TESTIMONY OF DAN ASHE, SCIENCE ADVISOR TO THE DIRECTOR, U.S. FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR, BEFORE THE HOUSE NATURAL RESOURCES SUBCOMMITEE ON FISHERIES, WILDLIFE, AND OCEANS REGARDING OVERSIGHT HEARING ON PLANNING FOR A CHANGING CLIMATE AND ITS IMPACTS ON WILDLIFE AND OCEANS; STATE AND FEDERAL EFFORTS AND NEEDS

JUNE 24, 2008

Introduction

Chairwoman Bordallo and Members of the Subcommittee, I am Dan Ashe, Science Advisor to the Director of the U.S. Fish and Wildlife Service (Service). I am pleased to be with you today to discuss the actions the Service is undertaking and planning to adaptively and strategically manage fish, wildlife and plants and their habitats in the face of increasing uncertainties that are the result of a changing climate system.

The Department of the Interior and the Service applaud the Subcommittee's interest in this issue and your focus upon what is happening on the ground today. Natural resource management is a challenging endeavor. I know that the Subcommittee and Committee Members appreciate the complexities that the Service's managers and partners face in dealing with issues such as limited water resources, invasive species introductions, habitat degradation and fragmentation, and wildlife trade and disease. Climate change adds an entirely new dimension of complexity and challenge to the stewardship of fish and wildlife resources.

Observations of the Natural Environment

There is strong scientific consensus that the Earth's climate is changing, and that the related changes in temperature, precipitation and sea level will have a significant impact on Earth's natural environment.

In 2007, the Intergovernmental Panel on Climate Change (IPCC) issued its Fourth Assessment Report concerning the observed and projected changes in the Earth's climate system, the impacts of climate change on the natural and human environment, and the capacity of these systems to adapt. Based on observational evidence world-wide, the Assessment concluded that –

> "Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases (very high confidence). A global assessment of data since 1970 has shown it is likely that anthropogenic warming has had discernable influence on many physical and biological systems."(IPCC WGII Technical Summary).

The Assessment included the following examples illustrating the impact on natural systems:

- changes in freezing, thawing, and drainage in Arctic and Antarctic Peninsula ecosystems, including those in sea-ice biomes that support polar bears and walrus;
- changes in the timing of ecological events (called phenological changes—e.g., bud burst, flowering, insect emergence, etc), earlier onset of spring vegetative growth, migration, and lengthening of the growing season;
- poleward and elevational shifts in ranges of plant and animal species; and
- poleward shifts in ranges and changes of algal, plankton and fish abundance in high-latitude oceans.

The Service is a field-based organization, and biologists working on-the-ground are observing changes in many of our natural systems. Nowhere are these changes more acutely evident than in the Arctic ecosystems. In the Service's Alaska Region, observations of Arctic changes include diminishing sea ice, coastal erosion, shrinking glaciers, thawing permafrost, wetland drainage, and earlier "green-up" of Arctic vegetation. Related to the deterioration of glaciers, we are seeing changes in the hydrology of glacially-fed streams. Increased temperatures in the Arctic 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. To explore these changes and begin discussions of management strategies, the Service and the U.S. Geological Survey (USGS) co-hosted a Climate Change Forum for Alaska, in Anchorage, in February 2007. The forum provided the opportunity for the Service to collaborate with USGS on recommendations for research and monitoring priorities, management directions, and methods to improve partner involvement.

Climate change in the Arctic will continue to affect the habitats of ice-dependent species such as polar bear and walrus. On May 15, 2008, the Service published a final rule to list the polar bear as a threatened species under the Endangered Species Act (ESA). The primary threat to this species is loss of sea-ice habitat, particularly summer sea ice, due to a combination of natural variation and climate change. Sea ice is essential habitat for many of the polar bear's life functions such as hunting, feeding, movement, and rearing cubs. To assist the Service in the decision on whether or not to list the polar bear, the USGS conducted research and modeling on the interaction between changes in the polar bear's sea-ice habitat and the distribution and abundance of bears. This decision required a level of scientific support and scrutiny that is atypical and perhaps unprecedented. The process of recovery planning will be immensely challenging because, in addition to science and management, it will require other issues, such as international diplomacy and cultural knowledge, to be addressed. Also, there are other species involved. The Service has been petitioned to list the walrus under the ESA while the National Marine Fisheries Service (NMFS) has been petitioned to list the ribbon seal. The NMFS is conducting a status review of all ice seals. Changing climate is driving ecology within the entire circumpolar arctic and our conservation efforts must address the suite of ice-dependent species in the Arctic, and thus, will require novel and collaborative solutions among scientists, managers, and native peoples – solutions that are at the landscape level and address multiple species.

Like the polar regions, the Northwest and the Mountain-West have also been experiencing reductions in annual snowpack. According to the USGS, climate changes over the last 50 years in these areas of the country have led to as much as a 17 percent decline in annual winter snowpack.[1] 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. One study predicts that if current allocations of water persist, there is a 50 percent chance that Lake Mead will not provide water without pumping by 2023, and a 50 percent chance that Hoover Dam will not be able to generate power by 2017.[2] While Departmental bureaus have previously noted before the Committee that there is much room for improvement in the demonstrated resolution of climate and streamflow modeling, as land and wildlife managers we have nevertheless managed around and through weather patterns like drought on annual to decadal scales. Now, however, managers must face the growing reality that these recent observations may not be part of an annual or even decadal change in weather pattern, but are possibly linked to a long-term change in the climate system itself. 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.

Apart from hydrological changes correlated with increased warming, Service biologists are also noting changes in abundance and distribution of species. These changes include 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 our 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.

We know that changes in temperature and moisture will affect species ecology. While some species will adapt successfully, and indeed, some will likely flourish in a warming

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[1] Statement of Dr. Thomas R. Armstrong, Program Coordinator, Earth Surface Dynamics Program U.S. Geological Survey, U.S. Department of the Interior to Committee on Commerce, Science and Transportation, Subcommittee on Global Climate Change and Impacts; Hearing on Projected and Past Effects of Climate Change: A Focus on Marine and Terrestrial Ecosystems; April 26, 2006

[2] Barnett, T. P., and D. W. Pierce (2008), When will Lake Mead go dry?, *Water Resour. Res.*, *44*, W03201, doi:10.1029/2007WR006704.

world, some will not. The challenge for resource scientists and managers will be in developing better capacities to model and predict these changes so that we can develop conservation strategies that are timely and effective. 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. Changes in ecological communities may decouple ecological relationships among species. Climate has influenced the development of intricate ecological relationships that have evolved over millennia, and relatively abrupt changes in climate may, for example, interfere with the synchrony between the life cycle of birds, bees, or other pollinators and the flowering of their host plants or emergence of insects they eat. Monitoring of phenological changes is one example of a potential area for future focus.

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 and over 50 coastal and marine parks managed by the National Park Service. 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. Similar threats are facing other refuges like Merritt Island National Wildlife Refuge which overlays and surrounds the Kennedy Space Center in Cape Canaveral, Florida, and serves as a home to more than 300 species of birds. At this refuge, projected sea level rise over the next few decades threatens to engulf much of the refuge. The Oregon Islands National Wildlife Refuge which supports significant seabird nesting and the Aransas National Wildlife Refuge along the Texas coast are also expected to experience substantial impacts from sea rise and subsequent loss of habitat for wildlife. Sea level rise will complicate some large scale restoration efforts, such as the effort currently underway to restore formerly diked salt ponds in the San Francisco Bay National Wildlife Refuge. It will be essential for the Service to understand not only the physical changes in habitat that will result from sea-level rise in and around our refuges, but the landscape-scale changes in population ecology that will be driven by those changes.

Increased ocean temperatures are also accelerating the intensity of algae blooms and incidents of red tide in the Gulf of Mexico. These increased incidents can cause significant fish kills, contaminate shellfish and, when inhaled, can create severe respiratory irritation to humans as well as generating more frequent and more intense events of coral bleaching and disease which can stress and kill corals. Coral reefs managed by the National Wildlife Refuge System, like other reefs world-wide, are experiencing bleaching episodes - most recently the reefs of Navassa National Wildlife Refuge demonstrated these effects after the extreme Caribbean bleaching episode of 2005.

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. .

As field biologists and ecologists research changes correlated with observed changes in climate, it is becoming increasingly apparent that those changes are widespread, and are adding increasing complexity to the challenge of fish and wildlife conservation. For instance, University of Texas ecologist, Dr. Camille Parmesan has done an extensive survey of scientific literature and concludes that –

> "Ecological changes in the phenology and distribution of plants and animals are occurring in all well-studied marine, freshwater, and terrestrial groups. These observed changes are heavily biased in the directions predicted from global warming and have been linked to local or regional climate change through correlations between climate and biological variation, field and laboratory experiments, and physiological research.[3]

This presents immense challenge for natural resource managers and scientists because we are facing what author Douglas Fox has termed "A No-Analog Future," that is, a future in which climate change leads to entirely new ecological communities for which there is no present analog.

Creating an Atmosphere of Awareness

The Service is preparing for this no-analog future by working with other agencies, states, and partners to understand developments as quickly as possible and to develop the capacity to respond. Based on the successful Climate Change Forum for Alaska, Service Director Dale Hall instructed all Regional Directors to work in concert with their USGS counterparts and develop a series of regional climate workshops. These workshops, like one that is occurring today for the Columbia River Basin, are bringing together partners from federal, state and tribal governments, conservation organizations and universities. The Service intends to use such information to develop our capacity to address the impacts of a changing climate.

Adaptation and Mitigation Strategies

The Service is establishing an impressive track record of adapting and mitigating strategies. Most noteworthy, perhaps, are our pioneering partnerships in habitat

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[3] Parmesan, C., (2006, Ecological and Evolutionary Responses to Recent Climate Change, *Annu. Rev. Ecolo. Evol. Syst. 37*: 637-69, doi:10.1146/annurev.ecolsys.37.091305.110100.

restoration and terrestrial sequestration. In our Southeast Region, an innovative partnership was launched eight years ago aimed at restoring native habitats to bolster populations of wildlife and migratory birds through a terrestrial carbon sequestration initiative. The Service is working with The Conservation Fund, Trust for Public Lands, and energy companies like Detroit Edison, American Electric Power, and Entergy, adding 40,000 acres of habitat to our National Wildlife Refuge System and reforesting a total of 80,000 acres with more than 22 million trees that will sequester approximately 30 million tons of carbon over 70 years. This effort has been fueled by a capacity to develop landscape-scale conservation strategies that has been built through the Lower Mississippi Valley Joint Venture Partnership.

In March 2007, the Service announced a new partnership with The Conservation Fund and its Go ZeroSM initiative that gives individuals and organizations a way to offset their own annual carbon emissions calculated based on daily commuting patterns, home energy usage and other factors. The Conservation Fund then offsets the carbon footprint by working with the Service to plant native trees on refuges. It's voluntary, non-regulatory, and represents another example of partnership that restores habitats, helps achieve goals in ecosystems, and contributes towards reducing atmospheric carbon dioxide.

The next frontier for this effort is to identify ways we can create an incentive to more broadly engage private landowners to restore native habitats that sequester carbon. For example, the Service is now working with the Department of Agriculture to replicate this sequestration initiative in other state and federal land management agencies as well as territories.

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 (NWRs). The SLAMM model simulates the dominant processes involved in wetland conversions and shoreline modifications during long-term sea level rise. Map distributions of wetlands are predicted under conditions of accelerated sea level rise and results are summarized in tabular and graphical form. Since June 2006, SLAMM modeling has been conducted for approximately 20 NWRs and at least an additional 26 are in the pipeline (see Table 1). The Service's National Wetlands Inventory (NWI) is an integral component to SLAMM modeling because SLAMM simulations run on NWI wetlands data. SLAMM results will be crucial elements in developing refuge and landscape-scale adaptation strategies and in revising refuge comprehensive conservation plans.

In addition to increased modeling and mapping efforts to better predict and understand the consequences of sea level rise on Service lands, we are assisting communities as they plan for potential environmental change. Sea level rise and subsequent increases in coastal erosion are already affecting portions of the coastline, particularly evident in western and northern Alaska. Hardening of shorelines and the relocation of vital infrastructure are already underway with potentially adverse impacts to high-value fish and wildlife habitat. In other communities, water shortages and droughts are likely to be community concerns. Service biologists are engaging to advise and assist communities across the country in planning for, and adapting to, these environmental changes while also conserving high-value fish and wildlife habitats.

Increasing Our Knowledge Base

Like the fish and wildlife populations that the Service is entrusted to conserve, we must adapt our work in an era of changing climate. This will require increasing ability to predict changes and design conservation strategies at landscape scales, to implement conservation projects, and to learn by adapting based on observed results. Improved understanding and models of future climate change is essential to plan for potentially significant changes. To that end, the Service is working with the USGS to develop modeling capacity and other research tools for assessing potential effects of climate change.

The USGS's 2009 budget proposal includes a $5 million Climate Change initiative. This initiative will result in science and adaptive management strategies for climate impacts and development of the methodology to assess geologic carbon storage. Results from this initiative will provide resource managers crucial information and tools to develop land and water management strategies and determine adaptive management activities in a dynamic environment affected by climate change. The USGS is also currently conducting research into water use and availability trends in order to examine the implications for managing the National Wildlife Refuge System. Part of this analysis will include projections on climate related changes in water availability.

The Service has joined an important new partnership with the USGS, The Wildlife Society, and others to develop a National Phenology Network. Our hope is that this effort will fuel a new generation of information on changes in ecological relationships in response to climate, a new generation of citizen scientists that will create opportunity for volunteerism, and support efforts to connect people with nature.

Another example of USGS-Service partnership in addressing impacts of climate change is the ongoing development of Adaptive Harvest Management (AHM) as an objective, science-based framework for establishing annual migratory bird hunting regulations. AHM, as a decision-making framework, is built upon alternative models that describe competing ideas about how hunted populations respond to the environment and to harvest. Population ecologists have traditionally attempted to exploit historical relationships between bird population dynamics, environmental factors, and harvest data to predict effects of future management decisions. Climate change has the potential to drastically alter the way that bird populations respond to their environment and to human activities such as hunting. This requires consideration of alternate potential future system states in the decisions harvest managers make today. To this end, Service and USGS scientists are evaluating ways to incorporate the predictions of climate models, which may suggest future conditions outside the realm of historical experience, within the decision-making process. These efforts represent a new scientific frontier in the general fields of structured decision-making and adaptive resource management.

A partnership with USGS and the Environmental Protection Agency involves the authoring of a case study on adaptation strategies for the National Wildlife Refuge System. This case study will be published as a chapter in the U.S. Climate Change Science Program (CCSP), Synthesis and Assessment Product (SAP) SAP 4.4: Adaptation Options for Climate-Sensitive Ecosystems and Resources (The CCSP Strategic Plan calls for the creation of a series of more than 20 synthesis and assessment reports. The lead agency for SAP 4.4 is the Environmental Protection Agency.) The 3rd draft of SAP 4.4 was posted on the CCSP web site on February 29, 2008, and the final report is scheduled to be posted in June 2008. The final report was posted on the CCSP web site on June 20, 2008. Lead authors of the National Wildlife Refuge Chapter are J. Michael Scott and Brad Griffith of USGS with three contributing authors from the Service: Robert S. Adamcik, Daniel M. Ashe, and Brian Czech. This report provides a preliminary review of adaptation options for climate-sensitive ecosystems and resources in the United States. Other chapters address National Forests, National Parks, Wild and Scenic Rivers, National Estuarine Reserves, and Marine Protected Areas.

Finally, the Service is cooperating with USGS to implement a framework for landscape scale conservation that we call "Strategic Habitat Conservation (SHC)." SHC is an adaptive management framework that begins with explicit trust resource population objectives. Because climate change affects species and habitat change globally, the Service needs a consistent approach to understand and address this challenge. This direction of change is inspiring and challenging us to reshape not just how we do the work of conservation, but how we think about conservation. Implementation of this approach and building this capacity will be an essential ingredient in our response to the changing climate system.

SHC integrates five functional elements into an adaptive framework: biological planning, conservation design, conservation delivery, decision-based monitoring, and assumption-driven research. While methods may vary, the essence of SHC begins and ends with explicit trust resource population objectives for a key species or group of key species. These objectives are met by applying predictive models and conservation biology principles to define the ecological conditions that must be sustained at the landscape scale and by using spatially explicit data to strategically target conservation priorities at the site scale. Landscape-level conservation through adaptive management provides a habitat conservation framework within which scientists and managers can factor in actual and projected changes in climate. Habitat fragmentation, dispersal and migration corridors, nonlinear changes in ecosystem response, and factors including intensified wildfires, droughts, and storms can be more effectively addressed through this framework. As we face the extraordinary complexity of changing climate, the Service will need to be increasingly strategic in conservation delivery. We must develop capacities to understand and anticipate change on broader landscape scales relevant to the types of climate changes likely to occur and develop new and innovative strategies such as potential climate refugia and conservation designs that result in landscape connectivity allowing habitat and populations to adapt as successfully as possible.

The SHC framework has been successfully applied in key regions for several years, most notably the Lower Mississippi Valley and Prairie Pothole regions, and increasingly is being expanded to other geographic areas. For example, in the plains of the Southwest, the Playa Lakes Joint Venture followed the SHC framework to conserve habitat for the lesser prairie-chicken and associated wildlife through strategic enrollment of land into Farm Bill conservation programs such as the Conservation Reserve Program. Applying the SHC framework (including a rigorous biological planning process to identify priority bird species in the region and habitat acres based on their potential benefit to the prairie-chicken), Joint Venture partners determined that, in the Texas Panhandle, 20,000 acres of CRP placed randomly on the landscape had no noticeable effect on the chickens' numbers. CRP acres spatially targeted and planted with native grasses, however, can support 217 prairie-chickens.

Conclusion

Critical to the Service's success in addressing these challenges will be our ability to build the capacity to understand the changing climate and to predict and adapt to its forcing effects on the natural environment, and the capacity to build partnerships with organizations like USGS, states, and other partners that have relevant expertise, tools and information. Admittedly, there is still a lot of work to be done, but the Service is making significant strides in developing adaptive and mitigation responses and expanding our knowledge of climate change trends and effects. Despite the enormity of the many challenges associated with this issue, the Service is committed to addressing climate change and its potential impacts on our Nation's fish, wildlife, and habitat. We are creating an atmosphere of awareness and an important new direction of change. We are modeling innovative new partnerships in adaptation and mitigation. We are increasing our knowledge and capacities to implement landscape-scale and adaptive approaches.

We appreciate your attention to this issue and we look forward to working with the Subcommittee, the Committee, and the entire Congress as we all work to address this challenge in the months and years to come.

Table 1. Sea Level Affecting Marshes Model (SLAMM) on coastal National Wildlife Refuges (Refuges)

Completed SLAMM Modeling	**Modeling Scheduled for FY-08**
ACE Basin NWR	Alligator River NWR
Bayou Sauvage NWR	Bayou Teche NWR
Big Branch Marsh NWR	Bogue Chitto NWR
Blackbeard Island NWR	Bon Secour NWR
Cape Romain NWR	Cabo Rojo NWR
Culebra NWR	Caloosahatchee NWR
Dungeness NWR	Chassahowitszka NWR
Egmont Key NWR	Chincoteague NWR
Harris Neck NWR	Crystal River NWR
J.N. Ding Darling NWR	Eastern Shore of Virginia NWR
Pinckney Island NWR	Green Cay NWR
Pine Island NWR	Island Bay NWR
Savannah NWR	Laguna Cartagena NWR
Swanquarter NWR	Mandalay NWR
Tybee NWR	Matlacha Pass NWR
Vieques NWR	Merritt Island NWR
Waccamaw NWR	National Key Deer NWR
Wassaw NWR	Passage Key
Willapa NWR	Pea Island NWR
Wolf Island NWR	Pinellas NWR
	Sabine NWR
	Sandy Point NWR
	Shell Keys NWR
	St. Johns NWR
	St. Marks NWR
	St. Vincent NWR

*Approximately 11 refuges of the Cheasapeake Bay region will be parsed out of a broader analysis being conducted for the National Wildlife Federation.

**Pacific Coast Refuges may also be included in FY-08.