

**WRITTEN TESTIMONY OF
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**HEARING ON
PLANNING FOR A CHANGING CLIMATE AND ITS IMPACTS ON WILDLIFE,
COASTS, AND OCEANS: STATE AND FEDERAL EFFORTS AND NEEDS**

**BEFORE THE
COMMITTEE ON NATURAL RESOURCES
SUBCOMMITTEE ON FISHERIES, WILDLIFE AND OCEANS
UNITED STATES HOUSE OF REPRESENTATIVES**

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Introduction

Good morning Madam Chairwoman and members of the Subcommittee. I am Margaret A. Davidson, Director of the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center. I had the honor of participating in the Intergovernmental Panel on Climate Change (IPCC) report chapter on adaptation, am an active advisory committee member for the National Center for Atmospheric Research, and have just been elected to the rank of American Meteorological Society Fellow. I thank you for the opportunity to testify on the effects of climate change on coastal communities, and to highlight how NOAA is working across all levels of government and with other partners on planning and adapting to climate change. Changing climate is potentially one of the most significant long-term influences on the infrastructure and function of coastal communities, and coastal and marine ecosystems. Therefore, impacts must be identified and addressed in order to meet NOAA's management and stewardship goals of ensuring healthy, resilient, and productive coastal and ocean environments.

After all, NOAA's vision is an informed society that uses a comprehensive understanding of the role of the oceans, coasts, and atmosphere in the global ecosystem to make the best social and economic decisions.

Today, I will discuss the range of risks facing coastal communities in light of climate change. I will highlight how NOAA is working to help communities plan and adapt by collaborating with our partners to support the best possible science and develop appropriately scaled products, services, tools, and training that will enable officials and key organizations to make the right decisions to prepare and sustain their communities. NOAA recognizes the pressing national interest in coordination of the nation's climate adaptation efforts, through partnerships that bridge the gap between climate science and decision-making.

Changing Climate and its Effects on the Nation

Since the beginning of human settlements, we have chosen to dwell where land and water meet and where our needs for food, transportation, and waste disposal needs are easily met. More

recently in the United States and elsewhere, the rate of relative population growth along the coast has soared as a result of an expanding coastal recreation and tourism economic sector. In the past 50 years, the density and the economic value of the built environment has escalated, and so have the repetitive disaster losses. The U.S. coast comprises merely 17 percent of national land area but supports nearly 50 percent of our population. Coastal areas generate nearly 60 percent of U.S. gross domestic product, and account for the most repetitive flood loss claims with both the National Flood Insurance Program and the private casualty loss insurance industry.

An analysis of data shows that the Earth's oceans may have warmed almost .04 degree Celsius over the second half of the 20th century¹. These data, along with findings from the recent IPCC assessments of 2001 and 2007 show that not only have the atmosphere and oceans warmed, they will continue to do so during the 21st century, at least in part due to increased greenhouse gases in the atmosphere. The 2007 IPCC Working Group II report stated: "Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases." Along with increases in global ocean temperatures, the IPCC projects that global sea level will rise between 7 and 23 inches by the end of the century (2090–2099) relative to the base period (1980–1999) (model based range excluding future rapid dynamical changes in ice flow). It is projected that the average rate of sea level rise during the 21st century is *very likely* to exceed the 1961–2003 average rate².

As climate changes, the effects on coastal communities and economies is likely to grow. These include the potential for increased flooding due to sea level rise, more severe coastal storms, drought, increased coastal erosion due to storminess and loss of sea ice, and accelerated decline of natural resources. These changes affect many aspects of coastal community investments in critical infrastructure (such as port facilities), how and where communities are built, economic drivers (e.g., fisheries, shipping), and the social and cultural fabric of these coastal communities.

In addition to effects on coastal communities and economies, climate change also affects coastal ecosystems, human health, and living marine resources. A recent study³ by the Harvard Medical School's Center for Health and Global Environment found climate change will affect the health of humans as well as the ecosystems and species on which we depend, and that these health effects will have significant economic consequences. Some of the major climate-forced changes are changes to the physical ocean environment (e.g. temperatures, stratification, currents), the loss of sea ice in the Arctic and Antarctic, ocean acidification forced by increased carbon dioxide levels, sea level rise, changes in the incidence and geographic distribution of disease causing organisms, and changes in freshwater supply and quality. These climate-forced changes affect the availability of habitat, the movements and distributions of organisms, the timing of biological

¹ S. Levitus, J. Antonov, and T. Boyer. 2005. Warming of the world ocean, 1955–2003. *Geophysical Research Letters*, 32: L02604

² IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

³ Epstein, Paul R. and Mills, Evan, editors, 2005. *Climate Change Futures: Health, Ecological and Economic Dimensions*, Harvard Medical School, Swiss Re, United National Development Programme.

phenomena, the physiology of species, and the productivity of individual species and whole ecosystems. All of these factors need to be considered in management programs administered by NOAA, other agencies and the states.

Climate change information is being incorporated into living marine resource management decisions through an increasing emphasis on an ecosystem approach to management. Climate change is only one of a complex set of factors (both human induced and naturally occurring), that influence the productivity of marine ecosystems. Effective management of resources in this complex environment necessitates balancing many competing and simultaneous objectives. NOAA is committed to advancing an ecosystem approach to its many stewardship responsibilities as a way forward in striking this balance. Ecosystem level advice (including climate conditions and potential consequences for the living marine resources) is being integrated and made available through publications and advisories such as the Status of the California Current System Report, the Ecosystems Considerations chapter of the North Pacific Groundfish Stock Assessment and Fisheries Evaluation reports, and Ecosystem Advisories for the Northeast Shelf large marine ecosystem.

The coastal margins are the first line of defense in tackling escalating challenges linked to climate change and resulting threats to coastal communities, economies, and ecosystems. Neither the federal government, nor individual localities have thorough plans, sufficient capabilities, or communication frameworks that address these threats. Fragmented decision-making made by a single sector or locality will not adequately handle these complex regional or national challenges. When developing comprehensive action plans, partnerships among federal, state, and local governments, regional organizations, nongovernmental organizations, academia, and the private sector must be considered. In addition, a Government Accountability Office report issued in August 2007 (*Climate Change: Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources*, GAO-07-863) recommended that Federal agencies develop guidance incorporating their best practices advising managers on how to address climate change effects on the resources they manage. In response, the relevant agencies agreed with this recommendation and are working to develop such guidance.

During the past decade, the nature and urgency of these challenges have been well documented by the IPCC, as well as in distinguished national studies conducted by the U.S. Commission on Ocean Policy, Pew Commission, Coastal States Organization, National Research Council, Government Accountability Office, the Department of Commerce Office of Inspector General, and others. Dozens of other specific assessments support these studies in verifying the need for federal, state, local, and nongovernmental organizations to address these urgent issues. NOAA is committed to continuing our service and leadership for the nation in developing these needed partnerships to address the challenges of community planning and adaptation to climate change.

Understanding Climate Adaptation

A changing climate coupled with an increasing coastal population, waterfront development pressure on natural resources, and the growing intermodal needs of the transportation industry increases the risks to communities, ecosystems, businesses, and critical infrastructure. This leaves lives and livelihoods vulnerable to the effects of climate change. If dry becomes drought, wet becomes flood, and storms become more intense and devastating, it will be crucial for

communities, economies, and ecosystems to become resilient and learn to adapt to the changing climate.

The IPCC defines adaptation as, “Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned.” Planned adaptation is the result of a deliberate policy decision based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state. To remain resilient in the face of climate change, coastal communities and natural resource managers should consider the range of future climate variability and begin planning now for their actions to have the most benefit. Actions taken now will not only have a lasting value as effects of climate change manifest themselves, they will also support resilient communities and ecosystems in the short term, as the coastal regions face seasonal storms, flooding, erosion, and other natural hazards as well as the loss and migration of critical natural resources and living marine resources.

Adaptation is also critical to ensure continued economic vitality. According to the Climate Change Futures report, implementing adaptation strategies that reduce vulnerability will be particularly important to the insurance industry to help reduce future losses. Local governments may experience escalating costs and losses if they do not consider potential future conditions when siting and building critical infrastructure. For example, a recent report from the National Science and Technology Council’s Committee on Environment and Natural Resources (*Scientific Assessment of the Effects of Global Change on the United States*) states that municipalities will see escalating costs associated with water treatment infrastructure due to climate change related effects on water quality. These effects include higher temperatures and nutrient loads.

In order to ensure social, economic, and environmental vitality both now and in the future, coastal communities must have the capacity to develop and implement adaptation plans that address their current needs as well the pressures they are likely to face as climate changes. NOAA is working every day to help these communities not only understand the changing climate around them, but to meet our goal of providing the tools and resources necessary to help them adapt.

NOAA Mandates Related to Adaptation to Climate Change

NOAA’s overarching mission is to understand and predict changes in the Earth’s environment. NOAA operates under a breadth of mandates that direct our efforts regarding climate prediction and adaptation, ecosystems, safe navigation, mapping, coastal planning, resource management, and balancing of uses. Addressing the effects of climate change necessarily involves partnerships among federal, regional, state and local governments, and civil society organizations. The *Coastal Zone Management Act* provides a basis for NOAA to work through its partnerships with the state coastal zone management programs and the National Estuarine Research Reserves to improve climate adaptation planning, including the outreach and education required to ensure that state and local decision-makers are able to apply NOAA’s information and products most effectively.

Other congressional and presidential directives that guide our climate-oriented activities include

the *Harmful Algal Bloom and Hypoxia Research and Control Act*, the *Oceans and Human Health Act*, the *National Climate Program Office Act*, the *Hydrographic Services Improvement Act*, and the Climate Change Science Program. In executing our responsibilities under these mandates, NOAA focuses on the needs of local, regional, national, and international users, in strong partnership with appropriate agencies and organizations.

In addition, numerous legislative mandates require NOAA to manage living marine resources in a way that must take climate change effects on these resources, and adaptation and mitigation strategies, into consideration. These include the *Magnuson Stevens Fishery Conservation and Management Reauthorization Act*, the *Marine Mammal Protection Act*, the *National Marine Sanctuaries Act*, the *Coral Reef Conservation Act*, and the *Endangered Species Act*. As an example, the *Endangered Species Act* requires use of the “best scientific and commercial data available” in making listing determinations and formulating biological opinions. In many cases this will require the incorporation of climate data and projections. For example, in recovery planning for Pacific salmon and determinations of whether to list ice-dependent seals as threatened or endangered, predictions and projections of the future climate conditions and how these might impact the species must be taken into account. When elkhorn and staghorn corals were listed as threatened in 2006, the NOAA listing decision identified 13 stressors, or specific conditions, causing adverse impacts. Among these were several climate-related impacts including: elevated sea surface temperatures, which contribute to temperature induced bleaching and may exacerbate occurrence of diseases; elevated carbon dioxide levels and associated ocean acidification, which may lead to decalcification of coral structures; and sea level rise, which may cause present corals to be located at less favorable depths in the future.

Developing Capacity to Anticipate and Adapt to Climate Change

Coastal resource managers at the state and local levels are demanding information and services to prepare their coastal communities for the effects of climate change, including the potential for increased frequency and severity of coastal hazards such as erosion and flooding. Nine states (California, Louisiana, Maryland, Massachusetts, New Jersey, North Carolina, Oregon, South Carolina, and Washington) reported to the Coastal States Organization that they have begun taking steps to plan for climate change at the state level, and Florida has recently formed a Climate Task Force. Many of the steps include policy changes that states and communities, through their coastal programs, are undertaking to improve their resilience to flooding, storm surge, and other forms of coastal inundation will also provide capacity for adapting to accelerated rates of Sea Level Rise. Additionally, two-thirds of the coastal states reported to NOAA (through the Coastal Zone Management Act Section 309 assessments) that coastal hazards are a high priority.

NOAA’s products and services, such as high resolution digital elevation models, coupled coastal inundation models as well as coastal risk and vulnerability assessments, can help these states and their coastal communities understand the effects of coastal hazards in the near term, as well as the potential changing conditions with increased sea level rise. Similarly, the protection and restoration of natural resources that serve as buffers for storm surge and flooding, such as wetlands, barrier islands, and mangroves, provide water quality protection benefits can help protect communities from coastal inundation and the future effects of sea level rise. NOAA’s

research on the effects of climate change on living marine resources can help federal and state managers make decisions about how best to protect these sensitive species, at sea and on shore.

NOAA's Research, Models, and Observations

NOAA engages in oceanic and atmospheric research, model development, and data collection and management focused on climate change and adaptation. NOAA's efforts spur and enhance the development of NOAA's products and services that provide the necessary tools and training for effective climate adaptation planning. Some of the key research, model, and observation projects and programs, as well as their contributions to climate change issues, are summarized below.

Regional Research Partnership

The NOAA's Regional Integrated Sciences and Assessments (RISA) program supports research that investigates complex regional climate sensitive issues of concern to decision-makers and policy planners. The RISA research team includes universities, government research facilities, non-profit organizations, and private sector entities. Traditionally, the research has focused on the fisheries, water, wildfire, and agriculture sectors. Recently, the RISA program has expanded to include coastal impacts and transportation research. Of the eight teams supported by the RISA program, the Climate Impacts Group at the University of Washington has the strongest focus on climate and fisheries issues, and is unique in its focus on the intersection of climate science and public policy. The Climate Impacts Group performs fundamental research on climate impacts on the Pacific Northwest and works planners and policy makers to apply this information to regional decision-making processes.

Ocean and Coastal Mapping

The mapping and charting of our coastal and marine waters, including the Great Lakes, continues to be an activity of great national importance especially in the face of climate change. Partnerships, such as the Integrated Ocean and Coastal Mapping initiative that was called for by the National Research Council and identified as a priority in the President's *Ocean Action Plan*, can provide the baseline geographic information needed to accurately predict relative sea level rise. The Integrated Ocean and Coastal Mapping effort will provide a consistent national spatial framework, increased access to geospatial data and mapping products, and increased inter- and intra-agency communication, cooperation, and coordination. Ultimately, those entities dependent on maps for navigation, national security, scientific research, energy development, location of cultural resources, and coastal and living marine resource management will all greatly benefit. The integrated mapping information is essential to understanding the effects of coastal inundation, and will allow communities to develop effective adaptation plans.

Accurate Heights and Water Levels

Accurate height and water levels are acquired through NOAA's Height Modernization Program and Continuously Operating Reference Stations. There are also two federally coordinated data collection efforts, the Joint Airborne Bathymetry Lidar Technical Center of eXpertise (JABLTCX) and the National Digital Elevation Program. In addition, relative sea level trends, developed from years of continuous tidal monitoring observations through NOAA's National Water Level Observation Network, are essential for activities such as improved transportation systems, integrated observing systems, subsidence monitoring, sea level rise estimation, flood

plain mapping, urban planning, storm surge modeling, habitat restoration, emergency preparedness, coastal and resource management, and construction.

A state-based example of observation work can be found in California, where the Pacific Institute for Studies in Development, Environment and Security is working on a “Costs of Adapting to Sea Level Rise” project for the California Energy Commission. In order to derive meaningful results, this type of climate change study requires accurate water elevation data, which NOAA has provided to the Institute.

Visualization Models

Visualization models are tools that help us better understand potential effects of climate change. Working with local partners in Charleston, South Carolina, NOAA is developing visualizations of sea level rise to enable coastal managers to identify areas at potential risk from rising water based on various sea level rise scenarios. A methodology for creation of Geographic Information System (GIS) based maps of sea level rise inundation is being developed, as well as a comparison of high and lower resolution maps. Social and economic metrics will be investigated, as well as ecological effects of sea level rise as they relate to ecosystem services. Similar locally scaled tools are envisioned as an essential component of a coastal climate adaptation partnership.

U.S. Integrated Ocean Observing System (IOOS)

NOAA recognizes the importance of a national integrated ocean observing infrastructure as a valuable tool to characterize, understand, predict and monitor changes in coastal-ocean environments and ecosystems. NOAA’s IOOS program enhances NOAA’s ability to monitor effects of climate change, including coral bleaching and sea level rise. A number of NOAA’s IOOS multi-year, regional investments are directed toward climate change issues. IOOS data products and services are targeted to high-impact decision support tools, such as coastal inundation and hurricane intensification modeling, and integrated ecosystem assessments, which will inform the management plans and policy decisions related to climate change. For example, the Chesapeake Inundation Prediction System is a partnership among federal and state agencies, industry, and academia. The System predicts inundation in the Washington, DC, metropolitan area and the tidal Potomac River, and provides a flood forecast prototype that simulates street-level flooding from storm events using a high-resolution circulation model both for immediate storm response and advanced mitigation planning and decision-making. Based on preliminary results, the tool has potential to enhance the capability of NOAA Weather Forecast Offices around the country to deliver more specific, and timely inundation forecasts to local communities.

A Regional Approach Towards Leveraging Federal Climate Capabilities

NOAA actively engages in a regional approach towards leveraging federal climate capabilities. For example, NOAA is working closely with the West Coast Governors Agreement, the Gulf of Mexico Alliance, the Northeast Regional Ocean Council, the Great Lakes Regional Collaboration, our international partners, and others, to help coastal states better define their needs in regards to understanding coastal and marine ecosystems and the effects of climate change at regional scales.

In May 2008, twelve federal agencies, representatives from seven states, and several associations in the southeast met for a workshop called Adapting to a Changing Climate. Sponsored by the Southeastern Natural Resources Leadership Group and assisted by NOAA, this workshop brought together regional federal and state executives who lead agencies with natural resource conservation as part of their mission. This regional leadership gathering addressed the current status of science, knowledge acquisition, mitigation, and adaptation for a changing climate in the southeastern United States. The workshop proceedings will help inform the focus and needs for the development of a broader climate adaptation strategy for the region.

A National Approach Towards Leveraging Federal Climate Capabilities

In addition to our local and regional efforts, NOAA is also developing national tools and services that leverage federal climate capabilities. The *National Integrated Drought Information System (NIDIS) Act of 2006* prescribes an approach for drought monitoring, forecasting, and early warning at watershed, state, and county levels across the United States. Led by NOAA, NIDIS is being developed through the consolidation of physical, hydrological, and socio-economic effects data, engaging those affected by drought; integrating observing networks; developing of a suite of drought decision support and simulation tools; and delivering standardized information products through an interactive internet portal (www.drought.gov). NIDIS is a dynamic and accessible drought risk information system that provides users with the capacity to determine the potential effects of drought, and provides the decision support tools needed to better prepare for and mitigate the effects of drought.

NOAA's Sectoral Applications Research Program (SARP) is a research service that develops the knowledge base, decision support tools, capacities and partnerships in sectors affected by climate in a substantial and increasingly visible way. SARP is designed to catalyze and support interdisciplinary research, innovative outreach, and education activities that enhance the capacity of key socioeconomic sectors to respond to and plan for climate variability and change through the use of climate information and related decision support resources. The program is designed to systematically build an interdisciplinary knowledge base and a mechanism for the creation, dissemination, and exchange of climate-related research findings and decision support resources, which are critical for understanding and addressing resource management challenges in vital social and economic sectors such as coastal resources, water, agriculture, and health.

NOAA's Tools and Information to Support Adaptation Planning

Despite a growing awareness of climate change and sea level rise, local decision-makers often still lack the tools to examine different management objectives (i.e., coastal hazards and conservation) in relation to one another and to visualize alternative scenarios for resource management that meets multiple objectives. NOAA is working in partnership with local communities to develop a suite of tools and information services to meet their climate change adaptation needs.

Guidebooks

Guidebooks are an instructive tool designed to assist local communities in meeting their climate change adaptation needs. NOAA, in concert with local partners, produced the King County (Washington) Climate Adaptation Guidebook. The Guidebook was designed to facilitate planning for climate effects by specifying practical steps and strategies that can be used locally

to build community resilience into the future. The Guidebook will enable communities to integrate climate preparedness strategies into existing hazard mitigation plans, reduce the costs associated with disaster relief, and prioritize vulnerabilities such as infrastructure, water supply, and human health.

In response to the devastating Indian Ocean tsunami of 2004, NOAA and the U.S. Agency for International Development created a new coastal community resilience guidebook. The guidebook, titled *How Resilient Is Your Coastal Community? A Guide for Evaluating Coastal Community Resilience to Tsunamis and Other Hazards*, presents a framework for assessing resilience of communities to coastal hazards. The framework, developed in concert with over 140 international partners, encourages integration of coastal resource management, community development, and disaster management for enhancing resilience to hazards, including those that may occur as a result of climate change.

Risk Management

NOAA's Pacific Risk Management 'Ohana (PRiMO) is involved in a partnership to develop tsunami risk information for U.S. Flag Islands outside Hawaii. The initial effort is focused on Guam and has been a successful collaboration with participation by many PRiMO partners from NOAA, the Federal Emergency Management Agency (FEMA), the Guam Homeland Security Office of Civil Defense, the Guam Coastal Zone Management Program, and Guam GIS. Modeling results are expected to be completed in the next few months. Once complete, there will be opportunities to integrate this risk information into projects, plans, and programs.

Regional Decision-Making

To support regional decision-making, NOAA, in partnership with state coastal management programs, provides technical assistance and funding to support projects to help state and local governments prepare for and adapt to climate change and sea level rise. Climate change related projects include creating sea level rise inundation models, developing plans for adapting to climate change, and establishing new regulations for dealing with sea level rise. For example,

- NOAA is providing technical assistance for The Nature Conservancy for a project on Long Island that will help coastal decision-makers visualize, and make informed decisions about, conservation, land protection, and coastal development. NOAA will also work with partners to effectively incorporate project outputs into the Digital Coast partnership pilot effort;
- NOAA, along with its research partners at Cornell University, is creating decision support tools related to east coast winter storm frequency and effects. Researchers are developing a rating system that quantifies the potential for coastal effects as a result of an east coast winter storm, and investigating modifying the existing seasonal forecast procedures to reflect the severity of impact of coastal storms as opposed to overall storm frequency. The network of coastal decision-makers that are accessible through NOAA and New York Sea Grant will be instrumental in assuring the climatological tools developed will be valued and used in decision support; and
- NOAA is supporting the San Francisco Bay Conservation and Development Commission's regional planning efforts to adapt to climate change in the bay area. This effort includes mapping shoreline areas vulnerable to sea-level rise; organizing a regional program to address climate change in the bay area, and updating the San Francisco Bay Plan findings and policies to address global climate change effects on San Francisco Bay.

NOAA's Capacity Building, Outreach, and Education

In addition to the resources and tools we develop, NOAA is also supporting local communities through capacity building, and outreach and education efforts. A few of these efforts include:

- The RiskWise partnership network is providing an educational approach to improve the safety and resilience of communities threatened by coastal hazards. Through the partnership's existing resources and programs, local decision-makers will have access to training, tools, and networks that better enable them to increase their resilience through community planning, economic development, and disaster management;
- The Association of State Floodplain Managers (ASFPM), in partnership with NOAA, has published the Coastal No Adverse Impact handbook, to educate local officials and residents on the benefits of a "do no harm" coastal management and development philosophy;
- The NOAA Sea Grant extension network of 350 agents and specialists in 30 coastal states and Puerto Rico serve as outreach intermediaries between NOAA's climate researchers, coastal decision-makers, and diverse constituents helping to define and deliver NOAA's climate tools and products needed at the local level; and
- NOAA's National Marine Sanctuary Program is piloting a climate change "story template" that will help each of the thirteen sanctuary sites and the marine national monument identify what the local and regional effects of climate change will be. This will aid in the development of a climate change action plan for each site to help plan and adapt to future impacts. NOAA is also developing a climate change component to its Marine Protected Areas (MPA) management capacity training program that will provide basic tools and procedures for MPA managers.

Incorporating Climate Change Information into Coastal and Ocean Resource Management

As noted previously, NOAA's work to incorporate climate change and adaptation into our mission and activities has resulted in numerous efforts that will assist the nation, states, regions, and local communities. Climate change information is being incorporated into coastal and ocean living marine resource and coastal ecosystem management decisions within NOAA itself through an increasing emphasis on an ecosystem approach to management.

Climate-related ecosystem level advice is being integrated and made available through programs, publications and advisories such as the Coral Reef Conservation Program, the *Status of the California Current System Report*, the Ecosystems Considerations chapter of the *North Pacific Groundfish Stock Assessment and Fisheries Evaluation* reports, and Ecosystem Advisories for the Northeast U.S. Shelf Large Marine Ecosystem. A short summary of other efforts include:

- In 2006, NOAA and partners produced *A Reef Manager's Guide to Coral Bleaching*. The guide articulates the state of knowledge on the causes and consequences of coral bleaching and provides information on responding to mass bleaching events, highlighting how to develop bleaching response plans and other management strategies to help reef managers increase the resilience of coral reefs and related ecosystems to expected changes in the global climate system.
- Climate information was used for fisheries management by the North Pacific Fishery Management Council who decided to reduce the Bering Sea pollock quota for 2008 by about 30 percent from 2007 levels. Climate information supplied by NOAA indicating relatively warm ocean conditions contributed to this decision.

- The state-managed National Estuarine Research Reserve System serves as sentinel sites to monitor the effects of change, as well as reference sites for guiding mitigation and adaptation strategies in larger coastal areas and watersheds. In addition, the Reserves' education and training programs provide science-based information to help individuals, agencies and organizations mitigate and adapt to the effects of climate change. At the Waquoit Bay National Estuarine Research Reserve in Massachusetts, staff participates on the Falmouth Energy Committee and helped to develop the *Climate Action Plan* for the town of Falmouth and have been active in getting towns on the Cape to commit to the Cities for Climate Protection program.
- NOAA is working with coastal managers and planners to better prepare for changes in coastal ecosystems due to land subsidence and sea level rise. Starting with southern Pamlico Sound, North Carolina, the approach is to simulate projected sea level rise using a coastal flooding model that combines a hydrodynamic model of water levels with a high resolution digital elevation model. The final products will be mapping and modeling tools that allow managers and planners to see projected shoreline changes and to display predictions of ecosystem impacts.

How NOAA Incorporates Climate Change Information - Ecosystem Services Restoration and Protection

Coastal habitats provide a variety of important ecosystem services that help protect coastal citizens and infrastructure from impacts of storms, flooding, sea level rise and other coastal hazards. Irreplaceable for floodwater retention, water filtration, fish and wildlife habitats and coastal buffers, coastal wetlands, barrier islands, mangroves and coral reefs provide a “green infrastructure,” helping to reduce erosion, storm surge and flooding, and provide buffers against the onslaught of storms and wave energy. The extensive damage caused to the Gulf of Mexico from hurricanes Katrina and Rita was due in part to the degraded state of the wetlands and barrier islands. Nationally, coastal erosion results in loss of coastal structures and property valued at an estimated \$500 million per year. Protection and restoration of coastal wetlands, estuaries, and rivers can help protect coastal communities against the onslaught of coastal hazards, sea level rise, and other effects of climate change.

We need to fully understand ecosystem processes and interactions, in order to predict and forecast how climate change will alter these ecosystem processes and interactions and the vital services they provide, and to adapt to those changes. For example, wetlands and barrier islands provide significant flood protection benefits. Recent research shows that each wetland alteration permit in Florida costs an additional \$1,000 in property damage per flood claim, and all permits combined cost the state \$30.4 million a year⁴. We need to understand how this value might change with increasing sea level rise and develop strategies to ensure that the ecosystem services are protected and maintained as the climate changes.

NOAA works with federal agencies, state and local governments, nonprofit, and private sector organizations to help coastal communities acquire, protect, conserve and restore coastal habitats, not only for the aesthetic and natural habitat benefits, but also because they provide important

⁴ Brody, SD., Zahran S., Maghelal, P., Grover, H., Highfield, WE. *The Rising Costs of Floods: Examining the Impact of Planning and Development Decisions on Property Damage in Florida*, Journal of the American Planning Association, Vol. 73, No. 3, Summer 2007

services to reduce the impacts of storms, flooding and other coastal hazards. NOAA's efforts include large-scale, regional efforts involving multiple projects, to individual, local projects to protect or restore coastal wetlands, rivers, and other habitats. Some key examples of projects or programs include:

- In the Chesapeake Bay, NOAA and partners restored near-shore oyster reefs and seagrass beds that reduced wave damage and protected coastal property from erosion;
- In Maine, the Land Trust Alliance, the Maine Coast Heritage Trust, and the Maine State Planning Office entered into a cooperative agreement with NOAA to leverage the skills and resources of approximately 50 organizations engaged in protecting Maine's coast for future generations. The project resulted in a coastal conservation plan that identifies protection priorities and strategies and implements a series of pilot projects at the local level;
- In coastal Louisiana, through the Coastal Wetlands Planning, Protection, and Restoration Act Program, NOAA has helped restore barrier islands resulting in increased protection of oil and gas infrastructure and coastal communities from risk of storm and wave damage; and
- NOAA's Coastal and Estuarine Land Conservation Program provides a tool for states to address climate change and coastal hazards through cost-sharing land acquisition.

NOAA recognizes that it is imperative to work with states and community partners to develop ecosystem approaches to respond to the effects of climate change. NOAA has several successful programs that partner with states, local communities, and non-profit organizations to protect and restore coastal habitats. A strong planning element, matched by determined local involvement will lead to proactive adaptation.

Next Steps

Federal, state, and local governments, nonprofit organizations, and the private sector continuously demand more climate information and services to effectively address the challenge of climate change and adaptation. NOAA is working hard to address these needs within its current budget and programs. Climate researchers at NOAA are making progress in matching the time and space scales of climate projections with time and space scales relevant to coastal management, land-use decision making, and hazard mitigation planning. We are also working to incorporate climate observations and predictions into coastal and living marine resource management.

NOAA looks forward to working with stakeholders to prioritize future research efforts. Among the stated needs of stakeholders are integrating climate information into infrastructure decisions for ports and waterways, clarifying the mechanisms of climate impacts on coastal and living marine resources and habitats, and assessing the socioeconomic impacts of a changing climate on coastal communities.

Conclusion

Providing a comprehensive suite of climate products and services that support effective adaptation planning requires a partnership approach, particularly in the economically important and politically challenging coastal domain. No single agency can meet all of the nation's needs for climate services. But as the world's preeminent source for climate data and information,

NOAA is uniquely positioned to help coordinate and provide climate information, products, and services across the federal government to ensure U.S. citizens, particularly those in coastal areas, have the tools required to adapt to the effects of a changing climate. NOAA is also working to ensure climate change information is being incorporated into living marine resource management decisions through an increasing emphasis on an ecosystem approach to management.

NOAA will continue to expand and improve its partnerships to meet growing constituent demands for tools, products, and services that will help them improve their resilience to the impacts of climate change on coastal ecosystems, communities, and economies.

Thank you for the opportunity to appear before you today.