Questions for Witnesses:

Admiral James D. Watkins, USN (Ret.), Chairman, U.S. Commission on Ocean Policy

1. Please outline the key findings and recommendations in the Preliminary Report of the U.S. Commission on Ocean Policy.

Dr. Andrew Solow, Director Marine Policy Center, Woods Hole Oceanographic Institution

1. What are the major deficiencies in the way ocean and coastal policy is currently organized at the federal level?
2. Do you agree with the U.S. Commission on Ocean Policy recommendation to create a National Ocean Council to address theses deficiencies? If not, why not?
3. Are there alternative changes to the federal structure with respect to ocean policy that you would recommend?

Dr. Shirley A. Pomponi, Acting Managing Director, Harbor Branch Oceanographic Institution

1. What are the major problems and issues with respect to national efforts in ocean and coastal research? Did the U.S. Commission on Ocean Policy Preliminary Report adequately address the problems and issues?
2. Please provide examples of how ecosystem-based management, as recommended by the U.S. Commission on Ocean Policy, would change ocean and coastal management from current methods. What research is needed to make ecosystem-based management feasible?

3 If there is limited new money available from the Federal and State governments, what are the top three recommendations regarding ocean and coastal science and research you believe should be implemented without delay?

Dr. Leonard J. Pietrafesa, Director of External Affairs, College of Physical and Mathematical Sciences, North Carolina State University

1. What are the current strengths and weaknesses of ocean and coastal programs at the National Oceanic and Atmospheric Administration?
2. Do you agree with the U.S. Commission on Ocean Policy recommendations with respect to NOAA? If not, why not?
3. Are there limitations to NOAA's ability to carry out the new responsibilities the U.S. Commission on Ocean Policy recommends? If so, please explain those limitations.
4. Would it be helpful for NOAA to have an organic act? Why? What would be most important to include in such legislation?
5. If there is limited new money available from the Federal Government, what are the top three recommendations regarding NOAA you believe should be implemented without delay?

Dr. Michael H. Freilich, Associate Dean, College of Oceanic and Atmospheric Sciences, Oregon State University

1. Do you agree with the U.S. Commission on Ocean Policy's recommendation to transfer some of NASA's Earth observing programs to NOAA? Why or why not?
2. Are there other ways to strengthen the interaction between NASA's and NOAA's Earth observing programs?
3. Is NOAA currently doing a good job providing researchers data from Earth observing systems? Are data management needs being adequately considered in the planning for new observing systems?
4. If there is limited new money available from the Federal and State governments, what are the top three recommendations regarding observing systems you believe should be implemented without delay?

Appendix A – U.S. Commission on Ocean Policy Members. More detailed biographical information is available at www.oceancommission.gov.

Chairman

Admiral James D. Watkins, USN (Ret.)
Chairman and President Emeritus
Consortium for Oceanographic Research and Education
Washington, D.C.

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Thomas Kitsos, Ph.D.
Executive Director

EXECUTIVE SUMMARY

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

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

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

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

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

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

The message was clear: major changes are urgently needed. Ocean management responsibilities are dispersed among a confusing array of agencies at the federal, state, and local levels. While new scientific understanding has taught us that natural systems are complex and interconnected, our decision-making and management systems have not been updated to address that complexity and interconnectedness. Better approaches and

tools are also needed to gather data to understand the complex marine environment. Perhaps most important, people must understand the role the oceans have on their lives and livelihoods and the impacts they themselves have on the oceans.

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

A VISION FOR THE FUTURE

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

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

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

Create a New National Ocean Policy Framework

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

A New National Ocean Policy Framework to Improve Decision-Making

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

National Ocean Council and Related Elements

A central component of the proposed National Ocean Policy Framework is the establishment, within the Executive Office of the President, of a National Ocean Council, chaired by an Assistant to the President and composed of all the cabinet secretaries and independent agency directors with ocean-related responsibilities. A Presidential Council of Advisors on Ocean Policy, consisting of nonfederal representatives from state, territorial, tribal, and local governments and nongovernmental, academic,

and private sector entities with ocean interests, would also be created to ensure a formal structure for nonfederal input on ocean and coastal policy matters. A small Office of Ocean Policy would provide staff support. The Commission recommends that this structure be established immediately by Congress. Pending congressional action, the President should put this structure in place through an Executive Order.

Strengthened Federal Agency Structure

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

Enhanced Opportunities for Regional Coordination

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

Strong Science for Wise Decisions

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

Strengthen Science

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

Strengthen Science and Meet Information Needs

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

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

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

Meet Information Needs

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

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

Education – A Foundation for the Future

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

Enhance Ocean Education

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

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

TAKING ACTION FOR CHANGE

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

IMPLEMENTING A NEW NATIONAL OCEAN POLICY

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

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

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

CRITICAL ACTIONS RECOMMENDED BY THE U.S. COMMISSION ON OCEAN POLICY

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

Chairman BOEHLERT. The hearing will come to order.

I want to welcome everyone here today, but I want to give a special welcome to Admiral Watkins and his team. Our nation has turned repeatedly to Admiral Watkins for creativity and leadership on a wide range of issues, and once again, he has risen to the occasion with energy, open-mindedness, thoughtfulness, and the most comprehensive approach possible. Admiral, we are in your debt.

Admiral WATKINS. Thank you, Mr. Chairman.

Chairman BOEHLERT. The Ocean Commission had before it a Herculean task, or perhaps our reference should be to Poseidon. The oceans not only cover most of the Earth's surface, they serve us as playground and food source, and sadly, sometimes as dumping ground. They help determine our climate and our security. We are land dwelling creatures, but we are utterly dependent on the oceans, and more and more of our nation's citizens live near a coastline.

Yet while the oceans lap daily at our shores, they only intermittently lap at our consciousness. We still take the oceans for granted, even as they are increasingly troubled by over-development, over-fishing, climate change, and other human insults. Worse still, perhaps, we don't even know all that much about the oceans, certainly not as much as we would like to properly identify, diagnose, and remedy problems.

The Ocean Commission report should bring focused attention to this predicament for the first time in decades. I don't think anyone can disagree with the basic thrust of this report that more needs to be done to understand, manage, and take advantage of the world's oceans, and doing so will take new thinking and new money.

I have to say that message is especially timely as the Congress, and this committee in particular, review proposals to embark on a new space exploration mission. I support that effort, but as I have said before, I think it is more important to know more about our own planet than it is to know about Mars. Happily, I don't think we have to make an either/or choice, but we do have to set priorities, and I think that it is more important to study the water that is still visible and that we rely on.

Setting and implementing those priorities is going to take some work, and there is only so much the Commission can do in that regard. I am reminded of a famous exchange in Shakespeare's "Henry IV" in which Glendower brags, "I can call spirits from the vasty deep." Hotspur replies, "So can any man. But do they come when you do call them?" The Commission can call for changes, but it can't bring them into being. That task belongs, in the first instance, to the Congress.

That is why we are having today's hearing and why we wanted to hear from a variety of experts. We have plenty of issues to raise with our panel, because while the Commission's general thrust is unarguable, the specific recommendations raise a lot of questions.

Let me just list a few of them that I hope we can discuss today.

The first, and most obvious, concerns money. Can the Nation afford the increases in ocean R&D being suggested, given other demands, even within science? Regardless of how much money is available, how should we set priorities for spending? That is a key

question and one in which the report offers little guidance. And does it make sense to set up a "trust fund" from oil royalties, giving the relatively unhappy experience with the Land and Water Conservation Fund and the unlikelihood of any new mandatory spending?

We also have questions related to government organization. Do we need a new structure for oceans in the White House? How would such an entity interact with organizations, like the Office of Science and Technology Policy and the Council on Environmental Quality, which must deal with oceans as part of their own cross-cutting responsibilities?

Another set of questions. Should responsibilities that now reside with other agencies be transferred into NOAA? I have to say that I am always skeptical of such moves, which need to have a big payoff to make up for the disruption that they cause.

And finally, I am fully behind the Commission's suggestion that Congress write an organic act for NOAA, and, indeed, the staff has been working on such a bill for months with Chairman Ehlers. I would like some guidance today on precisely what such a bill should and should not contain. I would hope that we could have hearings on an organic act in early summer.

So we have our work cut out for us, and that is nothing new, thanks to the hard work the Commission has already put in. I look forward to having a conversation with all of our witnesses today, so that we can get some specific guidance on how to turn the Commission's exhortations into responsible public policy.

[The prepared statement of Mr. Boehlert follows:]

PREPARED STATEMENT OF CHAIRMAN SHERWOOD L. BOEHLERT

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the vastly deep." Hotspur replies, "So can any man. But do they come when you do call them?" The Commission can call for changes, but it can't bring them into being. That task belongs, in the first instance, to the Congress.

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Another set of questions. Should responsibilities that now reside with other agencies be transferred into NOAA (the National Oceanic and Atmospheric Administration)? I have to say that I am always skeptical of such moves, which need to have a big payoff to make up for the disruption they cause.

And, finally, I am fully behind the Commission suggestion that Congress write an organic act for NOAA, and, indeed, the staff has been working on such a bill for months with Chairman Ehlers. I'd like some guidance today on precisely what such a bill should and should not contain. I would hope that we could have hearings on an Organic Act in June or July.

So we have our work cut out for us, thanks to the hard work the Commission has already put in. I look forward to having a conversation with all our witnesses today so that we can get some specific guidance on how to turn the Commission's exhortations into policy.

Chairman BOEHLERT. Ms. Woolsey.

Ms. WOOLSEY. Thank you, Mr. Chairman.

I want to thank the witnesses for coming here today to share your expertise with us. Thank you very much. And as usual, Mr. Chairman, I expect this will be one of your open, honest, good science hearings, the kind that we just so covet around here, so thank you for having it.

As you know, I represent the 6th Congressional District of California, just north of the Golden Gate Bridge, Marin and Sonoma Counties, and my District encompasses the entire coastline of Marin and Sonoma Counties, most of the north shore of the San Francisco Bay. Historically, fishing has always been an important part of our economy, but in recent decades, it has dwindled to near disappearance.

San Francisco Bay once supported a heron rookery and was famed for its wild oysters, and both are completely gone. No longer is the bay-front city of Sausalito home to a fishing fleet and the commercial fishing fleet of Bodega Bay is just actually a remnant of past days. Once, the Russian River, which empties into the Pacific Ocean, supported a world-class Steelhead run and a large population of Coho and Chinook salmon. Now all three species are listed as endangered.

These tragic depletions and disappearance of our fisheries are symptomatic of many things: over-fishing, inland habitat destruction, climatic changes, coastal development, all of which are addressed by the Ocean Commission's report, and all of which we must deal with seriously.

On a more positive note, however, I would like to mention that there are many efforts going on in my District to both understand the marine issues to protect our fisheries and to restore them. The Bodega Marine Lab is at the forefront of many areas of marine research, including the effects of currents on sea life. The San Francisco Estuarine Reserve is developing best practices for restoration of our baylands. The Marine Mammal Center is researching diseases and places that affect marine mammals. The Fairlong's National Marine Sanctuary and the Cordell Bank National Marine Sanctuary are setting aquatic populations on the continental shelf. And the Russian River Watershed Council and the Gualala River Watershed Council are preparing science-based watershed management plans. All of these efforts are so important, and all of them need and deserve federal support, not just in my area, but as a model for the Nation.

Finally, it is important that we do no more harm to our marine resources, including our sparkling beaches. The Oil Exploration Moratorium off our California coast needs to be extended forever. The oceans report should be the wake-up call that we need to do things differently. Instead of drilling every last drop from the most fragile places on this planet, we need to make energy conservation a national priority. And we could do that by raising CAFE standards first and then husbanding our amazing technological knowledge to begin the necessary transition to clean, renewable energy.

Our waters can be blue and productive, Mr. Chairman, our technology green and job creating. I look forward to hearing from all of you as today's witnesses, because you will be able to tell us the best ways to ensure that we leave our oceans in good shape for generations to come.

Thank you very much.

Chairman BOEHLERT. Thank you very much, Ms. Woolsey.

Without objection, all Members shall have the opportunity to insert any opening statements they wish to have in the record at this juncture.

[The prepared statement of Mr. Smith follows:]

PREPARED STATEMENT OF REPRESENTATIVE NICK SMITH

I would like to thank Chairman Boehlert and Ranking Member Gordon for holding this important hearing to examine the key findings and recommendations of the Preliminary Report of the U.S. Commission on Ocean Policy. I would also like to thank the distinguished witnesses for joining us here today.

While I myself do not represent a district that borders an ocean, the Great Lakes are a very important symbol and resource for my home State of Michigan. Also, as the Chairman of the Research Subcommittee, my Subcommittee maintains oversight over the National Science Foundation (NSF) which, significantly funds the Directorate of Geosciences for its subdivision, the Division of Ocean Sciences (OCE). The OCE supports basic research and education to further understanding of all aspects of the global oceans and their interactions with the Earth and the atmosphere. OCE also supports the operation, acquisition, construction, and conversion of major shared-use oceanographic facilities needed to carry out oceanographic-related research programs.

Coincidentally, we're having a hearing in the International Relations committee on water shortages throughout the world. Lack of clean water is perhaps the world's largest humanitarian problem. Three billion people a year suffer from a lack of clean water and over 6,000 of them die every day.

Conditions in much of the world are expected to worsen in the years to come. The Central Intelligence Agency (CIA) reports that nearly half of the world's population will live in water-stressed countries by 2015. This has led the United Nations Gen-

eral Assembly and the World Summit on Sustainable Development to call for increasing international cooperation to address these problems.

A widely used rule of thumb is that a population is considered to be in a state of "water stress" if the average annual per capita availability of water is below 1,000 cubic meters. Israel, which has the most advanced water infrastructure and water management capabilities in the region, has an average annual availability of only some 250–300 cubic meters per capita. Jordan, at some 170–200 cubic meters per capita, and the Palestinians in West Bank and Gaza, at some 70–90 cubic meters per capita, are under even greater water stress. By comparison, average annual water availability in the United States is on the order of 7,000 cubic meters per capita.

The hope is that desperation for scarce water will lead to greater cooperation and agreement among Israel, Jordan, and the Palestinians, as well as in other countries facing water problems. Michigan is blessed with having one-sixth of the entire world's supply of fresh water. But we see water supply problems and even rationing in the western United States, especially for food production. We need to determine and implement ways to increase the supply of water and to improve the distribution, utilization, and management of current and future water supplies.

While it is agreed upon that our oceans and our coasts are in serious trouble, there remains an ability to reverse the distress on our oceans that have taken place for so long. On the other hand, I must express my concern with a more troubling problem—that is the $500 billion debt we are facing and the unfortunate fact that we are now adding more new debt to our books every year. We need to re-impose discretionary spending caps which expired after 2002. We must cut out waste and abuse. And we need to make hard decisions to prioritize programs, reduce spending on some and eliminate others. So I think the question must be: what produces the best and most cost effective scientific research?

Again, I would like to thank the Chairman and Ranking Member for holding this hearing that allowed Congress to examine and question the Preliminary Report of the U.S. Commission on Ocean Policy.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

I am pleased that we are here today to discuss the U.S. Commission on Ocean Policy's Preliminary Report. As Chairman of the Environment, Technology and Standards Subcommittee of the Science Committee, I oversee much of the National Oceanic and Atmospheric Administration (known as NOAA). I, along with many others, have been anxiously awaiting release of the Commission's recommendations so Congress can help update and improve our nation's ocean policy.

I must commend Admiral Watkins and the other commissioners for all their hard work, effort, and tenacity. Their charge was vast and difficult, and they performed it admirably. They have given Congress and the Administration the foundation by which we may improve the health and management of our coasts, oceans and the Great Lakes.

For example, the Commission recommends that Congress pass an organic act for NOAA. I strongly agree. I believe it is critical for NOAA's mission to be clearly defined and its internal structure strengthened so it can better fulfill its role in observing, managing, and protecting our nation's coastal and ocean resources. My subcommittee staff and I spent many hours working on this bill last year, and I look forward to working with my colleagues in a bipartisan fashion to pass this bill into law this year. This will not be an easy task, but it is so important to our environment, our economy, and our children's and grandchildren's future, that we *must* succeed.

I thank the Commission for advocating increased funding for ocean research and focusing on science as the foundation for ocean management decisions. However, I am concerned that the Commission did not clearly specify which scientific issues and programs should be our highest priorities. I hope we can discuss this recommendation in more detail at today's hearing, because in the current budget climate I think it will be extremely difficult to find the $4 billion in new money for the oceans recommended by the Commission. I hope we can engage in a healthy discussion about which research areas require the most immediate attention.

I am enthusiastic and optimistic that we can all work together to develop a strong national ocean policy that protects this resource and our environment for generations to come. I look forward to hearing from our witnesses this morning and engaging in a thoughtful discussion about the recommendations from the U.S. Commission on Ocean Policy.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good morning. I want to thank the witnesses for appearing before our committee to discuss the key findings and recommendations of the Preliminary Report of the U.S. Commission on Ocean Policy. Under the *Oceans Act of 2000,* Congress initiated a major review of ocean policies in this nation and took action to improve our understanding of ocean systems and the ocean environment as a whole. As the ranking member of the Water Resources and Environment Subcommittee, I realize the importance of protecting our ocean, waterways, and coasts and the tremendous benefits they offer all Americans. Our oceans provide us with jobs, food, recreational as well as educational opportunities, medicine, and transportation.

We need to ensure that we have a coordinated policy to deal with the pressures our oceans and coastal areas face. Our last effort to update our national policies on oceans was in 1969 under the Commission on Marine Science, Engineering, and Resources—known as the Stratton Commission. While many of the Commission's recommendations have been implemented, it has been far too long since we last updated our ocean policies.

State and local jurisdictions have enacted numerous laws and policies to deal with the environmental problems that have occurred in our ocean and coastal communities. This has resulted in overlapping and conflicting rules between the federal and State levels. The recommendations put forth by this Commission will help to alleviate many of these problems by bringing ocean policy into the 21st Century by creating new coordinated and comprehensive policies.

The report strongly encourages ecosystem-based management, rather than species-by-species or problem-by-problem management. I am interested to know if our students in the ocean sciences are being trained in ecosystem management. Further, federal research devoted to oceans has dropped from seven percent to 3.5 percent as noted in the report. However, many of the national security issues that drove oceanographic research have disappeared with the ending of the Cold War. I am interested to learn more about the Commission's reasoning for doubling ocean research now in such tight budgetary times.

I welcome our panel of witnesses and look forward to their testimony.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman. I would like to commend Chairman Boehlert for calling this very important hearing on the U.S. Commission on Ocean Policy Preliminary Report.

On June 15, 2001, President George W. Bush announced his intent to appoint the 16 members of the new Commission on Ocean Policy, based on a process that included nominations by the Congress and appointment by the President.

Oceans play a very significant part in all our planet's survival. Many are unaware that the oceans control the weather. Few would believe that significantly more oxygen is generated to Earth's precious atmosphere by oceanic photosynthesis than by all the Earth's terrestrial plants

combined. Yet, today, the oceans are in serious danger from improper development, overuse, and pollution. Most of the world's 17 major ocean fisheries are in serious decline. Fragile coastal habitats are disappearing at an alarming rate, and coral ecosystems are experiencing unprecedented deterioration. These facts are a sad testimonial to the very low importance the oceans have among the people of the world.

Our challenge today is to achieve an increased public perception and awareness of the tremendous importance and value that the oceans and aquatic resources represent for all people.

I look forward to the testimony of our distinguished witnesses today and I yield back my time.

Chairman BOEHLERT. And now our panel, a panel of very distinguished Americans. And let me, first of all, thank you all for serving as resources to this committee. This is a dialogue with some interesting people, and we are going to learn from what we hear.

Our first witness is Admiral James D. Watkins, the Chairman of the U.S. Commission on Ocean Policy. Admiral Watkins is also

President Emeritus of the Consortium for Oceanographic Research and Education. He was formerly Chief of Naval Operations for the United States Navy, and was Secretary of Energy under President George Herbert Walker Bush. Admiral Watkins. Dr. Andrew Solow is the Director of the Marine Policy Center at Woods Hole Oceanographic Institution. That is absolutely beautiful up there. What a deal you have. Dr. Solow is a member of the U.S. Commission on Ocean Policy Science Advisory Panel Governance Working Group. Dr. Shirley A. Pomponi is the Acting Managing Director of the Harbor Branch Oceanographic Institution. Dr. Pomponi was a member of the U.S. Commission on Ocean Policy Science Advisory Panel Research, Education, and Marine Operations Working Group.

For the purpose of an introduction, the Chair now recognizes our distinguished colleague, Mr. Miller.

Mr. MILLER. Thank you, Mr. Chairman. I am very pleased to introduce Dr. Leonard Pietrafesa. Dr. Pietrafesa is a distinguished American, but even more importantly, is a distinguished citizen of North Carolina, of Wade County, of the North Hills neighborhood, of Raleigh Creek 617, which votes at the fire station on Six Forks Road. I have represented Dr. Pietrafesa in Congress since January of last year. Before that, I represented him in the State Senate, and before that, in the State House. I am not sure exactly which house on Pitt Street Dr. Pietrafesa lives in, but I am sure I was in his front yard while banging one of my campaign signs into the ground.

Mr. Chairman, I think all of that alone is sufficient for this committee to treat Dr. Pietrafesa's views, opinions with great defers and respect on ocean policy, or on any other topic.

Chairman BOEHLERT. Well, thank you very much.

Mr. MILLER. But there is actually more.

Chairman BOEHLERT. Well, the sign gets bigger every time, doesn't it?

Mr. MILLER. But Dr. Pietrafesa is, in fact, a very distinguished expert on this topic as well. He is a—he has a Bachelor's degree from Fairfield University in physics and math, a Masters from Chicago in fluid physics, a Ph.D. from the University of Washington in fluid physics. He is now the Director of the Office of External Affairs in the College of Physical and Mathematical Sciences and a professor at North Carolina State University. He has been the author and co-author of 155 peer-reviewed publications on the topics of oceanography and meteorology and estuary and climate dynamic impacts. He also serves as Chair of the Board on Oceans and Atmosphere of the National Association of State Universities and Land Grant Colleges. He is the Chair of the Council on Ocean Affairs and is a member of the Board of Trustees of the University—Corporation for Atmospheric Research. He also serves as Chair of the National Oceanic and Atmospheric Administration Science Advisory Board. Mr. Chairman, I am very pleased to introduce Dr. Pietrafesa.

Chairman BOEHLERT. Well, thank you very much, Mr. Miller. And my colleague's pride is obvious. He wanted to introduce you, one, because he is proud of you, and secondly, I think he was afraid I might garble the name. But I just want Dr. Pietrafesa to know

that I have an aunt who was Pietrapaula, and this suit was made by a Pietrafesa operation, and I am sure you are aware of that firm.

So we are glad to welcome you here. And our final witness is Dr. Michael H. Freilich. He is the Associate Dean of the College of Oceanic and Atmospheric Sciences at Oregon State University. Dr. Freilich is a member of the National Research Council's Space Studies Board and Chair of the Board's Committee on Earth Studies.

Now if I went on and gave a longer introduction, you would probably let me put a sign in your lawn, too. Thank you so very much.

Thank you all. And here is how we are going to proceed. We are going to give the Chairman, Admiral Watkins, 10 minutes for an opening statement and the others, we are going to give you five minutes. And the reason we are going to try to limit the opening statements is because we really want to have a good exchange. We are here to learn from you and hopefully we will learn.

So let us start with Admiral Watkins.

STATEMENT OF ADMIRAL JAMES D. WATKINS, USN, (RET.); CHAIRMAN, U.S. COMMISSION ON OCEAN POLICY

Admiral WATKINS. Mr. Chairman, Members of the Committee, the U.S. Commission on Ocean Policy's Preliminary Report offers a practical blueprint for ocean policy in the 21st century by laying the groundwork for a coordinated, comprehensive national strategy with a logical sequence of steps that can start immediately. The report includes almost 200 action-oriented recommendations that present workable solutions for some of the most pressing problems facing our oceans and coasts. Implementation of these recommendations will result in bountiful, sustainable oceans that benefit and inspire Americans for decades to come.

Because of the time limitation today, my remarks will focus primarily on our recommendation in the areas of science, technology, and education. My written testimony submitted for the record covers our report in greater depth.

What is the vision here? There are few key messages highlighted throughout our report. Our oceans and coasts are national assets that are in trouble. To reverse these negative trends, we must act now. And finally, our existing fragmented system for managing oceans and coasts combined with the historic under-investment in these areas leaves us unprepared to meet the challenge. Our vision for the future of ocean and coastal management acknowledges the complexities of ecosystems and human needs, and to move toward an ecosystem-based management is the hallmark of our report, and it requires fundamental changes in governance and greatly improved science and education.

Let me focus on governance. After 2½ years of study and deliberation, the Commission concluded that a national ocean policy framework will be necessary to reap the benefits of a comprehensive and coordinated ocean policy. The framework should include a number of components, all of which are explained in the report. Three elements of particular interest to this committee are the following.

First, the National Ocean Council should be established in the Executive Office of the President to coordinate federal ocean activi-

ties and set national policy. The Council would include the leaders of all ocean-related agencies and should be chaired by an assistant to the President who can serve as a strong voice for ocean policy within the White House.

Second, a Presidential Council of Advisors on Ocean Policy is also needed to provide input and advice from non-federal perspectives. This was probably the most highlighted of all of the issues we heard in the 15 site visits and hearings across the country: "Please bring us to the table in the planning process up front. We are key players in the game, and we are not being heard today." That is a very important non-federal aspect to our framework.

Third, the federal agency structure must be strengthened and streamlined to increase its effectiveness and minimize redundancies. Our report suggests the logical sequence of steps to achieve this. The first step is the passage of the organic act to strengthen NOAA followed by additional action that will ultimately move the Nation toward a structure that merges the management of land, air, water, and all natural resources. It touches on some of the issues raised by the Chairman in his opening statement.

Let me talk about science-based decision-making. One major theme in our report is the need for enhanced science and technology. Improved understanding of our oceans and coasts will allow us to manage marine environments and resources wisely, conserving precious species and habitats while exploring new uses and protecting national security.

You are probably aware that the federal budget for ocean research has suffered in recent decades, despite growing needs. As a proportion of all federal research spending, ocean science funding has dropped from seven percent in the 1990's to less than 3½ percent today. As a result, the Federal Government is reluctantly turning away about one half of the highly rated grant proposals they receive. For the U.S. to remain an international leader in ocean research and for managers to obtain the information they need, the federal ocean research budget should be restored to historic levels by doubling it to $1.3 billion over the next five years.

Ultimately, any increased funding should be allocated based on a research strategy developed by the National Ocean Council in conjunction with Congress and the ocean science community. But several specific programs discussed in our report could be funded immediately, including an enlarged National Sea Grant College Program, two, an expanded Oceans and Human Health Initiative, led jointly by NOAA, NSF, NIEHS with additional funding of $14 million over the current appropriations, and a social science and economics program in NOAA at a cost of approximately $10 million a year.

Other research needs are discussed throughout our report in connection with specific issue areas, for example: understanding the links between upstream activities and coastal water quality; identifying and eradicating invasive species; elucidating the role of oceans and climate; conducting cooperative fisheries research; clarifying the breeding grounds, migration patterns, and feeding locations to protect a species; and finally, understanding the role of biological diversity and overall ecosystem health.

As a complement to traditional research activities, we must also venture forth to explore the ocean depths for new ocean species and habitats. NSF and NOAA should undertake a joint program in ocean exploration that draws on their respective strengths in basic and applied science. Funding for ocean exploration should grow to a level of $110 million per year over the next five years.

Integrated Ocean Observing System, let me focus on that for a minute. To achieve adequate observational and forecasting capabilities for the oceans and coasts, the Commission strongly recommends implementation of the National Integrated Ocean Observing System, with NOAA as the lead operational agency. The IOOS, as we call it, should combine a network of regional coastal observations with an array of open ocean observations. As IOOS matures, NOAA, EPA, NASA, Department of Interior, and others must ensure its integration with national water quality monitoring networks and other national and global environmental observing systems, leading, eventually, to a unified Earth observing system.

One particularly important recommendation calls for a smooth transition of Earth-observing satellites from their design and launch at NASA to continued operations at NOAA. This is one of the controversial issues I think that the Chairman may have eluded to, and I know that Congressman Vernon Ehlers has brought that up in hearings in the Senate before the Commerce Committee there. Implementing the IOOS will require extensive interagency and stakeholder cooperation, as well as a long-term financial commitment by both the Administration and the Congress. The estimated five-year start-up costs for implementation of the National IOOS is close to $2 billion, with ongoing costs of approximately $750 million per year thereafter.

Infrastructure and data management. The conduct of ocean and coastal research depends on the availability of modern ships, aircraft, laboratories, undersea vehicles, satellites and future scientific advances will require continual technological improvements to these tools. Long-term priorities for the purchase, maintenance, operations, and upgrading of ocean research facilities should be based on a coherent interagency ocean science infrastructure plan. However, several urgent infrastructure needs can be addressed immediately, and these include recapitalization of the UNOL fleet, that is the University National Ocean Laboratories fleet, requiring $445 million to build 10 ships over the next 20 years. Second, construction of two specialized fishery research vessels planned by NOAA at $52 million each. And third, for vision of appropriate support for ocean exploration, including a dedicated ship and submersible, at a cost of approximately $70.

Enhanced ocean research exploration and observing efforts will produce massive amounts of new data. To ensure that these data result in useful information that benefits scientists, resource managers, educators, businesses, the general public, our report recommends improvements in our method of processing large information streams, coordinating federal data management, and creating environmental models and information products from those data. Input from national, regional, and local users should guide this process.

To coordinate federal activities in ocean research, education, and operations, we recommend expansion of the existing National Ocean Research Leadership Council, which was created by the Congress in their National Oceanographic Partnership Program in 1997. This new body should be placed under the oversight of the National Ocean Council and renamed the Committee on Ocean Science, Education, Technology, and Operations.

Let us talk about education now. Another major theme in our report is the promotion of lifelong education. In the long run, sensible stewardship of our oceans and coasts will require strong public support. Our report includes detailed discussions about the value of boosting ocean knowledge with recommendations that focus on two important avenues. First, we outline methods for improving formal education in schools by integrating ocean themes into the curriculum to promote achievements in math and science, including the social sciences. In addition, we recommend federal partnerships with aquariums, science centers, museums, and private laboratories to promote broader public awareness of ocean issues, and instill a national sense of stewardship for the oceans.

These goals could be accomplished by strengthening the existing education component of the National Sea Grant College Program and expanding upon the NSF-sponsored Centers for Ocean Sciences Education Excellence, known as the COSEE centers. COSEE is recognized as a model for enhancing education and bringing accessible ocean-related information to the public. To build on its success, other agencies should become involved, and the number of COSEE regional centers should be tripled from seven to 21, with each center receiving at least $1.5 million a year for an initial five-year period.

How do we implement all of this? Implementation of the recommendations I have discussed today, along with the many others found in our report, will result in measurable improvements for our oceans and coasts. But meaningful change requires meaningful investments. The new cost of initiatives outlined in our report, including direct support to states for the critical role they play, is estimated to range from $1.2 billion in the first year to approximately $3.2 billion a year after full implementation. We believe this is a modest investment when you consider the economic, aesthetic, and ecosystem values of our oceans and coasts.

To cover these costs, the Commission recommends that an Ocean Policy Trust Fund be established in the Treasury, which would receive revenues generated from offshore oil and gas and future activities in federal waters now yet not foreseen by all of us. These funds would supplement, not replace, existing appropriations, and would support the new or expanded responsibilities recommended in our report. Establishment of such a fund would signal the Nation's recognition of our commitment to help ensure a healthy future for our oceans, a priceless national resource.

Call to action, in closing. As a special call to action for the U.S. House of Representatives, we believe it is critical for the following actions to occur as soon as possible. Authorize establishment of a National Ocean Council and a Presidential Council of Advisors on Ocean Policy in the Executive Office of the President. Two, enact an organic act for NOAA. Three, establish an Ocean Policy Trust

Fund in the United States Treasury. And for this committee, in particular, Mr. Chairman, we urge, first, authorization of a doubling of ocean research funding, two, support for a new era of ocean exploration, three, implementation of the Integrated Ocean Observing System, and finally, provision of the infrastructure needed to realize these goals.

I thank you for holding this hearing and for the continuing support of the Members of this committee. It is through your continued leadership that the Nation will be in a position to realize the full potential of the oceans. We look forward to working with you and your colleagues in the Senate on implementing our report.

Thank you, Mr. Chairman.

[The prepared statement of Admiral Watkins follows:]

PREPARED STATEMENT OF ADMIRAL JAMES D. WATKINS

INTRODUCTION

Mr. Chairman and Members of the Committee, I am pleased to appear before you to discuss the Preliminary Report of the U.S. Commission on Ocean Policy, which was released to the public on Tuesday, April 20. We believe this report offers a blueprint for a coordinated, comprehensive national ocean policy for the 21st century. It includes nearly 200 action-oriented recommendations that present workable solutions for a broad range of ocean- and coastal-related issues.

As you know, the last comprehensive review of U.S. ocean policy took place more than 35 years ago when the Commission on Marine Science, Engineering and Resources—known as the Stratton Commission—issued its report, *Our Nation and the Sea.* Since then, considerable progress has been made, but many challenges remain and new issues have emerged. The value of the oceans to our nation has only grown in 35 years, and the time to act is now.

The simple fact is that the oceans affect and sustain all life on Earth. They drive and moderate weather and climate, provide us with food, oxygen, transportation corridors, recreational opportunities, energy resources and other natural products, and serve as a national security buffer. In our travels around the country, we heard and saw first-hand how communities care about the ocean and coasts, and how they worry about their future.

THE VALUE OF THE OCEANS AND COASTS

America's oceans and coasts provide ecological and aesthetic benefits with tremendous value to our national economy. In 2000, the ocean economy contributed more than $117 billion to American prosperity and supported well over two million jobs. More than $1 trillion, or one-tenth of the Nation's annual GDP, is generated within the relatively narrow strip of land immediately adjacent to the coast. Considering the economies of all coastal watershed counties, that contribution swells to over $4.5 trillion, fully half of the Nation's GDP. The contribution to employment is equally impressive, with 16 million jobs in the near-shore zone and 60 million in coastal watershed counties.

The country also remains highly dependent on marine transportation. More than thirteen million jobs are connected to the trade transported through the Nation's network of ports and inland waterways. Annually, the Nation's ports handle more than $700 billion in goods. The cruise industry and its passengers account for another $11 billion in spending.

Offshore oil and gas operations have expanded into deeper waters with new and improved technologies. The offshore oil and gas industry's annual production is valued at $25–$40 billion, and its yearly bonus bid and royalty payments contribute approximately $5 billion to the U.S. Treasury.

The commercial fishing industry's total annual value exceeds $28 billion, with the recreational saltwater fishing industry valued at around $20 billion, and the annual U.S. retail trade in ornamental fish worth another $3 billion. Nationwide, retail expenditures on recreational boating exceeded $30 billion in 2002.

In the last three decades, more than 37 million people and 19 million homes have been added to coastal areas. Every year, hundreds of millions of Americans and international visitors flock to the coasts to enjoy the oceans, spending billions of dollars and directly supporting more than a million and a half jobs. In fact, tourism and recreation is one of the fastest-growing business sectors—enriching economies and supporting jobs in communities virtually everywhere along the coasts of the

continental United States, southeast Alaska, Hawaii, and our island territories and commonwealths.

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

TROUBLE IN PARADISE

Development comes with costs, and we are only now discovering the full extent of those costs. Pollution, depletion of fish and other living marine resources, habitat destruction and degradation, and the introduction of invasive non-native species are just some of the ways people harm the oceans, with serious consequences for the entire planet.

In 2001, 23 percent of the Nation's estuarine areas were not suitable for swimming, fishing, or supporting marine species. In 2002, about 12,000 beach closings and swimming advisories were issued across the Nation, most due to the presence of bacteria associated with fecal contamination. Marine toxins afflict more than 90,000 people annually across the globe and are responsible for an estimated 62 percent of all seafood-related illnesses. Such events are on the rise, costing millions of dollars a year in decreased tourism revenues and increased health care costs.

Experts estimate that 25 to 30 percent of the world's major fish stocks are overexploited, and many U.S. fisheries are experiencing similar difficulties. Since the Pilgrims first arrived at Plymouth Rock, over half of our fresh and saltwater wetlands—more than 110 million acres—have been lost.

Our failure to properly manage the human activities that affect oceans and coasts is compromising their ecological integrity and diminishing our ability to fully realize their potential. Congress recognized this situation when it passed the *Oceans Act of 2000* calling for a Commission on Ocean Policy to establish findings and develop recommendations for a coordinated and comprehensive national ocean policy. Pursuant to that Act, the President appointed 16 Commission members, including individuals nominated by the leadership in the United States Senate and the House of Representatives. These individuals were drawn from diverse backgrounds with knowledge in ocean and coastal activities.

Because of the vast scope of topics the Commission was required to address, it sought input from individuals across the country. The Commission members traveled around the United States obtaining valuable information from diverse marine-related interests. They heard testimony on ocean and coastal issues during nine regional meetings and experienced regional concerns first-hand during seventeen site visits. The regional meetings also highlighted relevant success stories and regional models with potential national applicability.

Four additional public meetings were held in Washington, D.C., after completion of the regional meetings, to publicly present and discuss many of the policy options under consideration for the Commission's recommendations. In all, the Commission heard from some 445 witnesses, including over 275 invited presentations and an additional 170 comments from the public, resulting in nearly 1,900 pages of testimony (included as Appendices to the report).

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

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

VISION AND STRATEGY FOR THE 21ST CENTURY

Any strategy for change must begin with a clear picture of the desired endpoint. In the desirable future we wish to create, the oceans and coasts would be clean, safe, and sustainably managed. They would contribute significantly to the economy, supporting multiple beneficial uses such as food production, development of energy and mineral resources, recreation, transportation of goods and people, and the dis-

covery of novel medicines and other products, while preserving a high level of biodiversity and a full range of natural habitats. The coasts would be attractive places to live, work and play, with clean water and beaches, easy public access, sustainable economies, safe bustling harbors and ports, adequate roads and services, and special protection for sensitive habitats. Beach closings, toxic algal blooms, proliferation of invasive species, and vanishing native species would be rare. Better land use planning and improved predictions of severe weather and other natural hazards would save lives and money.

The management of our oceans and coasts would also look different: it would follow ecosystem boundaries, considering interactions among all elements of the system, rather than addressing isolated areas or problems. In the face of scientific uncertainty, managers would balance competing considerations and proceed with caution. Ocean governance would be effective, participatory, and well coordinated among government agencies, the private sector, and the public.

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

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

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

The Commission believes this vision is practical and attainable. To achieve it, national ocean policy should be guided by a set of overarching principles including the following:

Sustainability: Ocean policy should be designed to meet the needs of the present generation without compromising the ability of future generations to meet their needs.

Stewardship: The principle of stewardship applies both to the government and to every citizen. The U.S. government holds ocean and coastal resources in the public trust—a special responsibility that necessitates balancing different uses of those resources for the continued benefit of all Americans. Just as important, every member of the public should recognize the value of the oceans and coasts, supporting appropriate policies and acting responsibly while minimizing negative environmental impacts.

Ocean–Land–Atmosphere Connections: Ocean policies should be based on the recognition that the oceans, land, and atmosphere are inextricably intertwined and that actions that affect one Earth system component are likely to affect another.

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

Multiple Use Management: The many potentially beneficial uses of ocean and coastal resources should be acknowledged and managed in a way that balances competing uses while preserving and protecting the overall integrity of the ocean and coastal environments.

Preservation of Marine Biodiversity: Downward trends in marine biodiversity should be reversed where they exist, with a desired end of maintaining or recovering natural levels of biological diversity and ecosystem services.

Best Available Science and Information: Ocean policy decisions should be based on the best available understanding of the natural, social, and economic processes that affect ocean and coastal environments. Decision-makers should be able to obtain and understand quality science and information in a way that facilitates successful management of ocean and coastal resources.

Adaptive Management: Ocean management programs should be designed to meet clear goals and provide new information to continually improve the scientific basis for future management. Periodic re-evaluation of the goals and effectiveness of management measures, and incorporation of new information in implementing future management, are essential.

Understandable Laws and Clear Decisions: Laws governing uses of ocean and coastal resources should be clear, coordinated, and accessible to the Nation's citizens to facilitate compliance. Policy decisions and the reasoning behind them should also be clear and available to all interested parties.

Participatory Governance: Governance of ocean uses should ensure widespread participation by all citizens on issues that affect them.

Timeliness: Ocean governance systems should operate with as much efficiency and predictability as possible.

Accountability: Decision-makers and members of the public should be accountable for the actions they take that affect ocean and coastal resources.

International Responsibility: The United States should act cooperatively with other nations in developing and implementing international ocean policy, reflecting the deep connections between U.S. interests and the global ocean.

Ecosystem-based Management

Ecosystem-based management emerged as an overarching theme of the Commission's work. To move toward more ecosystem-based approaches, managers must consider the relationships among all ecosystem components, including human and nonhuman species and the environments in which they live. Management areas should be defined based on ecosystem, rather than political, boundaries. A balanced precautionary approach should be adopted that weighs the level of scientific uncertainty and the potential risk of damage before proceeding.

In moving toward an ecosystem-based approach, the U.S. Commission on Ocean Policy considers the following actions absolutely critical. First, a new national ocean policy framework must be established to improve federal leadership and coordination and enhance opportunities for State, territorial, tribal, and local entities to improve responses at the regional level. Second, decisions about ocean and coastal resources need to be based on the most current, credible, unbiased scientific data. And third, improved education about the oceans is needed to give the general public a sense of stewardship and prepare a new generation of leaders to address ocean issues.

IMPROVING GOVERNANCE

Many different entities at the federal, regional, State, territorial, tribal and local levels participate in the management of the Nation's oceans and coasts. At the federal level, eleven of the fifteen existing cabinet-level departments and four independent agencies play important roles in the development of ocean and coastal policy. All of these federal agencies also interact in various ways with State, territorial, tribal, and local entities.

A lack of communication and coordination among the various agency programs at the national level, and among federal, State and local stakeholders at the regional level, continues to inhibit effective action. A new National Ocean Policy Framework is needed to provide high-level attention and coordinated implementation of an integrated national ocean policy.

National Coordination and Leadership

A first step in enhancing management, and a central part of the new National Ocean Policy Framework, is improved coordination among the many federal programs. A number of attempts have been made to coordinate on particular topics, such as coral reefs or marine transportation, or within a broad category, such as ocean science and technology. Within the Executive Office of the President, three entities have specific responsibilities relevant to oceans: the Office of Science and Technology Policy that addresses government-wide science and technology issues and includes an ocean subcommittee; the Council on Environmental Quality (CEQ) that oversees broad federal environmental efforts and implementation of the National Environmental Policy Act; and the National Security Council's Policy Coordi-

nating Committee that addresses international issues and also includes a subcommittee on international ocean issues.

While all these coordinating bodies are helpful in their designated areas of interest, they do not constitute a high-level interagency mechanism able to deal with all of the interconnected ocean and coastal challenges facing the Nation, including not only science and technology, the environment, and international matters, but the many other economic, social, and technical issues that affect the ocean.

The value of the ocean to American society also cries out for greater visibility and leaderships. Only the Executive Office of the President can transcend traditional conflicts among departments and agencies, make recommendations for broad federal agency reorganization, and provide guidance on funding priorities, making it the appropriate venue for coordinating an integrated national ocean policy.

National Ocean Council

Congress should establish a National Ocean Council within the Executive Office of the President to provide high-level level attention to ocean and coastal issues, develop and guide the implementation of appropriate national policies, and coordinate the many federal departments and agencies with ocean and coastal responsibilities. The National Ocean Council, or NOC, should be composed of cabinet secretaries of departments and directors of independent agencies with relevant ocean- and coastal-related responsibilities and should carry out a variety of functions including the following:

- developing broad principles and national goals for ocean and coastal governance;
- making recommendations to the President on national ocean policy;
- coordinating and integrating activities of ocean-related federal agencies;
- identifying statutory and regulatory redundancies or omissions and developing strategies to resolve conflicts, fill gaps, and address new and emerging ocean issues;
- developing and supporting partnerships between government agencies and nongovernmental organizations, the private sector, academia, and the public.

Presidential Council of Advisors on Ocean Policy

A Presidential Council of Advisors on Ocean Policy, co-chaired by the chair of the National Ocean Council and a non-federal member, should advise the President on ocean and coastal policy matters and serve as a formal structure for input from non-federal individuals and organizations. It should be composed of a representative selection of individuals appointed by the President, including governors of coastal states, other appropriate State, territorial, tribal and local government representatives, and individuals from the private sector, research and education communities, nongovernmental organizations, watershed organizations and other non-federal bodies with ocean interests. The members should be knowledgeable about and experienced in ocean and coastal issues.

Need for Presidential Action—the Assistant to the President

Although Congress should establish the National Ocean Council and the Presidential Council of Advisors on Ocean Policy in law to ensure their long-term future, the Commission is cognizant of the complex and often lengthy nature of the legislative process. While awaiting congressional action, the President should immediately establish these entities through Executive Order, and should appoint an Assistant to the President to chair the Council. As chair of the NOC and co-chair of the Presidential Council of Advisors on Ocean Policy, the Assistant to the President should lead the coordination of federal agency actions related to oceans and coasts, make recommendations for federal agency reorganization as needed to improve ocean and coastal management, resolve interagency policy disputes, and promote regional approaches. The Assistant to the President should also advise OMB and the agencies on appropriate funding levels for important ocean- and coastal-related activities, and prepare a biennial report as mandated by section 5 of the Oceans Act of 2000.

Office of Ocean Policy

Because the National Ocean Council will be responsible for planning and coordination rather than operational duties, the support of a small staff and committees will be required to carry out its functions. An Office of Ocean Policy should support the Assistant to the President, the National Ocean Council, and the Presidential Council of Advisors on Ocean Policy. The Office of Ocean Policy should be composed of a small staff that reports to the Assistant to the President, managed by an executive director responsible for day-to-day activities. Strong links should be maintained

among the National Ocean Council, its committees and staff, other parts of the Executive Office of the President, and ocean-related advisory councils and commissions.

Committee on Ocean Science, Education, Technology, and Operations

A committee under the National Ocean Council will be needed to assume the functions of the current National Ocean Research Leadership Council (NORLC), a congressionally-established government coordination and leadership organization for oceanographic research programs on the national level. By placing the NORLC under the NOC and broadening its responsibilities to include operational programs and educational activities in addition to research, it will become more visible and more effective. In recognition of its broader mandate, the NORLC should be redesignated as the Committee on Ocean Science, Education, Technology, and Operations (COSETO). Strong connections between the Office of Science and Technology Policy and the NOC (through COSETO) will be essential. To eliminate overlapping functions, the National Science and Technology Council's Joint Subcommittee on Oceans, should be subsumed into COSETO.

Committee on Ocean Resource Management

The National Ocean Council will need a second committee, to coordinate federal resource management policy, including the many existing, single-issue coordination efforts such as the Coral Reef Task Force, the Interagency Committee on the Marine Transportation System, the National Dredging Team, Coastal America, and many others. The NOC Committee on Ocean Resource Management (CORM) would perform high-level, cross-cutting oversight of these issue-specific efforts to ensure consideration of cumulative impacts, minimize conflicting mandates, and implement an ecosystem-based management approach. Because of the Council on Environmental Quality's role in environmental issues, this office should also maintain strong connections with the National Ocean Council and its CORM.

A Regional Approach

In addition to improved coordination at the national level, an important component of the new National Ocean Policy Framework is the promotion of regional approaches that allow decision-makers to address issues across jurisdictional lines. The Nation's ocean and coastal resources are affected by human activities that span cities, counties, States, and sometimes nations. Federal, State, territorial, tribal, and local governments need the ability to respond to ocean and coastal issues in a coordinated fashion within regions defined by the boundaries of ecosystems rather than somewhat arbitrary government jurisdictions. The voluntary establishment of regional ocean councils, improved coordination of federal agency efforts at the regional level, and dissemination of regionally significant research and information would enhance regional coordination and improve responses to regional issues.

Creating Regional Ocean Councils

There are many examples where concern for the health of a particular ecosystem (such as the Chesapeake Bay, Pacific Northwest, Gulf of Mexico, or Mississippi River Basin) has motivated a wide range of participants to create new structures for addressing regional concerns. There is a growing awareness that existing regional approaches can be strengthened and similar approaches can benefit the health and productivity of all the Nation's ocean and coastal regions.

Regional ocean councils can serve as mechanisms for a wide range of participants to join forces to address issues of regional concern, realize regional opportunities, identify regional goals, and promote a sense of stewardship for a specific area among all levels of government, private interests, and the public. It will be up to the participants—including representatives from all levels of government, the private sector, nongovernmental organizations, and academia—to determine how the council will operate in each region. Possible council functions might include:

- designating ad hoc subcommittees to examine specific issues of regional concern;
- mediating and resolving disputes among different interests in the region;
- monitoring and evaluating the state of the region and the effectiveness of management efforts;
- building public awareness about regional ocean and coastal issues;
- facilitating government approvals or permitting processes that involve several Federal, State, and local government agencies within the region; and
- helping to link activities located in upstream, coastal, and offshore areas within an ecosystem-based management context.

Regional ocean councils should be created by interested parties at the State and local level, rather than mandated by the Federal Government. However, to stimulate the process, the National Ocean Council should develop flexible guidelines for the voluntary creation of regional ocean councils. Initial efforts should be encouraged in regions where readiness and support for a regional approach is already strong. The first councils can then serve as pilot projects, allowing those involved to learn what works in the region, building support to implement a regional ocean council, and paving the way for councils in other regions. Once established, regional ocean councils will most likely evolve, as participants identify the structure and functions that best suit their needs. Whether a council has decision-making authority will be up to the regional participants. National involvement may be necessary to implement more formal decision-making mechanisms such as legislation, interagency agreements, and interstate compacts.

Regional ocean councils should encompass an area from the inland extent of coastal watersheds to the offshore boundary of the Nation's EEZ. The boundaries of the Regional Fishery Management Councils (RFMCs) may be considered as a starting point, although these regions may not always be suitable. For example, more than one regional ocean council will probably be necessary within California where there is only one RFMC. A regional ocean council for the Great Lakes region is also desirable.

Improving Regional Coordination of Federal Agencies

While the process of planning, establishing, and testing regional ocean councils is underway, federal agencies should be directed to immediately improve their own regional coordination and provide stronger institutional, technical, and financial support for regional issues. Currently, the actions of federal agencies often overlap, conflict, or are inconsistent with one another at the regional and State levels. Although several federal agencies already divide their operations into regions, the boundaries of these regions differ from one agency to the next, the functions of regional offices vary widely, and it is common for the regional office of one agency to operate in isolation from the regional offices of other agencies. Improved regional coordination should be a first step, followed in time by federal reorganization around common regional boundaries.

Enhancing Regional Research and Information

Decision-makers at all levels need the best available science, information, tools, and technology on which to base ocean and coastal management decisions. However, research and data collection targeted at regional concerns is severely limited. Furthermore, the data that do exist are rarely translated into products that are useful to managers. Regional ocean information programs should be established to set priorities for research, data collection, information products, and outreach activities in support of improved regional management. Where and when they are established, regional ocean councils will be the logical bodies to administer these programs.

Improved Governance of Offshore Waters

Converging economic, technological, legal, and demographic factors make federal waters an increasingly attractive place for enterprises seeking to tap the ocean's resources. The challenge for policy-makers will be to realize the ocean's potential while minimizing conflicts among users, safeguarding human and marine health, and fulfilling the Federal Government's obligation to manage public resources for the maximum long-term benefit of the entire nation. While institutional frameworks exist for managing some ocean uses, increasingly unacceptable gaps remain.

The array of agencies involved, and their frequent lack of coordination, can create roadblocks to public participation, discourage private investment, cause harmful delays, and generate unnecessary costs. This is particularly true for new ocean uses that are subject to scattered or ill defined federal agency authorities and an uncertain decision-making process. Without an understandable, streamlined, and broadly accepted method for reviewing proposed activities, ad hoc management approaches will continue, perpetuating uncertainty and raising questions about the comprehensiveness and legitimacy of decisions.

To start, each existing or foreseeable activity in federal waters should be overseen by one lead federal agency, designated by Congress to coordinate among all the agencies with applicable authorities while ensuring full consideration of the public interest. Pending such designations, the NOC should assign agencies to coordinate research, assessment, and monitoring of new offshore activities.

But better management of individual activities is only a first step. To move toward an ecosystem-based management approach, the Federal Government should develop a broad understanding of offshore areas and their resources, prioritize all potential uses, and ensure that activities within a given area are compatible. As the

pressure for offshore uses grows, and before serious conflicts arise, coordination should be improved among the management programs for different offshore activities. The National Ocean Council should review each single-purpose program that regulates some offshore activity with the goal of determining how all such programs may be better coordinated.

Ultimately, the Nation needs a coordinated offshore management regime that encompasses traditional and emerging uses, and is flexible enough to incorporate uses not yet foreseen. The new regime will need to make decisions and resolve disputes through an open process accepted by all parties. Congress, working with the NOC and regional ocean councils, should establish such an offshore management regime and establish principles for offshore use, including the need to:

- integrate single-purpose programs within the broader offshore regime;
- create a planning process for new and emerging activities; and
- ensure a reasonable return to the public in exchange for allowing private interests to profit from public resources.

Establishing a coordinated offshore management regime will take time, and it will not be easy. No regime for governing ocean activities will eliminate all conflicts, given the complexity of the problems and the diverse perspectives of competing interests. However, the National Ocean Council, Presidential Council of Advisors on Ocean Policy, regional ocean councils, and other components of the National Ocean Policy Framework provide a promising basis for more coordinated, participatory management of ocean activities.

Marine Protected Areas

In contemplating the coordinated, ecosystem-based management of both nearshore and offshore areas, marine protected areas can be a valuable tool. Marine protected areas can be created for many different reasons, including conserving living marine resources and habitat, protecting endangered or threatened species, maintaining biological diversity, and preserving historically or culturally important submerged archaeological resources. These areas have also been recognized for their scientific, recreational, and educational values.

The creation of new MPAs can be a controversial process: supported by those who see their benefits, while vigorously opposed by others who dislike the limitations MPAs impose on ocean uses. Thus, it is important to engage local and regional stakeholders in the design and implementation of marine protected areas to build support and ensure compliance with any restrictions. Because marine protected areas also have national implications, such as possible impacts on freedom of navigation, federal involvement and oversight will still be needed.

With its multiple use, ecosystem-based perspective, the National Ocean Council should oversee the development of a flexible process—which is adaptive and based on best available science—to design and implement marine protected areas. Regional ocean councils, or other appropriate entities, can provide a forum for applying the process developed by the NOC, with broad stakeholder participation.

Strengthening and Streamlining the Federal Agency Structure

Although improved coordination is a vital aspect of the new National Ocean Policy Framework, changes to the federal agency structure itself will also be needed. The proliferation of federal agencies with some element of responsibility for ocean and coastal activities immediately suggests that some consolidation is possible. Combining similar ocean and coastal functions and programs could improve government performance, reduce unnecessary overlaps, facilitate local, State, and regional interactions with the Federal Government, and begin to move the Nation toward a more ecosystem-based management approach.

However, the complex Legislative and Executive Branch process for making such changes compels a cautious, methodical, multi-phased approach for improving the federal structure.

Strengthening NOAA—Phase I

NOAA's mission is to understand and predict changes in the Earth's environment and to conserve and manage ocean and coastal resources to meet the Nation's economic, social, and environmental needs. Since its creation, NOAA has made significant strides in many areas, despite programmatic and functional overlaps and frequent disagreements and disconnects among its five line offices. Although the organization has evolved over time, including the recent creation of a sixth line office to improve integration on specific issues, these changes take time and results can be hard to quantify.

There is widespread agreement that NOAA needs to manage its current activities more effectively. Moreover, if the recommendations in the Commission's preliminary report are implemented, NOAA will be required to handle a number of new responsibilities. A stronger, more effective, science-based and service-oriented ocean agency—one that contributes to better management of oceans and coasts through an ecosystem-based approach—is needed.

NOAA's three primary functions can be summarized as follows:

1) *Assessment, prediction, and operations* for ocean, coastal, and atmospheric environments, including mapping and charting, satellite-based and in situ data collection, implementation of the Integrated Ocean Observing System, data information systems, and weather services and products.
2) *Marine resource and area management,* including fisheries, ocean and coastal areas, vulnerable species and habitats, and protection from pollution and invasive species.
3) *Scientific research and education,* including a focus on applied research, the availability of scientifically valid data, and promotion of educational activities.

One of the critical objectives for a strengthened NOAA is improved performance within these categories and smoother interactions among them. For example, resource management decisions should be based on the best available science, research itself should be planned to support the agency's management missions, and research in different areas—sea, land, and air—should be connected and coordinated. Changes of this nature will likely require adjustments to the internal operation of the agency, including possible additional changes to the current line office structure.

These changes can be promoted by codifying the establishment and functions of the National Oceanic and Atmospheric Administration through passage of an organic act for the agency. The act should ensure that NOAA's structure is consistent with the principles of ecosystem-based management and with its primary functions: assessment, prediction, and operations; management; and research and education. NOAA will require budget support commensurate with its important, varied, and growing responsibilities.

Reviewing NOAA's Budget

NOAA's placement within the Department of Commerce has an unusual history and continues to be questioned by many observers. If nothing else, this affiliation has distinct budgetary implications. As part of DOC, NOAA's budget is reviewed within the Office of Management and Budget's General Government Programs, along with other DOC programs with fundamentally different characteristics and missions. NOAA's OMB review also fails to consider its ocean and atmospheric programs in context with other federal resource management and science programs. To support the move toward a more ecosystem-based management approach, NOAA's budget should be reviewed within OMB's Natural Resources Programs, along with the budgets of more similar departments and agencies.

Consolidating Ocean and Coastal Programs—Phase II

As I have said, many agencies across the Federal Government—in addition to NOAA—administer ocean- and coastal-related programs. Although I have focused on NOAA as the primary ocean agency, the other agencies should also be strengthened in similar ways.

However, even solid performance within each agency will not eliminate the many similar or overlapping activities. In some cases, programmatic overlap can provide useful checks and balances as agencies bring different perspectives and experiences to the table. In other cases, the number of separate agencies addressing a similar issue is not helpful. Such fragmentation diffuses responsibility, introduces unnecessary overlap, raises administrative costs, inhibits communication, and interferes with the development of a comprehensive management regime that addresses issues within an ecosystem-based context.

The Commission's preliminary report presents specific recommendations on program consolidation in areas such as nonpoint source pollution, area-based ocean and coastal resource management, vessel pollution, invasive species, marine mammals, aquaculture, and satellite-based Earth observing. Using these recommendations as a starting point, the Assistant to the President, with advice from the National Ocean Council and the Presidential Council of Advisors on Ocean Policy, should review federal ocean, coastal and atmospheric programs, and recommend further opportunities for consolidation.

Programs not suitable for consolidation—such as security-related programs that cannot be transferred without harm to the overall enterprise—should continue to be coordinated through the National Ocean Council and the regional ocean councils. However, in most cases, judicious consolidation of ocean- and coastal-related functions will improve policy integration and program effectiveness.

Presidential Reorganization Authority

The recommended program consolidation will not be easy within the current legislative process. The creation and reorganization of agencies is often contentious, lengthy, and uncertain, involving multiple committees in both houses of Congress. Recognizing this shortcoming, Congress has several times in the past chosen to give the President limited reorganization authority. Renewing this authority by allowing the President to propose agency reorganization, with an expedited and limited congressional review and approval process, would provide an excellent mechanism to achieve reorganization of federal ocean- and coastal-related agencies in a timely fashion.

Managing all Natural Resources in an Ecosystem-based Management Context—Phase III

Strengthening the performance of ocean, coastal, and atmospheric programs through coordination and consolidation are important steps in moving toward an ecosystem-based management approach. By immediately establishing the National Ocean Council and strengthening NOAA, followed by the consolidation of suitable ocean and coastal programs and functions, the Nation will be poised to take a further step in strengthening the Federal Government structure.

Based on a growing understanding of ecosystems, including recognition of the inextricable links among the sea, land, air, and all living things, a more fundamental reorganization of federal resource agencies will eventually be needed. Consolidation of all natural resource functions, including those involving oceans and coasts, would enable the Federal Government to move toward true ecosystem-based management. This could be implemented through the establishment of a Department of Natural Resources or some other structural unification that brings together all of the Nation's natural resource programs.

SCIENCE–BASED DECISIONS: ADVANCING OUR UNDERSTANDING OF THE OCEANS

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

Greater knowledge can enable policy-makers and managers to make wise, science-based decisions at the national, regional, State, and local levels. However, existing research and monitoring programs, which tend to be agency-specific and single issue oriented, will need to be reorganized to support ecosystem-based management. The current mismatch between the size and complexity of marine ecosystems and the fragmented research and monitoring programs for coastal and ocean ecosystems must be resolved.

The Nation also lacks effective mechanisms for incorporating scientific information into decision-making in a timely manner. As knowledge improves, it must be translated into useful terms and actively incorporated into policy through an adaptive process. To make the translation effective, local, State, regional, and national managers need avenues to communicate their information needs and priorities to the research community.

In addition to these practical needs, ocean science and technology will continue to be an integral part of the overall U.S. basic research enterprise and future discoveries will undoubtedly contribute greatly to society. Fundamental knowledge about the oceans is essential to understanding the Earth's environment and how it changes over time, assessing and predicting the status of marine resources, finding beneficial new uses of ocean resources, and protecting national security.

Federal Leadership in Ocean Science and Technology

Our Commission defines ocean science and technology broadly to include: exploration of new ocean environments; basic and applied research to increase understanding of the biology, chemistry, physics, and geology of the oceans and coasts, their interactions with terrestrial, hydrologic, and atmospheric systems, and the interactions between ocean and coastal regions and humans; and the development of new methodologies and instruments.

Today, 15 federal agencies support or conduct diverse activities in ocean science, technology, assessment, and management. The heads of these agencies direct the National Oceanographic Partnership Program (NOPP), which coordinates national oceanographic research and education. NOPP has provided a useful venue for agencies to support a small number of ocean science and technology projects, but it has not realized its full potential as an overarching mechanism for coordination among federal agencies and State, local, academic, and private entities.

Under the proposed National Ocean Policy Framework, the National Ocean Council's Committee on Ocean Science, Education, Technology, and Operations (COSETO) will assume leadership of NOPP to implement a broad national strategy for ocean research, education, observation, exploration, and marine operations. NOPP's existing offices and committees will be incorporated within this structure. Ocean.US, the lead office for planning the Integrated Ocean Observing System (IOOS), and the Federal Oceanographic Facilities Committee which provides advice on oceanographic facilities, will both report to COSETO.

Creating a National Strategy for Ocean Science and Technology

The United States needs a national strategy for ocean and coastal research, exploration, and marine operations that can help meet the ocean resource management challenges of the 21st century and ensure that useful products result from federal investments in ocean research. Much more needs to be known about how marine ecosystems function on varying spatial scales, how human activities affect marine ecosystems and how, in turn, these changes affect human health. Coordinated and enhanced research activities and marine operations are needed to:

- understand biological, physical, and chemical processes and interactions
- maintain overall ecosystem health and biological diversity
- observe, monitor, assess, and predict environmental events and long-term trends
- explore the ocean depths for new resources
- map ocean and coastal areas for safe navigation and resource management

Furthermore, the ocean and coastal environment is rife with conflicts among competing users and between groups of people applying different sets of values to the same issues. To resolve these conflicts, information is needed not only about the natural environment but also about relevant social, cultural, and economic factors.

Better coordination and increased support of ocean science and technology activities nationwide will help the United States to address numerous management challenges, and will position the Nation to quickly tackle new issues as they emerge.

Advancing Ocean and Coastal Research

The United States has a wealth of ocean research expertise spread across a network of government and industry laboratories and world-class universities, colleges, and marine centers. With strong federal support, these institutions made the United States the world leader in oceanography during the 20th century. However, a leader cannot stand still. Ocean and coastal management issues continue to grow in number and complexity, new fields of study have emerged, new interdisciplinary approaches are being tried, and there is a growing need to understand the ocean on a global and regional scale. All this has created a corresponding demand for high-quality scientific information. And while the need for increased information continues to grow, the federal investment in ocean research has stagnated in recent decades.

The current annual federal investment in marine science is well below the level necessary to address adequately the Nation's needs for coastal and ocean information. Unless funding increases sharply, the gap between requirements and resources will continue to grow and the United States will lose its position as the world's leader in ocean research.

Congress should double the federal ocean and coastal research budget over the next five years, from the 2004 level of approximately $650 million to $1.3 billion per year. As part of this increase, the National Ocean Council or Congress should:

- fund the research component of the regional ocean information programs to provide practical, management-oriented information at regional, State, and local levels;
- create a national program for social science and economic research to examine the human dimensions and economic value of the Nation's oceans and coasts, with funding of at least $8–$10 million a year;

- establish a joint Oceans and Human Health Initiative funded at $28 million a year;
- significantly increase the budget of the National Sea Grant College Program.

To ensure that increased investments are used wisely and that important research activities continue, federal agencies will need to create long-term strategic plans. A mechanism is required to coordinate federally-funded ocean research, support long-term projects, and create partnerships throughout all agencies and sectors. Transparent and comprehensive research plans would achieve these goals and ensure that research results can be translated into operational products in a timely manner. The National Ocean Council should develop a national ocean research strategy that reflects a long-term vision, promotes advances in basic and applied ocean science and technology, and guides relevant agencies in developing ten-year science plans and budgets.

Ocean Exploration

About 95 percent of the ocean floor remains unexplored, much of it located in harsh environments such as the polar latitudes and the Southern Ocean. Experience teaches us, however, that these vast and remote regions teem with undiscovered species and resources. On virtually every expedition, oceanographers discover fascinating new creatures. Advances in deep-sea technologies have also made it easier to locate shipwrecks and historical artifacts lost in the ocean depths, such as the stunning discovery of the *RMS Titanic* in 1985. The continued exploration of marine archaeological sites will help us to better understand human history and our global cultural heritage.

Very little is known about the ocean depths due primarily to the lack of a long-term, large-scale national commitment to ocean exploration. In 2000, recommendations from the President's Panel on Ocean Exploration led to the establishment of the Office of Exploration within NOAA, at a modest funding level of $4 million in fiscal year 2001, and $14 million in each of fiscal years 2002 and 2003. This program is helping NOAA to fulfill its applied science, environmental assessment, and technology development responsibilities; although the program's small budget and agency-specific focus limit its effectiveness.

NOAA and NSF, by virtue of their missions and mandates, are well positioned to lead a global U.S. ocean exploration effort. NOAA currently runs the Office of Ocean Exploration, but NSF's focus on basic research provides an excellent complement to NOAA's more applied mission. Working together, the two agencies have the capacity to systematically explore and conduct research in previously unexamined ocean environments. To succeed, coordination, joint funding, and interactions with academia and industry will be essential. Congress should appropriate significant funding for an expanded national ocean exploration program and the National Oceanic and Atmospheric Administration and the National Science Foundation should be designated as the lead agencies. An expanded national ocean exploration program will require a budget of approximately $110 million annually, plus additional funds for required infrastructure.

Mapping, Charting, and Assessments

The need for routine mapping, monitoring, and assessment of U.S. waters has grown significantly in the past two decades. Accurate, up-to-date maps and charts of harbors, coastlines, and the open ocean are necessary for many activities, including shipping, military operations, and scientific research. In addition, expanded regulatory regimes rely heavily on routine assessments of living and nonliving marine resources and water quality. Modern sensor technologies, which can detect new variables in greater detail in the water column and sea floor, have improved our ability to follow changing ocean and terrestrial dynamics. But as these new technologies are implemented, they need to be calibrated against previous methods, as well as with each other, to provide useful environmental characterizations and ensure the consistency of long-term statistical data sets.

At least ten federal agencies, almost all coastal states, and many local agencies, academic institutions, and private companies are involved in mapping, charting, and assessing living and nonliving resources in U.S. waters. However, different organizations use varying methods for collecting and presenting these data, leading to disparate products that contain gaps in the information they present. Ideally, a variety of information (e.g., bathymetry, topography, bottom type, habitat, salinity, vulnerability) should be integrated into maps using Global Positioning System coordinates and a common geodetic reference frame. In addition, these maps should include living marine resources, energy resources, and environmental data when available, to create complete environmental characterizations necessary for developing and implementing science-based ecosystem-based management approaches.

Coordination of the many existing federal mapping activities will increase efficiency and help ensure that all necessary surveys are conducted. Drawing upon the mapping and charting abilities found in the private sector and academia will also be necessary to achieve the best results at the lowest cost.

The National Ocean Council should coordinate federal ocean and coastal resource assessment, mapping, and charting activities with the goal of creating standardized, easily accessible national maps that incorporate living and nonliving marine resource data along with bathymetry, topography, and other natural features.

Achieving a Sustained, Integrated Ocean Observing System

About 150 years ago, this nation set out to create a comprehensive weather forecasting and warning network and today most people cannot imagine living without constantly updated weather reports. Recognizing the enormous national benefits that have accrued from the weather observing network, it is time to invest in a similar observational and forecasting capability for the oceans. This system would gather information on physical, geological, chemical, and biological parameters for the oceans and coasts, conditions that affect—and are affected by—humans and their activities. The United States currently has the scientific and technological capacity to develop a sustained, national Integrated Ocean Observing System (IOOS) that will support and enhance the Nation's efforts for:

- improving the health of our coasts and oceans;
- protecting human lives and livelihoods from marine hazards;
- supporting national defense and homeland security efforts;
- measuring, explaining, and predicting environmental changes;
- providing for the sustainable use, protection, and enjoyment of ocean resources.

The National Ocean Council should make the development and implementation of a sustained, national Integrated Ocean Observing System a central focus of its leadership and coordination role. The United States simply cannot provide the economic, environmental, and security benefits listed above, achieve new levels of understanding and predictive capability, or generate the information needed by a wide range of users, without implementing the IOOS.

The IOOS is based on two components: 1) open ocean observations conducted in cooperation with the international Global Ocean Observing System (GOOS) and 2) a national network of coastal observations conducted at the regional level. The coastal component will include the U.S. exclusive economic zone, the Great Lakes, and coastal and estuarine areas.

A strong national governance structure is required to establish policy and provide oversight for all components of the IOOS and to ensure strong integration among the regional, national, and global levels. Interagency coordination and consensus through the National Ocean Council and Ocean.US will be essential. While regional systems will retain a level of autonomy, achievement of the IOOS with nationwide benefits will require the regional systems to follow some national guidelines and standards. In addition, developers of the IOOS must ensure that the global component is not minimized and that the connectivity with the GOOS, including U.S. funding and leadership, remains strong and viable.

Formalizing Ocean.US

Ocean.US has made significant progress as the lead organization for the design and implementation of the national IOOS. However, a fundamental problem current exists in that Ocean.US has a number of responsibilities without any real authority or control over budgets. Its ephemeral existence under the Memorandum of Agreement which created it, its dependence on personnel detailed from the member agencies, and its lack of a dedicated budget severely detract from its stature within the ocean community and its ability to carry out its responsibilities. Congress should formally establish Ocean.US under the National Ocean Council structure so that it may effectively advise the NOC and achieve its coordination and planning mandates. The office requires consistent funding and dedicated full-time staff with the expertise and skills needed to ensure professional credibility. In addition, outside experts on rotational appointments could help Ocean.US better meet its responsibilities.

Coordinating Regional Observing Systems

Ocean.US envisions the creation of a nationwide network of regional ocean observing systems that will form the backbone of coastal observations for the IOOS. Although Ocean.US has proposed the creation of Regional Associations, coordinated through a national federation, as the governing bodies of the regional systems, this

concept is unnecessarily narrow. To fully address the needs of coastal managers, ocean observations need to be integrated into other information gathering activities such as regionally-focused research, outreach and education, and regional ecosystem assessments. Thus, the proposed regional ocean information programs provide a more comprehensive mechanism for developing and implementing regional ocean observing systems, in coordination with their broader responsibilities. Regular meetings among all the regional ocean information programs and Ocean.US will be important for providing regional and local input into developing requirements of the national IOOS.

Reaching Out to the User Community

The IOOS must meet the needs of a broad suite of users, including the general public. To get the most out of the IOOS, resource managers at federal, State, regional, territorial, tribal, and local levels will need to supply input about their information needs and operational requirements and provide guidance on what output would be most useful. Other users, including educators, ocean and coastal industries, fishermen, and coastal citizens, must also have a visible avenue for providing input. Ocean.US and the regional ocean information programs will need to devote significant time and thought to proactively approaching users and promoting public awareness of the enormous potential of the IOOS.

Planning Space-based Observations

An integral part of the national IOOS are the space-borne sensors that provide comprehensive, real-time, widespread coverage of ocean conditions and features. However, implementing sustained observations from space requires intense planning with long lead times. Given the cost, the time frame for constructing and launching satellites, and the inability to modify satellites once in orbit, five- to ten-year plans are required to ensure that satellite observations will be available on a continuous basis and employ the most useful and modern sensors. Ocean.US and NOAA must work with NASA to ensure that ongoing satellite operations are fully integrated into the national IOOS.

Both NOAA and NASA currently operate civilian, space-based, Earth observing programs that measure terrestrial, atmospheric, and oceanic variables. NOAA's primary mission in this area is to provide sustained, operational observations for monitoring and predicting environmental conditions and long-term changes, with a focus on weather and climate. In contrast, NASA's mission is to advance research efforts and sensor development. A NASA project can last from a few days to a few years, and NASA has repeatedly asserted that it is not in the business of providing data continuity. In many instances, the lifetime of a NASA satellite, and its continued ability to collect and transmit data, outlasts its funding, resulting in premature termination at odds with the pressing demands for data in the operational context. Thus NASA's efforts have not, and will not, result in the sustained capabilities needed for the national IOOS.

Congress should transfer the operation of NASA's Earth environmental observing satellites, along with associated resources, to NOAA to achieve continuous data collection. NOAA and NASA should work together to plan future missions and then ensure the smooth transition of each Earth environmental observing satellite after its launch. By consolidating Earth, and particularly ocean, observing satellite missions in NOAA, more seamless, long-term planning will be possible, resulting in a smooth concept-to-operations data collection process.

Information Product Development

To justify large federal investments in the IOOS, the system must result in tangible benefits for a broad and diverse user community, including the general public, scientists, resource managers, emergency responders, policy-makers, private industry, educators, and officials responsible for homeland security. National Weather Service and commercial meteorological products have applications ranging from scientific research to human safety, transportation, agriculture, and simple daily forecasts. Similarly, IOOS products should be wide-ranging and based on the needs of regional and local organizations and communities, as well as national needs. The regional ocean information programs should help produce information products of benefit to regional, State, and local managers and organizations. These regional programs will also provide important feedback to national forecasters and modelers about ways to make national IOOS products more useful.

Funding the IOOS

To fulfill its potential, the IOOS will require stable funding over the long haul. The lack of long-term funding for existing regional ocean observing systems has contributed to their isolation and piecemeal implementation. But consistent funding

will help ensure that the American public receives the greatest return for its investment in the form of useful information, reliable forecasts, and timely warnings. The estimated start-up costs for the implementation of the national IOOS over the first five years is close to $2 billion.

Continuous improvements to IOOS observation and prediction capabilities will also require sustained investments in technology development. Considering the costs of sensor development, telecommunications, computer systems, and improvements in modeling and prediction capabilities, annual costs for operating, maintaining, and upgrading the national IOOS are estimated to be $650–$750 million a year.

Whole Earth Observations

The IOOS cannot exist as a stand-alone system, developed without considering associated observations. Rather, it should be integrated with other environmental observing systems to link weather, climate, terrestrial, biological, watershed, and ocean observations into a unified Earth Observing System. The National Ocean Council should oversee coordination of the IOOS with other existing and planned terrestrial, watershed, atmospheric, and biological observation and information collection systems, with the ultimate goal of developing a national Earth Observing System. Such a system would improve understanding of environmental changes, processes, and interactions, making ecosystem-based management possible.

Enhancing Ocean Infrastructure and Technology Development

A robust infrastructure with cutting-edge technology forms the backbone of modern ocean science. It supports scientific discovery and facilitates application of those discoveries to the management of ocean resources. The nation has long relied on technological innovation, including satellites, early-warning systems, broadband telecommunications, and pollution control devices to advance economic prosperity, protect life and property, and conserve natural resources. Ocean research, exploration, mapping, and assessment activities will continue to rely on modern facilities and new technologies to acquire data in the open ocean, along the coasts, in polar regions, on the sea floor, and even from space.

The three major components of the Nation's scientific infrastructure for oceans and coasts are:

- *Facilities*—land-based laboratories and ocean platforms, including ships, airplanes, satellites, and submersibles, where research and observations are conducted;
- *Hardware*—research equipment, instrumentation, sensors, and information technology systems used in the facilities; and
- *Technical Support*—the expert human resources needed to operate and maintain the facilities and hardware as well as participating in data collection, assimilation, analysis, modeling, and dissemination.

The number and types of assets included in the national ocean science infrastructure are extensive and cover a wide range of federal, State, academic, institutional, and private-sector entities.

Together, they represent a substantial public and private investment that has made possible great strides in modern oceanography over the last 50 years. But a recent assessment of these assets revealed that significant components of the U.S. ocean infrastructure are aged or obsolete and that, in some cases, current capacity is insufficient to meet the needs of the ocean science and operational community. The National Ocean Council's Committee on Ocean Science, Education, Technology, and Operations should develop a national ocean and coastal infrastructure and technology strategy to achieve and maintain an appropriate mix of federally-supported, modern ocean facilities that meet the Nation's needs for quality resource management, science, and assessment.

Funding Needed Assets

There are currently several critically needed components of the ocean science and technology infrastructure, including:

- Surface vessels, such as new University National Oceanographic Laboratory System vessels and fishery research ships
- Undersea vehicles, including an array of manned, remotely operated, and autonomous submersibles
- Aircraft, both manned and unmanned
- Modern laboratories and instrumentation
- Dedicated ocean exploration platforms

- Telecommunications technology
- Environmental and biological sensors

Congress should establish a modernization fund to support these critical ocean infrastructure and technology needs. Such a fund would be used to build or upgrade facilities and acquire related instrumentation and equipment. It would also provide a mechanism to coordinate similar equipment purchases across agencies, where feasible, creating significant economies of scale. Current and future spending priorities for the fund should be based on the National Ocean Council's ocean and coastal infrastructure and technology strategy.

Transferring Technology

The development of needed ocean technologies—whether identified by the national strategy or through interagency communication—requires directed funding and coordination. Federal agency programs will benefit by having a centralized office responsible for accelerating the transition of technological advances made by federal and academic laboratories into routine operations.

NOAA should create, and Congress should fund, an Office of Technology to expedite the transition of experimental technologies into operational applications. This office should work closely with academic institutions, the regional ocean information programs, the National Science Foundation, the U.S. Navy, the National Aeronautics and Space Administration, and other relevant agencies to achieve this mission.

Modernizing Ocean Data and Information Products

Ocean and coastal data are essential for understanding marine processes and resources. They are the foundation for the science-based information on which resource managers depend. But storing and processing large amounts of data, and converting them into information products useful to a broad community of end users, remains a huge challenge.

There are two major challenges facing data managers today: the exponentially growing volume of data, which continually strains data ingestion, storage, and assimilation capabilities; and the need for timely access to these data by the user community in a variety of useful formats. Meeting these challenges will require a concerted effort to integrate and modernize the current data management system. The ultimate goal of improved ocean data management should be to effectively store, access, integrate, and utilize a wide and disparate range of data needed to better understand the environment and to translate and deliver scientific results and information products in a timely way.

Interagency Coordination

An interagency group, dedicated to ocean data and information planning, is needed to enhance coordination, effectively use existing resources for joint projects, schedule future software and hardware acquisitions and upgrades, and oversee strategic funding.

Congress should amend the National Oceanographic Partnership Act to create and fund Ocean.IT as the lead federal interagency planning organization for ocean and coastal data and information management. Ocean.IT should consist of representatives from all federal agencies involved in ocean data and information management, be supported by a small office, and report to the National Ocean Council's Committee on Ocean Science, Education, Technology, and Operations.

Ocean.IT should coordinate the development of a viable, long-term data management strategy which includes:

- The implementation of an interagency plan to improve access to data at the national data centers, Distributed Active Archive Centers, and other discipline-based centers. This plan will need to be appropriately integrated with other national and international data management plans, including those for the Integrated Ocean Observing System and Global Ocean Observing System.
- Opportunities to partner with the private sector to enhance environmental data and information management capabilities.

This organization should not have an operational role, but instead should be responsible solely for interagency planning and coordination, similar to the role of Ocean.US for the IOOS.

Informational Product Development

Compared to a few decades ago, an impressive array of data and information products for forecasting ocean and coastal conditions is now available from a wide range of sources. A mechanism is now needed to bring these data together, includ-

ing the enormous amounts of information that will be generated by the national IOOS, and use these data to generate and disseminate products beneficial to large and diverse audiences.

The National Oceanic and Atmospheric Administration and the U.S. Navy should establish a joint ocean and coastal information management and communications program to generate information products relevant to national, regional, State, and local needs on an operational basis. This program should build on the Navy's model for operational oceanography and take advantage of the strengths of both agencies to reduce duplication and more effectively meet the Nation's information needs. This partnership will also allow for the prompt incorporation of classified military data into informational products without publicly releasing the raw data. A NOAA–Navy joint program would rapidly advance U.S. coastal and ocean analyses and forecasting capabilities using all available physical, biological, chemical, and socioeconomic data.

Interactions between private companies and the NOAA–Navy national ocean and coastal information management and communications program could lead to the production of a wide range of general and tailored forecast and warning products. An interface between national forecasters at the NOAA–Navy program and the regional ocean information programs would also help identify ocean and coastal informational products of particular value at the regional and local levels.

PROMOTING LIFELONG OCEAN EDUCATION

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

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

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

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

Ocean Stewardship

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

Science Literacy

Ocean-related education has the potential to stem the tide of science illiteracy threatening to undermine the Nation's health, safety, and security. Children have a natural curiosity about the world around them and this allure could be parlayed into higher achievement in other subjects as well. The influence of the ocean on nearly every aspect of daily life, and the central role it plays in the development of the Nation, make ocean-based studies ideal for enhancing student performance in areas such as geography, history, economics, policy, and law. Strengthening science literacy, therefore, encompasses not only natural sciences, but a full suite of social sciences.

Future Ocean Leaders

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

Coordinating Ocean Education

Although not all ocean-related federal agencies have a specific education mission, most have made efforts to reach out to students, teachers, and the public to inform them about ocean issues, sometimes by adding ocean-related components to larger science and environmental education efforts. And while it is valuable for ocean-related information to be included as part of broader environmental and science education efforts, it is also important to support educational efforts that focus specifically on oceans, coasts, and the human relationship with them.

Federal programs can provide many opportunities for ocean-related education, but ultimately education is a State responsibility, and control is exerted primarily at the local level. Therefore, the interaction between education administrators at the State, district, and individual school levels and federal agencies will be fundamental to the success of any effort to use ocean-based examples to enhance student achievement. Aquariums, zoos, and other informal education centers also provide the public with opportunities to learn about the marine environment and should be integral components of a national effort to increase ocean-related education.

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

To strengthen ocean education and coordinate federal education efforts, the National Ocean Council should establish a national ocean education office (Ocean.ED) under its Committee on Ocean Science, Education, Technology, and Operations. This office should coordinate and integrate federal agency programs and leverage resources; serve as a central, visible point of contact for K–12, university-level, and informal education partners; and work with all parties to develop coherent, comprehensive planning for ocean education efforts.

To fulfill its coordination activities, Congress should provide dedicated funding for Ocean.ED operations and program implementation. However, this national effort is not meant to replace other successful programs and activities, but rather provide a mechanism for communication, coordination, and joining of forces.

Developing Ocean Curricula

The value of ocean-based learning must be recognized within local school districts to create a demand for ocean-related education products. Federal, regional, State, and local education professionals need to advocate for the inclusion of ocean-based examples in State and local education requirements and testing. Collaborative efforts will be needed to develop research-based, ocean-related curricular materials that are aligned with State and national educational standards and meet the needs of teachers. Ocean.ED, working with State and local education authorities and the

research community, should coordinate the development and adoption of ocean-related materials and examples that meet existing education standards.

Teaching the Teachers

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

The ocean research community is brimming with potential for engaging K–12 educators in the excitement and satisfaction of the scientific enterprise, and the Nation's research infrastructure provides significant opportunities for formal preparation, hands-on involvement, and teacher certification. Although several public and private sector programs can provide teachers with research experience in ocean-related topics, access to these programs is quite limited, very few have long-term, stable funding, and the different efforts are poorly coordinated. Ocean.ED, working with academic institutions and local school districts, should help establish stronger and more effective relationships between the research and education communities to expand professional development opportunities for teachers and teacher educators.

Bringing Oceans Education to All Students

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

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

Federal agencies and academic institutions should find ways to provide all students with opportunities to participate in ocean research and exploration, virtually or in person, including summer programs, field trips, remote participation in ocean expeditions, and, most important, after-school activities. Mentoring, especially near-peer guidance, is critical and should be a component of any student-oriented program. Ocean.ED should promote partnerships among school districts, institutions of higher learning, aquariums, science centers, museums, and private laboratories to develop more opportunities for students to explore the marine environment, both through virtual means and hands-on field, laboratory, and at-sea experiences. Ocean.ED should also ensure that ocean-based educational programs and materials acknowledge cultural differences and other aspects of human diversity, resulting in programs that expose students and teachers from all cultures and backgrounds to ocean issues.

Drawing Students into the Field of Ocean Science and Management

The ocean community must compete with countless other professions in attracting the talent it needs. Success lies, in part, in promoting marine-related career opportunities among undergraduate students from a broad range of disciplines. First-hand experiences in marine fields can be influential in demonstrating the possibilities and rewards of an ocean-related career.

Intellectually stimulating and financially attractive options for pursuing graduate studies in an ocean-related field must follow, so a student's developing interest in ocean studies is not overshadowed by other professions that actively pursue, encourage, and support their future leaders. Ocean sciences have another potentially important role to play at the undergraduate level. Marine science courses can be attractive options for non-science majors who need to fulfill science requirements for graduation, presenting an excellent opportunity to raise general ocean awareness.

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

Training Ocean Professionals

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

Ocean.ED should guide and promote the development of the Nation's ocean-related workforce by:

- promoting student support, diversified educational opportunities, and investment in innovative approaches to graduate education that prepare students for a broad range of careers in academia, government, and industry;
- encouraging graduate departments of ocean sciences and engineering to experiment with new or redesigned programs that emphasize cross-disciplinary courses of study.

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

Informing the Public

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

Informal education requires outreach programs, in partnership with local communities, to make contact with individuals where they live and work, regarding issues that affect how they live and work, in a style that speaks to them. Information supplied to the public should be timely and accurate. It should also be supported by a system that allows for follow-up and the acquisition of additional information or guidance. Ocean.ED, working with other appropriate entities, should enhance existing and establish new mechanisms for developing and delivering relevant, accessible information and outreach programs to enhance community education.

Regional Outreach—Connecting the Research and Education Communities

Collaboration between the research and education communities must be improved if ocean-based information, including ocean data and new discoveries, is to be transformed into exciting and accessible materials to stimulate student achievement and enhance public awareness. Some efforts do exist to make these connections, most notably through the Centers for Ocean Sciences Education Excellence (COSEE) and National Sea Grant College Program.

COSEE

The COSEE network, supported primarily through NSF, includes regional centers and a central coordinating office that work to integrate oceanographic data and information into high-quality curricular materials, to provide ocean scientists with opportunities to learn more about educational needs and requirements, to provide K–12 teachers with the knowledge and skills they need to effectively incorporate ocean-related information into their lessons, and to deliver ocean-related information to the public. Though recognized as a model for enhancing education and bringing accessible ocean-related information to the public, COSEE currently has only seven regional centers, each serving a limited number of schools in its area. The program does not have the level of committed, long-term support required to fully realize it's potential.

While COSEE is currently a National Science Foundation program, placing it within the National Ocean Council (NOC) structure would capitalize on the tremendous potential to enhance and expand the program. The NOC and the NSF should relocate COSEE within the larger NOC structure as a program to be organized, overseen, and funded through Ocean.ED. In addition, the number of COSEE re-

gional offices should be tripled to 21 with each center receiving at least $1.5 million a year for an initial five-year period.

National Sea Grant College Program

The National Sea Grant College Program was created by Congress in 1966 as a partnership between the Nation's universities and NOAA. Sea Grant programs sponsor research, education, outreach, and technology transfer through a network of Sea Grant Colleges and research institutions.

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

Despite its successes, however, Sea Grant is currently an under-utilized resource. The existing Sea Grant network requires increased funding to expand its roles and responsibilities, particularly in education and outreach. In particular, Sea Grant extension and communications programs, familiar to many resource managers and others in coastal communities, should become the primary mechanisms for delivering and interpreting information products developed through the regional ocean information programs

Specific Federal Responsibilities

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

National Oceanic and Atmospheric Administration

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

NOAA should establish a national ocean education and training program, patterned after the National Institutes of Health model, within its Office of Education and Sustainable Development to provide diverse, innovative ocean-related education opportunities at the undergraduate, graduate, and postdoctoral levels.

In addition, NOAA should establish competitive "Distinguished Professorships in Marine Studies" within Sea Grant Colleges or other leading institutions of higher education with a demonstrated commitment to marine programs. Disciplines of interest to NOAA for such professorships could include fisheries science, climate research, atmospheric studies, and marine resource economics, policy, aquaculture, genomics, education, and ecosystem studies. The intent would be to create a cadre of distinguished NOAA endowed chairs at universities around the Nation.

National Science Foundation

At the undergraduate level, NSF's Research Experience for Undergraduates program could be expanded to include more marine-related experiences. At the graduate and postdoctoral levels, opportunities could include fellowships that encourage cross-disciplinary research, interdisciplinary traineeships, and master's degree fellowships. Programs such as NSF's Integrative Graduate Education and Research Training program, Centers for Learning and Teaching, and Graduate Teaching Fellows in K–12 Education should be supported and enhanced both within NSF and adopted by other federal ocean agencies. The National Science Foundation's Directorates of Geosciences, Biological Sciences, and Education and Human Resources should develop cooperative programs to provide diverse educational opportunities at the undergraduate, graduate, and postdoctoral levels in a range of ocean-related fields.

Office of Naval Research

The success of the Navy depends on a well-developed understanding of the environment in which it operates. Understanding the ocean environment—including the atmosphere above it, the sea floor beneath it, and the coastlines that encircle it—will always be a core naval requirement. Thus the Navy should play a central role in ensuring support for the education of future generations of ocean professionals. The Office of Naval Research should reinvigorate its support of graduate education in ocean sciences and engineering. This could be partly accomplished by increasing the number of ocean-related awards made under ONR's National Defense Science and Engineering Graduate Fellowship Program.

SPECIFIC MANAGEMENT CHALLENGES

Although the areas I discussed—improved governance through a new National Ocean Policy Framework, the incorporation of scientific information in decision-making, and broad public education—represent the overarching areas that this nation must address using the guiding principles I mentioned earlier, the U.S. Commission on Ocean Policy did not stop there in its deliberations and recommendations. The Commission also addressed a wide range of specific ocean management challenges—challenges that will continue to be addressed individually, but which now must also become part of more ecosystem based management approach, applying the guiding principles throughout the management process. These individual ocean and coastal management challenges include: Linking the management of coasts and watersheds; Protecting life and property from natural hazards; Restoring and conserving habitat; Better managing sediments and shorelines; Supporting marine commerce and transportation; Reducing water pollution from all sources, including from vessels and through the introduction of marine debris; Preventing the introduction of invasive species; Sustainably managing our fisheries; Protecting marine mammals and other marine species; Conserving corals and corals reefs; Enabling the environmentally-sound development of marine aquaculture; Understanding and safeguarding Oceans and Human Health; and, developing offshore energy resources and marine minerals.

IMPROVING MANAGEMENT OF COASTS AND WATERSHEDS

Let me begin by addressing some of the issues in our coastal areas. While coastal counties (located entirely or partially within coastal watersheds) comprise only 17 percent of the land area in the contiguous United States, they are home to more than 53 percent of the total U.S. population. Coastal population trends indicate average increases of 3,600 people a day moving to coastal counties, reaching a total population of 165 million by 2015. These figures do not include the 180 million people who visit the coast every year.

Population growth and tourism bring many benefits to coastal communities, including new jobs and businesses and enhanced educational opportunities. The popularity of ocean and coastal areas increases pressures on these environments, creating a number of challenges for managers and decision-makers. Increased development puts more people and property at risk from coastal hazards, reduces and fragments fish and wildlife habitat, alters sedimentation rates and flows, and contributes to coastal water pollution.

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

To reap economic benefits and mitigate pressures associated with growing coastal development, State and local governments needs more federal support to enhance their capacity to plan for and guide growth, and to employ watershed management approaches.

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

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

The Coastal Zone Management Act (CZMA) is the Federal Government's principal tool for fostering comprehensive coastal management. The CZMA created the Coastal Zone Management Program CZM Program, a unique partnership between the Federal and coastal State governments, whose goal is to balance the conservation of the coastal environment with the responsible development of economic and cultural interests. The tools, assistance, and resources provided by the CZMA have enabled States and territories to increase their management capacity and improve decision-making to enhance the condition of their coastal areas.

However, the CZM Program can be strengthened in a number of ways, including by developing strong, specific, measurable goals and performance standards that reflect a growing understanding of the ocean and coastal environments and the need to manage growth in regions under pressure from coastal development. A large portion of federal funding should be linked to program performance with additional incentives offered to States that perform exceptionally well. In addition, a fall-back mechanism is needed to ensure that national goals are realized when a State does not adequately participate or perform. Finally, the land-side boundaries of State coastal management programs should also be reconsidered. At a minimum, each State should set the inland extent of its coastal zone based on the boundaries of coastal watersheds.

In addition to the CZM Program, other federal area-based coastal programs include NOAA's National Estuarine Research Reserve System and National Marine Sanctuaries Program; EPA's National Estuary Program; and Fish and Wildlife Service's Coastal Program and Coastal Barrier Resources System. These programs have made significant progress in managing coastal resources in particular locations, working with communities and decision-makers in those areas, and fostering improved coordination between different levels of government. However, because these programs generally operate in isolation from one another, they cannot ensure effective management of all ocean and coastal resources or achievement of broad national goals. As NOAA is strengthened through the multi-phased approach described earlier, consolidation of area-based coastal resource management programs will result in more effective, unified strategies for managing these areas, an improved understanding of the ocean and coastal environment, and a basis for moving toward an ecosystem-based management approach.

Federal programs related to transportation, flood insurance, disaster relief, wetlands permitting, dredging, beach nourishment, shoreline protection, and taxation also exert a profound influence on the coast. While these laws and policies address specific issues, and have each provided societal benefits, in many cases federal activities under their purview have inadvertently led to degradation of coastal environments. For this reason, policies should be re-evaluated to ensure consistency with national, regional, and State goals aimed at achieving economically and environmentally sustainable development.

Linking Coastal and Watershed Management

For well over a decade there has been a growing interest in watershed management. This approach addresses water quality and quantity issues by acknowledging the hydrologic connections between upstream and downstream areas and considering the cumulative impacts of all activities that take place throughout a watershed. Watersheds are optimal organizing units for dealing with the management of water and closely related resources. The benefits of a watershed focus have also been recognized at the State, regional, national, and international levels through successful efforts such as the Chesapeake Bay Program, the Delaware River Basin Commission, and the bi-national Great Lakes Commission. At the federal level, EPA has supported efforts to address a variety of problems at the watershed level.

Many watershed groups are formed at the local level by community members concerned about water quality or the health of fish and wildlife populations. Often, these groups work to improve watershed health through partnerships among citizens, industry, interest groups, and government. However, the environmental and political characteristics of the Nation's watersheds vary tremendously, and watershed management initiatives can differ widely in size and scope. As interest in watershed management continues to grow, so does the need for a framework to guide such initiatives and evaluate their effectiveness.

The Federal Government can play an important role by helping to develop this framework and by providing assistance to States and communities for watershed initiatives. Congress should amend the Coastal Zone Management Act, the Clean Water Act, and other federal laws where appropriate, to provide better financial, technical, and institutional support for watershed initiatives and better integration of these initiatives into coastal management.

Assessing the Growing Cost of Natural Hazards

The nation has experienced enormous and growing losses from natural hazards. Conservative estimates, including only direct costs such as those for structural replacement and repair, put the nationwide losses from all natural hazards at more than $50 billion a year, though some experts believe this figure represents only half or less of the true costs. More accurate figures for national losses due to natural hazards are unavailable because the United States does not consistently collect and compile such data, let alone focus on specific losses in coastal areas. Additionally, there are no estimates of the costs associated with destruction of natural environments.

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

Opportunities for improving federal natural hazards management, include: Amending federal infrastructure policies that encourage inappropriate development; Augmenting hazards information collection and dissemination; Improving the National Flood Insurance Program (NFIP); and Undertaking effective and universal hazards mitigation planning.

Conserving and Restoring Coastal Habitat

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

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

Conserving valuable ocean and coastal areas protects significant habitat and other natural resources. Millions of coastal acres have been designated for conservation by various levels of government, and the tools for implementing conservation programs are found in a multitude of statutes. A number of federal programs aim to preserve the natural attributes of specific areas while providing varying levels of access to the public for educational, recreational, and commercial purposes. In addition, nonregulatory conservation techniques—including fee simple land acquisition, the purchase or donation of easements, tax incentives and disincentives, and tradable development rights—play a special role in enabling willing landowners to limit future development on their land for conservation purposes. Land acquisition and easements are often implemented through partnerships among governments, nongovernmental organizations such as land trusts, and the private sector. Funding and support for continued conservation of coastal and estuarine lands is important to ensure the ability to maintain critical habitats and the benefits they provide.

Conservation is cost-effective, avoiding the much larger expense and scientific uncertainties associated with attempting to restore habitats that have been degraded or lost. Even so, once critical habitat has been lost, or the functioning of those areas diminished, restoration is often needed. Habitat restoration efforts are proliferating in response to heightened public awareness of and concern for the health of the Nation's oceans and coasts.

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

In addition to the large-scale, regional restoration efforts, there are numerous small-scale efforts that collectively make significant contributions. These activities often demonstrate the power of public—private partnerships, bringing together community members, government agencies, and businesses to solve common problems.

However, as long as each project continues to be planned and implemented in isolation, its overall impact will be constrained.

Currently the many entities that administer conservation and restoration activities operate largely independently of one another, with no framework for assessing overall benefits in an ecosystem-based context. The multitude of disjointed programs prohibits a comprehensive assessment of the progress of conservation and restoration efforts and makes it difficult to ensure the most effective use of limited resources. An overarching national strategy that sets goals and priorities can also enhance the effectiveness of individual efforts and provide a basis for coordinating measures and evaluating progress of both habitat conservation and restoration activities.

Managing Sediment and Shorelines

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

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

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

Coastal stakeholders have increasingly recognized the need to develop more proactive and preventive strategies. However, their absence from broad watershed planning efforts—where decisions about land use and water management could reduce excess and contaminated sediments at their source—makes such change difficult to realize. The nation needs both a better understanding of the interactions between human activities and sediment flows, and a better mechanism for involving all potentially affected parties.

Moving toward an ecosystem-based management approach is a critical step. Participation by federal, State, and local entities in watershed management efforts, along with key stakeholders such as coastal planners and port managers, is one way to diminish upland sources of excess and contaminated sediment that harm the marine environment. Ecosystem considerations should be included in the process for permitting any activity that alters sediment flows.

Dredged materials have long been used to create new land for commercial, residential, and infrastructure developments, as well as to bolster beaches and barrier islands to protect against storm and erosion hazards and enhance tourism and recreation. Since the 1970s, these beneficial uses of dredged materials have also included environmental enhancement, such as restoration of wetlands, creation of wildlife habitat, and improvement of fish habitat. Surprisingly, navigation-related dredged materials do not find their way into beneficial use projects as often as perhaps they should. This is due in part to sediment contamination, but also to USACE policies that favor disposal in open waters or in upland dump sites. These policies may be unnecessarily foregoing opportunities to support economic growth or environmental protection and may have serious unintentional consequences for aquatic ecosystems. A more accurate system for selecting and ranking projects would be based on a comparative net economic and environmental return for the United States rather than a narrow cost-benefit analysis for a specific project.

Finally, the characterization, containment, removal, and treatment of contaminated sediment continue to be technically difficult and prohibitively expensive, and point to the importance of adopting an adaptive management approach to the problem. Scientifically sound methods for identifying contaminated sediment and developing innovative technologies to improve dredging and treatment of this material are critical steps toward improving the economic and ecological health of coastal

areas. To be successful, these efforts will require new resources and effective regional planning.

Supporting Marine Commerce and Transportation

As the world's largest trading nation, the United States imports and exports more merchandise than any other country and has one of the most extensive marine transportation systems in the world. U.S. marine import-export trade is an essential and growing component of the national economy, accounting for nearly seven percent of the Nation's gross domestic product. Domestically, coastal and inland marine trade amounts to roughly one billion tons of cargo, worth more than $220 billion a year. The marine transportation system itself is a highly complex public-private sector partnership consisting of an interconnected mix of waterways, ports and terminals, water-based and land-based intermodal connections, vessels, vehicles, equipment, personnel, support service industries, and users.

For the Nation's marine transportation system to meet current and future demands, ongoing maintenance, improvement, and expansion will be required. A key prerequisite for a robust system is better coordination, planning, decision-making and allocation of resources at the federal level. In particular it will be essential to enhance the connections between this system and other modes of transportation, such as highways, railways, and airports. At the same time, in moving toward an ecosystem-based management approach, planning for the movement of cargo and passengers should be coordinated with the management of many other ocean and coastal uses and activities, and with efforts to protect the marine environment.

Within the Federal Government, responsibilities for marine commerce and transportation are spread among numerous agencies, primarily the U.S. Department of Transportation (DOT), U.S. Coast Guard, USACE, NOAA, U.S. Customs Service, and EPA. These agencies have many roles, including vessel traffic management, national security, marine safety, waterway maintenance, environmental protection, and customs. These responsibilities are poorly coordinated and do not mesh well with the structure and function of such system. Statutory, regulatory, and policy differences among federal agencies with roles in marine transportation lead to fragmentation, competition, and in some cases, an inability to work collaboratively due to conflicting mandates. National leadership and support will be needed to achieve better integration within the Federal Government, better links with the rest of the Nation's transportation infrastructure, and coordination between marine transportation and other important ocean and coastal uses and activities. The logical agency to assume this responsibility, as it does for the highway, aviation, and railway systems, is DOT.

Even with one clearly mandated lead federal agency, coordination will be needed among the federal and non-federal participants in the marine transportation system. Given the significance of domestic and international trade to the Nation and the complexity of the components that make up the system the Interagency Committee for the Marine Transportation System (ICMTS) should be strengthened, codified and placed under the oversight of the National Ocean Council. And because marine transportation involves many actors outside the Federal Government, the Marine Transportation System National Advisory Council should be maintained to coordinate among non-federal participants in the marine transportation system and a venue for providing input to the Federal Government on important national issues.

An important step in allowing the U.S. marine transportation system to grow, while minimizing increased congestion, delays, and costs to U.S. businesses and consumers, is to improve the movement of cargo into and out of ports. Existing intermodal connections are inadequate to meet the expected increase in foreign and domestic trade. The nation's transportation infrastructure is largely an agglomeration of competing transportation modes, each focusing on its own priorities. While this approach has produced an extensive infrastructure, a national strategy is needed to enhance the connections among these modes, including the Nation's ports, and ensure greater overall effectiveness.

DOT, working with the ICMTS, should draft a new national freight transportation strategy to support continued growth of the Nation's economy and international and domestic trade. Based on the new strategy, investments should be directed toward planning and implementation of intermodal projects of national significance. In developing the national freight transportation strategy, DOT should emphasize strategic planning with States, regions, and the public sector as is already being carried out for the U.S. highway system.

Planning for the future of the U.S. marine transportation system requires accurate and timely information, including estimates of the volume of current and future cargo transportation, their origins and destinations, and the capacity of the various

transportation modes. Such information is essential to understand the strengths and weaknesses of the current system and the challenges and opportunities for improving its effectiveness. DOT, working with other appropriate entities, should establish a national data collection, research, and analysis program to provide a comprehensive picture of freight flows in the United States and to enhance the performance of the Nation's intermodal transportation system. DOT should periodically assess and prioritize the Nation's future needs for ports and intermodal transportation capacity to meet expected growth in marine commerce.

Finally, natural disasters, labor disputes, terrorist attacks, ship collisions, spills of hazardous materials, and many other human and naturally caused events can disrupt the flow of marine cargo and passenger services, causing severe economic and social ramifications nationally and internationally. Diminished port capacity could also affect vital military operations. In developing a national freight transportation strategy, DOT should work closely with the U.S. Department of Homeland Security and the FEMA to incorporate port security and other emergency preparedness requirements. The strategy should focus on preventing threats to national security and port operations and on response and recovery practices that limit the impacts of such events, including an assessment of the availability of alternative port capacity.

COASTAL AND OCEAN WATER QUALITY

Coastal and ocean water quality is threatened by multiple sources of pollution, including point and nonpoint source pollution, atmospheric deposition of pollutants, vessel pollution, invasive species, and trash being washed into the ocean and onto beaches. Addressing these multiple pollutants will require development of an ecosystem-based and watershed management approach that includes a variety of management tools, coordination, and ongoing monitoring.

Addressing Coastal Water Pollution

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

Any solution must be founded on an ecosystem-based and watershed management approach involving a broad range of agencies, programs, and individuals. The complex array of laws, agencies, and programs that address water pollution, and the number of parties involved, will require greatly enhanced coordination among federal agencies, primarily EPA, NOAA, USDA, and USACE. Greater coordination is also needed between the Federal Government and managers at the State, territorial, tribal, and local levels, watershed groups, nongovernmental organizations, private stakeholders, and the academic and research communities. Solutions will also require a substantial financial investment and will take time.

Reducing Point Sources of Pollution

Over the last few decades, great strides have been made in controlling water pollution from point sources, although further improvements could be realized through increased funding, strengthened enforcement, and promotion of innovative approaches such as market-based incentives. The Commission also addresses several specific point sources of pollution, including wastewater treatment plants, sewer system overflows, septic systems, industrial facilities, and animal feeding operations.

Increasing the Focus on Nonpoint Sources of Pollution

While considerable progress has been made in reducing point sources of pollution, further progress toward improving coastal water quality will require significant reductions in nonpoint sources as well. This pollution occurs when rainfall and snowmelt carry pollutants over land, into streams and groundwater, and down to coastal waters. Ninety percent of impaired water bodies do not meet water quality standards at least in part because of nonpoint source pollution. The majority of the nonpoint source pollution entering rivers, estuaries, coastal waters, and ultimately the oceans is from agricultural and storm water runoff.

To address nonpoint source pollution, the NOC should establish significant reduction of nonpoint source pollution in all impaired coastal watersheds as a national goal, and set measurable objectives to meet water quality standards. The nation has a number of opportunities to reduce the impacts of nonpoint sources of pollution on coastal waters. Because agricultural runoff contributes substantially to nonpoint source pollution, USDA should align its conservation programs and funding with

other programs aimed at reducing nonpoint source pollution, such as those of EPA and NOAA. Other opportunities for the Nation to reduce nonpoint source pollution include coordination of federal nonpoint programs so they are mutually supportive, more targeted and aggressive use of State revolving loan funds, broader implementation of incentives and disincentives, and improved monitoring to assess compliance and overall progress. State and local governments also have important roles to play in land use planning and storm water management decisions.

Watersheds are often the appropriate geographic unit for addressing water-related problems and collaborative watershed groups have had significant successes in addressing nonpoint source pollution. Therefore, the NOC and regional ocean councils should strengthen the ability of collaborative watershed groups to address problems associated with nonpoint source pollution by developing and implementing strategies to provide them with adequate technical, institutional, and financial support.

Addressing Atmospheric Sources of Pollution

Atmospheric deposition of pollutants can also harm water quality, aquatic resources, and human health. To address atmospheric deposition, EPA, States, and watershed groups should explore regional approaches for managing atmospheric deposition, particularly when it affects water bodies in states far from the source.

Creating a National Water Quality Monitoring Network

Pollution of the Nation's coastal waters has led to beach closures, oxygen depletion, health impacts from toxic contamination, and many other problems. Despite these threats to coastal waters, there is no national network in place to monitor water quality changes and their causes, facilitate estimates of their economic impact, and measure the success of management efforts. Increased monitoring is needed not only along the Nation's coasts, but also inland where pollutants make their way downstream, ultimately impacting coastal waters. A national water quality monitoring network is essential to support the move toward an ecosystem-based management approach that considers human activities, their benefits, and their potential impacts within the context of the broader biological and physical environment. An essential step toward controlling pollution will be to strengthen and coordinate monitoring efforts to provide decision makers with necessary information.

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

Ensuring Comprehensive, Coordinated Coverage

The nation's coastal margin is the most densely populated and developed region of the Nation, and its waters have been significantly degraded by pollution. Yet in recent years, due largely to lack of funding, monitoring has been extremely sparse along the coasts. Much remains unknown about the status of coastal waters, and increased monitoring will be required to make informed management decisions about this economically and ecologically valuable region. Yet the close connections between coastal and upstream waters dictate that any water quality monitoring network must be national in scope. NOAA, EPA, and USGS should lead the effort to develop a national water quality monitoring network that coordinates existing and planned monitoring efforts, including federal, State, local, and private efforts. The network should include a federally-funded backbone of critical stations and measurements needed to assess long-term water quality trends and conditions.

Because of the inherent overlap between inland, coastal, and open-ocean monitoring and observing, the national water quality monitoring network should be closely linked with the Integrated Ocean Observing System (IOOS) and ultimately with a broad Earth observing system. NOAA should ensure that the water quality monitoring network includes adequate coverage in both coastal areas and the upland areas that affect them, and that the network is linked to the IOOS, to be incorporated eventually into a comprehensive Earth observing system.

Creating an Effective Monitoring Network and Making Data Accessible and Useful

In addition to coordinating existing monitoring efforts, an effective national water quality monitoring network should have specific goals and objectives, reflect user needs, and be helpful in assessing the effectiveness of management approaches. The overall system design should determine what and where to monitor, including defi-

nition of a set of core variables. Technical expertise will be needed to standardize procedures and establish quality control and data management protocols. The network should be periodically assessed and modified as necessary. Most important, the data collected through the National monitoring network should be useful to managers and stakeholders in evaluating management measures, determining best management practices, and making continual improvements in reaching ecosystem goals. This data should also be translated into timely and useful information products that are readily accessible to decision makers and the public. The design and implementation of the national monitoring network will require not only federal coordination, but also significant input from the States.

Limiting Vessel Pollution and Improving Vessel Safety

The benefits from vessel activities are significant—ships carry more than 95 percent of the Nation's overseas cargo—but these operations also present safety, security and environmental risks that must be effectively addressed.

Success in addressing these concerns will depend on a broad domestic and international framework comprised of three key components. The first component is a strong voluntary commitment on the part of vessel owners and operators to build a workplace ethic that incorporates safety, security, and environmental protection as important and valued aspects of everyday vessel operations. Reliable means of measuring the success of these efforts, as reflected in crew and company performance, are essential and should include extensive use of third-party audits. The U.S. Coast Guard, through incentives and partnership programs, should encourage industry partners to develop stronger voluntary measures, particularly those that reward crew member contributions, as part of a continuing long-term effort that focuses on building a culture of safety, security, and environmental compliance.

The second key component is effective oversight and control by the primary vessel regulator, the vessel's flag state. Foreign flag vessels, subject primarily to the jurisdiction and control of other governments, carry more than 90 percent of international commercial freight entering and departing the United States and account for 95 percent of passenger ships and 75 percent of cargo ships operating in U.S. waters. Although many flag states take their responsibilities seriously, oversight and enforcement vary dramatically. Over the past decade, the International Maritime Organization has developed guidelines to improve flag state oversight and enforcement. However, implementation of these measures has met with mixed results. Mounting international security concerns have made effective flag state oversight and control more urgent today than ever before. The United States should work with other nations to accelerate efforts at the International Maritime Organization to enhance flag state oversight and enforcement. Initiatives should include expeditious promulgation of a code outlining flag state responsibilities, and development of a mandatory external audit regime to evaluate performance and identify areas where additional technical assistance can be used to best advantage.

The third key framework component is effective control over vessels visiting U.S. ports. The Coast Guard currently carries out a port State control program that allocates limited inspection resources to the highest-risk vessels, based on an assessment of the vessel owner, flag state, classification society, performance history, and vessel type. Performance-based vessel inspections, while the most effective means of verifying compliance, are resource intensive. These inspections have played a critical role in identifying and correcting potential problems, and in assessing the effectiveness of overall efforts to improve safety and environmental compliance. Concerns have been expressed in Congress and elsewhere about the adequacy of Coast Guard resources to meet new security demands while fulfilling other important responsibilities. Congress should provide the U.S. Coast Guard with the resources necessary to sustain and strengthen the performance-based inspection program for marine safety and environmental protection while also meeting new vessel security inspection and other maritime security requirements. In addition, the Coast Guard should work at the regional and international levels to increase effective coordination and vessel information sharing among concerned port states.

In addition to outlining a framework to address vessel safety, security and environmental concerns, our report also recommends more comprehensive approaches to address waste stream, oil and air pollution from commercial and recreational vessels. Recommendations include: establishing a uniform national regime to deal with cruise ship waste streams; ratifying and working to strengthen MARPOL Annex V1 air emission standards; developing comprehensive policy guidance and contingency plans for vessels seeking places of refuge in the United States; developing a long-term plan that identifies and addresses the greatest risks associated with marine oil transportation systems; and updating and accelerating efforts to reduce recreational vessel pollution. We also place particular emphasis on the use of market-

based mechanisms and incentives to reduce pollution and encourage appropriate voluntary actions.

Preventing the Spread of Invasive Species

The introduction of non-native marine organisms into ports, coastal areas, and watersheds has damaged marine ecosystems around the world, costing millions of dollars in remediation, monitoring, and ecosystem damage. Invasive species policies are not keeping pace with the problem primarily because of inadequate funding, a lack of coordination among federal agencies, redundant programs, and outdated technologies.

Making Prevention the First Line of Defense

The discharge of ballast water is considered a primary pathway for introduction of non-native aquatic species. Exchanging ballast water in the middle of the ocean to reduce the risk of transferring organisms from one ecosystem to another is the primary management tool currently available for ships to control the introduction of invasive species.

To better control the introduction of invasive species, the U.S. Coast Guard's national ballast water management program should: apply uniform, mandatory national standards; incorporate sound science in the development of a biologically meaningful and enforceable ballast water treatment standard; include a process for revising the standard to incorporate new technologies; ensure full consultation with EPA; and include an interagency review, through the NOC, of the policy for ships that declare they have no ballast on board.

While ballast water is considered a primary pathway, there are also other important ship-related sources of non-native aquatic species, including ships' hulls, anchors, navigational buoys, drilling platforms, and floating marine debris. Other pathways include intentional and unintentional human introductions of fish and shellfish, and illegally released organisms from the aquaculture, aquarium, horticulture, and pet industries. There is increasing concern that an expanding trade through the Internet and dealers of exotic pets is exacerbating the invasive species problem.

To address these pathways of introduction, the NOC, working with the Aquatic Nuisance Species Task Force and the National Invasive Species Council, should coordinate public education and outreach efforts on aquatic invasive species, with the aim of increasing public awareness about the importance of prevention.

Accelerating Detection and Response

Only the most draconian prevention strategy could hope to eliminate all introductions of non-native species and thus prevent the possibility of an invasion. Yet no effective mechanism is in place for rapidly responding to newly discovered aquatic invasions when they do occur. Therefore, the National Invasive Species Council and the Aquatic Nuisance Species Task Force, working with other appropriate entities, should establish a national plan for early detection of invasive species and a system for prompt notification and rapid response.

Improving the Control of Invasive Species

As biological invasions continue, there is a pressing need to improve the control of invasive species by reducing the overlaps and redundancies caused by the involvement of so many agencies with insufficient interagency coordination. The NOC should review and streamline the current proliferation of federal and regional programs for managing marine invasive species, and coordinate federal, regional and State efforts.

The study of marine biological invasions is a relatively new research area and little is understood about how or why certain species become invasive, what pathways of introduction are most important, and whether certain factors make an ecosystem more susceptible to invasions. To better understand marine biological invasions, the NOC should coordinate the development and implementation of an interagency plan for research and monitoring to understand and prevent aquatic species invasions.

Reducing Marine Debris

The trash and other waste that drifts around the global ocean and washes up on the Nation's shores poses a serious threat to fishery resources, wildlife, and habitat, as well as human health and safety. Approximately 80 percent of debris is washed off the land, blown by winds, or intentionally dumped from shore, while 20 percent comes from vessels and offshore platforms.

NOAA currently addresses marine debris as a part of several other efforts, but there is a need to coordinate, strengthen, and increase the visibility of the marine debris efforts within NOAA by creating a centralized marine debris program within

the agency. This program should be coordinated with EPA's marine debris activities, as well as with the significant efforts conducted by private citizens, State, local, and nongovernmental organizations.

Interagency Coordination

Although strengthening NOAA's work on marine debris through establishment of an office within the agency is an important step, an interagency committee under the NOC is needed to unite all appropriate federal agencies around the issue. Such a committee could support existing marine debris efforts by agencies and nongovernmental organizations, and should expand and better coordinate national and international marine debris efforts, including: public outreach and education; partnerships with State and local governments, community groups, nongovernmental organizations, and industry; and monitoring, identification and research.

Eliminating Derelict Fishing Gear

Whether intentionally discarded or unintentionally lost during storms or fishing operations, derelict fishing gear poses serious threats, entrapping marine life, destroying coral reefs and other habitat, and even posing danger to humans. Although derelict fishing gear is a worldwide problem, currently no international treaties or plans of action address it. A strong need exists for the U.S. Department of State and NOAA, working with the United Nations Food and Agriculture Organization, to develop a plan of action to address derelict fishing gear, to be implemented on a regional, multi-national basis. In addition, within the United States, a public–private partnership program is needed to prevent, remove, and dispose of derelict fishing gear.

Ensuring Appropriate Port Reception Facilities

Under requirements for port reception facilities in Annex V of MARPOL, member nations must provide waste disposal facilities in their ports to receive waste from ships. Despite this requirement, many ports do not have adequate facilities. In addition, Annex V calls for the designation of Special Areas that receive a higher level of protection than is required in other ocean areas. Special Areas have been designated for many parts of the world, however, for a Special Area to receive extra protection, there must first be a demonstration of adequate port reception facilities. Some important Special Areas, such as the Wider Caribbean, are not yet eligible to receive extra protection because of inadequate port reception facilities. Therefore, the U.S. Department of State should increase efforts to ensure that all port reception facilities meet the criteria necessary to allow implementation of Special Areas protections.

ENHANCING THE USE AND PROTECTION OF OCEAN RESOURCES

The ocean's biological and mineral resources are of enormous value to the Nation, not only for their direct economic output, but also for their incalculable aesthetic importance.

The commercial fishing industry's total value exceeds $28 billion annually, with the recreational saltwater fishing industry valued at around $20 billion. NOAA estimates that U.S. coral reefs cover approximately 7,600 square miles. In 2001, coral reefs in the Florida Keys alone supported $105 million in income and more than 8,000 jobs. Further, approximately one half of all federally managed commercial fish species depend on coral reefs for at least part of their life cycle. Currently, energy development in federal waters accounts for more than 30 percent of domestic oil production and 25 percent of natural gas, with a total annual value of between $25–$40 billion, and a contribution of about $5 billion in royalties to the U.S. Treasury.

In order to provide for sustainable use, management needs to be strengthened in a broader context that looks at impacts of management decisions on the ecosystem as a whole.

Fisheries Management

The last 30 years has seen the evolution of an industry from being largely unregulated but with seemingly boundless potential, to one that is highly regulated and struggling to regain its potential as we move toward a sustainable, ecosystem-based fisheries management regime.

In 1976, based in part on the recommendations of the Stratton Commission, Congress approved the Magnuson–Stevens Fishery Conservation and Management Act to manage and assert U.S. control over fishery resources within 200 nautical miles of the coast. Eight Regional Fishery Management Councils (RFMCs) were created to develop management plans for fisheries in federal waters. The Act required regional plans to be consistent with broad national guidelines, but otherwise granted considerable flexibility to the RFMCs. The regional flexibility that had been seen as

a great strength of the new law now showed its downside as some RFMCs set unsustainable harvest levels, leading to the collapse or near-collapse of several important fisheries.

In the over 30 years since the Stratton report, some fishery management bodies have revealed fundamental weaknesses in the system that led to over-exploited stocks and ecosystem degradation in some regions. However, the management practices in some regions, particularly the North Pacific, protected fisheries from over-exploitation and served as a model for many of the Commission's fisheries recommendations. The Commission fishery recommendations can be grouped into six areas: strengthening the link between science and management, clarifying jurisdiction representation, expanding the use of dedicated access privileges, improving enforcement, and strengthening international management.

The link between fishery management decisions and peer-reviewed scientific info must be strengthened, including developing an expanded research program that is more responsive to managers' needs. To accomplish this, a number of management improvements are needed. RFMCs should be required to rely on the advice of their Scientific and Statistical Committees (SSCs), especially when setting harvest levels. RFMCs should not be allowed to approve measures less conservative than recommended by the SSC. SSC members should be nominated by the RFMCs and appointed by the NOAA Administrator. To ensure that SSC members are of the highest quality, their credentials and potential conflicts of interest should be reviewed by an external organization. To ensure sufficient external review of the scientific advice of the SSCs, NOAA should develop a standardized, independent peer-review process for implementation by all RFMCs. To ensure that needed conservation measures are implemented in a timely manner, default measures should be developed that would go into effect with a lack of action on the part of the RFMCs. Finally, to ensure that manager's have the information they require, NOAA's process for developing research plans should incorporate manager's priorities to the extent practicable. An expanded cooperative research program and increased emphasis on in-season recreational fishery data collection should be an important component of this effort.

Responsibilities and jurisdiction of the various federal and interstate fishery management entities need to be clarified, and the representation on the federal regional fishery management councils need to be broadened. To ensure that jurisdictional confusion does not lead to delaying conservation measures, Congress should assign a lead management authority among the various federal and interstate management authorities, based primarily on proportion of catch occurring within each entities jurisdiction. To ensure that the RFMCs have appropriate representation, particularly as we move toward ecosystem-based management, the governors should be required to submit a broader slate of candidates to be appointed by the NOAA Administrator. To ensure that RFMCs members have the necessary knowledge to properly manage fisheries, members should be required to take a training course. Finally, to ensure that all interstate fishery commissions have the necessary means to manage the fisheries under their jurisdiction, Congress should grant authority similar to the Atlantic Coastal Fisheries Cooperative Management Act to the Gulf and Pacific States Commissions.

To reverse existing incentives that create an unsustainable "race for the fish," fishery managers should explore widespread adoption of dedicated access privileges to promote conservation and help reduce over-capitalization. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act to affirm that fishery managers are authorized to institute dedicated access privileges, subject to meeting national guidelines; and every federal, interstate, and State fishery management entity should consider the potential benefits of adopting dedicated access programs. In addition, Congress should directly address over-capitalization by revising federal programs that subsidize over-capitalization, as well as work with NOAA to develop programs that permanently address over-capitalization in fisheries.

Fishery enforcement must be improved through adoption of better technology, such as Vessel Monitoring Systems (VMS) and better cooperation among federal agencies and States. Funding should be increased for Joint Enforcement Agreements between NOAA's National Marine Fisheries Service and coastal states as the best method of restoring the enforcement presence of the Coast Guard diminished because of the increased need for maritime security following the 9/11 terrorist attacks. The expanded use of VMS is another cost effective way of increasing enforcement capabilities.

Fishery management needs to continue the move toward ecosystem-based management in order to improve management, reduce conflicts between socio-economic impacts and biological sustainability, and provide a proper forum to address difficult management issues. In particular, issues such as habitat damage and bycatch

should be approached from an ecosystem basis and management plans should be designed to reduce impacts from these factors.

Because many of the stocks targeted by U.S. fishermen traverse international waters, it will be impossible to conserve some stocks without the aid of other countries. In addition, many endangered species such as sea turtles and whales travel the high seas. To promote international cooperation to conserve living marine resources, the Commission makes the following recommendations. The U.S. should work to encourage other countries to adopt and enforce existing international agreements to promote worldwide adoption of sustainable fisheries practices, in particular the Fish Stocks Agreement and the United Nations Food and Agriculture Organization's Compliance Agreement. The National Ocean Council should recommend effective methods to promote adoption of other important international conservation agreements, such as the Code of Conduct for responsible fisheries. In addition, the United States should continue to press for the inclusion of environmental objectives—particularly those specified in international environmental agreements—as legitimate elements of trade policy.

Marine Mammals and Endangered Species

Because of their intelligence, visibility and frequent interactions with humans, marine mammals hold a special place in the minds of most people and are afforded a higher level of protection than fish or other marine organisms. The American public has also consistently been supportive of efforts to prevent species from becoming endangered or extinct from human-caused activities. Because of the concern that the American public has shown for marine mammals and endangered species, specific legislation was enacted to provide them greater protection. The Marine Mammal Protection Act and the Endangered Species Act are landmark laws that have protected marine mammals and populations in danger of extinction since their passage. However, both Acts need to move toward a more ecosystem-based regime to improve protections for these populations.

The biggest threat to marine mammals worldwide today is their accidental capture or entanglement in fishing gear (known as "bycatch"), killing hundreds of thousands of animals a year. Commercial harvesting contributed to major declines in the populations of marine mammals but only a few nations still allow hunting for purposes other than subsistence. Hunters from those nations continue to kill hundreds of thousands of seals, whales, dolphins, and other marine mammals each year while legal subsistence hunting accounts for thousands more. Other potential causes of death and injury to marine mammals, such as ships strikes, pollution and toxic substances, and noise from ships and sonar, cause many fewer deaths than bycatch and hunting.

The threats to endangered marine species such as sea turtles and sea birds are myriad and not easily categorized. One factor that is common to declines in many species is the destruction or degradation of their natural habitat. Thus the successful recovery of a species depends to a large degree on protection or restoration of this habitat.

One of the critical components to improving protections for protected species is expanding the knowledge base. We know very little about the basic biology for these species, particularly marine mammals. The lack of basic scientific information has perhaps contributed to the frequent mismatch between causes of impacts to marine mammal populations and the amount of management attention paid to them. For example, the top two impacts to marine mammals by orders of magnitude are bycatch and hunting, yet most recent attention is being paid to other causes. Under ecosystem-based management, the most critical impacts should be addressed first. However, our overwhelming lack of knowledge of marine mammal and endangered species makes it difficult to properly rank and address impacts to these species. As the foundation to improving management, the Commission recommends an expanded research, technology, and engineering program, coordinated through the National Ocean Council, to examine and mitigate the effects of human activities on marine mammals and endangered species. In particular, Congress should expand federal funding for research into ocean acoustics and the potential impacts of noise on marine mammals. The U.S. should increase efforts to extend the benefits of the expanded research program to other countries.

Another important component to improving protections for protected species will be to clarify and coordinate federal agency actions. The Commission recommends that jurisdiction for marine mammals be consolidated within NOAA, and that the NOC improve coordination between NOAA and the Fish and Wildlife Service with respect to the implementation of the Endangered Species Act, particularly for anadromous species or when land-based activities have significant impacts on marine species.

The MMPA, with limited exceptions, prohibits the hunting, killing, or harassment of marine mammals. One of the exceptions authorizes the issuance of permits for the unintentional and incidental taking of small numbers of marine mammals provided it has only a negligible impact on the species. This provision has been problematic because terms such as small numbers and negligible impact are not defined in the Act, resulting in a lack of clarity about when a permit is necessary and under what circumstances it should be granted. Congress should amend the Marine Mammal Protection Act to require the NOAA to more clearly specify categories of activities that are allowed without a permit, those that require a permit, and those that are prohibited. Specifically, Congress should amend the Marine Mammal Protection Act to revise the definition of harassment to cover only activities that meaningfully disrupt behaviors that are significant to the survival and reproduction of marine mammals.

As an adjunct to clarifying allowed and permitted activities, the permitting process itself should be streamlined. Specifically, programmatic permitting should be used where possible to simplify agency permitting.

Coral Communities

Tropical and deep water coral communities are among the oldest and most diverse ecosystems, rivaling tropical rain forests in biodiversity and economic value. But, tropical coral reef health is rapidly declining, with pristine reefs being rare or nonexistent and possibly one-third of the world's reefs severely damaged. The existing management structure is inadequate and agencies and laws overseeing coral reef management have made little progress in actually protecting corals. Immediate action is needed to avoid irreversible harm.

In the short-term, the Coral Reef Task Force (CRTF) should be strengthened by placing it under the NOC, and adding the U.S. Department of Energy and the U.S. Army Corps of Engineers. The strengthened CRTF should begin immediate development of actions to reverse impacts of coastal pollution and fishing on coral communities. The EPA and USDA, at the minimum, should be charged with implementing the coastal pollution reduction plan and NOAA should be charged with implementing the plan for reversing impacts from fishing. In addition, the CRTF's area of responsibility should be expanded to include deep water coral communities as well.

In the long-term, the Congress should enact a "Coral Protection and Management Act" that provides direct authority to protect and manage corals, and provides a framework for research and cooperation with international protections efforts. This legislation should include the following elements: support for mapping, monitoring, and research programs; support for new research and assessment activities to fill critical information gaps; liability provisions for damages to coral reefs similar to those in the Marine Protection, Research, and Sanctuaries Act; support for outreach activities to educate the public about coral conservation and reduce human impacts; and, support for U.S. involvement, particularly through the sharing of scientific and management expertise, in bilateral, regional, and international coral reef management programs.

As the world's largest importer of ornamental coral reef resources, the United States has a particular responsibility to help eliminate destructive harvesting practices and ensure the sustainable use of these resources. Many of these resources are harvested by methods that destroy reefs and over-exploit ornamental species. A balance is needed between sustaining the legitimate trade in ornamental resources and sustaining the health and survival of the world's coral reef resources. The U.S. should develop domestic standards for the importation of coral species, to ensure that U.S. citizens do not indirectly promote unsustainable practices in coral harvesting countries.

Aquaculture

Marine aquaculture has the potential to supply part of the ever increasing domestic and worldwide demand for seafood. However, there are two major concerns that need to be addressed: environmental problems with existing aquaculture operations, particularly net-pen facilities, and a confusing, inconsistent array of State and federal regulations that hinder private sector investment.

To oversee a comprehensive and environmentally sound management regime, Congress should amend the National Aquaculture Act to designate NOAA as the lead federal agency for implementing a national policy for environmentally and economically sustainable marine aquaculture and create an Office of Sustainable Marine Aquaculture in NOAA.

This new NOAA office should develop a single, multi-agency federal permit for the aquaculture industry and ensure aquaculture facilities meet State and national en-

vironmental standards to lessen impacts from escapement and disease and protect the sustainability and diversity of wild stocks.

Furthermore, the permitting and leasing system and implementing regulations should: reflect a balance between economic and environmental objectives consistent with national and regional goals; be coordinated with guidelines and regulations developed at the State level; include a system for the assessment and collection of a reasonable portion of the resource rent generated from marine aquaculture projects that use ocean resources held in public trust; require applicants to post a bond to ensure that any later performance problems will be remedied and that abandoned facilities will be safely removed at no additional cost to the taxpayers; and, require the development, dissemination, and adoption by industry of best management practices that are adaptable to new research and technology advances.

Enhanced investments in research, demonstration projects, and technical assistance can help the industry address environmental issues, conduct risk assessments, develop technology, select species, and improve best management practices. It is also vital for developing fair and reasonable policies, regulations, and management measures. Most of the federal research to support marine aquaculture has been carried out under the auspices of NOAA's National Sea Grant College Program, which funds primarily university-based research. Congress should increase funding for expanded marine aquaculture research, development, training, extension, and technology transfer programs in NOAA. The Office of Sustainable Marine Aquaculture should set priorities for the research and technology programs, in close collaboration with academic, business, and other stakeholders.

Because the U.S. market for seafood is one of the largest in the world, we can use our market power as a positive force for promoting sustainable, environmentally sound aquaculture practices not only in the U.S., but the world as well. The U.S. should work to ensure that all countries adhere to aquaculture standards such as are in the UN FAO Code of Conduct for Responsible Fisheries.

Oceans and Human Health

Beneficial and harmful links between human health and ocean health exist. While several important medical treatments are based on chemicals discovered in marine animals, increasingly common phenomena such as harmful algal blooms have demonstrated ability to negatively impact human health. The health of marine ecosystems is affected by human activities such as pollution, global warming, and fishing. But in addition, human health depends on thriving ocean ecosystems. A better understanding about the many ways marine organisms affect human health, both for good by providing drugs and bioproducts, and for bad by causing human ailments, is needed.

Congress should establish an oceans and human health initiative to create a competitive grant program and coordinate federal activities. Existing programs at NOAA, NSF and the National Institute of Environmental Health Sciences should be coalesced in this initiative. This initiative should be expanded to include other pertinent agencies such as the EPA and FDA.

New knowledge and technologies are needed to detect and mitigate microbial pathogens. These methods must be quick and accurate so that information can be communicated to resource managers and the coastal community in a timely manner. As they are developed, technologies need to be integrated into biological and biochemical sensors that can continuously monitor high-risk sites. It is important that site-specific sensor data and satellite sensor data be incorporated into the IOOS. To accomplish this task, the National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support the development and implementation of improved methods for monitoring and identifying pathogens and chemical toxins in ocean waters and organisms.

Offshore Energy and Mineral Resources

Oil and gas development on the Outer Continental Shelf (OCS) provides over a quarter of our domestic oil and gas reserves, and contributes thousands of jobs and billions of dollars to our economy. In addition to its responsibilities for living marine resources, the Federal Government also exercises jurisdiction over nonliving resources, energy and other minerals located in the waters and sea bed of the more than 1.7 billion acres of OCS. Offshore oil and gas development has the most mature and broadest management structure of all such resources. Although controversial in many areas, the process for oil and gas leasing and production is well institutionalized, reasonably comprehensive, and could be a model for new ocean-based renewable energy projects as part of a coordinated offshore management regime.

MMS's Environmental Studies Program (ESP) is a major source of information about the impacts of OCS oil and gas activities on the human, marine, and coastal environments. Since 1986, annual funding for the program has decreased, in real dollars, from a high of $56 million to approximately $18 million in 2003. The erosion in ESP funding has occurred at a time when more and better information, not less, is needed. There continues to be a need to better understand the cumulative and long-term impacts of OCS oil and gas development, especially in the area of low levels of persistent organic and inorganic chemicals, and their cumulative or synergistic effects.

The U.S. Department of the Interior should reverse recent budgetary trends and increase funding for the Minerals Management Service's Environmental Studies Program. The development of technologies and exploratory activities moving into very deep waters requires an increase in the MMS environmental studies program to keep track of new and emerging environmental issues. In addition to this program, the development of the IOOS could provide better information that can improve management of offshore resources. Industry and federal agency partnerships should allow use of industry facilities to be incorporated into the IOOS.

To make certain that the federal-State partnership is strengthened and that critical marine ecosystems are protected, more investment of the resource rents generated from OCS energy leasing and production into the sustainability of ocean and coastal resources is necessary. Specifically, some portion of the revenues received by the Federal Government annually for the leasing and extraction of nonrenewable offshore resources need to be allocated to all coastal states for programs and efforts to enhance the conservation and sustainable development of renewable ocean and coastal resources. Congress should ensure that revenues received from leasing and extraction of oil and gas and other new offshore uses are used to promote sustainable development of renewable ocean and coastal resources through creation of a grant program to all coastal states, with a larger share going to OCS producing States.

Conventional oil and gas are not the only fossil-based fuel sources located beneath ocean floors. Methane hydrates are solid, ice-like structures composed of water and natural gas. They occur naturally in areas of the world where methane and water can combine at appropriate conditions of temperature and pressure, such as in thick sediments of deep ocean basins, at water depths greater than 500 meters. The estimated amount of natural gas in the gas hydrate accumulations of the world greatly exceeds the volume of all known conventional gas resources. Conservative estimates reveal the quantity is enough to supply all of the Nation's energy needs for more than 2,000 years at current rates of use. However, there is still no known practical and safe way to develop the gas and it is clear that much more information is needed to determine if methane hydrates can become a commercially viable and environmentally acceptable source of energy. The National Ocean Council (NOC), working with the U.S. Department of Energy and other appropriate entities, should determine whether methane hydrates can contribute significantly to meeting the Nation's long-term energy needs. If such contribution looks promising, the NOC should determine how much the current investment in research and development efforts should be increased.

There is continued interest in offshore renewable technologies as a means of reducing U.S. reliance on potentially unstable supplies of foreign oil, diversifying the Nation's energy mix, and providing more environmentally benign sources of energy. As long as federal agencies are forced to bootstrap their authorities to address these activities, the Nation runs the risk of unresolved conflicts, unnecessary delays, and uncertain procedures. What is urgently needed is a comprehensive offshore management regime, developed by the National Ocean Council, which is designed to review all offshore uses in a greater planning context. A coherent and predictable federal management process for offshore renewable resources that is able to weigh the benefits to the Nation's energy future against the potential adverse effects on other ocean users, marine life, and the ocean's natural processes, should be fully integrated into the broader management regime. Congress, with input from the National Ocean Council, should enact legislation providing for the comprehensive management of offshore renewable energy development as part of a coordinated offshore management regime. Specifically, this legislation should: streamline the process for licensing, leasing, and permitting renewable energy facilities in U.S. waters; subsume existing statutes, such as the Ocean Thermal Energy Conversion Act, and should be based on the premise that the oceans are a public resource; and, ensure that the public receives a fair return from the use of that resource and development rights are allocated through an open, transparent process that takes into account State, local, and public concerns.

ADVANCING INTERNATIONAL OCEAN SCIENCE AND POLICY

The United States has traditionally been a leader in international ocean policy-making and has participated in the development of many international agreements that govern the world's ocean areas and resources. That leadership must be maintained and reinvigorated. The international ocean challenges of the 21st century will require improved collaboration among domestic and international policy-makers to establish ambitious objectives and take the actions necessary to achieve them.

The United States can best advance its own ocean interests and positively contribute to the health of the world's oceans by first ensuring that U.S. domestic policies and actions embody exemplary standards of wise, sustainable ocean management. The new national ocean policy framework will be instrumental in setting this positive tone for the international ocean community. The Commission also recommends several specific actions to maintain and reinvigorate the leadership of U.S. in global ocean issues:

U.S. Accession to the United Nations Convention on the Law of the Sea

The United States should accede to the United Nations Convention on the Law of the Sea—the preeminent legal framework for addressing international ocean issues. Until that step is taken, the Nation will not be able to fully participate in bodies established under the Convention that make decisions on issues of importance to all coastal and seafaring nations, or to assume its important leadership role and protect United States interests as the law of the sea evolves.

Enhanced Coordination Among U.S. Ocean-Related Federal Agencies

Within the U.S. Government, the U.S. Department of State is the lead agency for most ocean-related international negotiations. However, the role of more specialized agencies is extremely important due to the science and resource focus of many multilateral ocean issues. Consistent involvement of a wide range of experts is essential both to establish international standards that reflect U.S. interests, and to ensure that subsequent actions by the United States and others are in accordance with those standards.

A new mechanism is needed to provide the optimum degree of coordination among U.S. agencies sharing responsibility and knowledge of international ocean issues. An interagency committee should be established under the auspices of the National Ocean Council to enhance coordination and collaboration among U.S. Government agencies, strengthening U.S. performance at international negotiations and improving implementation of international ocean policy.

Successful national and international ocean policy depends on sound scientific information. It is essential, therefore, to ensure that U.S. policy-makers benefit from timely advice and guidance from the U.S. marine scientific community. This, in turn, requires procedures that both give scientists the opportunity to provide input and policy-makers the chance to carefully consider their recommendations. The State Department should increase its internal training and scientific support to ensure better integration of ocean-related scientific expertise in policy and program development and implementation. In addition, the Department should develop more effective mechanisms to facilitate input from other government agencies and the broader scientific community.

Building International Capacity in Ocean Science and Management

Implementation of international ocean policy and improved management of ocean and coastal resources worldwide are affected by the adequacy of the science and management capacity of every coastal nation. To maintain progress on a global scale, the United States and other capable nations must assist coastal nations of more limited means. To be most effective, assistance should be science-based and developed within the context of an ecosystem-based approach. The U.S. Department of State should offer strong support for U.S. scientists conducting research programs around the world. Existing international partnerships should be strengthened and new partnerships promoted to facilitate the conduct of international research.

Capacity-building efforts should be concentrated on issues that have been identified as particularly critical for the health of an ecosystem or marine species, and have the greatest potential for positive impacts. In most instances, effective capacity-building will require long-term efforts to change detrimental practices and build support for new, sustainable management approaches. These efforts will require a funding commitment sufficient to make the changes needed to preserve or rebuild healthy ecosystems. As part of its international leadership role, the United States should increase its efforts to enhance long-term ocean science and management capacity in other nations through funding, education and training, technical assistance, and sharing best practices, management techniques, and lessons learned.

IMPLEMENTING A NEW NATIONAL OCEAN POLICY

To implement the blueprint for a new national ocean policy outlined in our report, several key elements are required: the will to move forward, the actors to carry out the changes, and the resources to support sustainable management of our oceans and coasts. Congress and the President have already demonstrated political will by enacting the *Oceans Act of 2000* and appointing the U.S. Commission on Ocean Policy. Our preliminary report specifies who should carry out each recommendation and discusses what the costs will be and how they can be covered.

Who Should Take Action

In our report, we make 198 specific recommendations to implement a more coordinated and comprehensive national ocean policy. One of our goals was to ensure that every recommendation was aimed at a clear responsible party who could take action and be held accountable over time. As you read the report, you will see the recommendations grouped according to subject area. However, to highlight the assignment of responsibility, we also present a summary of all 198 recommendations, organized by the primary actors, in Chapter 31.

In brief:

- We include 54 recommendations for Congress, 69 for Executive Branch leaders, and 125 for Federal Government agencies.
- Of the 69 recommendations for Executive Branch leaders, eight recommendations are for the President, 45 for the new National Ocean Council, 13 for the offices under the NOC's Committee on Ocean Science, Education, Technology, and Operations, two for the Assistant to the President, and one for the Presidential Council of Advisors on Ocean Policy.
- Of the 125 recommendations aimed at Federal Government agencies, 44 are for NOAA, 20 for EPA, 10 for the U.S. Coast Guard, nine for NSF, nine for the Department of the Interior, eight for the U.S. Navy, eight for the Department of State, six for the Department of Transportation, five for NASA, three for the National Institute of Environmental Health Sciences, two for the U.S. Army Corps of Engineers, two for the Department of Agriculture, and one for the Department of Labor.

(Note that some recommendations include more than one actor. As a result, the breakdown by organization adds up to more than 198.)

Although we have avoided targeting States (and local, territorial, and tribal governments) as the primary actors in our recommendations, they have a critically important role to play in the new National Ocean Policy Framework—through establishment of regional ocean councils, and in areas such as coastal development, water quality, education, natural hazards planning, fishery management, habitat conservation, and much more. States should also participate in the design and implementation of regional ocean observing systems and their integration into the national IOOS, as well as other research and monitoring activities.

How Can the Needed Changes Be Achieved: Costs and Revenues

The recommendations I've just alluded to outline a series of ambitious proposals for improving the use and protection of the Nation's oceans and coasts. But meaningful change requires meaningful investments. In the case of the ocean, such investments are easy to justify.

As I explained earlier and as we discuss in more detail in the preliminary report, more than one trillion dollars, or one-tenth of the Nation's annual gross domestic product, is generated each year within communities immediately adjacent to the coast. By including the economic contribution from all coastal watershed counties, that number jumps to around five trillion dollars, or fully one half of our nation's economy. Those contributions are threatened by continued degradation of ocean and coastal environments and resources.

Modest levels of new funding will reap substantial dividends by supporting new management strategies to sustain our ocean and coastal resources and maximize their long-term value.

Costs

From the start, this Commission pledged to be clear about the costs of its recommendations. In keeping with that goal, the final report will include a complete accounting of the startup, short-term, and continuing costs associated with each issue area, including an analysis of federal, State, and local budget implications to the extent possible.

At this stage, I am able to provide a rough estimate of overall new federal spending associated with the Commission's preliminary recommendations. The Commis-

sion continues to refine its calculations and the information on which they are based, and will have more detailed costs and revenue estimates in the final report to the Congress and the President.

The total estimated additional cost for initiatives outlined in our report will be approximately:

- $1.2 billion in the first year
- $2.4 billion in the second year
- $3.2 billion per year in ongoing costs thereafter.

A few special investments are worth highlighting:

- Creation of the National Ocean Council and related elements, with first-year costs of $1 million and ongoing annual costs of $2 million.
- Expansion of ocean education programs, with first-year costs of $7 million, second year costs of $251 million, and ongoing annual costs of $246 million.
- Establishment of an integrated ocean observing system, with first-year costs of $290 million, second-year costs of $312 million, and ongoing annual costs of $652 million.
- Increased ocean science and exploration, with first-year costs of $230 million, second-year costs of $395 million, and ongoing annual costs of $760 million.
- Dedicated federal support for needed State actions, with first-year costs of $500 million, second-year costs of $750 million, and ongoing annual costs of $1 billion.

In view of the value generated by the ocean and coastal economy, we believe these are very reasonable investments.

Revenue: Creation of an Ocean Policy Trust Fund

Mindful of intense budgetary pressures at both federal and State levels—and sensitive to the hardship associated with unfunded federal mandates—the Commission set out to identify appropriate sources of revenue to cover the cost of its recommendations. A logical, responsible funding strategy is outlined in the preliminary report and will be developed further in the final report.

The Commission proposes creation of an Ocean Policy Trust Fund composed of rents generated from permitted uses in federal waters. The Fund would include Outer Continental Shelf oil and gas revenues that are not currently committed. It would support the additional responsibilities we suggest for federal agencies and prevent the creation of unfunded mandates to states.

The critical nature of the Nation's oceans assets and the challenges faced in managing them make it clear that the time has come to establish an Ocean Policy Trust Fund in the U.S. Treasury to assist federal agencies and State governments in carrying out the comprehensive ocean policy recommended by this Commission.

The Fund would include federal revenues from Outer Continental Shelf oil and gas development that are not currently committed to other funds. The Land and Water Conservation Fund, the National Historic Preservation Fund, and the OCS oil and gas revenues given to coastal states from the three mile area seaward of their submerged lands would not be affected. After those programs were funded, in accordance with law, the remaining OCS monies would be deposited into the Ocean Policy Trust Fund.

Additional funds may also become available based on new offshore activities. In several sections of the preliminary report we discuss revenues that may be generated from permitted uses of federal waters. In general, when a resource is publicly-owned, its use by private profit-making entities should be contingent on a reasonable return to taxpayers. Creating a link between permitted activities in federal waters and the cost of associated regulatory and management responsibilities is logical and well justified by precedents in federal land management.

Approximately $5 billion is generated annually from OCS oil and gas revenues. Protecting the three programs noted above would remove about $1 billion. Thus, some $4 billion would remain available for the Ocean Policy Trust Fund each year under current projections. At this time it is not possible to specify the amount of revenue that might be produced by emerging uses in federal waters, nor predict when they may begin to flow.

The report recommends that a portion of the revenues received from the use of offshore resources be granted to States for the conservation and sustainable development of renewable ocean and coastal resources. OCS oil and gas producing States should receive a larger portion of such revenues to address the impacts on their States from extraction activities in adjacent federal offshore waters.

In the Commission's view, Trust Fund monies should be used exclusively to support improved ocean and coastal management consistent with the Nation's new coordinated and comprehensive national ocean policy. Such funds would be used to supplement—not replace—existing appropriations for ocean and coastal programs, and to fund new or expanded duties.

CLOSING STATEMENT

What I have presented to you today is a broad overview of the Commission's preliminary report—the culmination of two and a half years of work by 16 dedicated commissioners, 26 world-class science advisors, and a tireless staff of experts. To create this report, the Commission heard testimony and collected other information that shaped our understanding of the most pressing issues facing our nation's oceans and coasts.

The Commission balanced environmental, technical, economic, and scientific factors in making its recommendations. These bold recommendations for reform call for immediate implementation, while it is still possible to reverse distressing declines, seize exciting opportunities, and sustain the oceans and their valuable assets for future generations. Clearly, the Commission's recommendations will require some new investments. However, without major change, the tremendous potential of our oceans and coasts to American prosperity will continue to deteriorate.

It has taken more than 35 years for the Nation to refocus its attention on these vital resources. Our report provides a blueprint for the 21st century to achieve a future where our oceans and coasts are clean, safe, and sustainably managed and continue to contribute significantly to the well being of all the Nation's citizens. The time to act is now and everyone who cares about the oceans and coasts must play a part. Leadership from this committee and others in Congress, and from the White House, will be essential and we look forward to working closely with all of you in the months and years to come.

BIOGRAPHY FOR ADMIRAL JAMES D. WATKINS

Admiral James D. Watkins, U.S. Navy (retired), is currently serving as chairman of the U.S. Commission on Ocean Policy. The Commission, authorized by Congress in the *Oceans Act of 2000,* includes 16 members appointed by the President. The Commission's task is to recommend a new, comprehensive national ocean policy to the Congress and the President in 2003.

Prior to his appointment to the Ocean Commission, Admiral Watkins served as president of the Joint Oceanographic Institutions (JOI), in Washington, D.C., from September 1993 until October 2000. In September 1994, Admiral Watkins led the historic effort to establish an expanded partnership among the more than 60 U.S. marine institutions. The effort resulted in a public-private corporation known as the Consortium for Oceanographic Research and Education, or CORE. In September 1996, as a result of CORE's efforts, Congress authorized and funded the *National Oceanographic Partnership Act* which implemented a new, broad ocean science and technology agenda for the Nation. Admiral Watkins served seven years as founding President of CORE, stepping down in March 2001.

For his work with JOI and CORE, Admiral Watkins was awarded honorary doctor of science degrees from the College of William and Mary and Oregon State University in 1999. In March 2001, he was given the title of President Emeritus of CORE, and was awarded the Navy's Distinguished Public Service Award by the Secretary of the Navy for his contributions to the Nation in ocean science and technology matters.

Prior to his oceanographic work, Admiral Watkins served as the sixth Secretary of Energy under President George H.W. Bush, from March 1989 through January 1993. He also served as the 22nd Chief of Naval Operations under President Ronald Reagan. Admiral Watkins is a native of California and a 1949 graduate of the U.S. Naval Academy.

Chairman BOEHLERT. Thank you very much, Admiral.

Dr. Solow.

STATEMENT OF DR. ANDREW R. SOLOW, DIRECTOR OF MARINE POLICY CENTER, WOODS HOLE OCEANOGRAPHIC INSTITUTION

Dr. SOLOW. Thank you very much. It is an honor to testify before this committee.

Before I begin, I would like to say that, in my opinion, Admiral Watkins, Tom Kitsos, and the rest of the Commission staff have performed a true service to the Nation and a near-miracle by producing this report.

I have been asked to address three questions about the recommendations of the report. The first question is: "What are the major deficiencies in the way ocean and coastal policy is organized at the federal level?" In broad terms the main deficiency in the way federal policy in this area is organized is fragmentation. At least six departments, Agriculture, Commerce, Defense, Energy, Interior, and Transportation, have significant responsibilities in ocean and coastal policy, as does the Environmental Protection Agency. Other departments and independent agencies have more limited involvement. This fragmentation tends to impede policy coordination. Policy coordination is especially important in this area, because the various biological and environmental components of the marine and coastal system are linked and therefore can not be managed effectively in isolation.

Having said that, in my opinion, there is a tendency to overstate the connection between policy outcome and policy structure. Although federal policy structure in this area is fragmented, this fragmentation is not, by itself, responsible for the problems on the ground and in the water. Federal entities can, and do, communicate and coordinate, both formally and informally. This process is uneven and imperfect, but it is part of the picture. By the same token, rationalizing the federal policy structure is no guarantee that the problems will be solved. This is by no means an argument against improving the structure. I only wish to be realistic about what an improved structure, by itself, can deliver.

The second question that I have been asked to address is: "Do you agree with the Commission's recommendation to create a National Ocean Council?" This Council would consist of secretaries and directors of departments and agencies with responsibilities in this area. If the Commission's only recommendation in the area of federal structure had been to create this Council, then I would not have been terribly enthusiastic about it. As the old adage goes, you can lead a horse to water, but you can't make him drink. However, the Commission also recommends the appointment of an assistant to the President to chair this Council, the formation of a group of non-federal advisors to work with the Council, and the formation of a small White House Office of Ocean Policy, headed by the assistant to the President, that would support the Council and oversee the implementations of its recommendations and decisions. This raises the prospect that the horses will drink, and I am enthusiastic about the complete package of recommendations for three reasons.

First, although I do not believe that the problems on the ground and in the water would be solved by better coordination alone, better coordination could certainly contribute to the formulation and execution of better policies. Second, this is a time when new uses of the ocean, for example ocean aquaculture and wind power, and new methods of management, for example market-based approaches and multiple-use management, are being contemplated. At such a time, it would be good to have a federal structure that

is light on its feet, and an enhanced degree of coordination would help in this regard. Third, enacting this package of recommendations would elevate the visibility of ocean issues and underline the Nation's determination to address them. To the extent that this will galvanize the people and the government, this, too, could help.

The third question that I have been asked to address is: "Are there alternative changes to the federal structure that you would recommend?" Federal structure in this area has essentially evolved by itself over the past 30 years. In my opinion, it is a good time to take a comprehensive look at the product of this evolutionary process and make improvements where possible. The Ocean Commission has made an excellent start at this, and provided the political will is there, the structural changes that it recommends are a good way to see that the job is finished, at least for this generation. The only additional change that I would recommend would be to ensure that all federal activities relating to the ocean undergo common policy and budgetary review within the Office of Management and Budget. The Commission's recommendation to review the NOAA budget within the Natural Resources Program at OMB would be a big step in the right direction.

I would again like to thank the Committee for giving me this opportunity to testify.

[The prepared statement of Dr. Solow follows:]

PREPARED STATEMENT OF ANDREW R. SOLOW

Thank you very much. It is an honor to testify before this committee.

Before I begin, I would like to say that, in my opinion, Admiral Watkins, Tom Kitsos, and the rest of the Commission staff have performed a true service to the Nation and a near-miracle by producing this report.

I have been asked to address three questions about the findings and recommendations of the report. The first question is: What are the major deficiencies in the way ocean and coastal policy is organized at the federal level? In broad terms, the main deficiency in the way that federal policy is organized in this area is fragmentation. At least six Departments—Agriculture, Commerce, Defense, Energy, Interior, and Transportation—have significant responsibilities in ocean and coastal policy, as does the Environmental Protection Agency. Other Departments and independent Agencies have more limited involvement. This fragmentation tends to impede policy coordination. Policy coordination is especially important in this area because the various biological and environmental components of the marine and coastal system are linked and, therefore, cannot be managed effectively in isolation.

Having said that, in my opinion, there is a tendency to overstate the connection between policy outcome and policy structure. Although federal policy structure in this area is fragmented, this fragmentation is not by itself responsible for the problems on the ground and in the water. Federal entities can and do communicate and coordinate both formally and informally. This process is uneven and imperfect, but it is part of the picture. By the same token, rationalizing the federal policy structure is no guarantee that the problems will be solved. This is by no means an argument against improving the structure. I only wish to be realistic about what an improved structure, by itself, can deliver.

The second question that I have been asked to address is: Do you agree with the Commission's recommendation to create a National Ocean Council to address these deficiencies? This Council would consist of Secretaries and Directors of Departments and Agencies with responsibilities in this area. If the Commission's only recommendation in the area of federal structure had been to create this Council, then I would not be terribly enthusiastic about it. As the old adage goes, you can lead a horse to water, but you can't make him drink. However, the Commission also recommends the appointment of an Assistant to the President to chair this Council, the formation of a group of non-federal advisors to work with the Council, and the formation of a small White House Office of Ocean Policy, headed by the Assistant to the President, that would support the Council and oversee the implementation

of its decisions. This raises the prospect that the horses will drink and I am enthusiastic about the complete package of recommendations for three reasons.

First, although I do not believe that the problems on the ground and in the water would be solved by better coordination alone, better coordination could certainly contribute to the formulation and execution of better policies. Second, this is a time when new uses of the ocean—for example, ocean aquaculture and wind power—and new methods of management—for example, market-based approaches and multiple-use management—are being contemplated. At such a time, it would be good to have a federal structure that is light on its feet and an enhanced degree of coordination would help in this regard. Third, enacting this package of recommendations would elevate the visibility of ocean issues and underline the Nation's determination to address them. To the extent that this will galvanize the people and the government, this, too, could help.

The third question that I have been asked to address is: Are there alternative changes to the federal structure that you would recommend? Federal structure in this area has essentially evolved by itself over the past 30 years. In my opinion, it is a good time to take a comprehensive look at the product of this evolutionary process and make improvements where possible. The Ocean Commission has made an excellent start at this and, provided the political will is there, the structural changes that it recommends are a good way to see that the job is finished—at least for this generation. The only additional change that I would recommend would be to ensure that all federal activities relating to the ocean undergo common policy and budgetary review within the Office of Management and Budget. The Commission's recommendation to review the NOAA budget within the Natural Resources Program at OMB would be a big step in the right direction.

I would again like to thank the Committee for giving me the opportunity to testify.

BIOGRAPHY FOR ANDREW R. SOLOW

Professional Experience

1994–present—Director, Marine Policy Center, Woods Hole Oceanographic Institution

1987–present—Scientific Staff, Woods Hole Oceanographic Institution

1985–1987—Post-doctoral Research Fellow, Woods Hole Oceanographic Institution

Education

1986—Ph.D., Statistics, Stanford University

1977—BA, Economics, Harvard University

Selected memberships

Editorial Board, *Environmental and Ecological Statistics*

Editorial Board, *Ecology*

Member, National Academy of Sciences, Commission on Geosciences, Environment, and Resources

Member, Scientific Working Group, Intergovernmental Panel on Climate Change

Member, U.S. Ocean Commission Science Panel

Selected publications

Solow, A.R. 1989. A randomization test for independence of animal locations. *Ecology,* 70(5): 1546–1549.

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Costello, C. and Solow, A.R. 2003. Discovery patterns or introduced species. *Proceedings of the National Academy of Sciences,* 100: 3321–3323.

Recent collaborators

Stephen Bollens, San Francisco State University; Christopher Costello, University of California, Santa Barbara; Laura Moore, Oberlin College; Stephen Polasky, University of Minnesota; David Roberts, Royal Botanic Gardens, Kew; Woollcott Smith, Temple University; Lewi Stone, Tel Aviv University

Graduate and Postdoctoral Advisors

Andre Journel (Ph.D. Advisor), Stanford University

James Broadus (Postdoctoral Advisor), deceased

Ph.D. Committee Service MIT–Woods Hole Joint Program

Carla Curran; Michelle Durand; Masami Fujiwara; Rebecca Green; Gorka Sancho; Laela Sayigh

Other Ph.D. Committee Service

Anand Patwardhan (Carnegie Mellon); Oren Barnca (Tel Aviv University); Ercan Yesilinnak (University of Izmir)

Chairman BOEHLERT. Thank you very much, Dr. Solow, particularly because you were very precise in addressing each of the questions.

Now I would like you to be precise in the answer to this. Would you care to issue an invitation to this committee to join you in Woods Hole this summer?

Dr. SOLOW. Mr. Chairman, I have already written on the pad that I—that we would like to invite you all to visit.

Chairman BOEHLERT. It is one of the great places in the world for my colleagues who have not been there. And thank you for that kind invitation.

Dr. Pomponi.

STATEMENT OF DR. SHIRLEY A. POMPONI, ACTING MANAGING DIRECTOR OF THE HARBOR BRANCH OCEANOGRAPHIC INSTITUTION

Dr. POMPONI. Well, I would like to invite you to come to Fort Pierce, Florida, but not in the summertime. You will want to come there in January.

Chairman BOEHLERT. No, we have 12 months a year, and——

Dr. POMPONI. Right.

Chairman BOEHLERT [continuing]. And we will know when we will deal with——

Dr. POMPONI. Thank you, Chairman Boehlert and Members of the Science Committee, for the opportunity to appear before you this morning. While my testimony represents my own views, I am also testifying today as an elected member of the executive committee of the Consortium for Oceanographic Research and Education, or CORE. I have been asked to address the major problems and issues with respect to national efforts in ocean and coastal re-

search to identify the top recommendations that should be implemented immediately, given a limited budget, and to provide an example of how ecosystem-based management would change ocean and coastal management from current methods.

In the interest of time, I am providing just brief comments on each of these areas. My written testimony provides more detail for your consideration.

I believe four of the 12 critical actions identified by the Commission in its executive summary are essential to ocean and coastal science. First, improve the federal agency structure and strengthen NOAA. Coordination of ocean and coastal science programs remains a top priority for strengthening ocean science and does not require enormous financial resources, but rather a commitment by a dozen or so federal ocean agencies to coordinate their efforts and implement improved mechanisms that will allow them to work together efficiently. Enactment of a NOAA Organic Act that clearly lays out an integrated agency structure and mission is essential if NOAA is to address the Commission recommendations.

Second, double the U.S. investment in ocean research. Research areas where increased investment could lead to substantial benefits include bio-diversity and ecosystem research, development of ocean information systems, climate and ocean modeling, and discovery and development of new marine products. One of the most incredible scientific discoveries of the 20th century, in my opinion, animals that depend not on photosynthesis but on chemosynthesis was realized through exploration of deep-sea vents. Since that discovery more than 25 years ago, we have only explored less than 50 of the estimated 5,000 deep-sea vents and seeps. We have explored 200 of the estimated 30,000 sea mounds that could each provide new opportunities for fishery resources. A robust ocean exploration program will dramatically alter not only our understanding of life on Earth, and maybe even other planets, but also lead to new technologies and improved scientific understanding with benefits comparable, and likely even superior, to those we have realized as a result of space exploration.

While the overall levels of funding should be doubled, increases for individual agencies and programs should be based on a careful and comprehensive assessment of priorities related to national ocean policy goals and on the role of each federal ocean agency in carrying out that policy. For example, doubling of the NSF ocean science's budget is consistent with efforts to double the agency's budget overall. By contrast, at NOAA, the report recommends new responsibilities in several areas, such as ocean observing systems and oceans and human health, that would require substantial new, competitive research initiatives. For the Office of Naval Research, its vibrant support for basic research must be restored.

Third, implement the National Integrated Ocean Observing System. The ocean science community supports the Commission's high priority on development and implementation of an Integrated Ocean Observing System as well as on enhancing ocean infrastructure and technology development. Ensuring the future of the academic research fleet is one of the most acute needs of the marine science enterprise. Funding for an Integrated Ocean Observing System may be more of a challenge since NOAA is the logical home

for much of the program. By providing leadership and coordination, regional pilot programs that are already in progress could be fully integrated into a larger scale effort and initiate the implementation process.

Fourth, increase attention to ocean education. The Commission offers a number of recommendations to strengthen the role of science education as a specific part of each federal ocean agencies' mission. Currently, NSF and NASA are the only agencies that include education in their missions. Other agencies must support education to ensure continued agency capabilities.

The concept of ecosystems-based management enjoys broad-based support, because it makes sense both intuitively and scientifically. In my home State of Florida, a Comprehensive Everglades Restoration Plan is being implemented. Florida Bay is included in the restoration plan because of its linkages with the Everglades. One potential scenario is that nitrogen and phosphorus in the freshwater runoff from the Everglades could increase phytoplankton blooms in the Bay, and these blooms could be carried out to the Florida Reef Tract. The fact that we lack a circulation model that would enable us to link changes in Everglades hydrology with Florida Bay and reef tract ecology is hampering resource managers and restoration planners.

In conclusion, I would like to acknowledge the achievement represented by the Commission's report. The commissioners have given us a wide-ranging assessment of the current status of our oceans and coasts. They offer us a vision and a starting point for addressing America's relationship to the sea. With a clear path to follow, the support of stakeholders around the country, and your commitment to make the necessary changes, we have a unique opportunity to develop and implement a strong ocean policy.

Thank you.

[The prepared statement of Dr. Pomponi follows:]

PREPARED STATEMENT OF SHIRLEY A. POMPONI

Chairman Boehlert, Ranking Member Gordon and Members of the Science Committee, I want to thank you for the opportunity to appear before you this morning and for the Committee's leadership in considering the recommendations of the U.S. Commission on Ocean Policy (Commission). I am Shirley Pomponi, Acting Managing Director of Harbor Branch Oceanographic Institution. In addition, I serve on the Commission's Science Advisory Panel.

While my testimony represents my own views, I also am testifying today as an elected member of the executive committee of the Consortium for Oceanographic Research and Education (CORE). The 76 member institutions of CORE represent the mainstream of American oceanographic research and education. Through CORE, an incredibly diverse, dynamic and independent ocean sciences community works together to develop and promote a common vision and goals.

I would like to begin by acknowledging the enormous achievement represented by the Commission's preliminary report. This bipartisan panel of 16 experts from government, academia, and industry has released the most monumental review in three decades of how our country manages its vast ocean resources. Authorized by Congress and appointed by the President, the Commission has spent the past two years considering testimony from hundreds of citizens, scientists, and policy-makers. Over and over again, they heard that the oceans are in danger and that the responsible federal agencies and State and local governments are not working together effectively. Ultimately, they distilled an avalanche of material to produce a clear, stepwise plan for turning the situation around and developing a coherent national ocean policy.

This is not to say that there is agreement within the ocean community, or even within the Commission membership, on each of the Commission's recommendations.

Nor does it suggest that the preliminary report comprehensively addresses each of the many ocean policy challenges that this nation faces. What the Commission has given us is a wide-ranging and honest assessment of the current status of our oceans and coasts. Its members examined everything from stewardship of marine resources and pollution prevention to enhancing and supporting marine science, commerce and transportation, and their recommendations are just as far reaching. The preliminary report offers us a vision and starting point for addressing America's relationship to the sea. Now it is our responsibility to ensure that vision is implemented.

Ocean And Coastal Research Problems And Issues

While most Americans recognize that Earth is the only known living planet, few understand that its life is derived in large measure from its oceans. Oceanographic research to date has revealed that the seas play a critical role in regulating Earth's weather and climate, replenishing and maintaining the viability of our atmosphere, housing extraordinarily diverse forms of life, and significantly influencing the creation and ever-changing appearance of our coastlines.

Nor does the public fully understand the essential role of the oceans in our economy and to our quality of life. As the Commission points out, our nation's ocean economy contributed more than $117 billion and supported well over two million jobs in 2000. More than $1 trillion, or about a tenth of the U.S. annual gross domestic product is generated in a relatively narrow strip of land along our coasts, and almost half ($4.5 trillion) is generated in coastal watershed counties. One out of every six jobs in the United States is marine related, and over half of our population lives and works next to the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Great Lakes. Overseas trade via U.S. ports is expected to double by 2024, and the growth in passenger transportation is likely to continue. Offshore areas provide 30 percent of the oil, and 25 percent of the natural gas powering our economy and our homes.

My home State of Florida is among the most reliant on healthy oceans. With an economy and lifestyle that is intimately tied to coastal proximity, Floridians can feel the effects of ocean health decline in the form of beach closings, decreases in tourism, and even poor fishing. Such consequences threaten not only a way of life, but also the continued favor of the 50 million tourists that visit each year, and the economy they support.

It is a powerful reality that knowledge of the oceans, their resources and their relationship to human activities is vital to our existence. It is a fundamental challenge for the ocean science community to convey that reality both to decision-makers and to the American public. Our ability to address problems and issues in ocean and coastal research will rely in large part on our success.

Coordinating ocean and coastal research and education programs.

One of the most significant conclusions of the new report is that the patchwork of agencies and processes that have evolved over the past three decades to oversee the Nation's ocean interests is simply not up to the challenge of fixing the problems identified. To remedy the situation, the report recommends substantial restructuring at the federal level, including mechanisms for making ocean policy decisions through a high-level interagency governance structure.

Focusing specifically on ocean and coastal science, more than a dozen federal agencies currently fund research or education activities. Consequently, interagency coordination is essential to avoid duplication and strengthen the scientific basis for ocean management. The Commission proposes to build on the model created under the National Oceanographic Partnership Program (NOPP) in 1997. NOPP promotes national goals of assuring national security, advancing economic development, protecting quality of life, and strengthening science education and communication through improved knowledge of the ocean. It creates a higher level of coordinated effort and synergy across the broad oceanographic community by establishing partnerships on two fronts. First, NOPP relies on collaboration among fifteen federal agencies, calling on the top official of each participating agency to serve on an interagency council that provides program oversight. Second, NOPP increases the visibility for ocean issues on the national agenda by facilitating projects among federal agencies, academia, industry, and other governmental and non-governmental organizations. While investment in the program to date has been relatively modest, it has proven to be an effective mechanism for building and coordinating federal ocean science partnerships. Consequently, the oceanographic community generally supports the Commission's recommendations to use NOPP as a model for coordinating expanded interagency ocean science investments.

Enhancing the ocean observation and operational infrastructure.

The Commission report places high priority on development and implementation of a sustained and integrated ocean observing system and on enhancing ocean infrastructure and technology development. There is broad-based agreement within the oceanographic community on the need to maintain and enhance our national infrastructure for ocean observation and to support scientific operations.

The academic research fleet is the most crucial shared resource currently used by ocean and coastal researchers. Without a dependable seagoing capability, the flexibility and mobility needed to explore new areas and respond to exciting and scientifically interesting phenomena will be eliminated. One of the most acute needs of the marine science enterprise and for deploying and maintaining an integrated ocean observing system is ensuring the future of the oceanographic fleet.

Over the coming decade, nearly all mid-sized vessels classified as Regional or Ocean Class will reach the end of their design life and require replacement. In 2002, a federal interagency committee on oceanographic facilities completed a report outlining the state of the fleet and suggesting a timeline for replacement. While the Navy and the National Science Foundation have indicated that they may provide future funding for fleet renewal, neither agency has made available the funds necessary to construct new ships in the Oceans class. The Commission report recommends establishment of a modernization fund to meet such critical infrastructure and technology needs. However, it provides little detail on how such a fund would be capitalized or administered.

The Ocean Drilling Program (ODP) has been another important scientific platform that allows researchers to examine the past in order to understand the history of the ocean and climatic environment by retrieving and examining core samples from the ocean floor. Features like the North Atlantic Deep Water Formation, a driver of today's ocean-climate engine and the chief mechanism for the distribution of heat throughout the world's oceans, have fluctuated at well-defined intervals during the last fifteen million years. Understanding such abrupt changes is absolutely essential for comprehending the many forces affecting our world's climate. As ODP moves into a new, international phase, the principal drilling vessel, the *JOIDES Resolution,* will be retired, and a replacement must be secured to ensure continued U.S. participation in the program. The fiscal year 2005 budget for the National Science Foundation proposes $45 million to initiate that process as part of its Major Research Equipment and Facilities Construction account.

While ships provide an on-site, mobile, and flexible instrument platform for research and observation, long-term, *in situ* observations are critical to understanding ocean processes. Results from activities such as the tropical atmosphere-ocean buoy array that monitors the El Niño Southern Oscillation in the Pacific, the Pirata Array in the tropical Atlantic, and free-drifting ARGO profiling floats are proving the value of long time series observations, and developing the scientific foundation needed to better understand the global climate. Moreover, these systems demonstrate that changes in distant oceans can affect the coastal oceans of our nation.

It is critical that we expand the reach of our ocean observing systems throughout the marine environment, including our nation's coastal areas. In addition, we must develop and deploy a robust data integration and management system and enhance our modeling capability to ensure full benefit and use of observational products from this system. Such an end-to-end approach from observations to analysis to modeling is critical if we are to improve both our understanding of the ocean as well as to develop decision support capabilities regarding ocean policy and management.

In order to progress and enhance our nation's ocean observing abilities, supporting a strong and vigorous program of research and development is essential. The National Science Foundation is proposing an Ocean Observatories Initiative to explore new scientific questions that require a sustained, multi-year, real-time observation capability. This is an important step in maintaining our ocean science leadership. Other technological needs that should be examined include the scientific demand for deep-diving vehicles, dedicated platforms to support ocean exploration, and remote sensing capabilities.

Advancing ocean education.

The Commission has made promotion of lifelong ocean education a centerpiece of its preliminary report. The report stresses the central role of both formal and informal education efforts for Americans of all ages from kindergarten through retirement, stating:

> "To successfully address complex ocean- and coastal-related issues, balance the use and conservation of marine resources, and realize future benefits from the ocean, an interested, engaged public will be needed."

The Commission proposes to accomplish this by: (1) building a collaborative ocean education network that links research and education communities; (2) integrating the oceans into elementary and high school education programs; (3) investing in higher education and the ocean workforce; and (4) strengthening informal education programs.

I think the vast majority of my colleagues join me in supporting the Commission's focus on education. Moreover, I completely agree that a knowledgeable public is the real key to sustainable ocean policies. Ocean scientists need to improve our communication with the American public about the value of the science we do. It has been said that the U.S. space exploration program enjoys the support that it has because everyone can look up into the sky. On the other hand, not everyone lives on the coast and can see the ocean. Not everyone understands the value of ocean exploration to the discovery of new fisheries, new drugs, and new energy sources; to predicting phenomena such as El Niño and harmful algal blooms (and their impact on our health and economy); and to protecting our coastlines from both natural and man-made threats to our health and security.

Not surprisingly, CORE has been particularly active and interested in the Commission's recommendations on investing in higher education and the ocean workforce. Graduate education in the United States is based upon a strong national research infrastructure at centers of higher education and research. The future quality of ocean sciences in the United States and our nation's capability to understand and manage marine issues related to environmental quality, economic well-being, and national security depend upon maintaining graduate educational programs of high caliber. This area of education cannot be the concern of a single agency. All ocean agencies depend upon a well-educated and well-trained workforce and need to assume responsibility for this endeavor.

The Commission offers a number of recommendations to strengthen the role of science education as a specific part of each federal ocean agency's mission. Currently NSF and NASA are the only agencies that include education in their missions. Other "mission-oriented" agencies such as the Navy, NOAA, the U.S. Geological Survey (USGS) and the Environmental Protection Agency (EPA) all support science education to varying degrees—most commonly through graduate student research assistantships. At the same time, such support is vulnerable to budget cuts if education is not perceived by the executive branch to be a part of the agencies' core missions. Given each agency's workforce needs, it is essential that they provide significant financial assistance for supporting graduate students in order to ensure continued agency capabilities as well as the future health of the profession.

The financial aid system for graduate students in the ocean sciences depends primarily upon research assistantships and currently falls below other sciences. Over 50 percent of all graduate students in residence during fall 2001 were supported through research assistantships. In comparison, NSF and the National Aeronautics and Space Administration (NASA) offered an average of 15 graduate fellowships per year between 1995 and 2000. NSF also funded an average of six traineeships per year between 1995 and 2000. By contrast, the Federal Government supported almost 17,000 graduate traineeships and fellowships for all science and engineering fields during 2000.

While research assistantships are appropriate for supporting field-based graduate student research, traineeships allow the best students to support themselves in non-traditional educational programs that are often interdisciplinary and can produce a masters or doctorate with the knowledge of science, management and communications that is so desperately needed in our ocean-related workforce. The National Institutes of Health (NIH), which funds more than 50 percent of all federally-funded traineeships, provides a good potential model. Furthermore, the creation of large-scale integrated ocean research and observation programs offers new opportunities to support more fellowships and traineeships that allow the development of multi- or interdisciplinary educational experiences. Recognizing that this is an imbalance that must be corrected, the Commission recommends establishment of a NOAA traineeship program; initiation of this effort may occur under NOAA's Ocean and Health Initiative. Although the ocean science community supports the need for such a NOAA program, we also recommend that other mission agencies examine how each could create such programs to support a significant number of graduate students in a range of marine fields to ensure we have well-educated professionals for the coming decades.

Finally, a strong national research infrastructure at centers of higher education and research is predicated on the availability of talented individuals who are well-educated and well-trained in science, mathematics and technology. Efforts to create a pool of such individuals must begin during elementary and secondary school and continue through graduate education and on-going professional development. Efforts

underway, such as the Centers for Ocean Science Education Excellence and National Ocean Sciences Bowl, have begun to address needs along the educational continuum. As the Commission has recommended, more must be done to expand learning experiences and professional development for future marine scientists, technicians, educators and resource managers.

Increasing the investment in ocean science research.

Much of the great progress made in marine science over the past several decades has been a result of federal investments made during the 1960s and 1970s, under the cloud of the Cold War. Under the model adopted by Vannevar Bush following World War II, the academic researcher, with public support, has been the leader in much of this scientific advancement. This model has led to great discoveries that have changed our lives, such as increased environmental predictive capabilities, a better understanding of the marine ecosystem and marine resource mapping, the ability to remotely sense ocean features from satellites in orbit, and national superiority in undersea surveillance and antisubmarine warfare.

Today, great advances in information and communication technology, molecular biology and other disciplines promise astounding returns from investments in ocean research by offering fundamentally new means of analyzing and understanding the biology, chemistry, geology and physics of ocean dynamics and processes. There is great potential to more fully predict ocean processes, discover marine organisms with unique capabilities, understand the linkages between human and ocean health, and provide the scientific basis to better utilize and manage ocean resources.

Unfortunately, U.S. funding for basic research in ocean sciences has remained stagnant for nearly two decades, effectively halving its buying power. At the same time, the total federal support of basic research has nearly doubled. While we are faced today with growing problems and opportunities, requiring an increased understanding of the Earth's oceans, resources to address them are insufficient. Society's increasing demands on the sea and the growing awareness of the human impact on the environment require ocean sciences to be at the forefront of scientific and social research. This requires a renewed commitment to marine scientific research.

Remarkable fundamental discoveries about the natural world have opened the way for an even more exciting and productive future. But this future will be unrealized without the wherewithal to support a robust and vigorous research enterprise. For this reason, personally and on behalf of CORE, I enthusiastically endorse the Commission's recommendation to double the federal ocean and coastal research budget over the next five years. The report proposes to increase the budget from the fiscal year 2004 level of about $650 million to $1.3 billion each year. While the overall levels should be doubled, increases for individual agencies and programs should be based on a careful and comprehensive assessment of priorities related to national ocean policy goals and needs and on the role of each federal ocean agency in carrying out that policy. For example, doubling of the NSF ocean sciences budget would be entirely consistent with efforts to double the agency's budget overall. By contrast, at NOAA, the Commission recommends new responsibilities in several areas such as ocean observing systems and oceans and human health that would require substantial new competitive research initiatives. Completion of the research strategy recommended by the Commission would address this concern and provide a solid blueprint for agency research investment. Similar strategic planning completed for the U.S. Climate and Global Change Program was instrumental to that program's success in the mid 1980s.

Strengthening the NOAA research enterprise.

The summary of recommendations in the Commission's preliminary report devotes almost five pages to recommendations for NOAA and its line office, the National Marine Fisheries Service. As the Nation's lead civilian oceanographic agency, NOAA clearly has a central role in implementing a national ocean policy and it is almost inconceivable that such a policy could be effective unless NOAA is successful in carrying out it ocean missions.

NOAA was established in 1970 under a recommendation from the report of the first Stratton Commission, bringing together the ocean and coastal-related programs and activities of several federal departments and agencies. Each of those initial elements brought along its own bureaucratic culture and approaches and over the years, NOAA has often struggled to create a fully integrated agency. In addition, it has faced enormous growth in its mission and statutory responsibilities, often not accompanied by adequate fiscal resources.

From a scientific perspective, a recent CORE survey indicated that NOAA currently is the third largest funder of academic marine research in the Federal Government. As such, it provides support for scientists at almost all oceanographic in-

stitutions and participates in a number of national research programs. As national attention to climate, coastal and ocean management issues grows, NOAA support for mission-related research at academic institutions must increase. Although NOAA is poised to play a central role in the ocean sciences, its current programmatic, organizational and administrative structure offers real impediments to effective partnerships with the academic community.

In October 2003, NOAA requested that its Science Advisory Board establish a Research Review Team to evaluate NOAA science programs. In a preliminary report published in February, the team recommended development of an agency-wide research strategy and plan, and establishment of a senior-level research structure to provide more coherent research management and guidance for transitioning research into operations. A second phase of the effort is ongoing and will address the NOAA-wide research infrastructure including such issues as laboratory consolidation. The final report is scheduled for completion by the end of this month.

Enactment of a NOAA organic act that clearly lays out an integrated agency structure and mission, including its role in ocean and coastal research and education, is essential if NOAA is to address the Commission recommendations and the findings of the Research Review Team.

Ecosystem-based Management

The concept of ecosystems-based management is a key theme for the Commission report. It is a concept that enjoys broad-based support among managers, scientists, fishers, conservationists and other stakeholders because it makes sense both intuitively and scientifically. As the report states:

> "Ecosystem-based management looks at all the links among living and non-living resources, rather than considering single issues in isolation. This system of management considers human activities, their benefits, and their potential impacts within the context of the broader biological and physical environment."

The Commission also points out that the success of ecosystem-based management will rely on a balanced precautionary approach that weighs the level of scientific uncertainty and the potential risk of ecosystem damage as part of every management decision. At the present time, we simply do not have adequate information to reduce that scientific uncertainty.

In a 2000 report on marine fisheries data, the National Research Council recommended that fishery managers must improve their "understanding of the functioning of the marine ecosystems affected by fishing activities by studying important non-target species to determine their feeding habits, their distribution, and their prey and predators." In addition, we must shift from our current focus primarily on maritime activities to looking more broadly at the interrelationships among land-based activities, climatic and oceanic process, and marine ecological factors. It means, for example, recognizing that pollution from Central and South Florida can harm fish and coral as far away as the Keys and beyond.

The implications of ecosystem-based management for ocean science are enormous. Federal and State resource managers typically have focused their support for research and monitoring on science that is very close to the decision at hand. Be it counting fish or mapping bottom habitat, the avenue of investigation has been relatively narrow. While we now realize the limitations of such an approach, we have just begun to define scientific needs and to develop strategies that will allow scientific inquiry to keep pace with the growing complexity of management needs.

For example, a Comprehensive Everglades Restoration Plan (CERP) is being implemented in my home State. Florida Bay is included in the CERP because of its intimate linkages with the Everglades. These include freshwater run-off, groundwater fluxes, and nutrient inputs. We currently do not know the biological and ecological effects of increased nutrient loading, particularly as it relates to the growth of phytoplankton and macroalgae in Florida Bay. One potential scenario is that nitrogen and phosphorus in the freshwater runoff from the Shark River Slough could increase phytoplankton blooms in the Bay, and that these blooms could be carried out to the Florida Reef Tract. The fact that we lack a circulation model that would enable us to link changes in Everglades hydrology with Florida Bay hydrology and ecology is hampering resource manages and restoration planners. A recent NRC report recommends research in several areas to remedy this situation.

Implementation of an integrated and sustained ocean observing system could supply critically needed information for the transition to ecosystem-based management. Pilot observing systems already maintain the capability to monitor key physical parameters such as temperature and currents that control or strongly influence the impacts of human activities on the marine environment. The system would also pro-

vide longer time series needed to track climate and other sources of variability and to develop ecosystem forecast models.

At present, the primary source of biological information remains stock assessment surveys and other ship-based sampling programs. However, ecosystem-based management will require development of new technologies to explore, discover, and exploit these biological resources to their full potential. Scientists are already exploring a variety of techniques and platforms from *in situ* molecular analyses to satellite remote sensing to sophisticated tagging programs and marine cable systems that will allow marine animals themselves to serve as data collectors.

Without broader knowledge developed from a robust research and exploration effort, ecosystem-based management will be difficult, if not impossible. One important research need identified by the Commission is the study of marine biodiversity, and one effort to address that need is the Census of Marine Life. I currently serve on the U.S. national committee for the Census, an international research program to assess and explain the abundance, diversity, and distribution of marine organisms throughout the world's oceans. The Census is focusing on field studies that explore little known habitats and re-examine familiar areas using innovative technologies. The Census is also developing an integrated biogeographic information system with the potential to bring marine biodiversity information into the ocean observing system data network. It is unique in its focus on diversity through the higher levels of food webs, the discovery and classification of newly discovered species, and its examination of timelines extending back beyond the limits of modern ocean science. Information collected will support modeling efforts to better understand the response of living marine systems to environmental change and harvesting.

The Census of Marine Life is just one example of cutting edge research conducted by academic institutions and government agencies throughout the United States—and in collaboration with international universities and government agencies—that will contribute to ecosystem-based management. It again reinforces the importance of working cooperatively to address complex management needs, an approach hindered, if not prevented, by current systems. Improved coordination will be absolutely critical if we are to begin managing the oceans in a way that takes into account the big picture instead of focusing narrowly on individual problems without regard to their interconnections.

Recommendations for Immediate Implementation

The third question posed by the Committee in your invitation letter is probably the most difficult. With the prospect of limited availability of new money, it requests that I identify the "top three" recommendations regarding ocean and coastal science that should be implemented immediately. As you know, the preliminary report includes almost 200 formal recommendations, in addition to hundreds of suggestions for strengthening ocean science and generating high-quality accessible information to inform decision-makers.

Interestingly though, many of the most significant recommendations have a relatively modest price tag. What they do require is a national level of commitment to changing the way we do business in the oceans—if we do that, I am optimistic that the financial investments will follow more easily. In its executive summary, the Commission identified 12 actions that its members concluded were critical, of which I believe four are essential to ocean and coastal science and correspond to problems and issues identified earlier in my testimony:

- Strengthen NOAA and improve the federal agency structure
- Double the U.S. investment in ocean research
- Implement the national Integrated Ocean Observing System
- Increase attention to ocean education

The first of these is probably not a question of fiscal resources as much as structure and organization. Coordination of ocean and coastal science programs remains a top priority for strengthening ocean science and does not require enormous financial resources, but rather a commitment by a dozen or so federal ocean agencies to coordinate their efforts and implement improved mechanisms that will allow them to work together efficiently. At the same time, new dollars clearly will be required to double the ocean research investment, implement an integrated ocean observing system, and improve ocean education.

With respect to research, for example, the Commission report calls for development of a national strategy for ocean and coastal research, exploration and marine operations that can "integrate ongoing efforts, promote synergies among Federal, State, and local governments, academia, and the private sector, translate scientific and technological advances into operational applications, and establish national

goals and objectives for addressing high-priority issues." Other sections of the report identify research areas where increased investment could lead to substantial benefits including climate and ocean modeling, biodiversity and ecosystem research, development of ocean information systems, and development of marine products. We have already begun this effort with proposed increases in ocean research programs such as the new centers for oceans and human health and NSF's international ocean drilling program. Proposed increases should be spread out over several agencies—in coordinated programs—so no single agency would bear the full cost. Similarly, implementation of the education recommendations should build upon existing programs and be coordinated across agencies.

Funding for the integrated ocean observing system may be more of a challenge since NOAA is the logical home for much of the program. Still, NOAA currently is making an initial investment through funding for a number of regional pilot programs. By providing needed leadership and coordination, those projects could be fully integrated into a larger scale effort and initiate the implementation process.

Conclusion

Though identifying many problems, the Commissioners and those of us fortunate enough to spend our lives studying the oceans recognize that they are still an awe-inspiring place with more than enough blue frontier to keep us exploring, discovering, and benefiting from those discoveries for the foreseeable future.

Next month, through State of Florida funding for a program called the Center of Excellence in Biomedical and Marine Biotechnology, a team from Harbor Branch Oceanographic Institution and Florida Atlantic University will be searching waters off Florida's east coast and the Florida Keys for new organisms that produce chemicals with the potential to cure human diseases from cancer to Alzheimer's. As startling as this may sound, even within a few miles of shore, our group will have no trouble finding places that no one has ever seen. And if history serves as a guide, we'll have no trouble making promising new discoveries.

But such programs are just a drop in the world's largest bucket, so another of the report's recommendations is that this nation begins a serious effort to study the 95 percent of the oceans that remain unexplored. There is still much to discover. For example, we have studied only a couple hundred of the estimated 30,000 seamounts—and the potential new fisheries they support. One of the most incredible scientific discoveries of the 20th century—animals that depend not on photosynthesis, but on chemosynthesis—was realized through exploration of deep-sea vents. Since that discovery more than 25 years ago, we have explored less than 50 of the estimated 5000 deep-sea vents and seeps. I have no doubt that a robust ocean exploration program, coupled with development of novel techniques for *in situ* analyses of unique plants, animals, and microbes, will dramatically alter not only our understanding of life on Earth (and perhaps other planets), but also lead to new technologies and improved scientific understanding with benefits comparable, likely even superior, to those we have realized as a result of space exploration. As evidence, consider that past ocean-based discoveries have already advanced everything from biotechnology to telecommunications, and that several promising disease treatments from marine organisms are now in human clinical trials.

We clearly have a great deal of work to do. The Commission recommends a framework that will make that work possible, but only if we put it to use. So, for everyone who enjoys fishing, diving, spending a day at a clean beach, and eating safe seafood, I would urge you to act quickly and decisively to carry out the Commission's recommendations. With a clear path to follow, the support of stakeholders around the country, and your commitment to make necessary changes, we have a unique opportunity to develop and implement a strong ocean policy that can reverse the downward spiral of ocean health.

Chairman BOEHLERT. Thank you very much, Dr. Pomponi.

Dr. Pietrafesa.

STATEMENT OF DR. LEONARD J. PIETRAFESA, DIRECTOR OF EXTERNAL AFFAIRS, COLLEGE OF PHYSICAL AND MATHEMATICAL SCIENCES, NORTH CAROLINA STATE UNIVERSITY

Dr. PIETRAFESA. Thank you very much, Chairman Boehlert.

The subject in my testimony is related to the 198 NOAA-centric recommendations in the comprehensive and visionary report. Five questions were posed to me, and I will address each in order.

Question number one was: "What are the current strengths and weaknesses of ocean and coastal programs at NOAA?" In the interest of time, I will mention but a few of the strengths and the weaknesses. First, some of the strengths.

Number one, good, competent personnel at the agency. Two, great satellite-based location information, achieving one-inch accuracy. Three, Sea Grant's excellent job of moving the results of science and technology into useable information for the public. Four, the reliable suite of Earth-observing satellites necessary for monitoring weather and climate globally. Next, the continuous data being collected in the National Estuarine Research Reserve Program, which relates changes in coastal fish habitat water quality to storm runoff. Six, the ability to forecast an El Nino event, allowing nations to brace for the impacts. Seven, the recognition of the national and international importance of NOAA by way of the leadership roles its lead administrators are assuming, such as Undersecretary Lautenbacher being the lead for the U.S. in the Earth Observing Summit.

Now some of the weaknesses. A serious under-sampling of basic variables, such as temperature in the water and in the atmosphere of our oceans and coastal regions. Two, the difficulty of squeezing the funding called for into NOAA appropriations. Why? Commerce, Justice, and State have many competing priorities. Next, the Navy and NASA appear to be backing away from ocean observations. NOAA simply can not go this alone. Next, a lack of the in-house capabilities necessary to provide complete leadership and technical skills called for in support of the Integrated Ocean Observing System. Next, under-funding of NOAA data centers needs to preserve and provide immediate access to the data necessary for ensemble forecasting of weather and climate. Next, the $130 million being spent on coastal zone management; what tangible good is the investment producing versus the paltry $15 million per year investment in ocean exploration where realistically $100 million per year is needed? Next, using the external community as a testbed to quickly develop and transition science and technology to operations and in dealing with a not-invented-here syndrome within the agency. These can lead to Congressional earmarks, some of which are very, very ill conceived.

Question number two: "Do you agree with the recommendations with respect to NOAA? If not, why not?" Overall, I agree with and believe that the 198 NOAA-centric recommendations are generally on target with several exceptions. For example, the assessment of the outcomes of federal projects within coastal watersheds must be done independently. You can call in the academic community here. Another recommendation, a truly integrated IOOS must include the collection of atmospheric data, such as temperature at all sites. Next, the modeling of coastal ecosystems must include precipitation and rivers if we are to relate such things as fish-kills and harmful algal bloom outbreaks to storms or drought.

Question number three: "Are there limitations to NOAA's ability to carry out the responsibilities recommended? And if so, what are they?" It comes down to money, money, and money. At a minimum, there should be an immediate doubling of the federal ocean research budget, as is called for by the Commission. Why? Increased

funding will lead to more data, better information, and better models. Under the present and future conditions of greater storm impacts and climate variability and change, this will help for better planning and mitigation.

Question number four: "Would it be helpful for NOAA to have an organic act? If so, why?" Yes, so that NOAA can have clear and specific responsibilities assigned to it with an unambiguous partitioning of these responsibilities. For example, NOAA should forecast the weather, the climate, and hydrologic impacts of the atmosphere and the oceans, not NASA. Alternatively, NASA should be the testbed for new satellite sensor technology and the operational transition of these systems, when successful and shown to be of value to improving forecasts, should be assigned to NOAA.

Question number five: "What are the three top recommendations regarding NOAA you believe should be implemented without delay?" The first is full implementation of the end-to-end, optimal, integrated Earth-observing system suite of measurements of oceanic, atmospheric, and hydrologic physical, chemical, biological state variables all networked for data transmission, data receipt, data assessment, data dissemination, data archiving and access all in real time and on the fly. The data must be useable in real time. Secondly, development of a crosscutting oceanic, coastal, atmospheric, hydrologic, physical, biological, chemical, and socio-economic impacts integrated Earth system modeling and operational forecast capability. We are capable of predicting it all. Finally, development of a socio-economic capability that supports NOAA's mission to serve the citizenry for the Nation and builds mitigation and resilience capacity for the Nation. NOAA is a mission agency that serves the needs of the public.

I thank you for this opportunity to meet with you, applaud you for the hosting of this important hearing, applaud the extraordinary efforts of the Commission, and would be happy to provide any additional information or personal opinions to you. Thank you.

[The prepared statement of Dr. Pietrafesa follows:]

PREPARED STATEMENT OF LEONARD J. PIETRAFESA

Introduction

Good Morning. My name is Dr. Leonard J. Pietrafesa and I am the Director of the Office of External Affairs in the College of Physical and Mathematical Sciences and a Professor at North Carolina State University in Raleigh, NC. I have been author or co-author of 165 peer reviewed publications in the areas of oceanography and meteorology and estuary and climate dynamics impacts. I have served as Chair of the Board on Oceans and Atmosphere of the National Association of State Universities and Land Grant Colleges (NASULGC) and as Chair of the Council on Ocean Affairs, the precursor to the Consortium for Oceanographic Research and Education (CORE). Presently, I am on the Board on Trustees of the University Corporation for Atmospheric Research, am the Chair of the Educational Advisory Committee of the American Meteorological Society and am the Chair of the NOAA Science Advisory Board, which falls under FACA.

The subject of my testimony is related to the Recommendations which have emanated from the bold, visionary and long awaited, U.S. Ocean Commission on Ocean Policy Report (USCOP) and is detailed in five questions which I will address individually.

The considerable challenges to the agency are reflected in the 198 recommendations dealing directly with NOAA in the USCOP Report.

Now to the questions posed.

1. What are the current strengths and weaknesses of ocean and coastal programs at the National Oceanic and Atmospheric Administration?

First (20 amongst many) strengths:

a. Agency Personnel
b. Advancing the technology for and maintaining the real time National Water Level Network focused on the Nation's 150 major ports
c. Continued advances in Operational Forecasting and evaluation metrics
d. Developing a large suite (~119) of coastal environmental models
e. Advancing the facilitation of the continuously operating incredibly precise lateral and vertical spatial observing network, including more hydrographic surveys to supplement the GPS satellite constellation and height modernization
f. Advancing the robust Shoreline Mapping Program
g. Conducting long-term estuary specific research programs
h. Sea Grant Extension's terrific job of moving the results of R&D into information that coastal managers and other stakeholders can understand and utilize
i. The Tropical Atmospheric and Oceanic Observing Array
j. The visionary and reliable NOAA (and partner agencies) continual suite of Earth observing satellites, such as:

Upcoming NOAA Launches

Satellite	Launch Date	Mission Changes
NOAA-M (17) (1030)	Launched 6/24/02(Titan II)	Mid-morning orbit, prototype solid state recorders
GOES-12 (geo)	Launched 7/23/02	CO_2 imager channel, 4-km H_2O_v channel, SXI
WindSat (0600)	Launched 1/6/03 / USN (Titan II)	Polarimetric microwave radiometer
DMSP F-16	Launched 10/18/03 / USAF (Titan II)	SSMIS
GOES-N (geo)	Dec 2004	1st of new series
NOAA-N (1330)	Jan 2005	Solid-state recorders, MHS
DMSP-F17	2005 / USAF (EELV)	(Launch Date = F-16 + 24 mths)
METOP-1 (0930)	Dec 2005 / EUMETSAT	Global 1-km AVHRR, ASCAT, IASI, MHS, GOME, GRAS, Argos-III
NPP (1000)	Oct 2006	VIIRS, CRIS, ATMS, OMPS
GOES-O (geo)	April 2007	4-km resolution CO_2 channel
NOAA-N' (1330)	Jun 2008	Argos-III (2-way messaging capability)
GOES-P (geo)	Oct 2008	None
Earth Observing-3 (geo)	2009 **(TBD)** / NASA	GIFTS (GOES Risk Reduction)
NPOESS C-1 (1330)	Jan 2010	VIIRS, CRIS, ATMS, CMIS, GPSOS, OMPS, SESS
METOP-2 (0930)	2010 / EUMETSAT	
GOES-R (geo)	2012	ABI, HES, Lightning Mapper, Coronograph

Missions colored "Green" include active sensors

k. The Argos drifter technology and drifter network strategy
l. The National Estuarine Research Reserve Program
m. Good coordination with Coastal Managers and Emergency Management responders
n. NOAA's recent leadership of ocean observations which has recently grown to annual expenditures of ~$400M
o. NOAA's recent national and international leadership roles: such as NOAA Administrator VADM C.L. Lautenbacher Jr. being the lead for the U.S., and one of four in the World, in the Earth Observing Summit; Assistant Administrator Dr. R. Spinrad's roles as Co-Chair (with Dr. M. Leinen of NSF) on the Joint Subcommittee on Oceans within OSTP, the U.S. representative to the Inter-Governmental Ocean Commission and as Chair of Ocean.US, to name but several.

Next (20 amongst many of) the weaknesses:

a. A serious under sampling of state variables in both the water and atmospheric oceanic, coastal, Great Lakes and estuary environments of the Nation. These data are important for: systematically documenting the spatial and temporal histories of the entire suite of phenomena which occur that affect and effect the Nation's and the Planet's weather and climate interactively coupled physical, biological, chemical and human socio-economic and health systems; to ground truth NOAA's and NASA's satellite sensors; and to drive to drive the development of interactively coupled diagnostic and predictive models, to assimilate data into the models, and for model validation. In the immediate future, these models could routinely and automatically forecast all environmental conditions over multiple time and space scales.

b. USCOP has outlined a bold role for NOAA in establishing and supporting the International Ocean Observing System (IOOS). There is much in house strength within NOAA. However, there are several principal concerns with this: NOAA does not have all the in-house capabilities to provide the necessary leadership and technical skills in these areas; herein, NOAA's budget process does not easily and readily permit planning for engagement with the extramural community. It tends to be highly political-centric.

c. It may be difficult to 'squeeze' the resources needed to build and sustain for IOOS into NOAA appropriations. Why? NOAA, within its parent Department Commerce, along with the departments of Justice and State, two perennial Hill favorites, exists in the smallest of the 13 appropriations bill.

d. There is growing evidence that both the Navy and NASA are backing away from environmental observations in the oceans in general and the coastal environment in particular because of massive budget cuts to their agencies and the reprogramming of the resources that remain. NOAA cannot and should not go it alone. As such, NOAA's past and present dependence on NASA compromises NOAA's ability to meet its' mission.

e. An end-to-end no-gaps new satellite system and succession system network funding strategy must be conceived for NOAA. (The model of USGCRP's budget formulation and budget execution might provide some worthwhile lessons as this ball is pushed uphill.) NASA satellites that are absolutely critical to NOAA's mission include, but are limited to: EOS Aqua and Terra; QuikSat; SeaWifs; Acquarius; Ocean Carbon Observation; Global Precipitation Mission; ICES. The lost of any of these amongst others would be devastating.

f. Under-funding of NOAA Data Centers archive and retrieval capabilities. For example the operations budget for all NOAA Data Centers is $34M in total, including the costs libraries. By contrast, the NASA DAAC budget is $70M. NASA maintains a research archive but NOAA maintains operational archives to which there must be real time access and an ability to mine data on the fly.

g. While the weather detection signal is usually strong, attention to the high resolution, precision and accuracy of the existing and new observing system instrumentation required to document climate signals is sometimes overlooked.

h. Assessment of performance of Coastal Zone Management activities. $130M is being spent annually and what is there to show for it? Unbridled, unabated coastal development, growing coastal water quality degradation, further destruction of maritime forests, destruction of marine fish, bird and mammal habitats, further destruction of wetlands, ill advised dredging of inlets and so on.

i. Ocean Exploration expenditures presently are at $15M annually but the realistic need is for ~$100M annually.

j. Connections of ocean and coastal information to educational venues, from "K to Gray."

k. A perceived lack of taking more extensive advantage of leveraging the intellectual and physical resources of the academic community. NOAA does leverage its in-house scientific talent with universities through various programs, including the National Sea Grant College Program, Joint and Cooperative Institutes, the Educational Partnership Program with minority serving institutions, Ocean and Coastal Remote Sensing Programs, the Coastal Ocean Program, Ocean Exploration and the National Undersea Research Program. Herein, NOAA expended nearly $257M on extramural research in FY03, al-

most 35 percent of the agency's entire R&D budget. Nonetheless, the University community has had difficulty tracking the true pathway of the external monies and is viewed as being abysmally low for the needs and responsibilities of the agency and compromises the agency's ability to more fully meet its responsibilities. This strategy also encourages earmarks.

l. The lack of a robust "test bed" enterprise in which new advances in technology by the external community that could be of benefit to NOAA could be tested out for efficacy and application via more NOAA/University partnerships. These are potentially low cost, high return investments.

m. NOAA operates the largest fleet of research and survey vessels of any federal agency (18 ships by 2005; 14 aircraft; as well as global ocean observing capability from research and operational satellites). Albeit, NOAA funded grant researchers have had to pay for the use of ships out of their grants which has a significant impact on the viability of those grants and presents a huge disincentive to do field work on behalf of NOAA. For comparison purposes, the National Science Foundation and the Office of Naval Research both provide greater support to the academic community in ocean research than does NOAA. And NSF's and ONR's ship use comes at no cost to the grant. This is a "sustained infrastructure" issue.

n. There is a not invented here syndrome which is perceived to exist within NOAA so appreciation and attribution for University advances of science and technology of value to NOAA are typically ignored. Alternatively, the University community is perceived by NOAA to be unappreciative of the support it does receive and does not always acknowledge the support that is provided by NOAA. So, the partnership is perceived as being weak on both sides and could improve with better communications and cross-credit sharing.

o. Poorly conceived and structured earmarks which do not comport with the core NOAA mission and end up wasting valuable NOAA resources on parochial, process driven local science for which (and rightfully so) competitive grants, peer reviewed support is generally denied by agencies.

2. Do you agree with the U.S. Commission on Ocean Policy recommendations with respect to NOAA? If not, why not?

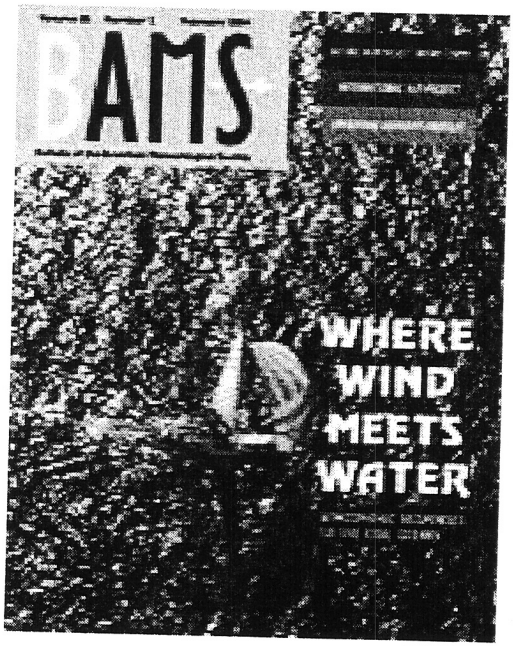
Generally "yes" on most of the 198 specific to NOAA, with several exceptions. Overall, I believe that the recommendations are very bold. My exceptions are based on my perceptions of some of the recommendations not going far enough.

Overall, I agree with and believe that the 198 NOAA centric recommendations are on target and bold with several variances.

a. Rec. 8.9: *The Chronicle of Higher Education* has already made a compelling case that colleges and universities consider the fulfillment of general education science requirements by introducing very relevant "meteorology and oceanography" courses for Liberal Arts and other majors.

b. Rec. 12.4: Federal agency assessments of the outcomes of past federal projects within coastal watersheds and ecosystems will not produce an independent and thus credible evaluation. The University could play an important role as an independent referee here.

c. Rec. 26.2: A truly integrated ocean observing system must include the collection of atmospheric state variables at all ocean state variable observing sites as alluded to I an article in a recent *Bulletin of the American Meteorological Society* written by a NOAA scientist.



d. 26.7 The limited connection that presently exists between ecosystem system modeling and hydrologic systems in a truly interactively coupled suite of models including atmosphere, ocean, coastal ocean, estuary, river, physical, biological, chemical system and even human socio-economic impacts modeling must be highlighted and properly addressed. Herein, the immediate future holds for numerical models that routinely forecast all environmental state variables over multiple space and time scales; down to minutes and a few tens of yards in some cases.

3. Are there limitations to NOAA's ability to carry out the new responsibilities the U.S. Commission on Ocean Policy recommends? If so, please explain those limitations.

In the context of the recommendations the principal limitation is money.

At a minimum, there should be a doubling of the federal ocean research budget from today's $630M to $1.3B over the next five years not only to bring it back to its seven percent parity level with the 1980s but more importantly because of what it would do for the Nation. Congressional action would clearly be required in order to double ocean research spending. Additionally, the move to five-year science plans and three-year grant cycles would both be made significantly more feasible with Congressional cooperation. Doubling the national investment in oceanic research would have an immediate positive impact within NOAA and the academic community and thus improve forecasting and stewardship capabilities. An increase in research capacity in the form of scientific infrastructure and graduate student researchers could be achieved in very short order and build greatly enhanced capacity for NOAA.

The most likely form of question by the public would be a question of why it is so important to be doubling oceanographic research at this moment and in the present fiscal environment. The answers should be framed in the context of the extreme societal demands that are being placed on coastal and ocean resources:

- More than half of the Nation's population lives in the coastal zone, including the continental U.S. coastlines, Alaska, Hawaii and the Great Lakes; in fact,

in some coastal regions population growth over the past century has been exponential.

- While only 15 percent of the Nation's coastal areas are presently developed, that figure is projected to rise to 25 percent within the next two decades; in fact, in some coastal areas the value of housing (adjusted to the Nation's Consumer Piece Index) has grown exponentially over the past half-century.
- Between 70–75 percent of all weather related losses over the past two decades have occurred in the coastal zones.
- Projected sea level rise may greatly exacerbate future weather related impacts in the coastal ocean regions.
- Projected shifts in climate will greatly impact the economies of coastal communities.
- Coastal communities have expressed great need for integrated oceans, coasts, and estuary centric products, services and delivery mechanisms for weather and climate related impacts. Prognostic capabilities must include development of high-resolution models and observations and data management and delivery systems that inform federal, State, and local agencies.

However:

- There is only sparse information presently available in and over the ocean, coastal and estuary environs. Examples include sparse marine buoy, coastal water level, CMAN, ocean, coastal and estuary mooring system based data.
- NWS verifications (the NWS national forecast verification Program) of forecast accuracy indicates that weather forecasts over land are far more accurate than are forecasts along the coasts and out over the ocean.
- There are many boating deaths and drowning of swimmers that are directly attributable to the lack of accurate coastal zone forecasts of sea state and currents. It is noteworthy that "rip currents" are responsible for the second largest number of fatalities ascribed to "weather."
- In 2003 the NWS determined that the addition of several new buoys lead to a dramatic improvement of significant wave height forecast capability lending credence to the assumption that more data in coastal areas will improve forecasts.
- Coastal ocean and estuary academic community developed coupled models of storm induced surge and flooding have proven to be very accurate and demonstrate that an advanced systems modeling approach, both deterministic and probabilistic, will significantly improve forecast accuracy.

Our living and non-living marine resources are in a great state of peril, yet there are few sustained exploratory missions to adequately measure, monitor, and model the great oceans. By comparison to the existing investment in research to understand our planet's vast oceans, an order of magnitude more dollars are available for fundamental research leading to determination of whether there is water on other planetary bodies. Our ocean-going fleet of ships, aircraft, and *in situ* buoy systems are numbered in the hundreds and are always over committed. Funds to support ocean-going research experiments are extremely limited and are frequently the component of research funds that are reduced when any funding rescissions have to be absorbed.

Whereas the previous 50 years were the half-century of rapid progress in numerical weather prediction and atmospheric sciences, the next 50 years could be the era of even more rapid development in the understanding of the ocean and its major influence on everyday life including weather over land. Using the advances developed in the world weather community, the capability for highly professional operational ocean services that would support coastal communities, ocean-related industries, and ocean weather prediction is now clearly possible. In this sense, an expansion of the professional oceanography economic sector could be anticipated along the lines of the meteorological service industry.

Federal funding for technology should be on a par with the requested increase for ocean research to ensure the Nation has the requisite tools, including the Integrated Coastal and Ocean Observing and Prediction Systems, to conduct a rigorous program of ocean science.

The Integrated Ocean Observing System and other key elements of the technological infrastructure that support ocean research should be fully funded. Moreover a robust atmospheric component should be added throughout the entire IOOS and should become an integral part of the IOOS. The Coastal Ocean Observing System

should also be highlighted and embellished as a core component of the IOOS. It often gets overlooked.

NOAA's satellites, ships, aircraft, buoy networks and laboratory facilities also provide a vital base for coastal and oceanic research activities. Funding to maintain this existing national asset and should also be considered and should be available for the conduct of NOAA projects.

As a corollary to the above, there should be a federal research policy which urges Congress to demand the Administration develop cross agency coordinated five-year science plans to improve stability in the research base. Congress should with the Administration in developing this planning process as the current annual appropriations process does not lend itself to five-year forward funded programs.

NOAA should partner with other federal ocean agencies to adopt a unified grants process within each agency, which also employs three-year grants. Additionally, NOAA should work ambitiously to streamline its grants process.

The transition of research into operations is a critical issue for NOAA that is actively being addressed by the NOAA Research Council, the NOAA Science Advisory Board, and the Blue Ribbon Research Review Panel. Hopefully this issue will be properly resolved.

4. Would it be helpful for NOAA to have an organic act? Why? What would be most important to include in such legislation?

NOAA needs to have an Organic Act so it can have clear and specific responsibilities assigned to it with an unambiguous partitioning of responsibilities. Otherwise NOAA's responsibilities are defined by a collection of non-connected laws and policies. These laws were often developed in response to specific issues rather than being in response to the generic, fundamental mission and role of NOAA in the context of its relationship to other federal agencies.

If there is limited new money available from the Federal Government, what are the top three recommendations regarding NOAA you believe should be implemented without delay?

I will do this by linking some of the overlapping recommendations.

- Support of the linked Recommendations 23.5, 23.6, 26.2, 26.9, 15.1, 15.2, 15.3, to fully implement an end to end architecture for the complete optimal suite of measurement sites of ocean, atmospheric and hydrologic physical, chemical, biological state variables, for data recovery, for data assessment, for data dissemination, for data archiving and for data access; all in real time and on the fly.
- Support for the development of a truly cross-cutting oceanic, coastal, atmospheric, hydrologic physical, biological, chemical, human socio-economic impacts integrated, complete Earth System Modeling and Operational Forecast capability (Recommendations 27.2, 27.5, 28.2).
- The development of an ambitious Socio-Economic capability, broadly defined, that supports and will help NOAA better meet its mission to serve the citizenry of the Nation, build capacity for the Nation and build a greatly expanded stakeholder network of NOAA supporters (Recommendation 25.3).

I thank you for this opportunity to meet with you, applaud you for your hosting of this important hearing, applaud the extraordinary efforts of the USCOP, and would be happy to provide any additional information and personal opinions to you and your staff.

BIOGRAPHY FOR LEONARD J. PIETRAFESA

Areas of Interest:

Observations and Modeling of Non-Linear Couplings of Atmospheric, Oceanic, Estuary, Hydraulic Coupled Systems, Oceanic and Atmospheric Weather and Climate Phenomena and Impacts, Wind-Wave-Current Coupled Interactions, Precipitation and River Discharge, Relationships between Climate Conditions, Weather Events and Human Health, Science and Public Policy.

Education:

1965 BS, Fairfield University (Fairfield, CT) Physics & Mathematics

1967 MS, Boston College/University of Chicago (Boston, MA/Chicago, IL) Geophysical Fluid Dynamics (Advisors: Fr./Dr. J. DeVane, Dr. L.F. McGoldrick)

1973 Ph.D., University of Washington (Seattle, WA) Geophysical Fluid Dynamics (Advisors: Dr. M. Rattray, Dr. J.D. Smith)

Industry Employment:

1965, 1966, 1968 Weston Geophysical Engineers, Boston, MA. (Projects: U.S. Nuclear Test Ban Treaty Verification; New England Power Blackout Source; Panama Canal Expansion Assessment; West Australia Environmental Assessment; Preservation of Old Man on the Mountain, NH)

Academic Experience:

10/1999—Director, Office of External Affairs, College of Physical and Mathematical Sciences, NCSU

7/1989–10/1999—Head, Dept. of Marine, Earth and Atmospheric Sciences, NCSU

5/1988–8/1989—Associate Dean for Research, College of Physical and Mathematical Sciences, NCSU

7/1988–6/1989—3rd Director, University Honors Council, NCSU

7/1992–12/1996—Director, Southeast University Consortium for Severe Storms (NCSU, FSU, GTU, UAL–H)

7/1981– —Full Professor, Department of Marine, Earth and Atmospheric Sciences, NCSU

7/1976–6/1981—Tenured Associate Professor, Departments of Geosciences & Marine Science & Engineering. NCSU

7/1973–6/1976—Assistant Professor, Dept. of Geosciences, NCSU

Recent (Selected) National Committee Service and Special Recognition:

01/2004–07—American Meteorological Society, Chair, Education Advisory Comm.

01/2004–05—American Meteorological Society, Co-Chair 2005 Conference on Living in Coastal Region (with M. Davidson, reporting to President S. Avery)

07/2003–04—Chair, National Center for Environmental Prediction Ocean Modeling Review Panel

10/2002–05—Board of Trustees of University Corporation for Atmospheric Research (Elected)

10/2002—Received 2002 UCAR "Lifetime Achievement Award" as a Champion for Science (Picture on the front of a "Wheaties" Box of whole grain Cereal

8/2000– —University Member Representative to the University Corporation for Atmospheric Research (UCAR)

6/2001–02—Chair, NOAA/National Geodetic Research Program Review Team

5/2002– —Member, NOAA/Climate Monitoring & Diagnostics Laboratory Review Team

10/2001—Received 2001 "Cheerleader for Science Award" from UCAR

6/1998–07—Chair, National Oceanographic and Atmospheric Administration (NOAA) Science Advisory Board (FACA approved)

3/1997– —Member, National Water Initiative Task Force of National Association of State Universities and Land Grant Colleges (NASULGC)

11/1999—Member, National Association of State Universities and Land Grant Colleges (NASULGC) Executive Committee on Food, the Environment and Natural Resources

11/1996–11/1997—Chair, NASULGC Board on Oceans and Atmosphere

01/2004– —Chair, American Meteorological Society (AMS)/UCAR Board on Higher Education

3/1998–3/2000—Chair, Consortium for Oceanographic Research and Education (CORE) Board on Education

5/1996– —Member, American Geophysical Union (AGU) Committee on Natural Hazards

5/1999– —Member, NASULGC/Department of Interior (USGS) Partnership Committee

5/1998–1/2001—Member, IPCC Assessment of Coastal Effects of Climate Change

5/1999– —Member, NASULGC/NASA Partnership Committee

3/1996–11/1997—Chair (the 3rd), Council on Ocean Affairs (the Precursor to CORE)

3/1997–10/2001—Presented oral and written testimony before Six different United States Senate and House Subcommittees on issues related to science, technology, natural resources, severe storms, coastal flooding, societal impacts of severe storms, ocean and atmospheric observing systems, education reform.

9/2002—Presentation to the U.S. House Science Committee staffers on the need for value of the USWRP Collaboration Fund at invitation of UCAR.

Professional Organizations:

1) American Meteorological Society—Elected Fellow
2) Sigma Xi (past local chapter president)
3) Phi Kappa Phi
4) American Association for the Advancement of Science
5) Society for Non-Linear Mathematics
6) American Geophysical Union
7) Oceanography Society (Charter—Lifetime member)

Five recent selected of 168 peer reviewed publications

1) Bright, R., L. Xie, I.J. Pietrafesa, 2003. Evidence of the Gulf Stream's Influence on Tropical Cyclone Intensity. *Geophysical Research Letters,* Vol. 29, No. 48, 1–4.
2) Pietrafesa, L.J., L. Xie, D. Dickey, S.M.C. Peng, S.W. Bao. 2003. *Numerical Modeling of Coastal & Inland Flooding,* Vol. 1, Sect. 1, 101–111, Ecosystems and Sustainable Development. WIT Press.
3) Xie, L., L.J. Pietrafesa, K. Wu, 2003. Numerical Study of wave-current interaction through surface and bottom stresses: Part II, Wind driven circulation in the South Atlantic Bight under uniform winds. *J. Geophys. Res.,* 108, 16841–16856.
4) Pietrafesa, L.J., C. Flagg, L. Xie, G. Weatherly, 2002. Winds, currents, sea level and sea state in the Mid-Atlantic Bight during the winter/spring 1996 Ocean Margins Program. *J. of Deep Sea Research,* 49, 4331–4354.
5) Xie, L., L.J. Pietrafesa and K. Wu, 2002. Inter-annual and decadal variability of land-falling tropical cyclones in the United States Southeastern States. *Advances in Atmospheric Sciences,* Vol. 19, 677–686.

Professional and Public (Invited Only) Presentations: Total of 177

Student Committees Supervised: Chair or Co of 22 Ph.D. (22 completed) & 22 MS (21 Completed)

Post Docs and Technicians Supervised: 32 Total.

Grants: Total of 81 Awards as Principal or Co-Principal Investigator totaling $20,865,069.

Chairman BOEHLERT. Thank you very much, Doctor.

Dr. Freilich.

STATEMENT OF DR. MICHAEL H. FREILICH, ASSOCIATE DEAN, COLLEGE OF OCEANIC AND ATMOSPHERIC SCIENCES, OREGON STATE UNIVERSITY

Dr. FREILICH. Chairman Boehlert, Members, I appreciate the opportunity to comment on the Ocean's Committee—Commission report from the standpoint of research and observations. I am Michael Freilich.

The report emphasizes scientific understanding as the foundation for wise ocean management and stewardship. It highlights the need to implement an Integrated Ocean Observing System that has global scope as well as regional focus, and it serves local and nongovernmental as well as federal users. I emphatically agree.

The report advocates a strengthened NOAA as the Nation's lead agency for ocean-related research, education, management, meas-

urements, and predictions. I agree, with reservations. In an ideal world, a strong lead agency may be the correct answer, but such an agency must recognize the equal importance of its research and education, management, and prediction and assessment tasks. It must be able to interact effectively with many diverse user communities. It must be funded sufficiently so that it can satisfy its responsibilities and plan realistically for future improvements. Faced with funding shortfalls, yet under the unremitting pressure to produce regular operational forecasts, I fear that NOAA, or any agency in that position, might shortchange its research activities. Indeed, between 1997 and 2002, NOAA research support at the selected core institutions decreased 12 percent in inflation-adjusted dollars, while NASA and NSF funding increased substantially. In this context, a near-term transfer of responsibilities for ocean observing research satellites from NASA to NOAA is premature. I am convinced that long-term research quality ocean observations, especially satellite observations, will eventually be acquired by operational observing systems since NASA's charter, indeed, does not include responsibility for acquiring long-term ocean observations.

However, NASA's Earth science enterprise has not prematurely terminated any ocean observing research mission as implied by the report. NASA continues to operate missions, which have both research and operational utility far beyond the end of their baseline lifetimes. Turning NASA's Earth science enterprise into a satellite engineering and launch activity only while levying additional research satellite responsibilities on an already overburdened NOAA seems to me needlessly risky, at least until NOAA has demonstrated its ability to take over those tasks.

So what do we do? Both the National Research Council's Committee on NASA-NOAA Transition from Research to Operations and the Ocean Commission advocate formal interagency coordination groups to help the research to operations transition. Moving the Executive's review of NOAA's budget to OMB's Natural Resources Program should help coordinate multi-agency funding, especially for satellite missions, which support both scientific and operational activities. Stronger interagency coordination, not a superagency, is the answer, in my opinion.

In the area of data systems and data management, it is costly but absolutely necessary to integrate appropriate data centers into an ocean information system that transforms measurements into useful policy guidance. I endorse the recommendations that an interagency coordination group, called Ocean.IT, be empowered to address ocean and coastal data and information issues and that a Presidential interagency task force be established to oversee the modernization, actually the creation, of the Nation's environmental data and information system.

The challenge for Ocean.IT will be to guide the development of flexible and evolvable ocean information systems that can meet the changing needs of the research and decision support communities.

I thank the Committee for your strong support of ocean sciences and multi-agency ocean research. I applaud you for taking the time to consider the Ocean's Commission report thoughtfully and carefully. The report's emphasis on science as the foundation for the Nation's ocean management and education policies is absolutely

correct. We must increase federal investment in ocean-related research and education. We must implement an Integrated Ocean Observing System that builds on past technological and scientific successes that connects coastal measurements to open-ocean observations and that serves a wide range of users. We must have better interagency coordination. Any transition to a primarily single agency approach must be measured and robust. We must ensure that research, education, and management activities are not neglected in the face of operational requirements and constrained budgets.

There are advantages to having multiple agencies with overlapping responsibilities and different approaches. One agency may falter, but it is likely that another will succeed. Concentrating ocean responsibilities in a single agency without strong assurances of success is an extremely fragile strategy.

[The prepared statement of Dr. Freilich follows:]

PREPARED STATEMENT OF MICHAEL H. FREILICH

Chairman Boehlert, Ranking Member Gordon, Committee Members:

I appreciate the opportunity to comment on the Oceans Committee Report. I am Michael Freilich, Associate Dean of the College of Oceanic and Atmospheric Sciences at Oregon State University and Chair of the National Research Council's Committee on Earth Studies.

I strongly endorse the Report's emphasis on science as the foundation for wise ocean management and stewardship. We *must* understand interdisciplinary ocean processes and the interactions between the ocean, the atmosphere, the sea bed, and the land.

Implementation of the Integrated Ocean Observing System (IOOS) is crucial. The IOOS must have global scope as well as regional focus—global processes force the local ocean, just as distant storms influence local weather. The Report correctly advocates broadening the scope of data products and services to address the needs of non-federal and non-research users.

Our national ocean policy is at best loosely coordinated. The Report advocates a strengthened NOAA as the government's lead agency for ocean-related research, education, measurement, management, and prediction.

In an ideal world, a strong lead agency may be the correct answer. But such an agency must recognize the *equal* importance of its research and education, management, and prediction/assessment tasks. It must be able to interact effectively with many diverse user communities. It must be funded sufficiently so that it can satisfy its responsibilities and plan realistically for future improvements.

Faced with funding shortfalls, yet under the unremitting pressure to produce regular operational forecasts, I fear that NOAA—or any agency in that position—will short-change its other *(research, education, and management)* activities. Indeed, between 1997 and 2002, NOAA research support at CORE institutions decreased 12 percent in inflation-adjusted dollars, while NASA and NSF funding increased substantially.

A near-term transfer of responsibilities for ocean-observing satellite missions from NASA to NOAA is premature. While NASA's charter does not include responsibility for acquiring *long-term* ocean observations, NASA's Earth Science Enterprise has not prematurely terminated any ocean-observing research mission as implied by the Report. NASA continues to operate missions which have both research and operational utility far beyond the end of their baseline lifetimes. NASA maintains effective ties with the ocean research community.

I am convinced that long-term research-quality ocean observations—especially satellite observations—will *eventually* be acquired by operational observing systems. However, turning NASA's Earth Science Enterprise into a satellite engineering and launch activity only, while levying additional space mission research support responsibilities on an already overburdened NOAA seems needlessly risky until NOAA has demonstrated its ability to take over those tasks.

Both the National Research Council's CONNTRO report and the Oceans Commission advocate formal interagency coordination groups to help the research-to-operations transition. Moving the Executive's review of NOAA's budget to OMB's Nat-

ural Resources Program should help coordinate multi-agency funding for satellite missions which support both scientific and operational activities.

Data Systems and Data Management

Acquiring accurate ocean measurements is necessary, but not sufficient. The measurements must be made available to researchers, and the data must be transformed into useful guidance for managers, policy makers, and the public. Ocean information must be archived, refined, and distributed for decades and longer.

The Report highlights the need for timely and consistent submission of ocean data sets to national data centers.

Equally importantly, the centers must advertise their holdings to potential users, and be adaptable and flexible in response to changing user needs, technology, and understanding. It is these tasks which differentiate useful "knowledge systems" from "data repositories."

It is costly but necessary to integrate our national data centers into a knowledge system. I endorse the recommendations that an interagency coordination group, Ocean.IT, be empowered to address ocean and coastal data/information issues *and* that a Presidential interagency task force be established to oversee the modernization—actually the creation—of the Nation's environmental data and information system. The challenge for Ocean.IT will be to guide the development of flexible and evolvable information systems that can meet the changing needs of the research and decision-support communities.

Concluding remarks

I thank the Committee for your strong support of ocean sciences and multi-agency ocean research. I applaud you for taking the time to consider the Oceans Commission report thoughtfully and carefully. The Report's emphasis on science as the foundation for the Nation's ocean management and education policies is absolutely correct; we must increase federal investment in ocean-related research and education.

We must implement an Integrated Ocean Observing System that builds on past technological and scientific successes, connects coastal measurements to open-ocean observations, and serves a wide range of users. Pilot projects will help develop the organizational structures needed to ensure that the Integrated Ocean Observing System truly is integrated and useful.

While better interagency coordination is necessary, any transition to a primarily single-agency approach must be measured and robust. The transition must ensure that research, education, and management activities are not neglected in the face of operational requirements and constrained budgets. There are advantages to having multiple agencies with overlapping responsibilities. Different agencies will address challenges in different ways. One may falter, but it is likely that another will succeed. Concentrating ocean responsibilities in a single agency without strong assurances of success is an extremely fragile strategy.

BIOGRAPHY FOR MICHAEL H. FREILICH

Born: January 14, 1954

Citizenship: U.S.

Affiliation: Professor and Associate Dean, College of Oceanic & Atmospheric Sciences, Oregon State University, Oceanography Admin. Bldg. 104, Corvallis, OR 97331–5503

EDUCATION

1971–1975—B.S. Physics (Honors), B.S. Chemistry, Haverford College, Haverford, PA

1975–1981—Ph.D. Oceanography, Scripps Institution of Oceanography, University of California, San Diego

DISSERTATION

Resonance effects on shoaling surface gravity waves: Ph.D. Dissertation, University of California, San Diego, 113 pp.

PROFESSIONAL ORGANIZATIONS

American Association for the Advancement of Science (past member)

American Geophysical Union

American Meteorological Society
The Oceanography Society (past member)

PROFESSIONAL EXPERIENCE

1977–1981—Sea Grant Trainee, Shore Processes Laboratory, Scripps Institution of Oceanography

1982–1983—Assistant Professor, Marine Sciences Research Center, SUNY/Stony Brook

1983–1992—Member of Technical Staff, Oceanography Group, Jet Propulsion Laboratory

1992–present—Associate Professor/*Professor/Associate Dean,* College of Oceanic and Atmospheric Sciences, Oregon State University

1983–1992—*Project Scientist,* NASA Scatterometer Project

1985–1987—*Associate Editor,* JGR–Oceans

1987–1990—Member, U.S. WOCE Science Steering Committee

1988–1998—Member (Science PI), ESA ERS–1/2 Science Working Team (also Coordinating Investigator for U.S. Scatterometer Activities)

1989–present—*NASA Mission Principal Investigator,* NASA EOS Scatterometer (SeaWinds)

1992–1999—Member (Science PI), NASA Scatterometer Science Working Team

1992–1999—Member, NASA/JPL PO.DAAC User Working Group

1992–1995—Member, NAS/NRC Ocean Studies Board

1993–1995—Member, NAS/NRC Panel on NOAA's Coastal Ocean Program (*Chair,* Coastal Hazards, Physical Oceanog. & Met. sub-group)

1994–1996—*Chair,* NASA EOS Panel on Data Quality

1994–2000—Member, NASA EOS Science Executive Committee

1996–present—*Chair,* NASA EOS Oceans Panel

1996–present—Member, NSCAT/QuikSCAT Calibration/Validation Panel

1997–1999—Member, NASA EOSDIS Review Group

1997–present—*NASA Mission Principal Investigator,* NASA QuikSCAT Mission

1999–present—Member (PI), NASDA (Japanese Space Agency) ADEOS–2 Science Team and AMSR/AMSR–E Science Team

2000–present—Member, NASA Earth Science Data and Information Systems and Services Advisory Subcommittee (official FACA NASA Advisory body)

2000–present—*Team Leader,* NASA Ocean Vector Winds Science Team

2001–present—*Chair,* National Research Council Committee on Earth Studies

2001–present—*Member,* National Research Council Space Studies Board

2002–2003—*Member,* National Research Council Committee on NASA–NOAA Transition from Research to Operations

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30 April 2004

The Honorable Sherwood L. Boehlert, Chairman
House Committee on Science
2320 Rayburn House Office Building
Washington, DC 20515

Dear Sir:

I am honored by the opportunity to comment before you and the Committee on the preliminary report of the U.S. Committee on Ocean Policy.

As required by House rules, below is my letter of financial disclosure detailing relevant federal agency funding on grants and contracts to Oregon State University, for which I am the Principal or Co-Investigator. Funding amounts are

FY 2004:

NASA, Earth Science Enterprise:	$ 190,552*
NOAA, NESDIS:	$1,218,005

FY 2003:

NASA, Earth Science Enterprise:	$2,557,546**
NOAA, NESDIS:	$ 174,106

FY 2002:

NASA, Earth Science Enterprise:	$2,621,008**
NOAA, NESDIS:	$ 0

* FY2004 funding for the SeaWinds Analysis Activities/Ocean Vector Winds Science Team has not yet been received from NASA. FY 2004 funding in the amount of ~$2,100,000 (including support for 12 Co-PI's on the science team through subcontracts) is expected for this activity.

** Includes ~$1.8M each year for support for 12 Co-PI's on the NASA Ocean Vector Winds Science Team through subcontracts.

Sincerely,

Michael H. Freilich, Associate Dean

DISCUSSION

TOP PRIORITIES FOR OCEAN RESEARCH AND DEVELOPMENT

Chairman BOEHLERT. Thank you very much.

Dr. Watkins, you must be gratified by the very favorable comments this distinguished panel has about this excellent report, and I applaud the report.

Admiral WATKINS. I did not talk to them ahead of time, I assure you.

Chairman BOEHLERT. Well, and let me say this. Any field, any discipline, is able to present a panel of very distinguished Americans to make a solid case for more money, and you make it better than most. But the reality is that we are faced with budgetary challenges, not like any in previous years. And so we are not going to be able to do everything you want. So we have to do some prioritizing.

So let me ask each of you, given the reality of the situation that, obviously, I think, we are going to be pushing for more, not nearly the more that you would like to satisfy your defined needs, but nevertheless a little bit more, what would be your top priorities? And let me go from the last to first. You know, the last shall be first. We know that one.

Dr. Freilich.

Dr. FREILICH. There are several top priorities, of course.

The very top priority is for better interagency coordination, so that the expertise that has been developed already in the Federal Government can be applied to interaction.

Chairman BOEHLERT. But that is not excessively costly. I am talking about dollars. We have got to have better coordination across the board. I mean, the intelligence community, it is about time. It took 9/11 to get the FBI to talk to the CIA. You know, I serve on the Intelligence Committee. I thought for the longest time that they were competitors rather than being on the same team. So the interagency coordination, I agree with that. And you won't find any dissenters up here, but that doesn't cost a ton of new money. But things that cost new money, prioritize. If you will, give me a couple of top priorities.

Dr. FREILICH. If we were to integrate the Integrated Ocean Observing System, which is absolutely the top research, scientific, and therefore, the foundational requirement. In an era of constrained budgets, we have got to spend our money wisely. That is a costly, but absolutely necessary initiative that we must implement rapidly. But given that we can't simply throw money at the issue, it does get back to the coordination problem. We have expertise spread among many agencies, expertise in making measurements, and expertise in dealing with the scientific and user communities. And that is where the coordination comes in so that the money that is spent on the Integrated Ocean Observing System is efficiently spent and not frittered away, if you will, building capabilities that exist well in one agency in another agency, which takes time as well as money.

Chairman BOEHLERT. Thank you.

Dr. Pietrafesa.

Dr. PIETRAFESA. I think the top priority should be the implementation and the establishment of the Integrated Ocean Observing System.

Chairman BOEHLERT. The score is two to nothing.

Dr. PIETRAFESA. Yes. The second is the implementation of an end-to-end Earth system modeling capability, which is not highly expensive. To put my first choice in context, North Carolina, as a single state, has been hit with approximately 20 billion dollar—in excess of billion dollar events, weather-related events, over a 22-year period. That is one state, and that is a great cost, not only to that state, but to the Federal Treasury. So by way of comparison, the investment called for in the Commission report pales, by comparison, to what that one state is having—has had to deal with over the last two decades.

Thank you.

Chairman BOEHLERT. Thank you.

Dr. Pomponi.

Dr. POMPONI. I have two top priorities. My first would be a robust, well disciplined, ocean exploration program. I believe that the outcomes from an ocean exploration program would provide the American public with many benefits, including national security, mapping of our coastlines, inventory of new resources, and outcomes related to our health, and fisheries as well. My second would be an Integrated Ocean Observing System.

Chairman BOEHLERT. Okay. You are an expensive date.

Dr. Solow.

Dr. SOLOW. I guess I think that observations is the top priority, but I am a statistician, and I think that it is important that observation systems be designed efficiently, and in this case, specifically to address scientific questions. And at a time when there are budget constraints, I am not as enthusiastic as Dr. Pomponi is about exploration. I am more enthusiastic about science to answer scientific questions and questions of importance to society.

Chairman BOEHLERT. Thank you.

And Admiral.

Admiral WATKINS. On page 374 of our report, we include a table of estimates on cost recommendations. The Commission decided that they are not in the right position to set priorities, particularly when you talk about research. From my experience as the Secretary of Energy, the most difficult task I had was to convince the physicists that chemistry was also important, that biology was important, that geology was important. And those are difficult things to do. So we say in our report, if you are willing to set up the less costly organizational structure that we have called the framework, we are ready to receive the kind of direction we could get out of the Congress. If you only have a few hundred million to give us instead of a billion, then give us that and tell the White House to come back from the National Ocean Council with a priority on which they can work with you. They ought to set priorities in concert with the Congress, not ask the Commission to come up and give you the line items. We can't do that.

So if you look at that table, it costs $1 million a year to $2 million, maybe, to set up the National Ocean Council framework that we recommended. So, to get it going is not beyond the scope of the

text here in Congress. Then we itemize the more expensive ones, for example, ocean science exploration and support for the states, to whom we give a lot of tribute to here, because they are the ones that have to do a lot of the work. And then other recommendations to take us up to the costs I mentioned earlier. If you gave us a fraction of the latter, then I would say make it proportional to costs estimated in our table, but tell the White House to come back to Congress with their list of priorities. I took this approach at Energy, and it worked. It worked, and instead of $800 million a year into waste cleanup for 50 years of nuclear bomb building, we ramped up to a sustained $6 billion a year. And the reason for this is that the President said, "I want to do it." And the Department of Defense hated it, because it came right out of their budget.

But that is the kind of direction we are talking about for the Assistant to the President. So let us set up an organization that is ready to receive the new guidance and the horizontal integration by ecosystems across the government and up here on the Hill. If we do that, then we are ready to move no matter how many dollars you give us.

Chairman BOEHLERT. I see a lot of nodding of the heads in the affirmative, so thank you very much for that. You can understand, Admiral, that all of us, with the exception of, well, we have got a few exceptions, like Dr. Ehlers, a distinguished physicist, but most of us are laypeople, and we are struggling all of the time with the various subject matter that comes before the Committee. And we are always looking for some guidance on establishing priority from the experts. And we would look for that, but you are saying that the new infrastructure, or the new structure, if we implement your recommendations, would be the ideal person to come before us. Because I can remember the frustration I experienced, particularly as a Junior Member, and we were going through something that you are familiar with, the future of the superconducting supercollider. I mean, I would get witnesses after witnesses, some of them with Nobel laureates in their satchel. And I would say, "Please, guide us. Give us some priorities." And I found, my experience was that one discipline did not want to be about another discipline, because then they said, you know, they saw the position they were in, and they said, but for the grace of God, when my turn comes, I don't want them saying things negative, but so thank you for the recommendation. Thank all of you for that input.

Mr. Cardoza. Or Mr. Honda, the distinguished colleague.

ECOSYSTEM-BASED MANAGEMENT APPROACH

Mr. HONDA. Good morning, Mr. Chairman. Thank you for putting this panel together, and I appreciate the report that I am reading and listening to. As a science teacher, your comments, Admiral, seem to make a lot of sense in terms of coming up with a global approach where you integrate all of the ecosystems together, unless you call the ecosystem the entire arena that is covered by water. And I think that those are important comments to make. And I guess what you are saying is that you gave us some of the information and you have the vision that we have to write it into statute and then pass it along so that we can get started. Is that a correct assumption?

Admiral WATKINS. Yes, it is, Congressman. And you know, a powerful theme in our entire report throughout is an approach to ecosystem-based management. We are not ready to do that today. We hear the buzzword around this town about science-based decision-making and ecosystem-based management. But, we are not ready for either one of them, because we don't devote the investment. We don't have an integrated strategy. We don't work together enough to accomplish that. So everything we are talking about is ecosystem-based management. You have 24 bills that are ocean-related right now in the 108th Congress here in the House of Representatives. If you properly handle those bills in a new way to demonstrate the Congress interest into ecosystem-based management, staffs need to talk to each other. You may need a select committee on the oceans to bring the staffs together. You will try to ensure that those individual bills aren't continuing the piecemealing that you have heard outlined here today. So there are a lot of people that need to get in the act here. It is not just the Executive Branch.

And so what I am saying is that we are recommending a new way of doing business. If we believe in ecosystem-based management, and I can't find anybody against the concept, then let us get on with it. We recognize that this is very difficult. If you take the budget process alone on ecosystem-based management, do you think OMB gives guidance to the National Ocean Partnership Program for integrated research packages? No way. They are not even an accepted entity by the Administration. They have about a $25 million budget at the end of seven years that the Program has been in effect. Their impact has been neutered, because nobody in a power position in the White House pays any attention. So the Congress has to say, "Pay attention. We want to see an integrated budget package. We want to see a strategy come up here, and we will be willing to support you, and we will organize our Congressional Committees to come together in some new way so that these bills don't continue to be piece-mealed, and, in many cases, counterproductive."

Mr. HONDA. I note to the Chair, I agree with you, and I think that I agree, also, if I understand it correctly, the reasons why you keep NOAA and NASA separate for the time being, because you want information to be gathered in a way that is going to be applicable to the ecosystem-based management. It sounds like this addresses all of the kinds of battles that we have along both coasts and along the Gulf areas where we are trying to manage our fisheries and yet, based on even the local science, it is only part of the solution and problem set, because we are not integrating the rest of the ocean in terms of looking at how you manage certain kinds of species and sustain them. And it appears that you have given us a pretty clear direction in order to come up with a statute or a policy that we can give to the other body and to the Administration, so I appreciate all of your work. And you know, it sounds like it makes sense to me, and I would like to support those positions that you have shared with us.

Thank you, Mr. Chairman.

Chairman BOEHLERT. Dr. Ehlers. I—excuse me. Excuse me. Mr. Gilchrest. We have got to go in order of appearance.

PUBLIC AWARENESS OF OCEAN ISSUES

Mr. GILCHREST. I will ask some questions with great appreciation to Dr. Ehlers for letting me go before his time.

We have been talking about this, the Chairman mentioned a couple of times, some of you mentioned a couple times the physics and physicists. I just want to bring up Jacob Burnowski was a physicist prior to World War II. He wrote that wonderful book, "The Ascent of Man", about 30 years ago. He saw the importance of biological diversity, so he went from physics to biology. We are still trying to talk Dr. Ehlers into doing that, and there is some hope, I think, serving on this committee and listening to the witnesses. It—I think your testimony has been invaluable. This study is not going to go on a shelf and gather dust. We are going to use all of the energy possible to move this idea, these concepts forward. And it can not just be, like the Admiral has mentioned, in the Executive Branch. There is—all of the leadership, all of the organizations, all of the brains do not reside in the Executive Branch. It has got to be co-equal with the Legislative Branch, and we are going to push and hopefully create, in the next Congress, a Committee to deal with the oceans. And we are working on that right now. It won't be a Select Committee. We want it to be a Standing Committee, and we want the Committee criteria and jurisdiction to be based, pure and simple, on the kind of testimony you gave here this morning and also the outline to the Commission's report, which is broad and encompasses all of the real vital things that the oceans involve.

The other thing is, I really think, with the help of the Executive Branch, and, certainly, this Congress, we have to raise the level of NOAA to the same level of NASA. I would venture to say that we ought to get Jay Leno to ask people on the street what NASA is. And I would hope that you get about 90 percent of the people that he would ask those questions to would know what NASA is. But you wouldn't have one percent of the population that knows what NOAA is. That push has to come from us so that NOAA has the same level, I am going to say the same level of funding, the same level of prestige, the same level of importance, and the same level of direction that NASA has. We are constantly discussing the understanding of creation of the universe in the sense of what the physics are. Well, we need, I think, to have some understanding of the physics of the ecosystem before us. And a number of you mentioned, and Admiral Watkins just mentioned again, we can't just bust right into ecosystem fisheries management or ecosystem management, because there is not enough known on it yet. But that is the clear direction that we need to move.

Chairman BOEHLERT. Hold on just one second, if you will. We have got a series of votes now, so here is what I would like to do. If you could come to a——

Mr. GILCHREST. I am going to wrap it right up.

Chairman BOEHLERT. Okay. And then we will have Dr. Ehlers and Mr. Gutknecht, both, quick questions, and then we will go and we will dismiss the panel. It is not fair to keep you here another half-hour while we wait around over there for the next vote. You know the system as well as I do.

Wrap up.

Mr. GILCHREST. 30 seconds. Not only education for those people in the various agencies, but we all know what the "Three Rs" are: reading, writing, arithmetic. In our public schools, it is essential that we add the biosphere to that, that you weave that curriculum, from K through 12, how life on Planet Earth needs to be sustained.

And I yield back, Mr. Chairman. Thank you.

Chairman BOEHLERT. Thank you very much.

Dr. Ehlers.

SPECIFIC FOLLOW-UP QUESTIONS

Mr. EHLERS. Thank you, Mr. Chairman.

First of all, one of the Commission's recommendations is that Congress pass an Organic Act for NOAA. As you probably know, my staff and I have been working on this for well over a year, and we hope to introduce the bill fairly soon. I would be interested in what specific recommendations each of you have on the NOAA Organic Act, and I could give a number of specifics, but I would just be interested in your comments on that.

Let me also say that I noticed the dearth of the "G" word during the testimony, and that is the Great Lakes. We have more coastline in the Great Lakes than we do on the Atlantic seaboard, and the interest and the comments from each of you as to whether or not the Great Lakes should receive a greater portion of the research and exploration money than it is getting at this time compared to the other coastline of our nation. And are there specific science and research needs for the Great Lakes that are different from those of the saltwater ecosystem? My understanding is that we will ask for written responses from you on each of these questions, so I zip through them fairly quickly, but I am very interested in how the Great Lakes fit into all of this. And I know almost everyone here represents the saltwater research, but let us consider the Great Lakes.

The other comment, hearing the brief interchange between Dr. Pomponi and Dr. Solow about exploration versus research, I thought I was listening to a NASA panel once again. That is an issue that we, as the Congress, have to resolve, I think, in every individual case. But I appreciate both points of view. I think we need both. And we need substantially more funding to do both properly, and I think that is the real answer. So we, rather than fighting about which it should be, I think we all have to join together, as a community, to request more funding so we can do both.

With that, Mr. Chairman, I will yield back.

Chairman BOEHLERT. Thank you, Dr. Ehlers and Mr. Gutknecht, and we will submit these questions to you in writing, but we want to be considerate of your schedules and mindful of ours.

Mr. Gutknecht.

Mr. GUTKNECHT. Mr. Chairman, I will submit a statement, not so much a question. It relates to agriculture, and we realize that there are some bad operators, and we are, in fact, part of the problem. But we also want to be part of the solution. So I will submit this for the record.

[The prepared statement of Mr. Gilknecht follows:]

PREPARED STATEMENT OF REPRESENTATIVE GIL GUTKNECHT

I want to offer a couple of words of caution and then talk about some good news relating to agriculture and the U.S. Commission on Ocean Policy Preliminary Report.

First, a word of caution. I think that America's farmers are often an easy target when we talk about pollution. Many who don't come from rural America and don't understand how modern production agriculture works think of manure pouring into streams, and farmers applying five times the fertilizer and other inputs needed. This is not the case.

America's farmers are the best stewards of our land and water. They not only care about the land because they live on it, but they also need to ensure it is productive for years to come. All of our producers voluntarily use Best Management Practices. It is also amazing to see how technology is being implemented to improve management practices. Farmers in Minnesota and around the country use global positioning systems and computers connected to their sprayers. Soils samples taken in every portion of their fields ensure that they spray just what is needed for that soil type. They use this to ensure that they spray the exact amount of inputs in every portion of their fields. Remember that fertilizer and other inputs cost money. Farmers know that fertilizer running off the field into streams wastes money and does not help their crops grow.

I also want to point out that most of the recommendations in the report relating to agriculture have already been implemented, either fully or partially. You recommend more strict regulations for animal feeding operations. In late 2002, EPA issued updated strict CAFE regulations and states are quickly coming into compliance and our producers are doing the same. Let's not forget though that compliance can be a very expensive and certainly can be hardest on some of our smaller and mid-size producers.

Most of your recommendations in regard to USDA conservation programs have already been implemented, many as part of the 2002 Farm Bill. The Farm Bill's unprecedented commitment to conservation contained more than $17 billion for conservation programs, and as you recommend, this funding is tied to compliance and cooperation with other programs. Approximately $1 billion annually is spent on the Environmental Quality Incentive Program, which cost shares environmental projects to, among other things, help producers comply with CAFE rules.

In addition, you recommend a watershed approach. Minnesota and many other states have implemented Conservation Reserve Enhancement Programs to tackle runoff issues on a watershed basis. The Conservation Security Program is a new and unique program that, while still being implemented, provides financial incentives for conservation practices.

I could go on and on.

I'll close again, with a word of caution. We need to be careful to consider the economic cost to our producers and also give America's farmers credit for the care and steps they've already taken to protect our oceans and environment.

Mr. GUTKNECHT. Thank you.

Chairman BOEHLERT. Thank you.

And once again, let me stress that we will submit some questions to you, those outlined by Dr. Ehlers, and you will get the benefit of the comments of our distinguished Vice Chairman, Mr. Gutknecht, who will have a few other questions. We would appreciate a timely response, and we are mindful of your schedules, too. We are not the only people in town that claim to be busy. But let me thank all of you for serving as resources. Admiral Watkins, thank you, particularly, for your leadership, but all of you in the field of science, you know, you are preaching to the choir here. I mean, we are arguing all of the time with OMB and other agencies on the importance of making the investment that we all appreciate is absolutely necessary for our long-range future and to guarantee that we remain preeminent in the international community. And shame on us if we don't heed the call and address the need.

Thank you very much. With that, we are adjourned.

[Whereupon, at 11:20 a.m., the Committee was adjourned.]

Appendix:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Admiral James D. Watkins, U.S. Navy (Retired); Chairman, U.S. Commission on Ocean Policy

Questions submitted by Chairman Sherwood L. Boehlert

Q1. Dr. Freilich testified that rather than having control of research satellites (once in orbit) transferred from the National Aeronautics and Space Administration (NASA) to the National Oceanic and Atmospheric Administration (NOAA), those agencies should instead establish an Interagency Transition Office to better coordinate planning and development of satellite programs between NASA and NOAA. Such an office was recommended by the National Research Council in its 2003 report "Satellite Observations of the Earth's Environment—Accelerating the Transition of Research to Operations." *Please explain why the Commission did not recommend an Interagency Transition Office. What other options, if any, did the Commissioners discuss for improving the transition between NASA research programs and NOAA operational programs?*

A1. The Commission specifically did not recommend an Interagency Transition Office because we did not see that as a particularly viable option. It would not, in our opinion, rectify the existing problem of lack of transition of research satellites into operational ones. As we note in our report, "The integration of space-based Earth environmental observing operations into one agency will greatly ease the implementation of a functional national system. By transferring Earth, and particularly ocean, observing satellite missions to NOAA, more seamless concept-to-operations data collection will be possible."

We also note in the report that NOAA and NASA need to work together to achieve the smooth transfer of Earth-observing satellites and we state very specifically in Recommendation 26.8 that, "NOAA and NASA should work together to identify research satellite missions which have operational applications and to ensure the smooth transition of each Earth environmental observing satellite after its launch."

During our deliberations we did not consider other options for accomplishing the transfer of Earth-observing satellite operations from NASA to NOAA. Our recommendation is based on the model which is currently being used for the transfer of the polar orbiting and geostationary weather satellite operations in which NASA has research, engineering, and development responsibility for the satellites and operational control of the satellites is turned over to NOAA after the integrity of the satellite is confirmed in orbit.

Q2. What is the difference between coastal observing systems and ocean observing systems? If there is not enough money to completely fund both systems, how should Congress allocate funding between the two systems and their components?

A2. While there is a differing geographic focus and varying parameters to be measured, coastal and ocean observing systems are integral components of the single Integrated Ocean Observing System, which also includes a global component. All three components are critical to the success of the IOOS. Thus, it is not realistic to consider funding one component, rather it must be viewed as an "integrated" system whose growth should be balanced across the three elements—coastal, ocean, and global. Our plan for building the IOOS is a step-wise process in which the first stage is implementation of two national pilot projects and one or two international pilot projects to link existing systems and produce operational applications relevant to national policy and a broad spectrum of users. Even with limited funding available, these pilot projects could still be developed. The pilot projects will provide important visibility and demonstrate the potential economic and societal benefits of the full system, while advancing research and development of useful technologies and applications.

Q3. Dr. Pietrafesa testified that NOAA does not have sufficient in-house leadership and technical capability to implement the Integrated Ocean Observing System (IOOS). Do you agree with his assessment? If so, how can the situation be improved to carry out the Commission's recommendation that NOAA be the lead agency in implementing IOOS?

A3. The Commission clearly recognized the limitation of the current NOAA organization, and highlighted the need to address these issues as part of the process for

strengthening NOAA. In Chapter 7, "Strengthening the Federal Agency Structure" the Commission states:

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

Contrary to Dr. Pietrafesa's statement, we believe that NOAA has the necessary core capacity which can be enhanced to achieve the requisite management, communication and science capabilities. Throughout our report we call for an overall strengthening of NOAA and discuss in some detail specific areas in which the agency needs to improve to take on the increased responsibilities we recommend for it. Inherent in our concept of strengthening NOAA is the recognition that action must taken to make it more capable, effective and efficient. As part of this process the Commission also recognized the potential need for NOAA to reconsider its current organizational structure, stating in Chapter 7:

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

These changes will require Congress to pass an organic act for NOAA, as highlighted in recommendation 7–1, an action that I identified in my testimony as one of this Congresses' highest priorities. I would also emphasize the need for an interagency coordination mechanism, such as the National Ocean Council we propose, to ensure the coordination and cooperation of all federal agencies in integrated coastal, ocean and Earth observations. NOAA should have a lead role in this effort; however, by no means should it be the only agency, nor should it duplicate effort or capacity that is more appropriately housed in another federal agency.

Q4. Dr. Freilich testified that "While better interagency coordination is necessary, any transition to a primarily single-agency approach must be measured and robust. The transition must ensure that research, education, and management activities are not neglected in the face of operational requirements and constrained budgets. There are advantages to having multiple agencies with overlapping responsibilities. Different agencies will address challenges in different ways. One may falter, but it is likely that another will succeed. Concentrating ocean responsibilities in a single agency without strong assurances of success is an extremely fragile strategy." What is your response to Dr. Freilich? Did the Commissioners consider risks, such as the one mentioned above, that a single agency might face?

A4. Yes, in our recommendations to strengthen NOAA we did consider the potential risks that concentrating certain ocean responsibilities in a single agency might pose. And, quite frankly, we found those risks to be minimal; they paled in comparison to the limited capacity for coordination and communication of the current bureaucratic system. I appreciate Dr. Freilich's concerns in this regard, but I believe the National Ocean Policy Framework we outline in Chapter 4 of the report will go a long way towards alleviating any significant concerns regarding the strengthening of NOAA and concentration of additional responsibilities within the agency. As an example, even though NOAA would have budgetary and operational responsibility for the IOOS including satellites, it would be required to coordinate with other federal agencies and gain prior approval for proposed actions and expenditures from the National Ocean Council. Having an interagency NOC with that level of authority and chaired by an Assistant to the President would virtually eliminate any risks of NOAA or any other federal agency "going it alone" on ocean science, education

and management policy actions. The key to strengthening NOAA and giving it additional responsibilities is to make sure it is also given the tools and the resources necessary to get the job done right.

Questions submitted by Representative Vernon J. Ehlers

Q1. Are there specific science and research needs for the Great Lakes that are different from those of saltwater ecosystems?

A1. In a word, no. We explicitly included the Great Lakes in our deliberations and in the writing of our report and treated them as the United States' northern ocean and northern coastline from the very beginning. Our early adoption of a holistic ecosystem-based management strategy as one of our guiding principles unequivocally dictated that the Great Lakes had to be considered in the same manner as we did for the oceans. The exact same categories of problems facing the Nation's salt oceans—point and non-point source pollution, over-fishing, dead zones, coastal development, contaminated seafood, natural hazards, invasive species, dredging, commerce and transportation, education and stewardship, and coastal development to name but some of them—face the Great Lakes. Thus, the broad science and research needs are the same. The site specific issues obviously do differ, for example zebra mussels are not a saltwater problem, but the same type of site-specific differences occur among the different ocean and marine coastal ecosystems. However, we believe that the national and regional strategies and processes we discuss and recommend in our report will serve the needs of the Great Lakes just as well as they do the open and coastal ocean areas.

The potential impact of increased water diversion for domestic, industrial and agricultural purposes at first glance would appear to be unique to the Great Lakes. But in reality it is not since aquifer drawdown and diversion of riverine waters are issues impacting marine coastal areas as land development and population growth continue to occur at high rates and as more and more marine coastal communities seriously consider turning to desalination of seawater to meet growing demand.

One good way for the Great Lakes governmental bodies to ensure that their issues and concerns and those of their constituencies are not overlooked by the National Ocean Council is to work together to develop and implement a Great Lakes Regional Ocean Council as the Commission outlines in its proposed National Ocean Policy Framework.

Q2. Given that the coastline of the Great Lakes is longer than the entire U.S. Atlantic coastline, is the Great Lakes basin receiving a fair portion of coastal research and management funds?

A2. This is a very difficult and subjective question to answer. It could just as easily be asked for the other coastal areas as well. To make a judgment simply based on miles of shoreline is not a valid or credible approach. To address the question knowledgeably and adequately and based on real need would almost require a task force or committee of its own. The Commission did not address the question of regional funding distribution. Rather, we recommended that one of the functions of the National Ocean Council would be to, "guide the effective use of science in ocean policy and ensure the availability of data and information for decision-making at national and regional levels." We also recommend that the Assistant to the President ". . .consult with the Office of Management and Budget (OMB) director and NOC members to identify programs that contribute significantly to the national policy for oceans and coasts, advise OMB and the agencies on appropriate funding levels for ocean- and coastal-related activities." In other words, the needs of the Great Lakes must be considered in the context of national ocean and coastal objectives, and an appropriate balance will need to be struck. Probably the best answer I can give is to iterate the value of creating a Great Lakes Regional Ocean Council to ensure that the coastal research and management and other needs of the Great Lakes are recognized and considered by the National Ocean Council.

Q3. You support increasing funding for ocean exploration from $10 million to $100 million annually. Given the difficult budgetary situation, why should we spend so much money on ocean exploration when our coastal regions face enormous problems with pollution and declining fish populations?

A3. As the Commission notes in its report, 95 percent of the ocean floor remain unexplored and unmapped and yet past experience has taught us that these vast areas are teeming with unknown numbers of new species and untold natural and cultural resources that we can only begin to imagine. Hydrothermal vents in the Pacific, chemosynthetic communities in the Gulf of Mexico, numerous new species of fish

and invertebrates, and important archaeological sites are but a few of the important discoveries made in the past thirty years alone. There is much more out there that remains to be discovered and which will make significant contributions to humanity in areas such as archaeology, marine-derived medicines, understanding the ocean's role in climate, and new energy sources. We see exploration as a critical component of the national ocean science strategy we lay out in our report. Exploration and research compliment each other; discovery leads to new research and research findings lead to new discovery. Both are important to advancing our scientific understanding of the oceans.

Ocean exploration also offers an unprecedented opportunity to engage the general public in marine science and conservation. Exploration missions to the depths of the ocean provide images of ancient human artifacts, amazing creatures, and never-before-seen ecosystems. These images stimulate the imagination of people of all ages and can be used in both formal and informal educational settings. It is the exploration activities of oceanographers like Dr. Bob Ballard, a member of our Commission, that kindles the desire to learn in young and old people alike and that helps to foster and galvanize a stewardship ethic in them.

When considering the importance of the world's oceans in human history and in regulating climate change, guaranteeing food security, providing energy resources, and enabling worldwide commerce, I find it astounding that we still know so little about the oceans and devote so little resources to exploring them and making new discoveries for the benefit of humankind. One hundred million dollars is not a lot of money to commit to gaining a better understanding of the 95 percent of the oceans we know virtually nothing about. I find it astounding that we know more about the surface of Mars than we do about the bottom of our oceans or that maps of Mars' surface are of higher resolution than maps of our ocean sea floor. We need to focus greater attention on the planet we live on and on the oceans which cover more than 70 percent of it and in doing so we will reap scientific, economic and cultural rewards beyond those associated with the space exploration program.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Andrew R. Solow, Director, Marine Policy Center, Woods Hole Oceanographic Institution

Questions submitted by Chairman Sherwood L. Boehlert

Q1. In your testimony you expressed support for the Commission's recommendation to establish a National Ocean Council. Why do you think this is a better approach to coordination than the existing (or a strengthened) National Oceanic Partnership Program (NOPP)?

A1. The National Oceanic Partnership Program (NOPP) provides a good way to integrate science and technology across agencies. However, it is not set up to integrate ocean *policy,* as is the intent of the proposed National Ocean Council. I believe that both are needed.

Q2. The Commission recommends transferring several responsibilities from other agencies to the National Oceanic and Atmospheric Administration (NOAA). Do you agree with these recommendations? If not, which programs should not be transferred? Are there programs not mentioned by the Commission that should be transferred to NOAA?

A2. I believe that it is first and foremost important to *strengthen* NOAA as it now exists before transferring new responsibilities to it. There is a need to modernize the way that NOAA is structured and operates so that it can perform its current mission effectively and efficiently. An important part of this modernization would be to strengthen procedures for external advice and review. It does not make sense to me to transfer new responsibilities to NOAA before its ability to meet its current responsibilities are strengthened.

Q3. What is the difference between coastal observing systems and ocean observing systems? If there is not enough money to completely fund both systems, how should Congress allocate funding between the two systems and their components?

A3. Although the line between coastal and ocean observing systems is not always clear, the former tends to focus on processes that occur over the continental shelf and the latter tends to focus on processes beyond the shelf. In some ways, coastal processes are of more immediate importance to human society—for example, through connections to fisheries, pollution, erosion, etc. However, processes that occur beyond the shelf can have profound impacts on society through their connection to climate. In my opinion, how to allocate resources not only *between* coastal and ocean observing systems but also *within* each system has not been adequately addressed by the oceanographic community. If it were up to me, I would establish a process for doing this—for example, administered through the Consortium for Ocean Research and Education (CORE)—with a clear charge and a relatively short lifetime.

Questions submitted by Representative Vernon J. Ehlers

Q1. One of the Commission's recommendations is that Congress pass an organic act for NOAA. The Committee is currently developing this bill. Are there specific structural components of NOAA that you believe should be written into law? If so, should an organic act reflect the current structure of NOAA or a different one? Are there specific missions for NOAA that should be in law?

A1. One important change that the organic act should include is an explicit statement that basic scientific research and education are part of NOAA's mission. On the structural side, I believe that it is critical that a functional external scientific advisory board be established to provide substantive advice and review on both planning and execution.

Q2. Given that the coastline of the Great Lakes is longer than the entire U.S. Atlantic coastline, is the Great Lakes basin receiving a fair portion of coastal research and management funds?

A2. I am embarrassed to say that I do not know what proportion of funds are allocated to the Great Lakes. As a general proposition, I do not believe that funds should be allocated on the basis of *coastline length.* There are other, more sensible criteria connected to the scientific and societal problems that funds are used to address.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Shirley A. Pomponi, Acting Managing Director, Harbor Branch Oceanographic Institution

Questions submitted by Chairman Sherwood L. Boehlert

Q1. In your testimony you expressed support for the Commission's recommendation to establish a National Ocean Council. Why do you think this is a better approach to coordination than the existing (or strengthened) National Oceanic Partnership Program (NOPP)?

A1. Agencies tend to look out for their own, wholly-owned priorities first, leaving promising, cooperative programs such as NOPP to languish. NOPP's National Ocean Research Leadership Council (NORLC) was intended as a forum that would bring together the leaders of the participating agencies to discuss the great challenges and opportunities that faced the ocean science community.

This has not happened because NORLC meetings are rarely attended by agency leaders, thus making NORLC a forum that can only present and discuss ideas and programs, but cannot make decisions. Moreover, agencies do not budget major project funds to NOPP, because to do so would be relinquish those funds to collective use rather than perhaps better defined, more urgent programs that indeed are congressionally-mandated.

The U.S. Commission of Ocean Policy recommends establishing a National Ocean Council (NOC) precisely to remedy many of NOPP's shortcomings. Chief among them is the lack of attention ocean issues get from the highest levels of the Executive branch. Establishing the NOC within the Executive Office of the President will immediately elevate the visibility and relevance of ocean issues within the Executive Branch. While Congressional support is necessary for the creation of policies and programs, the Executive branch has far-reaching influence on the vitality and importance policies and programs subsequently enjoy. It was Vice President Hubert Humphrey's support and personal interest in ocean policy that elevated the importance of the Stratton Commission Report and gave it such lasting impact.

Likewise, a 1997 National Research Council report recommended creating an office at the highest level of the Executive branch for the purpose of coordinating the Nation's ocean policies. Given that at least 15 federal departments and agencies have some jurisdiction over ocean issues, a high-level coordinating entity must exist that can provide leadership and break bureaucratic log jams between competing interests and between federal departments and agencies. If the NOC is created, the Departments of Agriculture, Defense, and Homeland Security, to name a few, as well as NOAA, EPA, Navy, Interior and other agencies, will have to coalesce around important ocean issues and policies because leadership will come from the very highest levels of the Executive Office.

Q2. What is the difference between coastal and ocean observing systems? If there is not enough money to completely fund both systems, how should Congress allocate funding between these two systems and their components?

A2. The differences between coastal and ocean observing systems can best be defined by the purposes they serve. Coastal observing systems will be most helpful in describing and monitoring human impacts on natural systems and resources within the US EEZ. Therefore, coastal observing systems will tend to be most useful in gathering data:

- to develop models and management practices to mitigate the harm caused by human impacts;
- for predictive models that can improve the efficiency of navigation and maritime transport;
- for national security intelligence assessments and to bolster homeland security;
- for basic research in coastal, estuarine and continental slope systems; and
- to develop products and services of commercial and societal value, much like the National Weather Service does with its weather forecasts.

For the most part, coastal observing systems will return benefits on a regional and national scale.

Ocean observing systems on the other hand will serve economic, scientific and social purposes on a continental and global scale. Systems that can measure physical,

chemical, biological, geological and atmospheric variables will in essence be taking the pulse of the oceans and will enable scientists to:

- understand and model climate change;
- accurately track fisheries trends and better manage fish stocks;
- predict storm events;
- understand and model circulation patterns; and
- understand the interactions at the land-sea interface and at the atmosphere-sea interface.

Beyond these benefits, ocean observing systems will play an integrative role in helping scientists understand the entire Earth system. Taken to its logical conclusion, a global ocean observing system should become a component of an all-inclusive Earth observing system that will gather data on land, in the ocean and in the atmosphere.

Defense, Homeland Security and Intelligence gathering would gain new surveillance and intelligence gathering capabilities, allowing coverage and tracking of most maritime activity taking place within the system's coverage area.

It is difficult and somewhat arbitrary to argue for the development of either a coastal observing system first, followed by an ocean observing system later on, or vice versa, but considering that several incomplete and poorly inter-connected coastal observing systems already exist, this might be the place to start. Also, coastal observing systems might provide greater immediate societal benefits, giving these systems the appearance of being more immediately valuable.

Given that numerous coastal observing systems already exist, it would possibly require a smaller investment to bring all of these systems up to shared acceptable standards and then to interconnect all existing systems. If any obvious location gaps exist between systems, it would be necessary to fund the construction of enough systems to create a seamless web of coastal sensors from Alaska to Maine.

If this course of action is pursued it should be coupled with a comprehensive effort to improve and standardize data management among all existing coastal observing systems because the potentially biggest pitfall would be to have a system that lacks interconnectedness and the necessary data management protocols to make the collected data widely accessible.

Q3. Dr. Pietrafiesa testified that NOAA does not have sufficient in-house leadership and technical capability to implement the Integrated Ocean Observing System (IOOS). Do you agree with this assessment? If so, how can the situation be improved to carry out the Commission's recommendation that NOAA be the lead agency in implementing IOOS?

A3. As recommended in the Ocean Commission report, NOAA, as the Nation's lead agency for the collection, analysis and dissemination of atmospheric and oceanic data, should be the lead agency for the implementation of the IOOS. However, equally important to note is that NOAA cannot develop IOOS on its own. Given that the IOOS is a very diverse system of systems, its development and implementation must be coordinated using the best federal, academic and private resources available. Furthermore, overall direction and oversight must be provided from above, perhaps in the form envisioned by the Commission, the National Ocean Council.

While it is important that NOAA lead the implementation of the IOOS, successful implementation may require significant restructuring of NOAA. If IOOS is to be successfully implemented NOAA will need to be reorganized according to its primary, or mission-dictated, functions.

Questions submitted by Representative Vernon J. Ehlers

Q1. One of the Commission's recommendations is that Congress pass an organic act for NOAA. The Committee is currently developing this bill. Are there specific structural components of NOAA that you believe should be written into law? If so, should an organic act reflect the current structure of NOAA or a different one? Are there specific missions for NOAA that should be in law?

A1. The Commission is substantially right in recommending a reorganization and codification of NOAA's functions. NOAA needs to be restructured to carry out its three most important functions.

a. **Observing systems (atmospheric and oceanic)**

Because the scientific frame of reference has shifted to ecosystem-based approaches, and as we embrace the notion of looking at interactions between

large scale systems, it is no longer useful to delineate research according to where it is carried out, i.e., in the atmosphere or in the ocean. Add to that the urgency with which we need to develop observing systems and it becomes quite clear that NOAA's current structure which separates atmospheric science from oceanography is no longer productive.

Rather, the future lies in seamlessly moving across the atmosphere-ocean interface by building new tools, instruments and facilities that will allow scientists to ask a fresh set of questions about the interactions between these systems. NOAA's greatest contribution over the next decade will be to implement and coordinate the operation of the Nation's observing systems. Consolidating observing technologies and operations in this fashion will yield more scientific insight and will enhance the efficiency of NOAA's operations.

b. **Resource protection, management, restoration.**

There is little doubt anymore that the Nation's coasts, including its wetlands, estuaries, Great Lakes, and coral reefs are in considerable peril. For that reason, resource protection and restoration must become a central theme for NOAA if it wishes to remain relevant and be trusted to provide solutions to the restoration, management and remediation issues that now impact our coastal areas.

c. **Research and Education.**

Research and education are very important functions if we as a society wish to overcome the challenges that now overwhelm us and escape our understanding. NOAA should make research and education a foundational component of their mission. The reason for this to both advance scientific knowledge and improve humankind's and Earth's condition, but also to increase the U.S. public's awareness of, and appreciation for, the state of our oceans. A general public that understands the costs and consequences of inadequate stewardship of our ocean resources will demand corrective action and will also more readily understand the need for conservation and remediation.

Research and education are functions that can very well be coordinated by NOAA, while allowing a large proportion of the actual work to be done by the best qualified extramural applicants for those research or reading programs. Open, competitive and merit-based processes for awarding research and education grants are very effective ways of making sure that public money is spent on the best available research and education products.

Q2. You support increasing funding for ocean exploration from $10 million to $100 million annually. Given the difficult budgetary situation, why should we spend so much money on ocean exploration when our coastal regions face enormous problems with pollution and declining fish populations?

A2. As a member of the panel that developed the National Research Council report titled *Exploration of the Seas* (2003, National Academy Press) and as a member of the committee that recommended the original framework of what was to become the Ocean Exploration program within NOAA, I have been involved in lively discussions regarding the risks and rewards of exploration. I have also had the opportunity to conduct missions of exploration using Harbor Branch Oceanographic Institution's Johnson-Sea-Link submersibles for the collection of novel specimens with pharmaceutical potential.

Bringing my experience to this debate, I am firmly convinced that if exploration is to be undertaken it needs to be done in a manner that allows investigators to:

- access new and truly unexplored sites (which may require more expensive transits to and from the exploration sites);
- utilize, within reason, the most appropriate tools to carry out the mission, rather than the cheapest compromise solution;
- engage in truly interdisciplinary exploration, thus creating conditions for new and creative ways of looking at new, as well as established research questions; and
- develop new tools and technologies for exploration.

Upon pondering resource allocations for research and exploration programs, it might be useful to establish the smallest possible funding amount that would return worthwhile results. Starting with the $10 million figure for current exploration efforts, allow me to list what does not get funded:

- post-cruise science is not funded; not all discoveries are made during the actual off-shore effort;

- data management is not funded; so no one else in the community has access to data collected with public funds;
- only limited technology development is funded. Completely new technology and sensors capable of measuring unsampled properties at novel sites are beyond financial reach;
- ship, ROV, and HOV costs are leveraged in an ad hoc manner with other investigators who are not necessarily doing work that is relevant or complementary to one's own work, thus emphasizing time at sea rather than productive collaborations;
- international cooperative efforts are not supported; and
- scientific community does not see a small exploration program as a promising or stable source of funding.

Therefore, in a sense, one could argue that spending $10 million on an inadequate program is a waste of public funds.

While coastal pollution is a very real and dire threat that requires immediate and aggressive attention, and while the budgetary picture gives plenty of reasons to say, "the Nation can't afford a $100 million exploration program," we should nonetheless pause to recognize that the term "exploration" is loaded with excitement, adventure, and optimism. Pollution remediation, on the other hand, conjures up images of oil soaked birds, floating trash and other unpleasant reminders of man's carelessness and indifference. No matter how important and pressing it is to spend money on reversing the effects of coastal pollution, it is still a depressing message, unlike the positive, expectant, can-do spirit of the exploration message.

$100 million is the cost of running an exploration program that can not only carry out its mission, but can also infect the general public with the excitement and anticipation of delving into the unknown. In the greater scheme of things, exploration symbolizes hope and optimism: and, as we often find out when we take our ships and submersibles to new, unexplored locations, we discover new life forms, some of which hold promising compounds that could someday be used to fight human diseases. Finally, it is important to consider "exploration" as the first step in the continuum of research—allowing us to formulate the questions we ask and the hypotheses we test.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Leonard J. Pietrafesa, Director of External Affairs, College of Physical and Mathematical Sciences, North Carolina State University

Questions submitted by Chairman Sherwood L. Boehlert

Q1. You testified that the National Oceanic and Atmospheric Administration (NOAA) does not adequately use the external community as a resource to quickly develop and transition science and technology research into operations. Please provide specific examples of cases where NOAA neglected to take adequate advantage of expertise in the external community. What could Congress do to encourage NOAA to work more closely with the external community?

A1.

a. The concept of "helicity" which basically means the condition of the atmosphere favorable to support spinning motions (like counterclockwise during a thunderstorm; thereby creating a tornado). This concept was introduced in about 1972 by a university scientist and it took until the mid 1990's to be accepted within the NWS as a useful operational forecast concept.

b. Operational forecast wave modeling at NOAA is a generation old and not in keeping with the state of university science.

c. Coupled ocean—atmospheric modeling has been done successfully at universities and could be made operational at NOAA but this has not been done.

d. Ocean buoy development is sorely lagging at NOAA. NOAA's technology, which is well tested and highly durable, is also out of date for much of the Nation's waters. Other technologies, developed by industry and universities is also highly durable, far less expensive than NOAA's technology, more portable, more modern and more cost-effective.

e. River/Estuary/Ocean Coupled modeling is being done in the university community but lags badly at NOAA.

f. Highly advanced Ecosystem modeling is being done in the university community and private industry but lags badly at NOAA.

g. Injesting of precipitation data into coastal and estuary models is now being attempted by the university community but NOAA is not engaged.

h. Socioeconomic data analyses and modeling, which has never been a NOAA activity, but is needed by the agency, will best be done by the university community. However, as the NOAA socioeconomic enterprise within NOAA is beginning to take root and emerge, there does not appear to be much university engagement.

i. Tropical cyclone modeling within NOAA has traditionally ignored the importance of the ocean. While NOAA resisted including the ocean in its TC modeling, it finally was forced to by the university community, but it still remains a NOAA centric activity.

j. Storm surge and coastal and inland flood inundation modeling at NOAA is several decades out of date. The university is well ahead of NOAA but NOAA chooses to maintain the status quo.

k. Socioeconomic data analyses and modeling at NOAA was essentially non-existent but following strong recommendations of the NOAA Science Advisory Board, NOAA created an internal activity. However, NOAA does not have the core competency to conduct this in-house without engaging the external community and there is no evidence that this is being done.

l. Congress could empower and authorize the NOAA Science Advisory Board to assess NOAA's science and technology to ensure that NOAA is supporting the creation and utilization of the best science and technology available to meet its mission. The NOAA SAB could evaluate program progress, with metrics, sponsor external reviews and make recommendations on how NOAA should proceed; either internally, externally or some combination of both.

Q2. The Commission recommends transferring several responsibilities from other agencies to NOAA. Do you agree with these recommendations? If not, which programs should not be transferred? Are there programs not mentioned by the Commission that should be transferred to NOAA?

A2.

a. NASA satellite sensors and satellites that have NOAA applications, particularly with regard to operations, should be transferred to NOAA; including the necessary resources and assets required to maintain and advance the capability.

b. The NASA data archives that have value for NOAA's mission as relates to weather, water, climate, fisheries, etc., should be transferred to NOAA's National Climatic data Center with all assets.

c. USGS's river and estuary modeling program assets should be transferred to NOAA. USGS should focus on maintaining the Nation's river gage monitoring network and leave the modeling to NOAA.

Q3. Please expand on your statement that NOAA does not have sufficient in-house leadership and technical capability to implement the Integrated Ocean Observing System. Please provide specific examples and any recommendations you may have to remedy the problem.

A3.

a. NOAA does not have the necessary experience in designing, deploying, maintaining and upgrading ocean monitoring systems. The TAO–TOGA Array was a university-NOAA partnership. That is how the IOOS system architecture/infrastructure should be designed up front.

b. Regionally focused and global scale focused teams of university and NOAA scientists, engineers and technical staff should be brought together and then these teams should work together to create the TAO Array analogues.

Q4. What is the difference between coastal observing systems and ocean observing systems? If there is not enough money to completely fund both systems, how should Congress allocate funding between the two systems and their components?

A4. From the East Coast U.S. perspective the difference is establishing a more robust capability to monitor and make forecasts of weather and ecosystem variability in the marine, coastal environments of the Gulf of Mexico, the U.S. East Coast and the Great Lakes. Deeper ocean observing systems are necessary on the West Coast of the U.S. because weather systems over the Pacific Ocean generally move east across the Pacific Ocean towards the U.S. Pacific Coast. In the GOM, along the U.S. East Coast and in the Great Lakes, the most expedient and productive investments would be in the coastal observing array; especially since the waters are so shallow on the broad continental shelves. On the West Coast an optimal deep water array along with a near coastal array are both required.

Questions submitted by Representative Vernon J. Ehlers

Q1. One of the Commission's recommendations is that Congress pass an organic act for NOAA. The Committee is currently developing this bill. Are there specific structural components of NOAA that you believe should be written into law? If so, should an organic act reflect the current structure of NOAA or a different one? Are there specific missions for NOAA that should be in law?

A1.

a. NOAA should have more responsibility in the monitoring and modeling the hydrologic, i.e., water systems of the Nation. The mention of "hydrologic systems" is done because this is a vastly overlooked responsibility that NOAA has that no one seems to really pay attention to but it should be part of this document which details NOAA's reason for existence. Water, i.e., hydrologic systems include the water in the Oceans, the Atmosphere and then what's on land. Now, one could argue that land water is overseen by USGS but USGS really only is good at the river monitoring network and underground water. NOAA is responsible for satellite estimates of precipitation, the National Doppler Radar Network, from which precipitation estimates can be derived, and for river, estuary and coastal (including the Great Lakes) flood forecasts. So, hydrologic system responsibilities need to part of the NOAA Organic Act. In fact, one of NOAA's four core areas is "weather and water."

b. The most rapid advances from targeted research to the creation of new operational forecast tools at NWS WFOs has occurred where WFOs are co-located on university campuses. So, identifying weather forecast challenges/issues that are really regional to local in nature, and for which there is core competency at the local WFO and university, could be addressed in a formal way

via the creation of "test beds" where the problem(s) could be addressed, solutions found and then tested out to ensure that the forecasts improve. Once proven, the new tool becomes part of the routine operations of that particular WFO specifically and probably part of the NWS in general. In summary, NOAA needs to partner better with the university community and work with the latter to improve its ability to better meet its mission. The NOAA SAB should be more like the National Science Foundation's National Science Board (the NSB). The point is that the NSB is a fiduciary board and the NOAA SAB should be more like the NSB. In fact, if NOAA ever became an independent agency, then the NOAA SAB should be almost exactly like the NSF NSB. The purpose of the Science Advisory Board should be expanded beyond just advising the Administrator and should be to also provide independent oversight of NOAA to Congress on long-range and short-range strategies for research, education, budget assessments, major project and program evaluation, policy directions and the application of science to resource management and environmental assessment and prediction. Science Advisory Board members who have rotated off of the Board could become ex-officio members of the board and be invited to regular meetings of the Board. Staffing support of the Science Advisory Board could be hired by and report to the Board.

c. No real changes in agency mission; which is quite broad and deep as it is.

Q2. You support increasing funding for ocean exploration from $10 million to $100 million annually. Given the difficult budgetary situation, why should we spend so much money on ocean exploration when our coastal regions face enormous problems with pollution and declining fish populations?

A2. Actually this is a good point. The coastal issues of the Gulf, East Coast, Great Lakes, Alaska, Hawaii, and West Coast are challenging and sufficiently demanding enough that if there were additional investments to be made this is where the money should go first. My comment was with regard to monies I believe are being wasted in coastal zone management for coastal zones that are being mismanaged, in my estimation. I would rather see this money be reprogrammed for Ocean Exploration where new pharmaceuticals and life forms, etc., will likely be discovered ultimately for the betterment of the human species and other life forms of our planet.

ANSWERS TO POST-HEARING QUESTIONS

Submitted to Mr. Michael H. Freilich, Associate Dean, College of Oceanic and Atmospheric Sciences, Oregon State University

These questions were submitted to the witness, but were not responded to by the time of publication.

Questions submitted by Chairman Sherwood L. Boehlert

Q1. The National Aeronautics and Space Administration (NASA) has proposed cutting some of its Earth Science projects to fund the President's exploration vision. Are there any of these projects that you think it would be particularly detrimental to cut? How important is it, for example, to restore funding for the Global Precipitation Mission?

Q2. Is the National Oceanic and Atmospheric Administration (NOAA) adequately preparing for data management in its new satellites programs (the National Polar-orbiting Operational Environmental Satellite System, NPOESS, and the next generation of Geostationary Operational Environmental Satellites, GOES–R)?