Testimony of Reed F. Noss, Ph.D. to the Subcommittee on National Parks of the Senate Committee on Energy and Natural Resources. Presented October 28, 2009.

I am Reed Noss, the Davis-Shine Professor of Conservation Biology at the University of Central Florida and President of the Florida Institute for Conservation Science. I have an M.S. degree in Ecology from the University of Tennessee and a Ph.D. in Wildlife Ecology from the University of Florida. I am the author of more than 260 scientific and semi-technical articles and several books. I have served as Editor-in-Chief of the journal *Conservation Biology* and as President of the Society for Conservation Biology. I am an elected Fellow of the American Association for the Advancement of Science. I was recently the Vice-Chair of a Federal Advisory Committee for the U.S. Climate Change Science Program. I am currently organizing a scientific workshop and book on adaptation to sea-level rise in Florida. At many times in the past I have served as an *ad hoc* advisor to the National Park Service and other federal agencies.

Our national parks have long been valued as public playgrounds, places for spiritual enrichment, and as bastions of democracy. Especially over the last few decades, the national park system has also been viewed as a reservoir of wildlife and biological diversity. We all know that this value is sometimes compromised, both by over-development and other problems within the parks and by things going on beyond park boundaries.

The best known examples of problems originating outside park boundaries, but affecting parks are clear-cutting, intensive agriculture, road-building, energy development, and urbanization, sometimes occurring right up to the boundaries of national parks. These activities turn some parks into ecological islands surrounded by highly altered land. Migrations of large mammals such as elk, bison, and pronghorn antelope in and out of some western national parks have been disrupted, to the extent that some populations face extinction.

Less visible but just as dangerous to the ecological integrity of national parks are air and water pollution, acid precipitation, and water withdrawals for agriculture and urban uses. Recently, undeniable scientific evidence has become available showing that climate change and attendant impacts such as sea-level rise may be the greatest environmental threat our nation and the world have ever faced. National parks are not exempt from this threat – in fact, due their locations (very high elevations or very low coastal elevations) they are probably more vulnerable than most other lands.

The two main things we know about climate change in relation to national parks are that:

1) Climate change will not be good for national parks - but
2) There are things we can do proactively to reduce the impacts of climate change on national parks – these things fall into the category of "adaptation."

Adaptation to climate change is very urgent because we are already seeing negative impacts of climate change on wildlife and ecosystems, and those impacts will continue to worsen for at least decades and probably centuries, even if we drastically reduce our combustion of fossil fuels and other inputs of greenhouse gases into the atmosphere.

To reduce the impacts of climate change on national parks in a cost-effective way, we need to prioritize, which requires asking several key questions:

1) What kinds of species are at greatest risk from climate change?
2) What national parks are most at risk from climate change, in terms of losing species and ecosystem functions?
3) Conversely, what kinds of parks are likely to be most resilient to climate change?
4) What kinds of actions should we take to minimize losses of biological diversity and ecological integrity within national parks?

All of these questions, but especially the last, require sound scientific research to answer with confidence and in detail. Nevertheless, we have sufficient knowledge now to make some generalizations and head in the right direction.

First, what kinds of species are likely to be at greatest risk? We can assume they will be:

- Species with narrow geographic distributions (i.e., endemics), in which case loss of only a small area of habitat could result in extinction.
- Species closely associated with habitats likely to be eliminated or greatly reduced by climate change. These include arctic, alpine, low-lying coastal, and nearshore marine habitats.
- Species that are not very mobile and cannot disperse quickly.
- Species that show limited responsiveness to natural selection (from low genetic diversity, long generation times, etc.).
- Species that are highly susceptible to emerging diseases and invasive non-native predators and competitors.

What kinds of national parks are likely to experience intense impacts from climate change? We can predict that these include parks in the far north, for example Alaska, and in the continental interior, because these are the regions expected to show the greatest increases in temperature and associated water stress. Alpine areas within parks – for example in the Rocky Mountains, Sierra Nevada, and Cascades – are also at high risk. Alpine areas and their species stand to be pinched right of the top of mountains as vegetation zones move upwards in elevation with warming temperatures.

But are mountain parks more at risk generally? Probably not. There are many reasons to suspect that parks with extensive elevation gradients and high topographic diversity will be more resilient to climate change than parks with limited topography. With adequate elevation range available, a terrestrial species can migrate upslope and reach a cooler climate with much less distance to travel than moving northward. In general, an average temperature 3^{o} F cooler can be reached by moving upslope 1000 feet but would require moving northward 100 miles.

In mountainous parks, species can also seek cooler microclimates such as sheltered coves, north-facing slopes, and areas around seeps and springs. Indeed, these cooler microhabitats probably serve an important role as refuges for species during times of hotter climate, from which they can move out and repopulate the surrounding landscape as the regional climate cools again.

Therefore, perhaps the most compelling recommendations that scientists can make with respect to biological adaptation to climate change are to:

- Maintain intact, connected habitats along environmental gradients, for example from the lowlands to the mountaintops.
- Locate and protect local areas of cooler and wetter microclimate.

Opportunities for adaptation are more restricted in flat terrain. National parks and other natural areas in low-lying coastal regions are the most vulnerable of all and will require the most immediate and probably the most costly intervention in order to prevent widespread losses of species. The culprit, of course, is sea-level rise.

Eminent geologists Orrin Pilkey and Rob Young recently wrote in their book *The Rising Sea* (2009): "Of all the ongoing and expected changes from global warming...the increase in the volume of the oceans and accompanying rise in the level of the sea will be the most immediate, the most certain, the most widespread, and the most economically visible in its effects."

Most of the acreage of the national park system in the eastern United States is coastal. Everglades National Park and the contiguous Big Cypress National Preserve total more than 2.2 million acres, slightly larger than Yellowstone National Park. The nearby Biscayne National Park encompasses another 172,000 acres. All but one of our 10 national seashores are on the Atlantic or Gulf Coasts, and these eastern national seashores total nearly 525,000 acres.

What will happen to these eastern national park units with rising sea level? Projections for Florida, as an example, do not look good (Fig. 1). Most projections now show the sea rising at least 1 meter by the year 2100 – this is the level currently estimated by the U.S. Climate Change Science Program. However, many recent projections are higher (for example, the State of California is now assuming 1.4 meters by 2100 in its planning) and some studies suggest that the rise to 1 meter or more above current levels could happen significantly sooner than 2100, depending on what happens to the polar ice caps.

Faced with projections such as these, a natural response would be despair. In Florida, we are currently in denial. I am not sure which is worse. A more intelligent approach is to examine the options for adaptation to the inevitable changes that will occur.

These options fall into two classes: (1) armor the shoreline with seawalls, levees and other structures, and bring in large amounts of new sand to build artificial beaches; or (2) managed retreat, where we relocate people, valuable structures, species, and habitat further inland, above the expected level of sea-level rise. Because many structures can not be relocated economically, they will have to be abandoned.

Pursuing either of these options will be difficult and expensive. The first option – coastal armoring and building artificial beaches – would be only a short-term fix, at best, and will soon prove economically unsustainable. It would be a disaster ecologically as well, by preventing the

natural inland movement of habitats and species, which has occurred during previous periods of sea-level rise many times over the past millions of years.

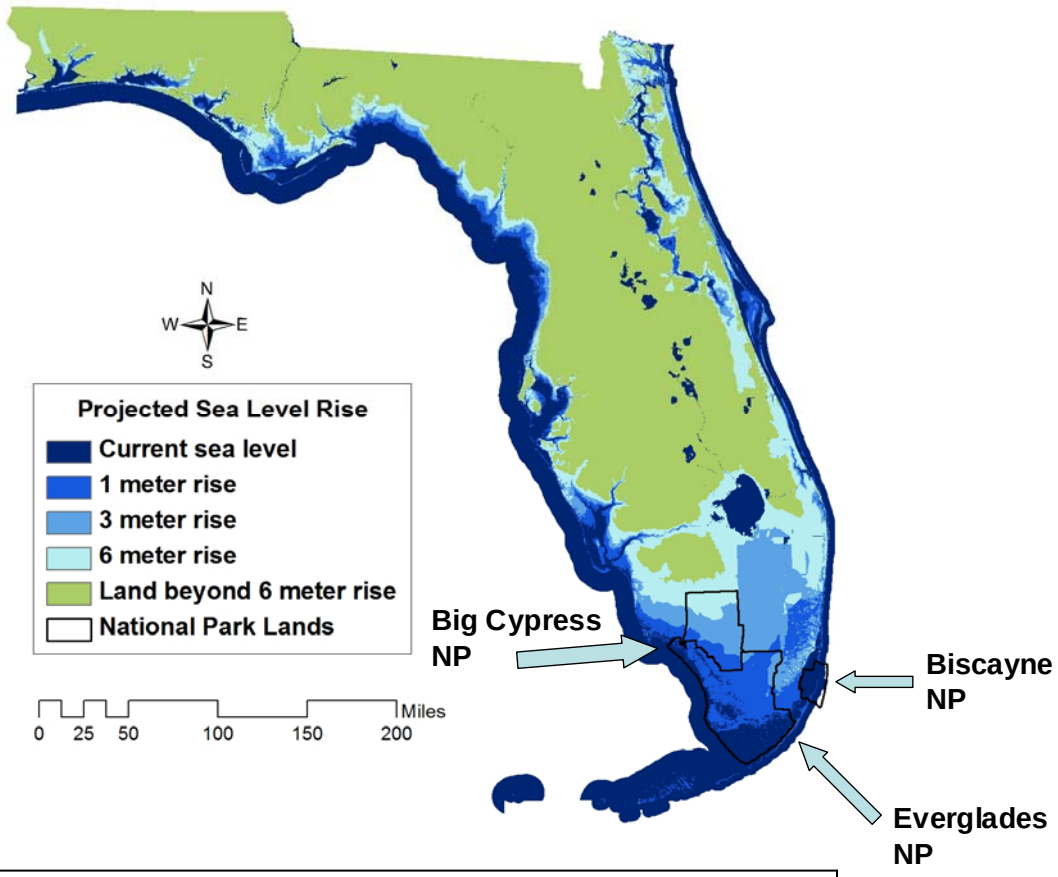

Figure 1. Projections of 1 meter, 3 meter, and 6 meter rises in sea level in Florida, given high-resolution data on elevation and shorelines. In South Florida, almost all of Biscayne National Park and Everglades National Park will be inundated with just a 1 meter rise in sea level, which is now considered a conservative estimate by the year 2100. Big Cypress National Preserve will take longer to inundate.

Source: Model from J. Weiss and J. Overpeck, University of Arizona. Refined by T. Hoctor, University of Florida.

For coastal national park units, assisting the movement of species inland to colonize new habitats is the only strategy with any hope of success. Yet we are still faced with many questions and much uncertainty about answers. In the Everglades, for example, can we really expect unique communities such as marl prairies (home of the federally Endangered Cape Sable Seaside Sparrow) to "migrate" inland? We simply do not know.

What about our national seashores? Most of these national park units are on barrier islands. Barrier islands naturally move around over time with changes in sea levels and currents. But before long there will be nowhere to move. The shorelines landward of the barrier islands, like much of the islands themselves, are often heavily developed.

All we can do in these cases is protect as much coastal habitat as possible now and establish broad movement corridors from coastal parks and other natural areas to inland conservation areas. We probably will have to physically translocate some species to higher ground and take others into captivity indefinitely. We may have to create new beaches, well inland of their current location, to provide essential nesting and feeding habitat for sea turtles, shorebirds, and many other creatures.

Sea-level rise and other challenges to national parks and our natural heritage posed by climate change do not have to be a catastrophe. As Orrin Pilkey and Rob Young put it, sea-level rise and its associated impacts "could all be seen as an opportunity for society to redesign with nature, to anticipate the changes that will occur in the future and to respond in such a fashion as to maintain a coast that future generations will find both useful and enjoyable. It provides a challenge to scientists, planners, environmentalists, politicians, and other citizens alike to stretch the limits of their imagination to respond with flexibility and with careful foresight to development challenges that our society has not faced before."

I urge this subcommittee to think hard about these questions and initiate a process to determine precisely what needs to be done to minimize the impacts of sea-level rise and other climatic phenomena on national parks and America's natural heritage in general. The sooner we take action, the more of our natural heritage can be preserved for future generations. We still have a chance to make a difference.

Thank you for the opportunity to testify before this subcommittee.

Respectfully,

Reed F. Noss, Ph.D.