

**STATEMENT OF
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BEFORE THE HOUSE COMMITTEE ON NATURAL RESOURCES
SUBCOMMITTEE ON NATIONAL PARKS, FORESTS AND PUBLIC LANDS**

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Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to participate on behalf of the Department of the Interior in today's hearing on combating climate change and the role of Federal lands. My name is Thomas R. Armstrong, and I am the senior advisor for Global Change Programs at the U.S. Geological Survey (USGS). I also represent the USGS and the Department as a Principal member of the U.S. Climate Change Science Program (CCSP).

The Department has a natural leadership role among Federal agencies addressing climate change on Federal lands and can bring all of its resource management expertise, capacity for alternative energy development, and scientific and information capabilities to bear in accomplishing that goal. As Secretary Salazar assembles his team, the Department will work with its counterparts in the Administration to address these important issues.

My statement today largely focuses on the USGS's role with regard to climate change research and science, focusing on climate impacts on our natural resources, including water, land, and wildlife. In addition, Section 711 of the Energy Independence and Security Act (P.L. 110-140), enacted into law in December 2007, authorized the Secretary of the Interior, acting through the Director of the USGS, to develop an assessment methodology and conduct a national assessment of geological storage capacity in collaboration with other relevant agencies. The USGS's ability to collect, monitor, and analyze relevant data allows it to provide scientific information about natural resource conditions, issues, and problems to decision-makers in the Department, at all levels of government, and the general public. This information – baseline scientific information, trends detection, modeling and forecasting, together with the effective dissemination of information and decision support tools – is key to understanding and addressing climate change and its effects.

The Administration has recognized the important role science plays in understanding and addressing the impacts of climate change. The President's 2010 Budget Blueprint includes more than \$130 million in additional funding for Interior, of which \$40 million is shared with the States to monitor, adaptively manage, and assess the impacts of climate change on the Nation's lands, fish and wildlife. While more details relating to the Department's budget, and these particular activities, will become available as the planning process continues, this is an important endorsement of the need for scientific analyses to understand and address these changes.

My statement also includes summary information on the impacts of changing climate as seen on the ground by the Department's land managing bureaus and the Bureau of Reclamation, as well as a brief look at adaptation and mitigation issues facing the bureaus as they carry out their missions. I am also joined by representatives from the Bureau of Land Management, the National Park Service, and the U.S. Fish and Wildlife Service, who are here to answer any questions you might have with respect to their programs.

Background

Perhaps no subject relevant to public land managers is as complex and challenging as global climate change. The Department of the Interior manages one in every five acres of the U.S. land mass. The bureaus within it operate dams and irrigation facilities that provide water to farmers and manage leases from which one-third of the Nation's domestic energy supplies are produced. Lands and waters under the Department's management jurisdiction account for significant contributions to our alternative energy supply from sources such as biomass, geothermal, solar, and wind power. Our wildlife refuges and national parks provide important wildlife habitat and manage extensive areas of shoreline and important wetlands. In Alaska alone, where the most tangible effects of climate change are being seen in the United States, the Department manages tens of millions of acres of public land, parks, and refuges.

Climate change affects biota, water, ecosystems, cultures, and economies. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) notes that climate change is expected to affect precipitation patterns, vegetation types and distribution, wildlife habitat and behavior, fire frequency, sea levels, the spread of pests and diseases, as well as a broad range of human activities. In order to effectively manage its lands and trust resources, the Department, working within the broader U.S. interagency climate change science framework, has a responsibility to further the scientific understanding of climate change processes and impacts. USGS scientists were contributing authors of the Climate Change Science Program's Synthesis and Assessment Product 4.4: Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources, drawing on their expertise to identify adaptation strategies for National Parks and National Wildlife Refuges. The USGS conducts scientific research to understand the likely consequences of climate change, especially by studying how climate has changed in the past and using this historical record to forecast responses to shifting climate conditions in the future; distinguishing between natural and human-influenced changes; and recognizing ecological and physical responses to changes in climate. These strengths allow USGS to play a critical role in conducting climate change science across the Nation's terrestrial, freshwater, and coastal systems – within and beyond Federal lands – and in providing objective science to assist decision-makers.

USGS Climate Change Science

Using these integrated assets, the USGS is creating a Climate Effects Network, an early warning system on the effects of climate change. USGS is also developing a National Climate Change and Wildlife Science Center for understanding fish and wildlife responses to changing climate and for testing and validating related adaptation decisions

by land managers and other stakeholders. The efforts of USGS will result in new knowledge and tools to support land and resource managers, citizens, and other stakeholders in making decisions that will be cost effective, provide more resilient ecosystems and watersheds, and safer communities.

The USGS provides on-the-ground scientific information from its numerous observation and monitoring networks and research activities. These observations and related research efforts are important components for building climate models, especially those that deal with the impacts of climate change to terrestrial, freshwater, and marine ecosystems. The ability to provide ground-truthing across multiple scientific disciplines in a wide variety of spatial and temporal scales enables the USGS to play a key role within the climate science community as we, and others in the international community, strive to develop adaptation and mitigation measures.

Regarding climate impacts on Federal lands, USGS findings and data provide critical information to decision-makers regarding many important climate-related issues, such as:

- Proliferation of invasive species and impacts on biodiversity, habitat, and ecosystems. The USGS is conducting several major studies throughout the United States looking at the evolution of forest and rangeland communities as a response to warming climate and changes in precipitation. The U.S. Forest Service, several land resource bureaus of the Department, and numerous State resource agencies are important stakeholders.
- Current and future trends of climate warming in the Arctic and resultant permafrost degradation and impacts on energy and transportation. The USGS is conducting several coordinated studies on the North Slope and Yukon Basin of Alaska. Emphasis is on permafrost and climate effects monitoring and related ecological and socio-economic changes. This work is a partnership with the U.S. Forest Service, the U.S. Fish and Wildlife Service, the Bureau of Land Management, the National Park Service, the University of Alaska, Alaska State agencies, and various Native communities.
- Coastal erosion in Alaska. A recent study, led by the USGS, finds that average annual erosion rates along part of the Beaufort Sea climbed from historical levels of about 20 feet per year between the mid-1950s and late-1970s, to 28 feet per year between the late-1970s and early 2000s, to a rate of 45 feet per year between 2002 and 2007. While the findings could represent a short-term episode, the study, published in the current issue of *Geophysical Research Letters*, could represent the future pattern of coastline erosion in the Arctic.
- Consequences of abrupt changes in climate including sea-level rise and impacts to low-lying coastal communities. USGS projects include two Priority Ecosystem Studies in the Chesapeake Bay and the Everglades. The USGS is collaborating with many partners, including the Army Corps of Engineers, the U.S. Environmental Protection Agency, the National Oceanic and Atmospheric

Administration (NOAA) and the land management bureaus within the Department.

- Impacts of climate change on land use and landscape change. In partnership with the National Aeronautics and Space Administration and NOAA, the USGS is involved in a variety of activities that are critical to understanding the impacts of climate change on public lands. These include monitoring of coastal zone topography and bathymetry; the production and distribution of national topography data; and improving our knowledge of topographic surface change through Landsat, and light-imaging detection and ranging (LIDAR) and radar imaging of the U.S. national land surface.
- Future availability of water for people and ecosystems. Specific projects underway include hydroclimatology studies in the Pacific Northwest and arid Southwest to assess current and future changes in water availability for these regions, and to identify associated impacts on dam and reservoir management strategies. The Bureau of Reclamation and several State water agencies are principal stakeholders for this work.

Scientific findings related to climate change must be effectively conveyed and delivered in a timely manner so that decision-makers are informed by the most relevant, up to date, objective information possible. Furthermore, scientists must provide this information with accurate estimates of uncertainty so that conclusions and recommendations drawn from scientific studies can be properly evaluated. The CCSP, of which both the USGS and the Department are members, is actively involved in developing a more effective decision support strategy for all interested stakeholders.

Although science has come far in understanding the impacts of climate change on people and ecosystems, many significant challenges and unique opportunities to better understand the long-term climate future for our planet remain. These include:

- Developing a holistic, earth-systems science approach to help communities and natural resource managers prepare for climate change impacts;
- Developing a better understanding of how the earth and its physical and biological processes interact, and with this understanding respond to climate change over the short-term and well into the future;
- Forecasting climate-related impacts for physical and biological systems;
- Forecasting precipitation changes as a consequence of changing climate;
- Determining how global warming may alter the frequency, intensity, and paths of strong storms, including hurricanes, as well as their impacts on coastal communities and natural resources; and;
- Understanding effects of climate change on entire ecosystems.

Included below is a summary of the impacts of changing climate on our bureau assets and resources and a brief look at adaptation and mitigation issues that the bureaus are currently facing. As can be seen, all the Department's land managing bureaus have taken some actions to identify and address the impacts of climate change, but the complexity of the problem and the scope of the issues to be addressed means more work is necessary.

Bureau of Land Management

The BLM is steward of the National System of Public Lands, 258 million acres of surface lands and 700 million acres of subsurface Federal mineral estate that are tremendously diverse. Encompassing Arctic tundra, coastal forests, and the vast mountains, deserts, and rangelands of the American West, they provide water resources, wildlife habitat, recreation opportunities, forest products, livestock forage, and mineral and energy resources.

The effects of climate change may already be apparent on public lands managed by BLM. One example is the desertification of public lands as a result of an increase in the frequency and duration of drought, which has recently been linked to long-term changes in the climate system. This has been accompanied by reductions in surface flow and groundwater levels, and a reduction in water availability. Vegetation in some places has converted to more drought hardy species, accompanied by or resulting from the expansion of non-native and other undesirable species. In some instances, species numbers have been reduced and, in affected habitat, some species have been lost. The overall results of these changes are more fragile ecosystems, a greater susceptibility to the outbreak of attacks by parasites and disease, increased vulnerability to wildland fire and erosion, and an overall reduction in carrying capacity. In Alaska, increased melting and other loss of glacial masses is seen and permafrost melting is occurring, resulting in loss of soil stability and increased erosion.

As a bureau, BLM is beginning to address climate change as a comprehensive factor in general management planning, and to identify the effects under cumulative impact analysis in environmental assessments. At this point, however, there is little guidance in dealing with this issue; as knowledge of climate change processes matures, the bureau's ability to address it will evolve and almost certainly improve. The BLM is currently working on refinements to enhance integration of science, planning, and project implementation. The BLM is also working to increase its ability to monitor, assess, predict, and respond to landscape changes over time, and is also continuing and expanding science research partnerships with the USGS, Department of Energy, other agencies, and universities.

The BLM is also implementing programs to address climate change on a broader scale. Maintaining and restoring healthy, resilient ecosystems is crucial to ameliorating and adapting to the effects of climate change. Much has been learned as this effort has evolved. Most importantly, the Bureau has recognized that landscape-scale problems require landscape-scale responses. Effective management must apply science, integrate disciplines, involve partners, coordinate jurisdictions, and link local actions to regional management strategies and priorities. Examples include the Great Basin Restoration

Initiative underway in Nevada, Oregon, and Idaho, and the Healthy Forests Initiative, which focuses on restoring forest ecosystems across public lands.

The BLM is providing opportunities for increased production of renewable energy through permitting on public lands of wind, solar and geothermal generation projects – of which there is vast potential – and projects for use of woody biomass resulting from forest management. The BLM’s completed programmatic plans estimate that, by 2025, wind energy capacity on public lands could reasonably increase five-fold from current levels. The projected increase for geothermal energy is even greater. Fully 90 percent of the existing and future geothermal resources in the United States are on Federal lands, and geothermal energy capacity could reasonably increase 15-20-fold by 2025. Similarly, solar energy on public lands holds great potential, and BLM is currently completing a programmatic environmental impact statement to assess potential development scenarios for solar energy and to help facilitate the development of solar energy projects on the public lands.

The public lands may also have an important role in efforts to mitigate emissions through terrestrial and geologic carbon sequestration. The capability to capture and store carbon dioxide in geologic formations could have a significant role in mitigating carbon dioxide emissions, which are a key factor in climate change. Geologic carbon sequestration is also considered especially important because it could enable the more climate-friendly use of the Nation’s vast coal resources. However, the challenges of geologic carbon sequestration are complex and significant, and many technological, scientific, legal and logistical questions exist. The BLM is working in cooperation with the Department of Energy to assess the feasibility of geologic sequestration, and BLM is currently preparing recommendations regarding the potential administration of geological sequestration projects on public lands.

Finally, BLM is implementing policies and practices that result in reduction of energy and other natural resources used by the bureau, as well as production of pollutants that exacerbate climate change effects.

National Park Service

National park units represent a wide range of ecosystems scattered across the nation that present a tremendous opportunity to observe the effects of climate change on resource conditions that scientists and managers have documented over decades. Begun almost nine years ago, the National Park Service Natural Resources Challenge Initiative has funded parks across the nation to conduct inventories and initiate vital signs monitoring of natural resources under the NPS’s jurisdiction. The combination of these sources of information, long-term legacy monitoring data, and new inventories has provided timely examples of the possible effects of climate change now visible in parks.

Based on NPS and other collaborative research, climate change presents significant risks and challenges to national parks. Warming temperatures have caused accelerated melting of mountain glaciers, reduced snowpack, and changes in timing and amount of stream flow. As noted above, these impacts are particularly felt in Alaska, where melting sea ice

threatens marine mammals as well as coastal communities, and thawing permafrost is contributing to the loss of buildings, roads, and facilities and disrupting the structural basis of large regions of interior Alaska. Shoreline vulnerability maps for parks, created by the USGS, predict that rising seas will erode beaches and coastlines and submerge wetlands and Native American cultural artifacts at coastal park units. Inundation of coastal estuaries, intertidal zones, and beaches will result in beach loss. Elevated water temperatures are causing coral bleaching and disease, and aggravating water quality problems that lead to harmful algal blooms. Estuaries, which are essentially fish nurseries that filter pollutants and protect the coast from storm surges, will be submerged faster than new sediment can build up. Valuable habitat for eelgrass beds, foraging waterbirds, shorebirds and nearshore fish will be lost. While some impacts are already measurable, the long-range effects of climate disruption on NPS natural and cultural resources, park infrastructure, and visitor experience are not currently known.

Because climate change has been identified as one of highest priorities for the NPS, many actions and activities have been undertaken at parks and within regions. The NPS is now in the process of developing a strategic framework for action that will detail long and short-term actions in three major areas: mitigation, adaptation, and public communication. The NPS has hired a Climate Change Coordinator, created six ad-hoc working groups – Legal & Policy; Planning; Science; Resource Stewardship; Greenhouse Gas Emission & Sustainable Operations, and Communication – to explore key goals and strategic actions that need to be addressed at park, regional, and national levels; and has held a series of regional and interagency workshops to explore climate change impacts and coping strategies and to develop action plans. In conjunction with the Environmental Protection Agency, in 2003 the NPS initiated the Climate Friendly Parks Program to promote sustainable operations in parks and create action plans to reduce greenhouse gas emissions, with almost 50 parks now participating. The NPS also created the Environmental Management Systems Programs with the goal of sustainable park operations and reduction of environmental impacts. Finally, NPS formed a service-wide Climate Change Response Steering Committee to foster communications, provide recommendations, and serve as an advisory body to NPS leadership; the Committee adopted the NPS Ocean Park Stewardship Action Plan in 2006 to guide actions to reduce ocean-related climate change impacts.

Looking to the future, the NPS will seek opportunities to capitalize on, and expand, the potential that units of the national park system provide for understanding long-term effects of climate change, testing innovative measures for adapting to climate change, and informing the public about climate-change-caused effects on natural and cultural resources and on the ability for visitors to experience enjoyable park visits.

U.S. Fish and Wildlife Service

The Service is a field-based organization, and biologists working on-the-ground are observing changes in many of our natural systems. Like the other land managing bureaus, these changes are more acutely evident in Arctic ecosystems where, in addition to the previously mentioned changes, observations include wetland drainage earlier “green-up” of Arctic vegetation, and changes in the hydrology of glacially-fed streams.

Increased Arctic temperatures have also contributed to the earlier onset of snow melt and the lengthening of the melting season, resulting in decreased total ice cover at summer's end. Climate change in the Arctic will continue to affect the habitats of ice-dependent species such as polar bear and walrus.

Like the polar regions, the Northwest and the Mountain-West have been experiencing reductions in annual snowpack, with USGS estimating that climate changes over the last 50 years in these areas have led to as much as a 17 percent decline in annual winter snowpack. The result has been a decreased recharge of ground water systems, increased stress to public water systems, changes in the timing of river ice-outs, and reduced river flows that affect temperature, depth, and other characteristics of spawning environments for fish such as Pacific salmon. Snowpack declines also have been accompanied by earlier annual peaks in river run-off, as documented in stream gage monitoring and analyses across the lower 48 States and throughout Alaska. As snow pack melts earlier throughout the western United States, reservoirs designed upon 20th century hydrology may not be able to adequately store the runoff. Predictions of less frequent, but more intense, summer storms may exacerbate storage and supply concerns.

Land managers face the growing reality that these recent observations may not be part of annual or even decadal change in weather patterns, but are possibly linked to a long-term change in the climate system. If this is the case, the implications for wildlife and fisheries management are substantial and will require extensive changes in the design and placement of projects to store water, protect and restore habitats, and manage populations.

Service biologists are also noting changes in abundance and distribution of species, including the expansion of pests and invasive species. Expansion of the mountain pine beetle into higher latitudes and elevations – areas once too cold to support it – is well correlated with observed temperature changes. This range expansion is increasingly impacting forest habitats, not just killing trees, but making these landscapes more susceptible to catastrophic wildfires and creating the potential to drive fundamental shifts in ecosystem function and structure. While some species will adapt successfully, some will not. Species most at risk are those that are unable to generalize or adapt. Long-distance migrants and birds with limited geographical ranges, for instance, may not be able to adjust to the changes caused by rising temperatures. Species at the end of geographical or elevational gradients will have difficulty adapting because they have nowhere to which they can migrate. Increased competition for habitat and the lack of suitable or available food in new locations would mean that a shift poleward may change the size of bird populations and composition of bird communities adapting to climate change.

Other significant changes associated with increased warming include rising sea levels and water temperatures that pose threats to marine habitats, coastal wetlands, and estuaries which are part of more than 160 National Wildlife Refuges the Service manages along the nation's coastline. Pea Island National Wildlife Refuge, part of the Alligator River National Wildlife Refuge Complex along the North Carolina coast, is losing ground annually to the Atlantic Ocean. The projected rise in sea level over the next 50 to 100

years will likely transform large expanses of marsh to open water, forest to marsh, and complicate habitat conservation for species such as the Federally endangered red wolf and many other species of birds and wildlife.

While the primary factor causing incidents of harmful algal blooms in the Gulf of Mexico is nutrient runoff, increased ocean temperatures are also accelerating the intensity of these blooms, or “red tides.” These increased incidents can cause significant fish kills, contaminate shellfish and, when inhaled, can create severe respiratory irritation to human. Increased ocean temperatures also contribute to more frequent and more intense events of coral bleaching and disease which can stress and kill corals. With the rise of atmospheric carbon dioxide levels, our oceans are becoming more acidic. As oceans absorb more carbon dioxide, the availability of carbonate ions is reduced. Reef-building organisms and shellfish require an abundance of carbonate ions to build their skeletons and shells.

The Service has established an impressive track record of adapting and mitigating strategies, including pioneering partnerships in habitat restoration and terrestrial sequestration. The Service is also beginning to address the potential for significant sea level rise. A comprehensive modeling effort using what is called the Sea Level Affecting Marshes Model (SLAMM) has been undertaken to determine the potential effects of sea-level rise on coastal National Wildlife Refuges. The SLAMM model simulates the dominant processes involved in wetland conversions and shoreline modifications during long-term sea level rise. SLAMM results will be crucial elements in developing refuge and landscape-scale adaptation strategies and in revising refuge comprehensive conservation plans.

The Service is working with other agencies, States, and partners to understand developments as quickly as possible and develop the capacity to respond to impacts on lands it manages and trust species under its jurisdiction.

Bureau of Reclamation

The Bureau of Reclamation is the largest wholesaler of water in the country, bringing water to more than 31 million people and providing one out of five Western farmers with irrigation water for 10 million acres of farmland. Reclamation is also the second largest producer of hydroelectric power in the western United States, with 58 powerplants annually providing more than 40 billion kilowatt hours – enough electricity to serve 6 million homes.

There is extensive study and discussion within the scientific community about the potential impacts of a changing climate on western water resources. For example, in 2007, a report from the National Academies of Science on Colorado River Basin Water Management concluded that “higher temperatures will result in less upper basin precipitation falling as snow, increased evaporative losses, and will shift the timing of peak spring snowmelt to earlier in the year.” The need to increase the predictive capabilities of climate change models was discussed earlier in this statement. As those

improvements occur, Reclamation will be looking to where and how to incorporate new climate change information.

Fortunately, Reclamation possesses operational flexibility to respond to hydrologic change and fulfill its mission to deliver water and power in the West. Drought, flood, and wide climate variability are all common occurrences in the western United States. Given its mission, Reclamation must manage with this variability in mind. However, solutions and strategies for incorporating climate change science into water project operations is an emerging effort being undertaken by all western water management interests, not just Reclamation. Identifying the information needed will require coordinated participation from all the organizations that can provide expert climate and hydrologic sciences.

Reclamation works with its many partners to better understand and incorporate climate information into western water resource management, including the USGS. The Reclamation Research and Development (R&D) Office is working with climate change experts in the USGS to help define the impact of changes in climate variability and climate change on western water resources.

Conclusion

In conclusion, there is a growing consensus that changes in the natural and human systems related to the effects of climate change must be better understood, monitored and forecasted so that all of the Nation's resources can be effectively managed and protected. The Department's bureaus are in an important position, partnering with USGS, to evaluate and develop responsive strategies for the impacts that we are observing and cataloging on resources in the Arctic, water resources in the southwest, and on the abundance and distribution of wildlife.

Thank you, Mr. Chairman, for the opportunity to present this testimony on behalf of the Department. I will be pleased to answer questions you and other Members of the Subcommittee might have.