Written Statement of
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Madam Chairwoman and members of the subcommittee, I am J. Christopher Haney, Chief Scientist for Defenders of Wildlife. Thank you for this opportunity to speak with you today about impacts of climate change from global warming on America's fish and wildlife.

My organization was founded in 1947 and is a national non-profit organization with more than 500,000 members and supporters dedicated to the protection and restoration of all wild animals and plants in their natural communities. I come before you today to express our profound concern that we stand at a crucial moment in our history when we must act, and act now, if we desire to protect this natural heritage – the nation's diverse fish and wildlife resources.

As you know, the U.N. sponsored Intergovernmental Panel on Climate Change (IPCC) recently released two out of an eventual four volume report that summarizes findings from much larger technical reports (IPCC 2007 Climate Change Fourth Assessment Report (WGI Science) Summary for Policy-Makers (SPM) and (WGII Impacts, Adaptation, and Vulnerability) SPM). The IPCC report makes clear that global warming is occurring, that it is exacerbated by human activity, and that it will have a devastating impact on fish and wildlife. The IPCC report is particularly important for two reasons.

First, the underlying technical report reflects a synthesis of the existing scientific and technical literature compiled by the world's top experts. It represents the collective understanding of literally thousands of scientists from around the world, and includes hundreds of top university researchers and government scientists from the U.S. Therefore, these Assessment Reports summarize the current science and portray our state of knowledge about climate change and global warming. Impacts of climate change in North America were included in this report.

Second, the report is based on actual observation. In my testimony today, I wish to share with you first-hand personal observations, and will emphasize ten (10) separate categories of

impacts from climate change that we at Defenders see affecting fish and wildlife resources across the country. These categories not only serve to further reinforce findings of the Intergovernmental scientific report, they will enable you to see direct connections to human welfare as well.

GLOBAL WARMING'S IMPACT ON WILDLIFE

Recent studies clearly demonstrate that species and biological communities are responding to changing climate due to global warming. The strength of these conclusions – that impacts of climate change are consistent across diverse species and geographic regions – is based on the robust nature of the meta-analyses[1] which examined hundreds of species and thousands of articles on climate change. A 2003 study by Parmesan and Yohe[2] examined more than 1,700 species. More than half showed measurable changes in distribution and/or timing of their life cycles coherent with global warming. An analysis by Root et al. (2003)[3] of 143 studies "reveal a consistent temperature-related shift, or 'fingerprint'…more than 80% of the species that show changes are shifting in the direction expected on the basis of known physiological constraints." Plants and animal populations are clearly feeling the effects of global warming.

Simply put, there is no real scientific debate: global warming from our activities[4] has altered biological and physical systems. Due to the timescales associated with climate processes and feedbacks, the *effects* will continue for decades or centuries. Thus, even if the human-induced emissions of greenhouse gases concentrations – the *causes* of the observed accelerated global warming – are stabilized in the very near future, our nation's wildlife will continue to feel those effects for some time to come.

MAJOR CATEGORIES OF CLIMATE CHANGE IMPACTS

(1) Sea and land ice meltdowns. According to the IPCC, average Arctic temperatures increased at almost twice the global average rate in the past 100 years. Satellite data since 1978 show that annual average Arctic sea ice extent has shrunk by 2.7% per decade. Temperatures at the top of the permafrost layer have generally increased since the 1980s in the Arctic (by up to 3°C). The maximum area covered by seasonally frozen ground has decreased by about 7% in the northern hemisphere since 1900, with a decrease in spring of up to 15%.

These changes in the Arctic environment have reduced the integrity of the region's unique terrestrial and marine ecosystems. Sea pack ice is disappearing, thinning, and moving further offshore from land, all of which tip the scales against wildlife that rely on this key habitat. Spectacled eiders (*Somateria fischeri*), a sea duck already listed as threatened under the

[1] Meta-analysis is a statistical method using multiple studies that examine similar factors and use similar methods. Conclusions reached through a meta-analysis are reinforced by the consistencies observed across multiple sources.

[2] Parmesan, C., and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. *Nature* 421: 37-42.

[3] Root, T. L. et al. 2004. Fingerprints of global warming on wild animals and plants. *Nature* 421: 57-60.

[4] Intergovernmental Panel on Climate Change (WG-I) concluded that evidence of global warming is unequivocal, and that dramatic changes to the planet's climate are, with a 90 percent certainty, the result of human-generated emissions of greenhouse gases.

Endangered Species Act, use large ice-free areas (termed polynyas) for foraging during the winter, and rest and sleep on adjacent ice edges strategically located over sea floor grounds rich in prey. Without such sea-ice roosting areas, spectacled eiders won't be able to easily reach their food sources. Rapidly changing ice conditions have forced ringed seals (*Phoca hispida*) to move and give birth to their pups in different locations – even under ice – making finding and catching seals a bigger challenge for the polar bears (*Ursus maritimus*) that depend on them for survival. With expectations that the Arctic Ocean will be largely devoid of summer sea pack ice later in this century, species such as polar bears, ivory gulls (*Pagophila eburnea*), walruses (*Odobenus rosmarus*), and the several species of ice-dwelling seals will find their habitat literally melted away.

Polar bears are especially dependent on sea ice as platforms for hunting the marine mammals that provide their nutritional needs. Because the necessary ice bridges linking land and sea have now been severed across wide areas, adult and young polar bears have starved and drowned. Some polar bears have resorted to cannibalism, leading scientists to remark that they are witnessing stressors unprecedented in decades of observation. The U.S. Fish and Wildlife Service has proposed listing the polar bear as threatened under the Endangered Species Act, a proposal which Defenders of Wildlife strongly supports.

On land, prospects are no better. Disappearance of permafrost has led to draining of Arctic wetlands, aquatic habitats used extensively by the breeding waterfowl that winter in the lower 48 states and support a multi-billion dollar sport hunting economy. Declining winter snow packs threaten terrestrial species such as the wolverine (*Gulo gulo*), a large relative of the weasel that relies upon snow drifts for maternal denning.

One key place where changes are especially visible is the Arctic National Wildlife Refuge in Alaska. The Arctic Refuge is the most important on-shore denning habitat for polar bears in the United States. As offshore sea-ice denning areas melt away, the Arctic Refuge becomes one of the last places for these polar bears to winter with their newborn cubs. The refuge's famed Porcupine caribou herd is also being affected by global warming. Caribou (*Rangifer tarandus*) are departing their wintering grounds a month earlier and are still having trouble making it to the coastal plain of the Arctic Refuge in time for the earlier arrival of spring, when the most nutritious forage is available for their calves. Thus, the significance of the Arctic Refuge to wildlife is reinforced by the added threats from global warming.

(2) Habitat shifts. As the planet warms, the habitats required by particular species shift as well, typically northward in the northern hemisphere, upslope, and inland. Northern and elevational boundaries have moved, on average, 6.1 km northward and 6.1 meters upward each decade.

For some species already on the edge, these shifts could spell ultimate extinction. For instance, the Cheat Mountain salamander (*Plethodon nettingi*) is found nowhere else but West Virginia. Its entire range is just 935 square miles, spread across the high mountains of the east central part of the state from Backbone Mountain, Tucker County in the north to Thorny Flat, Pocahontas County in the south. The Cheat Mountain salamander is generally found above 2,600–3,500 feet. With one of the most restricted ranges of any salamander in the United States, and already listed since 1989 by the U.S. Fish and Wildlife Service as threatened throughout its range, this amphibian is extremely vulnerable. If global warming

pushes it further up the mountains in search of a cooler environment, eventually it will find no place left to go.

(**3) Heightened risks from invasive species, including disease**. Rapidly changing environments increase the risk of invasive native and invasive non-native species, both of which can pose threats to other parts of natural systems they share. For example, the longer growing seasons from global warming have been implicated as facilitating unusually large and long outbreaks of spruce bark beetles (*Dendroctonus rufipennis*). In the past 25 years beetle outbreaks have resulted in the loss of an estimated two billion board feet of timber on the Kenai Peninsula and elsewhere in Alaska. Longer summers enable the beetles to complete one or more generations of their life cycle within a season, leading to exploding populations of this forest insect. In Guam, native wildlife is greatly threatened already from accidental introduction of the non-native brown tree snake (*Boiga irregularis*). Climate change will open new frontiers for such invasive species, and make conservation all the more challenging.

We know from studies of human health that rises in temperatures and increases in flooding are often associated also with a rise in certain infections and movement or spread of pathogens and disease vectors. Wildlife and fish are also susceptible to increases in disease risk. Such risk will become even more important as wild populations decline – a loss in numbers will increase demographic risks of extinction – as well as the impact of an increase in population density as animals move into the last remaining wild lands due to large-scale land conversions. This increased population density as well as increase risk of contacting an infected species or vector will magnify as new infections and disease vectors themselves spread into more regions with climate change.

(4) Rising sea levels. Projections of sea level rise from global warming range from 7 to 23 inches over the next century, according to the latest IPCC report. Accelerated melting of Antarctica or Greenland glaciers could raise sea levels by several meters[5]. Any rise will have negative consequences for some wildlife. Some islands used by the endangered Hawaiian monk seal (*Monachus schauinslandi*) could be completely underwater by century's end, overcrowding the remaining islands used for breeding and rearing of young and increasing the predation of seals by sharks. Other coastal species like the endangered Florida Key deer (*Odocoileus virginianus clavium*) depend entirely upon low-level barrier islands, and are especially vulnerable to sea level rise.

Essential habitats along low-lying coastlines are also at serious risk. Approximately 160 national wildlife refuges occur in coastal areas, including several refuges in New Jersey, Maryland, and Louisiana. Many of these refuges, like Maryland's Blackwater National Wildlife Refuge, protect coastal marshes that are only a foot or two above the current sea level. Even the lowest estimated rise in sea level over the next century will have profound effects on coastal wetlands, which are one of the most biologically productive ecosystems on earth. Coastal marshes also happen to be tremendous carbon sinks, and their loss will reduce their ability to absorb carbon and potentially release even more carbon dioxide into the atmosphere as the inundated marsh plants decompose.

[5] IPCC figures for the range in sea level rise are conservative. Ice cap and glacier melt, however, where the disintegration of ice shelves and lubrication of glaciers by meltwater speed up the flow of ice into the oceans, are more difficult to model.

(5) Longer droughts. Extended drought resulting from global warming poses an additional kind of threat to species that rely on already scarce water in arid environments such as the American southwest. For example, even in the best of times, survival can be precarious for desert bighorn sheep (*Ovis canadensis* spp.). Inhabiting steep, rocky terrain in the driest areas of the American southwest, they live in small groups isolated by miles of blazingly hot terrain. In southeastern California, rainfall has declined by as much as 20%, leading to drying of springs and disappearance of important food plants[6]. More than a third of the sheep populations that once lived in California's mountains have disappeared in the last century.

Less-arid regions face dramatic changes as well. As Defenders highlighted in our 2006 report, *Refuges at Risk: The Threat of Global Warming*, the prairie pothole region of the country is the nation's duck factory; its thousands of small lakes and ponds provide ideal habitat for breeding waterfowl. Over 50 national wildlife refuges, such as Medicine Lake refuge in eastern Montana, and Devils Lake Wetland Management District in North Dakota, have been established in this region to protect breeding bird habitat. Climate scientists predict that warmer climates in the northern prairie wetlands region will increase the frequency and severity of droughts – so much so that the number of breeding ducks in this region could be cut in half.

(6) Excess carbon dioxide. Often described as rainforests of the ocean, coral reefs support a dazzling array of creatures. But die-offs of corals, as much as 98% in some locations during the last 25 years, landed two coral species on the endangered species list. Staghorn (*Acropora cervicornis*) and elkhorn coral (*Acropora palmata*) form massive thickets, provide cover for numerous reef fish, and are essential for the health of entire reef ecosystems. However, warming ocean temperatures are stripping corals of the algae they need to survive, while carbon dioxide emissions are also turning the naturally alkaline oceans more acidic. Reefs subsequently turn into rubble because of lowering concentrations of carbonate ions, a key building block for calcium carbonate required by the corals. Threats from global warming to coral reefs have the potential to harm some of our most spectacular national wildlife refuges, including the Northwest Hawaiian Islands, Guam, Palmyra Atoll, Midway Atoll, and Kingman Reef in the south Pacific.

Guam's coral reefs are home to thousands of species of animals and plants, including hundreds of kinds of fishes and shellfishes. Fishes and other animals and plants taken from coral reefs are an indispensable part of the island's traditional diet. Tourists are attracted to the reef's abundant marine life and clear waters. Given other threats such as invasive starfish, pollution, silting, and other hazards, ocean acidification and other climate-change impacts only serve to increase the vulnerabilities of these key fishery habitats.

(7) Greater extremes in precipitation and/or flooding patterns. In natural systems, extremes can be just as important as the averages, and sometimes more so. The plains cottonwood (*Populus sargentii*) is the great tree of the American prairies; no other plant approaches the stature of this tree on the grasslands that sweep five hundred miles westward

[6] Epps, C. W., D. R. McCullough, J. D. Wehausen, V. C. Bleich, and J. L. Rechel. 2004. Effects of climate change on population persistence of desert-dwelling mountain sheep in California. *Conservation Biology* 18: 102-113.

from the ninety-eighth meridian to the foot of the Rockies. This key tree species acts to provide wildlife habitat, shade, and streamside stabilization in the region. But the plains cottonwood is a flood-sensitive species that depends upon just the proper amount of precipitation (intermediate flooding). Not only is drought a severe stress on this trees, spring runoffs that are too powerful scour out the river bottoms used by the tree, washing away the sand bars and banks and any young trees.

The streamside salamander (*Ambystoma barbouri*) of Tennessee, Kentucky, Ohio, Indiana, and West Virginia is another example of a species that requires the optimal amount of precipitation, with too much rain just as stressful as too little. The salamander is most successful in first- and second-order streams that are seasonally ephemeral, that have natural barriers (cascades, waterfalls) that block upstream movement of predatory fishes, and that also have large flat rocks for laying their eggs. Increased flooding causes high mortality in this species, an amphibian with a total population size of only about 10,000.

(8) Disruptions to migration patterns. Some species are able to modify their behavioral patterns in response to environmental patterns, others are not. Climate change is expected to severely disrupt the timing and patterns of seasonal cycles and breeding migrations. Budding, flowering, pollination, seeding, and generation times of plants will change. Origins, routes, and destinations of migrating animals will be different. If climate change creates conditions that exceed the biotic limits of these species, adaptation itself is at risk. For example, behavioral responses can be successful only if the animals are sufficiently mobile, their movements are not blocked, and they actually have an alternate place to live. For some species, this option is unlikely or even impossible.

Notably, we have very little information upon which to predict how climate-linked changes will disrupt the biotic interactions and inter-dependencies that have evolved at the community or ecosystem levels. The entire fabric of these systems is in jeopardy when species move, are extirpated from one site, invade others, or go extinct. We can expect surprises from these cascade or synergistic effects. Some of these surprises will detrimental to the interests of humans as well as wildlife.

(9) Direct effects of higher temperatures. Warming of the planet from greenhouse gases within the atmosphere is the ultimate trigger for all climate changes that we observe. However, regional expressions of elevated temperatures on the planet's surface from climate change can also directly impact fish and wildlife. For example, cutthroat trout (*Oncorhynchus clarki*) and certain other anadromous fishes have well-established climate sensitivities, and are susceptible to increases in the average temperatures of freshwater systems. Increasing ocean temperatures can cause gender imbalance in future generations of loggerhead sea turtles (*Caretta caretta*) because of their temperature-sensitive development. Studies also indicate that earlier nesting times of the sea turtle are directly linked to increases in sea surface temperature.

(10) More intense storms. Humans are by no means the only species to lose homes to the storms that are projected to be more virulent and to occur with greater frequency due to climate changes from global warming. Several imperiled species illustrate this particular vulnerability. Isolated populations of the threatened red-cockaded woodpecker (*Picoides borealis*), such as those found in parts of Florida, Louisiana, and other Gulf states, are

susceptible to having their key habitats wiped out by more intense and frequent hurricanes. The West Indian manatee (*Trichechus manatus*), currently listed as federally endangered and proposed for downlisting to threatened status, experiences lower survival probability during years with more intense storms. Even our concerted action to shelter species for eventual recovery in the wild is put at risk. Recently, all or nearly all of the endangered whooping cranes (*Grus americana*) being held in a Florida captive propagation facility prior to release into the wild were killed by intense tornados. And it would be the ultimate tragedy if the recently rediscovered ivory-billed woodpecker (*Campephilus principalis*) loses habitat as a result of global warming.

A NATIONAL STRATEGY TO REDUCE GREENHOUSE GAS EMISSIONS AND HELP WILDLIFE THROUGH THE BOTTLENECK OF GLOBAL WARMING IMPACTS IS NEEDED

For many species, global warming is the greatest threat to their survival because changes in seasonal and weather patterns are altering their ability to respond environmentally or behaviorally. Species that are very specialized, rare, or those with very limited ranges, are less able to adapt to change and thereby more vulnerable to extinction. Others have been brought to the brink due to non-climatic stressors that already reduced their numbers, distribution and range, thereby making them less resilient to climatic change and more vulnerable to extinction.

Moreover, every species has a "tipping point" – a set of conditions which, if exceeded, will push it towards extinction. Some rare species may already have reached this point whereas others may soon follow without our efforts to intervene and save them. Wildlife managers must now explore new approaches and innovative strategies to manage the broader landscape as well as wildlife populations if we are to help species survive and adapt to these changes. Because impacts of climate change from global warming are already here and will continue, fish and wildlife need our intervention to navigate through this bottleneck in order to survive and reap the eventual benefits of the steps we take today to reduce greenhouse gas emissions.

A national strategy for combating the impacts of global warming on wildlife must consist of two key approaches. First, we must take immediate steps to reduce greenhouse gas emissions, to address the root cause behind climate change. Second, we must also craft responses now to help wildlife navigate through a looming bottleneck of complex effects caused by global warming. These two approaches are usually referred to as mitigation and adaptation. Both approaches are absolutely essential for our nation to frame its policy response as we build a comprehensive strategy to protect fish, wildlife, and other natural resources.

CONCLUSION

Impacts of climate change from global warming represent a truly global threat to our efforts to conserve and recover fish, wildlife, and other natural resources for future generations of American citizens. As scientists and resource managers, we recognize the need to meet this challenge in a thoughtful, comprehensive manner. Where we have opportunities to reduce causes of climate change, we must support mitigation measures to reduce the levels of

greenhouse gas emissions. At the same time, we must take adaptive steps to assist wildlife in navigating effects of climate change so that they can survive decades to a century of impacts still to come. The time to use both mitigation and adaptation is now, immediately. By addressing the needs of fish, wildlife, and entire natural systems, we also help ourselves. We and the generations that follow can continue to benefit from the remarkable diversity of economic, cultural, spiritual, and social goods and services provided by all terrestrial, freshwater, and marine ecosystems.

On behalf of Defenders of Wildlife, I want to thank you for the opportunity to share our observations and perspectives on this critical issue, and submit this testimony for the record at this hearing. It is no exaggeration to say that all work on behalf of conserving wildlife and its habitat, in North America and around the globe, is at risk now from global warming. We stand ready to work with this subcommittee and the rest of the Congress to develop solutions that will reduce greenhouse gas emissions and enable wildlife to survive until the benefits of emission reductions are fully realized.