

Statement of Shirley A. Pomponi, Ph.D.
Executive Director, Harbor Branch Oceanographic Institute at Florida Atlantic University

before the

Subcommittee on Insular Affairs, Oceans, and Wildlife
Committee on Natural Resources, U.S. House of Representatives

MANAGING OUR OCEAN AND WILDLIFE RESOURCES
IN A DYNAMIC ENVIRONMENT:
PRIORITIES FOR THE NEW ADMINISTRATION AND THE 111TH CONGRESS

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Good morning Chairwoman Bordallo, Ranking Member Brown, and members of the Subcommittee. It is an honor to be invited to testify before this committee on ocean research priorities for the 111th Congress and the new administration. My name is Shirley Pomponi. I am the Executive Director of Harbor Branch Oceanographic Institute at Florida Atlantic University. Today I am providing my perspective as a career oceanographer, science advisor to the U.S. Commission on Ocean Policy, Chair of the Board of Trustees for the Consortium for Ocean Research, and Chair of the Ocean Studies Board of the National Research Council.

Both the U.S. Commission on Ocean Policy and the Ocean Studies Board have provided recommendations on issues ranging from the management of fisheries and protected marine species, the prevention of oil and other ocean pollutants, the ocean's role in climate change, and preparedness for coastal hazards such as hurricanes and tsunamis. Clearly, there is a need to improve our understanding of the oceans to inform decision making on these and a suite of other issues affecting society and imperiling our oceans.

I appreciate the opportunity to share with you what we have learned about data needs as well as methods and tools to manage living natural resources within an adaptable, ecosystem-based management regime. I will highlight five areas: ecosystem-based management, climate change, oceans and human health, ocean observing, and interagency cooperation. I will underscore some recommendations from recent Ocean Studies Board reports, the U.S. Commission on Ocean Policy Report *"An Ocean Blueprint for the 21st Century,"* and the Ocean Research Priority Plan and Implementation Strategy (ORPPIS) developed by the Joint Subcommittee on Ocean Science and Technology (JSOST), *Charting the Course for Ocean Science in the United States: Research Priorities for the Next Decade*. The Ocean Studies Board has prepared a set of booklets, the *Ocean Science Series*, which present overviews of key findings and recommendations from National Research Council reports on selected topics including: Oceans and Human Health, Coastal Hazards, Pollution in the Ocean, Marine Ecosystems and Fisheries, and Ocean Exploration (forthcoming). The booklets are available at: http://dels.nas.edu/osb/ocean_science_index.shtml.

INTRODUCTION

The ocean covers two-thirds of the planet, holds 97% of the Earth's water, and 97% of the biosphere. The ocean is the driving force behind climate, weather, and planetary chemistry; it generates more than half of the oxygen in the atmosphere; and it absorbs approximately one-

third of the carbon dioxide released to the atmosphere from the burning of fossil fuel. The ocean, coasts, and Great Lakes are critical to our survival and the long-term vitality of the United States: they provide food, recreation, and highways for commerce, thereby contributing significantly to our nation's economic engine. As an example, our commercial marine fishing industry contributed \$35.1 billion to the 2006 U.S. Gross National Product. More than 40 million people around the world depend on fishing or fish farming for their livelihood—a number that has more than tripled since 1970. The vast majority of these people are working in developing countries, where fishing and aquaculture constitute the economic backbone of most coastal areas. Their efforts now bring in more than 141 million tons of seafood per year, supplying a primary source of protein to more than one billion people.

But the ocean provides more than fish—it contains a dazzling diversity of life and a seemingly endless bounty of marine resources. Coral reefs draw tourists to support growing ecotourism industries. Marine organisms are the source of thousands of unique chemicals with the potential to treat human diseases. Some are already clinically available. Coastal communities have deep cultural ties to the ocean and depend on it for their livelihood.

But consider this sobering fact: despite the vastness of the ocean, it is not limitless. Ocean resources are under intense pressure to satisfy the expanding demand due to population growth and globalization. Globally, 75% of 441 different stocks of fish are fully exploited, overexploited, or depleted; invasive species have disrupted marine food webs; an increasing number of species are in danger of extinction as a result of human activities; and point and non-point pollution and marine debris are polluting our oceans at an alarming rate. Changes such as habitat loss and degradation are significant threats to marine life while climate change has the potential to modify entire marine ecosystems. The ocean's ability to continue to sustain the multibillion dollar industries it supports is increasingly uncertain.

As scientists have come to better appreciate the complexity of marine ecosystems, we have developed new approaches to ocean management that seek to balance the human uses of coastal and ocean environments while maintaining the integrity of the marine ecosystem. Scientific research on how these ecosystems function and react to physical, chemical and biological changes has helped inform policy decisions that promote the sustainable use of marine resources; however, we need sustained investments in research and strategic, long-term planning to ensure that future generations will have an opportunity to experience and enjoy the ocean and its many resources.

ECOSYSTEM-BASED MANAGEMENT

The concept of ecosystem-based management has been around for some time, yet we have not made significant strides toward realizing ecosystem-based management in our current regulatory and management regimes. In this approach, the many aspects of human interactions with the oceans—fishing, shipping, water quality, extraction and transport of oil, gas and renewable energy resources, and invasive species, among others—are taken into consideration as a whole in fishery management decisions. Recognizing that human activities often have rippling effects on marine ecosystems, ecosystem-based management takes a big-picture approach to using and conserving marine resources.

Although fisheries management is not its only application, ecosystem-based management represents a new approach to harvesting marine resources. Rather than focusing on single species, it emphasizes fisheries management practices that take into account food web and multispecies interactions. Ecosystem-based management recognizes the complex interactions

among fished species, their predators and prey, and other aspects of the marine environment. Two reports of the National Research Council—*Sustaining Marine Fisheries* (1999) and *Dynamic Changes in Marine Ecosystems* (2006)—conclude that an ecosystem-based approach would improve the prospects for long-term sustainability of marine fisheries. Integrating information about predator-prey relationships, food webs, habitats, and the effects of climate variation, ocean circulation patterns, chemistry, seafloor terrain and fish distributions should enhance attempts to improve fisheries management.

The National Research Council report *Understanding Marine Biodiversity* (1994) recognized that the human interactions can lead to transformations in ecosystem structure and function and that this transformation is manifested in changes to marine biodiversity. This report, which called for a national marine biodiversity research initiative, led to the Census of Marine Life (CoML), a global network of researchers in more than 80 nations engaged in a 10-year scientific initiative to assess and explain the diversity, distribution, and abundance of life in the ocean. From the work of CoML, we have learned that preserving natural marine biodiversity is critical to maintaining marine ecosystem functions and services, including fisheries, water quality, recreation, and shoreline protection. We need management systems that conserve marine biodiversity; doing so will increase the chance that ecosystems can adapt and recover following natural or human-caused disturbances. If we use conservation of marine biodiversity as a primary aim of ecosystem-based management, we will automatically conserve many of the myriad interconnections among species and their environment, we will generate a cost-effective way to coordinate diverse agency goals, manage trade-offs in providing ecosystem services, and ensure maximum ecosystem function and resilience.

Marine protected areas are an essential component of an ecosystem-based approach to management, as indicated by the National Research Council report on *Marine Protected Areas* (2001). Marine protected areas could provide some insurance against over-harvesting, provide an effective way to assess ecosystem structure and functions, and protect vulnerable habitats, such as coral reefs. In addition to committing to the establishment of marine protected areas, we must also ensure that there is continuing support for science to monitor their effectiveness, which will allow us to refine and improve the process for identifying and conserving important marine habitats.

To effectively use ecosystem-based strategies, we must improve our understanding of the effects of commercial and recreational fishing on marine ecosystems; in particular, we need greater knowledge of trophic effects and species interactions, indicators of ecosystem regime shifts, and baseline abundance data for non-target species and organisms that comprise the lower trophic levels of marine ecosystems. Only then can we develop accurate ecosystem models to propose alternative policy and management scenarios.

CLIMATE CHANGE

In the ongoing debates about climate change and how to mitigate and adapt to its effects, the role of the ocean and the impact of climate change on the ocean are often overlooked. The National Research Council addressed this issue in several reports. *Abrupt Climate Change: Inevitable Surprises* (2002) highlights how the ocean exerts a profound influence on climate through its ability to transport heat from one location to another and its capacity to store carbon. Because water has enormous heat capacity, the ocean typically stores 10-100 times more heat than equivalent land surfaces. Changes in ocean circulation, and especially the thermohaline circulation in the North Atlantic, have been implicated in abrupt climate change of the past.

Today, a question of great societal relevance is whether the North Atlantic circulation, including the Gulf Stream, will remain stable under the climatic changes and global warming that are expected to continue for the next few centuries. It was predicted that as the Greenland Ice Sheet melted, the influx of fresh, cold water could shutdown the ocean conveyor belt that delivers warm water (and weather) to northern Europe. A shutdown of this circulation would not induce a new ice age, but it was hypothesized that it would cause major changes in climate and in the ocean's circulation, upwelling and sinking regions, distribution of sea ice and sea level. Surprisingly, after seeing a predicted slow-down in this process, last year the conveyor belt strengthened, which suggests that something is happening that we scientists have not predicted.

In areas of the Arctic and Antarctic, the loss of sea ice has broader implications. For example, as air and water temperature rose, sea ice in Alaska has declined; populations of commercially important fish, seabirds, seals, walrus, sea otters, and other species depend on plankton blooms that are regulated by the extent and location of sea ice in the spring. As sea ice retreats, species composition of the blooms changes, reducing the amount of food reaching benthic organisms which in turn feed other portions of the Arctic food web. Our ability to fully understand the ramification of these changes or predict their impact on protected species or commercial fisheries is sorely lacking.

The future amount of greenhouse gases in the atmosphere, such as carbon dioxide (CO₂) and methane, will depend on the ocean's ability to absorb these gases in open-ocean and coastal systems. The ocean absorbs approximately one-third of the CO₂ emitted to the atmosphere from the burning of fossil fuels. However, this valuable service comes at a steep ecological cost - the acidification of the ocean. *Charting the Course for Ocean Science in the United States: Research Priorities for the Next Decade*, notes that a more acidic ocean will threaten a wide range of marine organisms from plankton and shellfish to massive coral reefs—further altering ecosystems and their processes. While the process by which ocean waters absorb CO₂ are well understood, the level at which the ocean loses this buffering capacity is not well known nor are the implications for ocean food webs and commercial fisheries that depend on shell-forming organisms. I want to thank this committee for its foresight and leadership in passing the Federal Ocean Acidification Research and Monitoring Act last year; this is a good first step. As the committee considers climate change and energy legislation, I urge you to include provisions that will provide the necessary funding to support research and monitoring activities to better understand the effect of climate change on the ocean.

OCEANS AND HUMAN HEALTH

The ocean is a source of health hazards, harboring toxins and disease-causing agents that can present serious threats to human health. For example, the phytoplankton that cause harmful algal blooms produce toxins that not only affect fish and marine mammals, but also humans who eat affected fish or shellfish, or in some cases, simply visit a beach during a bloom. To prevent disease outbreaks and improve public health, we need to develop more effective threat detection and monitoring systems, and conduct basic research to better understand of the causes and epidemiology of ocean-related health threats.

Environmental changes can affect the dynamics of waterborne diseases. When sea-surface temperatures increase, pathogens can become more concentrated in seawater, threatening to contaminate seafood and drinking water supplies in coastal communities. When sea levels rise, low-lying areas can become inundated with contaminated water. Adaptive management practices can recognize these environmental clues, such as higher sea-surface temperature or a

rise in sea level, and enable public health officials to take action to help prevent our citizens from being exposed to waterborne diseases.

The ocean is also a key source of plants, animals, and microbes that are beginning to yield new and potent drugs for the treatment of human disease, as well as new products for use in biotechnology. More than 20,000 chemicals with pharmaceutical potential have been isolated from marine organisms since the 1980s, several of these are currently in the drug development pipeline, and a few are already clinically available. One example is Prialt®, a drug developed from the venom of a fish-killing cone snail, and which is being used to treat chronic pain associated with diseases like cancer and AIDS. Another example is Yondelis®, a cancer drug developed from a chemical discovered in sea squirts that grow on mangrove roots in Florida.

Ocean research will enable us to develop effective ways of protecting communities from harmful toxins, such as those produced by harmful algal blooms, and dangerous pathogens, and to fuel discoveries of marine-derived medicines, biomedical research probes, and other products that improve public health and well-being. Now more than ever we need a renewed emphasis on research into the mechanisms of disease transmission and the effects of climate and weather patterns on ocean and human health. Only then can we equip public health systems with the tools and information they need to prevent human exposure to illness, both in coastal communities and hundreds of miles inland.

OCEAN OBSERVING

The capability to adaptively describe and forecast the state of the ocean is necessary to predict climate change and large scale phenomena such as El Niño and La Niña events, as well as local phenomena, from hurricanes and tsunamis to human health hazards. A report issued by the National Science and Technology Council Subcommittee on Ocean Science and Technology listed the “capability to forecast key ocean-influenced processes and phenomena” and “deploying an ocean-observing system” as two of its three central elements of science and technology that will “provide the U.S. with the knowledge and means to redefine our relationship with the ocean for the better”.

By measuring physical, biological and chemical water properties, integrated ocean observing systems provide the scientific data necessary to support ecosystem-based management and develop adaptive strategies to better manage our ocean resources. Models are invaluable tools that combine oceanographic data from observing systems with scientific theory to recreate past conditions, provide real-time observations and enable predictions of future impacts to the ocean. Output from models are used by harbor pilots to navigate vessels safely into port, to forecast the transport of harmful algal blooms near coastal cities, and to predict how increasing levels of carbon dioxide in our atmosphere will affect the acidity of the ocean.

An Integrated Ocean Observing System (IOOS) is a central recommendation of the U.S. Commission on Ocean Policy and serves as the U.S. contribution to the Global Ocean Observing System (GOOS). The IOOS combines information from many sensor types at multiple scales, from global to national to regional to local. By integrating and enhancing existing ocean observing and monitoring systems already in place, and expanding the system to incorporate new sources of data, we can aggregate information from regional systems into one national IOOS and provide multiple scales of information useful to a variety of end-users. The data need to be managed and relayed through an integrated communications system that allows feedback from end-users to keep the system relevant to their needs. Although IOOS is still in its infancy, it promises to be a powerful tool for end-users. IOOS end-users make decisions affecting or

affected by the ocean, from ship captains to coastal resource managers to climate scientists, recreational fishermen, and surfers.

A critical need is to expand and sustain components of the IOOS, in particular, ocean observations from space. NASA's earth observations have improved warning, monitoring, and recovery support from national disasters, such as hurricanes and floods; they provide more timely detection of tropical storms, resulting in much improved evacuation decisions; and they improve wildfire detection and El Niño forecasting. Satellite missions to observe sea surface height and ocean color are experimental, with no path for transition to true operational status. Declarations in the National Research Council's Decadal Survey call for a renewal of the national commitment to a program of Earth observations. One key recommendation of the survey tasked NOAA with restoring measurements of ocean vector winds and sea-surface temperatures to planned Earth observing missions: the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and the Geostationary Operational Environmental Satellite-R Series (GOES-R). Sustained measurements from Earth observing systems such as these provide the long-term record necessary to make sound policy decisions regarding our oceans.

While ocean data from space are important, satellite remote sensing can only provide information a few meters deep into the ocean. It is, therefore, critical that we continue to invest in our academic research fleet, buoys, floats, underwater vehicles, and sensors to expand our ability to measure biological, chemical and physical properties, and to integrate remote sensing from space with *in situ* measurements in the ocean. A robust, integrated ocean observing system should be able to describe the actual state of the ocean as well as provide data to predict changes in ocean ecosystems. This information will fundamentally alter our ability to understand, conserve, and manage our ocean resources.

Full development and sustained funding to support the operational costs of this ocean observing system are important: they will enable the promise of ocean forecasting, ecosystem-based management, and adaptive management during the next decade.

INTERAGENCY COORDINATION AND ACCOUNTABILITY

In 2007, the JSOST released the Ocean Research Priorities Plan and Implementation Strategy: *Charting the Course for Ocean Science in the United States: Research Priorities for the Next Decade*. The plan represents the first coordinated national research planning effort involving all federal agencies that support ocean science. I would like to emphasize one of the overarching recommendations from this report: the need for continued coordination among the federal ocean agencies. Ocean research activities are spread across the 25 federal agencies that comprise the JSOST. This poses a serious challenge for coordination, collaboration and integration of projects for implementing ocean research priorities. A central program office, similar to that of the National Oceanographic Partnership Program (NOPP), should be established to coordinate and manage projects to serve the broader ocean sciences community. NOPP has been effective in facilitating interagency collaboration on a wide variety of topics, including ocean observing system development, and biological and chemical sensor development and commercialization. Under the Ocean Action Plan (OAP), the NOPP program office has been instrumental in ensuring the effective coordination, collaboration, and integration of the Inter-agency Working Group on Ocean Partnerships, the Inter-agency Working Group on Facilities, and the Ocean Research and Resources Advisory Panel as a subset of the various interagency working groups established under the OAP.

Transparency in agency budget requests to specify how funds will be used to support the interagency research priorities would ensure accountability and encourage participation among

all federal ocean agencies. However, OMB budget reviews are performed largely per agency, presenting an administrative barrier to assessment of progress that can be more effectively accomplished through interagency coordination, such as those envisioned in the ORPPIS. A more coordinated mechanism will be required to ensure that the interagency priorities are included in budget planning for individual agencies. A comprehensive interagency review, as part of the annual budget process, would help ensure that the full suite of research priorities is addressed. Agency budget reviews should be coordinated to ensure that interagency priorities are included in the plans of each individual agency within the JSOST.

CONCLUSION

The ocean is the reason that Earth is inhabitable: it sustains all life. Yet, we have taken the ocean for granted, often looking to outer space and distant planets rather than inner space, the ocean's depths and the vast species diversity—diversity that feeds a planet and holds the cures to diseases that have plagued humankind. We must recognize that the oceans are finite and cannot indefinitely withstand stresses of overfishing, climate change, and pollution.

We have drawn down the assets of the ocean, but now more than ever we need to re-invest in and recommit to the health of our ocean planet. We have explored only five percent of the ocean and we protect only eight-tenths of one percent of it. We need to understand society's impact on the ocean and the ocean's impact on society to ensure a clean, healthy ocean. We need new technologies to map, explore, and observe the ocean—technologies that will enable us to achieve ecosystem-based and adaptive management, restore the health of the ocean and unlock its secrets. Chairwoman Bordallo, Ranking Member Brown, and members of the Subcommittee, I thank you for the opportunity to testify before you, and on behalf of the ocean science community, I look forward to working with you to provide the science to conserve our ocean planet for future generations.