WOODS HOLE OCEANOGRAPHIC INSTITUTION

Hearing on How the Mission and Related Research of NOAA Contribute to
The National Science Program

Written Testimony
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Committee on Appropriations
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Good morning, Chairman Mollohan and members of the Subcommittee. Thank you for the opportunity to speak with you today about the National Oceanic and Atmospheric Administration and its important contributions to the social and economic well-being of our nation. My name is Susan Avery, and I am President and Director of Woods Hole Oceanographic Institution in Woods Hole, Massachusetts. We are the world's largest private non-profit marine research and higher education organization. We are scientists, engineers, mariners and students dedicated to understanding the ocean and its interaction with the Earth system, and to communicating this understanding for the benefit of society. My own research background includes studies of atmospheric circulation and precipitation, climate variability and water resources, and the development of new radar techniques and instruments for remote sensing. I am author or co-author of more than 80 peer-reviewed articles. I also have a keen interest in scientific literacy and the role of science in public policy.

My primary message today is that NOAA is critical to our nation's research effort to understand our planet as an integrated system in which the oceanic, atmospheric, and terrestrial environments interact in a highly complex fashion. I also wish to stress that these are not arcane scientific problems. They are areas of inquiry that have both immediate and global implications for long-term social and economic well-being of all peoples and nations. As such, they require integrated intellectual approaches and close collaboration among researchers across disciplines, agencies throughout our government, and governments around the world.

You are doubtless all familiar with the National Academies 2007 report, *Rising Above the Gathering Storm*, which eloquently detailed the central importance of science and engineering to the U.S. economy, and which called on our government to support and enhance the national science and technology enterprise. I wish to press the case that NOAA is integral to that enterprise, not only for our country but for all nations. Both the ocean and the atmosphere are shared globally, and we must have global cooperation to address such issues as ocean
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acidification, collapsing fisheries, and adaptation to and mitigation of global climate change. NOAA has proven its willingness and ability to pursue such cooperation in numerous ways over many decades. Especially notable in recent years was its key role in providing scientific expertise and data to the Intergovernmental Panel on Climate Change. NOAA's climate modeling capability is considered one of the best in the world, and its models formed the basis for the IPCC reports.

In many ways, NOAA is unusual among our government's science agencies. It is a mission agency responsible for monitoring both the atmosphere and the ocean, from predicting hurricanes to protecting fisheries. It works to conserve and manage coastal resources and environments, where 14 of our country's 20 largest urban areas are located and where more than half of our population lives. And it operates our National Weather Service. Additionally, however, NOAA funds scientific research in use-defined areas. It not only predicts weather, it seeks to understand and predict climate. In effect, it makes a science investment in order to understand connectivity in our whole-Earth system. It conducts and funds research to develop unified modeling, understanding, and prediction across atmospheric, fresh water, and ocean ecosystems. Put another way, it touches all of our lives.

One example is so obvious that we tend more and more to take it for granted—the National Weather Service. We plan our daily commutes and our annual vacations with an ear always tuned to the weather. Farmers sow and reap according to NOAA weather predictions. Commercial transportation and shipping, both on land and at sea, depend on accurate weather forecasting to get products to market in the most cost-efficient way possible. NOAA warns us of approaching hurricanes and blizzards and alerts us to levels of fire danger in our state and national parks and forests.

With respect to forecasting the impacts of short to long-term climate variability, NOAA has long been a leader in detecting, predicting, and understanding the effects of the El Niño-Southern Oscillation. ENSO, as it's known, occurs every three to seven years, when Pacific trade winds either weaken or reverse, blowing east instead of west, causing surface water in the eastern tropical Pacific to be warmer than usual and altering atmospheric circulation patterns with near-global impacts on climate. As one of the key partners in the decade-long Tropical Ocean Global Atmosphere (TOGA) research program ending in 1994, in which many WHOI scientists and engineers participated, NOAA helped to design—and today continues to maintain—the major components of the ENSO Observing System, which provides accurate wintertime forecasts up to a year in advance based on knowledge of El Niño and La Niña events. The often severe results of such events are well known—based on the region, they can include drought or floods, colder or warmer than usual winters, more or fewer hurricanes and typhoons. In the U.S., coastal storms alone cause more than 70%, or $7 billion, of natural disaster losses every year.

An El Niño event in 1997-98 is estimated to have caused an overall U.S. economic impact of approximately $25 billion. That was about $1.2 billion better than the impact of an event in 1981-82, attributed in part to better forecasts and the actions people took in response to mitigate damage. The annual economic return to the U.S. economy of the ENSO Observing System is between 13 and 26 percent, more than double OMB's specified minimum rate-of-

return for Federal projects. The economic bottom line is truly eye-opening: best estimates are that nearly a third of our Gross Domestic Product, or $3 trillion, is either directly or indirectly affected by weather and climate. That is a simple but startling measure of NOAA's importance.

Yet, consider: the ENSO Observing System, spread out across the vast reaches of the southern Pacific Ocean, is anchored by only 70 moored ocean buoys, supplemented by free-drifting ARGO floats and ship-based observations. By contrast, in Maryland and Virginia alone, there are 84 land-based weather stations. Together with the Environmental Protection Agency, NOAA is playing a key role in the U.S.-led international effort to develop a Global Earth Observation System of Systems that would link together many thousands of weather stations, hundreds of ocean buoys and floats, and dozens of environmental satellites in order to provide the integrated data and research approach necessary for a great leap forward in forecasting accuracy. In short, a greater investment in NOAA's research, operations, and services, including its many academic and industrial research partners, could bring a commensurate increase in return on that investment. Again, broad collaboration is essential.

An example of how NOAA encourages collaboration to tackle issues of enormous socioeconomic importance is the agency's promotion of Regional Integrated Science and Assessment (RISA) programs, which reach out to stakeholders to incorporate more science into resources management in order to improve how communities, planners, managers, and end-users such as farmers and public utilities prepare for and adapt to a changing climate. By funding extramural research teams while requiring effective partnerships with other federal agencies, state and local governments, and the private sector, NOAA is helping our nation to deal with potentially devastating issues like the growing demand for and conflict over water resources in the West, the impacts of prolonged droughts, and coastal erosion. Here too, NOAA's influence is international—knowledge gained and improved forecasting models are freely shared with international colleagues. That intellectual generosity is serving to generate momentum in other countries to incorporate RISA-type activities in their own resource management efforts.

In fact, NOAA plays a key role in resource management, not only along our coasts but throughout the nation. An example is the National Integrated Drought Information System, which will provide a drought monitoring and forecasting system at federal, state, and local levels. When complete, this will be an interactive system that not only collects data and serves as a forum for stakeholders and policy-makers, but also provides tangibles like early warnings of impending drought, comparative information about risk and impact, and support for policy planning necessary to manage impacts, all based on scientific research either conducted by or funded by NOAA.

A robust scientific understanding is equally important to management of the nation's fisheries. Looking again at economic impacts, in 2006, the commercial fishing industry in the U.S. generated $103 billion in sales and $44 billion of income, and supported 1.5 million jobs. Recreational fishing generated $82 billion in sales, $25 billion of income and supported 534,000 jobs. In addition to its contribution to the nation's economy and food supply, both commercial and recreational fishing are strong elements of the traditional culture and social values of many coastal states and communities.

NOAA's National Marine Fisheries Services (NMFS) has responsibility for the management of fishing activity between the 3-mile and 200-mile limits of U.S. waters, and manages 230 commercial stocks via 47 different management plans administered by 8 regional Fishery Management Councils. Of these, 89 stocks are considered overfished or subject to overfishing. An additional 33 fish and 32 non-fish species are protected by NOAA Fisheries under the Endangered Species Act.

NOAA has the primary responsibility for sustaining these fishery ecosystems and the economies and cultures they support. Significant declines in fishery production over the last several decades have in most cases been linked to excess fishing pressure, often a symptom of inadequate management plans that are based on single stock assessments and rely on limitation of gear or effort to restrict catches. In recent years, the fishery science community has recognized the importance of understanding and managing coastal fisheries at the ecosystem level. This type of Ecosystem Based Management (EBM), increasingly embraced in principle by NOAA, considers multiple components of a fishery ecosystem, including major physical and biological factors that affect recruitment and survival of commercial species and sustainability of their populations. EBM allows development of management principles based on the reality of ecosystem function, and at the same time provides protection for habitats and the biodiversity they support.

Unlike previous management schemes that could be based on landings data and routine surveys, however, EBM rests on understanding a much more complex ecosystem structure, requiring a broader set of observations and more sophisticated interpretation and modeling. Achieving this will require significant participation by the academic research community working with NMFS and other NOAA scientists. Current solicitations for NOAA Cooperative Institutes recognize this need, and timely progress in ensuring the future sustainability of our fishery resources will only be possible through more extramural research support, whether for Cooperative Institutes or by other mechanisms. This is another powerful example of the value of NOAA's research partnership with the larger academic community.

An even broader partnership is seen in NOAA's Integrated Ocean Observing System. IOOS binds together a distributed network of open ocean and coastal observing capabilities with a comprehensive data management and distribution system that will provide immediate, relevant information about ocean conditions to a wide range of users. The system, organized through 11 regional associations that can tailor observational assets and products to local needs, provides the marine equivalent of short- and long-range weather forecasts to fishermen, shipping, recreational boaters, Coast Guard, state and city planners and coastal residents. The development of the IOOS involves NOAA with academic, commercial and government groups to design, build and maintain an observing network that meets real scientific, economic and public safety needs.

All of these examples illustrate the scope of NOAA's responsibilities to the nation, encompassing ocean, land, and atmosphere, and their connections and collective effect on our planetary environment and global society. We in the earth science community greatly value NOAA's important role in all these areas, and the productive research collaborations that we have developed over the years, and which we hope to expand in the future. I want to emphasize that the extramural research conducted by NOAA and its partners is critical to the agency's own

success. Research leads to understanding that refines the models that improve prediction that informs policy and therefore helps determine the ultimate economic benefit. In short, it is essential that all of NOAA's operations and services be based on science.

In summary, my recommendation is simple. They echo those of the *Rising Above the Gathering Storm* report. Given the breadth of its mission portfolio, the wide range of science needed to support that mission, and the ever-increasing demand for its products and services, I believe a doubling of NOAA's research budget can only increase the remarkable return on investment cited above. Given those clearly defined economic benefits, we were all pleased to see recognition for NOAA in the American Recovery and Reinvestment Act. Included in that legislation is $111 billion for infrastructure and science—a good investment. But to design and construct billions of dollars of infrastructure informed by 20th century weather forecasts rather than 21st century climate forecasts is short-sighted. We have a National Weather Service; now we need to give the nation the resources to realize its plans for a National Climate Service.

As things stand, the scope of NOAA's mission far exceeds the dollars devoted to it. Many of its facilities and operations are partially paid for out of its research budget, shortchanging the very science and partnerships that support and inform those services and operations and that contribute so greatly to NOAA's national value. In fact, the total research component of NOAA's 2009 budget request, $537 million, is only 14% of its total budget. That mismatch between funding for services and operations and funding for research can only, in turn, shortchange sound policy and decision-support. Increasing NOAA's research budget and recalibrating that balance will be in line with this Administration's determination to restore the voice of science to the collaborative formation of national environmental policy. That will be good for NOAA, good for science, and, most of all, beneficial for the nation.