Testimony of Dr. Lara J. Hansen
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"Climate change is arguably the greatest threat to the world's biodiversity." That is how I began my testimony to the Senate Committee on Commerce, Science and Transportation in March of 2004. Three years later this is no less true. In fact, the situation we find ourselves in is even more dire as was most recently highlighted in the Intergovernmental Panel for Climate Change (IPCC) Fourth Assessment Report released this year. Representing the top scientific experts in their fields, the three working groups of that body present the state of the science as demonstrating that:

1) Climate change is caused by greenhouse gas emissions from fossil fuels, such as carbon dioxide, and land use change;
2) We are already seeing the effects of climate change around us; and
3) We need to take action now both in terms of mitigation and adaptation to avoid an unacceptable future.

The time to act is now.

The primary response among policymakers has been to focus on reducing emissions of greenhouse gases, that is, mitigation of climate change. However, as the IPCC Working Group II emphasized, and as I have emphasized in my work over the years, adaptation – our ability to adjust to and prepare for the changes in climate already occurring and future changes to which our past emissions have already committed us -- is now equally important. There is no need to debate the virtues of mitigation versus adaptation. Neither alone will solve our problems. We need both and we need to see meaningful legislation addressing both mitigation and adaptation during this Congressional session.

As part of a conservation organization, my colleagues and I work to protect the world's biodiversity and natural resources. Traditional approaches to this work have relied on creating protected areas, limiting "take" of key species and resources and monitoring ecosystems of great importance and/or at great risk. Climate change makes these approaches inadequate. As the world's oceans warm and acidify, storm intensity increases, sea level rises, timing and concentrations of nutrient and contaminant run-off from terrestrial systems change, currents and upwelling patterns stop or move, timing of migration and lifecycle stages shifts, and ranges of species move, the oceans can not be protected from climate change by these old mechanisms. Conservation is now being planned across a matrix that is changing before our eyes and we are not prepared.

It could further be argued that the United States as a whole is not prepared. The IPCC Fourth Assessment Report asserts that climate change will be hardest on the poorest of the poor globally. The 2005 hurricane season indicates that the United States will not be unscathed by climate change. It is now over a year and a half since a record number of category five storms hit our Gulf Coast, and it has still not recovered from the battering. New Orleans is still in tatters. The calamities of climate change will be events like these and we are not prepared.

To address climate change in our conservation planning, WWF has adopted an approach to increase the resilience of natural systems to climate change that we are employing in ecoregions around the planet. This work is based on four basic tenets:

1. **Protecting adequate and appropriate space.** As the climate changes species (plants and animals) will react to these changes. They will react by altering how they live, such as using new resources, by moving to new areas, or by disappearing because they cannot find the habitat or resources they require. To help ecosystems respond to climate change we need to start planning where protected areas need to be in the future for species survival and how they need to be managed differently to support species groups. We need to look for locations that can act as refuges from climate change, opportunities for networks of reserves along climatological gradients (often across latitude or elevation), locations with high amounts of heterogeneity (or areas with different habitats and

species) and opportunities to support genetic diversity and gene flow. All of these strategies try to maximize the opportunity for species or ecosystems to respond to climate change, without adversely affecting ecosystems with our actions.

2. **Reducing all non-climate stresses.** Climate change presents a number of environmental stresses—increasing temperature, altered precipitation patterns, sea level rise, altered environmental chemistry to name just a few—but these stresses are not occurring in a vacuum. There are already a host of other environmental stresses out there, including invasive species, over-harvest, habitat degradation and fragmentation, disease and pests, and pollution. Unfortunately in many cases there are synergistic interactions between these traditional stresses and the stresses of climate change, effectively lowering the effect or "toxicity threshold." To increase ecosystem resilience to climate change we must lower the risk of adverse reactions by lowering the acceptable limits of these other stresses in the environment because climate change is already happening and our actions/inaction has already committed us to some changes.
3. **Implementing these pro-active approaches in adaptive management so we can learn as we go.** The actions we suggest are just good sense in light of climate change. If we enact small-scale tests and wait to implement our approaches broadly, the system will have changed and our approaches may no longer be useful or applicable. The window of opportunity for preparations may close as climate change progresses. Additionally, we do not have the funds or the human capacity to test strategies everywhere so we need to be learning lessons to share and implement as rapidly as possible.
4. **Reduce the rate and extent of climate change.** There is a limit to our ability to adapt to climate change. For example if we think about ocean acidification, there is a permanent commitment to changing the pH of the ocean every time we add more carbon to the atmosphere and it is not at all clear how we can adapt to these changes. Best estimates are that 2 ºC (3.6 ºF) increase in average global temperature brings us to a point where adaptation options become dramatically limited in feasibility and efficacy and prohibitively expensive in terms of cost. It is not new thinking that mitigation is necessary. This is simply another reason why we need to act sooner rather than later.

WWF's conservation adaptation projects are being implemented around the world, including in our marine ecoregions. In the tropics, we are testing how to protect coral reefs in American Samoa, Florida and the Mesoamerican Reef of Central America. We are also restoring and protecting mangrove forests to provide better coastal protection in Fiji, Cameroon and Tanzania. We are planning for sea level rise in low lying regions of the world, especially those that are home to endangered species, like endangered sea turtles in the Caribbean and beautiful tigers in the Sundarbans of India. In the Bering Sea of Alaska we are working to protect the future of that region's vital fisheries for the realities of climate change.

Some of our first work on climate adaptation was focused on coral reefs. Coral reefs are particularly sensitive to climate change. They bleach when ocean temperatures climb by as little as one degree Celsius. They are unable to create the calcium carbonate skeleton that forms the reef structure when the pH drops. And, they are damaged by increasingly intense tropical storm activity. The fate of coral reefs will have ramifications for human societies as well. It has been estimated that coral reefs have a global economic value of $30 billon in net benefits. In the case of coral reefs we are particularly interested in increasing resilience by decreasing those non-climate stresses that exacerbate the adverse effects of climate change; those factors that add to the overall stress and prevent corals from being able to withstand the stresses of climate change itself. In American Samoa our research group worked with local stakeholders to assess the current and potential impact of climate change on their coral reef resources. Almost annual coral bleaching in this region may be leading to reef degradation. Increased awareness of this issue in the region, in part due to this project, has lead to climate change being front and center on the agenda of the upcoming U.S. Coral Reef Task Force meeting to be held in American Samoa.

This first project led us to explore similar issues on a reef closer to home. In the Florida Keys, in fact for their whole Caribbean range, there are two species of coral, *Acropora cervicornis* and *A. palmata*, which are listed as threatened under the Endangered Species Act. The top three factors identified as the cause of their listing are increasing sea temperatures, hurricanes and disease. It is unclear how a recovery plan will be developed to respond to these threats given their inextricable link to global climate change and increasing greenhouse gas emissions. However the larger issue in the region is not how to protect these two species but rather how to protect the

entire reef ecosystem. We are currently developing a decision support tool to allow for the integration of historic coral bleaching data and water quality data in order to assess how improving regional water quality in the Keys may increase the resilience of those very economically valuable coral reefs. In 2001 it was estimated that coral reefs generated $3.9 billion in income for Broward, Mimai-Dade, Monroe and Palm Beach counties.

Coral reefs are not the only systems at risk from climate change. Coastal communities, both people and wildlife, also experience multiple climate change challenges—sea level rise, increasing storm intensity, changing precipitation, and increasing temperatures. Couple those stresses with the high human population density and development typical of coastal regions and climate planning becomes quite complicated. In some regions we are working to protect coastline and in other we are preparing for its loss.

Mangrove forests are already one of the most degraded ecosystems in the world. They have been cut down for firewood, building supplies and to clear coastline for development. Unfortunately these trees provide natural protection for shoreline from sea level rise and storm surge. Their loss has increased the vulnerability of coastal communities. WWF is working to restore and protect mangrove forests in order to increase coastal resilience in Fiji, Cameroon and Tanzania. As it turns out there is an added benefit of protecting mangroves; healthy mangroves may support healthy reefs. Mangroves filter nutrients out of the water as it flows from land to the oceans. It turns out coral reefs prefer low nutrient waters and when high nutrient waters flow into the oceans it can decrease the resilience of coral reefs. Additionally mangroves produce a compound that can filter out the harmful ultraviolet radiation that can exacerbate coral bleaching.

Sea level rise means the loss of land. For some species appropriate land is limited; others thrive right along the shoreline. In either of these cases, there are almost always human communities nearby that are also competing for this already precious space. Unfortunately it is getting more precious every day. An interesting case study is the Key Deer, a federally endangered species that finds suitable habitat on just two of the Florida Keys. With an elevation of less than 2 meters (or about six feet) at their highest point the vulnerability of the Florida Keys to climate change is clear. If you are a Key Deer, with nowhere to migrate in response to climate change, your future

is grim. While it is not clear what can be done for the Key Deer, WWF is trying to help develop plans to prepare other species for climate change. In the Caribbean basin, we are learning how sea level rise will inundate the nesting beaches of sea turtles. Sea turtles are vulnerable throughout their lives to climate change—their sex is determined by the temperature of the sand in which their eggs incubate, their long migrations and food sources are to varying degrees affected by ocean currents potentially vulnerable to climate, some rely on coral reefs and sea grasses which are themselves vulnerable and then their nesting beaches are being lost as the seas rise. Often as sea level rises, beaches retreat inland creating new coastline that would be suitable for turtle nesting. Unfortunately human infrastructure (buildings, roads) can prevent the generation of suitable new habitat. We are creating a new conservation plan for sea turtles that allows us to assess rate of sea level rise, beach elevations (looking for beaches that can withstand more sea level rise), local geology (subsidence and uplift), and patterns of human development. This will allow for choosing the right places for sea turtle protected areas and developing better coastal planning for not only sea turtles but human populations as well.

On the other side of the planet we are dealing with a similar but potentially more dangerous issue. In the Sundarbans of India, tigers live on low-lying mangrove islands. It is estimated that 12 of these islands will be lost to sea level rise by 2020. These are home to not only the tigers but people as well. As these islands are lost, both tigers and people will be looking for new homes, and with this may come increasing human/wildlife interactions that can have adverse consequences for both sides. We are again trying to develop a new conservation plan to prepare for the habitat that both humans and tigers will need as the landscape changes.

A similar process is occurring in our most northern oceans. In the Arctic, record sea ice loss is causing polar bears to spend more time on land or drown at sea. It is also making them go hungry because they require sea ice to hunt for their primary food source, ringed seals. More time on land means more time for potential interactions with people. In one Russian community where we work a young woman was killed by a polar bear near her village last year. We are now working with these communities on ways to decrease polar bear/human interactions without loss of life on either side through what are called "Polar Bear Patrols."

In the Bering Sea climate change is causing fish species ranges to shift (generally moving farther north) and historic fishing grounds will no longer be as robust. This is no small concern as the Bering Sea is home to a $2.1 billion fishing industry. WWF is working to develop new management approaches that plan for climate change and protect the resource as well as the livelihoods that rely upon it.

Obviously projects like these will not solve the problem of climate change. However they encompass the level of climate awareness that managers must now have and the range of activities they can engage in order to increase the resilience of their systems to climate change. They are part of a larger strategy that we must develop to address both the cause and effects of climate change.

Virtually all of the major bills introduced in this Congress relating to climate change are focused on mitigation, whether in the form of across-the-board cuts in U.S. greenhouse gas emissions, or in more targeted cuts for electric power plants, mobile sources of emissions, etc. Given the crucial need to address the root cause of climate change this is not misguided. However we must now also begin the task of addressing how to respond to the effects of climate change. At this point, bills on climate change have not addressed adaptation in a meaningful way.

Conservation organizations are not alone in their lack of preparedness for the effects of climate change. We need a bold new plan in all sectors to deal with this ubiquitous challenge. WWF proposes a legislative approach with two components. First we need a National Strategy for Adaptation, supported not only with funding, but with an extension agency that works to develop the myriad responses we will need in all sectors of our society, not just the oceans, not just natural resources and wildlife, but in civil society and the infrastructure on which we and our economy relies- food, water, housing, transportation, education, public health….the list is endless. This extension agency could be modeled after the Land and Sea Grant programs to work with all levels of society across the country on specifically addressing and adapting to climate change. Second, we need an impact assessment approach modeled after National Environmental Policy Act (NEPA) that would require public works, infrastructure activities and all other projects that might adversely affect natural systems to take into account the added effects of

climate change, and address how those adverse effects could be avoided. For instance, some pollutants become more toxic at elevated temperatures, so existing exposure limits may not adequately protect people and ecosystems as the planet warms and this could affect permitting for new sewage treatment projects. In fact this approach of assessing the vulnerability of projects to climate change should be good business practice for all federally funded project in order to ensure their value, success and longevity, regardless of whether they focus on natural resources.

The task of fully addressing climate change is massive, but we can no longer ignore it.

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