STATEMENT OF
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Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to participate in today's hearing to discuss emerging insights into the present and potential influences of climate variability and change on resources of interest to the American people. My name is Dr. Susan D. Haseltine, and I am the Associate Director for biology at the U.S. Geological Survey (USGS).

Global climate change is one of the most complex and formidable environmental challenges facing society today. While climate change is a natural, continuous Earth process, changes to the Earth's climate are related to human activities as well. Whether the causes are natural or from human influence, our focus is on understanding the impacts of climate change and the potential adaptive strategies for managing natural resources and ecosystems in the face of these changes.

Today, one need only turn to the Far North to witness the emerging signature of climate change. In Arctic and subarctic regions, the shrinking extent of and structural changes in sea ice and permafrost are a strong and visible signal of contemporary change in the Earth's climate system. Sea ice controls its associated ecological systems: From oceanographic patterns through the food chain to ice seals and polar bears, the Arctic marine world is tied to the dynamics of sea ice. I will focus my remarks on the realm of sea ice and recent publications by the USGS on this environment and its top predator, the polar bear. It should be recognized that this important work is part of a broad body of research carried out by other Federal agencies and nations around the Arctic.

Data from the observed record document a recent history of change in Arctic sea ice. Observations from the available satellite record (1979–2007) show a decline of 10 percent per decade in the minimum annual Arctic sea ice extent (end of summer melt season). That decline is punctuated by this year's (2007) melt season, which reduced the minimum ice cover in the Arctic to just over 4 million square kilometers—as compared to the 7-8 million square kilometers observed at the beginning of the satellite record (1979-1980). The 2007 melt season thus reflects a roughly 40 percent reduction in ice extent from the 1979–2000 average. Even more significant is the degree to which the year 2007 surpassed the previous sea ice loss record of 2005—by about one million square kilometers.

Owing to the influential role that sea ice plays in Earth's climate system, numerous institutions and agencies worldwide (including the USGS) are conducting research to better understand the mechanisms and trajectory of sea ice change. The USGS is an active collaborator in this arena. Complementing the extensive amount of research supported by the National Science Foundation, NASA, NOAA and others, the USGS is helping to define an emerging understanding of the changes in ice age structure and the relationships of those trends to atmospheric circulation patterns, thermal forcing, and other controlling mechanisms. While rising Arctic air temperatures have certainly contributed to the loss of sea ice, several other factors have interacted to accelerate the loss. Changes in prevailing wind patterns (Maslanik et al. 2007) have caused much of the older and thicker sea ice to drift out of the Arctic Ocean (Rigor and Wallace 2004; Belchansky et al. 2005), leaving behind a younger and thinner ice pack that is more vulnerable to the summer melt season. Concurrently, warmer ocean water has been entering the Arctic from both the Atlantic (Polyakov et al. 2007) and Pacific (Woodgate et al. 2006). A warmer Arctic Ocean further reduces the air-water temperature gradient, which suppresses winter ice growth (thickening) and renders it more susceptible to summer melt. And finally, onset of the Arctic melt season has been getting earlier (Belchansky et al. 2004; Stroeve et al. 2006). Earlier springs trigger an earlier start to an important positive feedback loop that begins when the bright surface of the ice darkens from the presence of melt ponds and open water, the darker surfaces warm faster because they absorb more solar radiation, and the warmth promotes more melt—and so on. To what degree natural climate variability has exacerbated the recent loss of sea ice is not well understood. However, there is growing scientific concern that the synergism of recent events, regardless of their origin, may have already pushed the Arctic past a threshold of cascading change (Lindsay and Zhang 2005; Serreze and Francis 2006).

The USGS is well poised to address the implications of ecological change in the Arctic by integrating its geophysical and biological expertise. Foremost among USGS biological studies in the Arctic is a long-term program of polar bear research. Owing to both the study's three-decade history and its longstanding collaboration with countries within the circumpolar distribution of polar bears, the USGS has accumulated a robust baseline of data crucial for assessment of population status in long-lived species such as the polar bear, for defining essential habitats, and for making projections of population status into the future. Nine recently released USGS reports build on this history of research and culminate in a new rangewide forecast of polar bear status under various projections of future climate change (Amstrup et al. 2007; Bergen et al. 2007; DeWeaver 2007; Durner et al. 2007; Hunter et al. 2007; Obbard et al. 2007; Regehr et al. 2007a; Rode et al. 2007; Stirling et al. 2007).

Polar bears occur throughout portions of the Northern Hemisphere where the sea is ice-covered for all or much of the year and essentially derive their sustenance predominantly from ice seals such as ringed seals. The dependence of polar bears on hunting at the ice surface raises concern about the implications of sea ice loss. In the southern parts of the polar bear range, such as Hudson Bay, the sea ice melts entirely each summer and bears fast until the ice refreezes in autumn. However, warming temperatures have established a trend of earlier sea ice break-up, leaving the bears stranded on land and deprived of food for longer periods of time (Stirling and Parkinson 2006). Recent data published by USGS and Canadian scientists document lower survival rates among young and sub-adult bears and establish scientific linkages between less ice cover, reduced survival, and population decline (Regehr et al. 2007b).

Similar to the early-warning signs seen in Western Hudson Bay, declines in body condition and survival are now documented for polar bears in Southern Hudson Bay and the Southern Beaufort Sea. These and other signs of stressed polar bear populations, together with the observed and forecasted declines in sea ice, prompted the USGS to assemble a team of polar bear, sea ice, and modeling experts aimed at reducing the uncertainties of observed and forecasted polar bear population status worldwide.

Because of the poor fossil record, we do not know how the forecasted distribution of bears compares to bear distribution at other times in the past when ice extent may have been restricted similarly to the models used for our forecasting.

The USGS assessed the pattern of observed changes in polar bear–sea ice habitat over the last two decades and forecasted the range of likely future habitat conditions out to the end of the centuryUsing long-term satellite tracking data from polar bear populations inhabiting the polar basin (Arctic Ocean), the USGS constructed habitat selection models using data collected during 1985-1995, before the sea ice changes had become pronounced. The resulting models demonstrated a strong preference for sea ice habitats that were near the periphery of the ice pack and over the shallow waters of the continental shelf. USGS habitat models for the 1996-2006 period found preferred habitats have already declined, especially in spring and summer with greatest losses in the Southern Beaufort, Chukchi, Barents, and Greenland seas (Durner et al. 2007).

The USGS then projected the range of likely future polar bear habitat conditions employing ten General Circulation Models (GCM) from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. These models were selected on the basis of their ability to reasonably simulate the amount of observed sea ice cover in the Northern Hemisphere during the 20th century. It should be noted that the USGS used GCM projections derived entirely from the IPCC SRES-A1B greenhouse gas emissions scenario, which is also called the “business as usual” or “middle of the road” scenario, to develop sea ice projections. Preliminary USGS analyses of other emission scenarios (as corroborated in the IPCC Fourth Assessment Report) indicate that scenarios with less atmospheric carbon dioxide loading do not make a substantive change in polar bear outcomes through mid-century, but do result in less depletion of sea ice and thus polar bear habitat at the end of the century.

Projections from the 21st century-based models exacerbated the already observed habitat losses, and added losses throughout all regions bordering Russia. Annual habitat loss for the full basin is projected at more than 35 percent by the end of the century, with a summer loss of nearly 80 percent for the Alaska-Eurasia portions of the Basin. In contrast, polar bear habitats were projected to be relatively stable during the 21st century in the high-latitude regions along the northwestern Canadian Archipelago and northern Greenland. These results are consistent with the general observation that most GCMs project modest ice declines in winter but strong declines in summer, resulting in either ice-free summers or remnant summer ice at the northernmost latitudes of North America.

To forecast the status of polar bear populations worldwide during the 21st century requires not only information on likely future habitat condition (Durner et al. 2007) but also projections of population status based on present vital rates (Hunter et al. 2007). The USGS then developed a Bayesian network (BN) model structured around population stressors that could affect the factors considered in Endangered Species Act decisions (Amstrup et al., 2007). The BN model combined empirical data, interpretations of data, and professional knowledge into a probabilistic framework. The BN model incorporated information about annual and seasonal sea ice trends on populations as well as potential effects of other population stressors such as harvest, disease, predation, and effects of increasing human activity in the north due to ice retreat. Sensitivity analyses of the final model indicates that sea ice habitat loss is the over-arching stressor responsible for model outcomes. Model results show that by mid-century, polar bear populations will likely be extirpated, or eliminated, from their southernmost range in southeastern Canada, as well as from regions of the polar basin bordering Alaska, Russia, and Europe. By late-century, populations in East Greenland and the Northern Beaufort Sea also have a high probability of extirpation. Model projections indicate a high likelihood of extirpation from regions of the Arctic that presently support two-thirds of the worldwide population of polar bears. These models, however, also predict a strong likelihood of remnant populations surviving in the high Arctic, which may provide a source of animals to reestablish former ranges if the Arctic's sea ice environment were to be restored by an ultimate slowing and reversal of global warming.

The USGS recognizes that the momentum of atmospheric greenhouse gas loading will challenge us with climate-related issues for at least the next 30–50 years. As such, we anticipate that the traditional approaches to natural resource conservation, public land management, and civil infrastructure planning may require accommodating and adapting to ecosystem change. The USGS conducts scientific research to understand the likely consequences of climate change, especially by studying how climate has changed in the past, then using the past 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 the USGS to play a critical role in conducting climate change science across the Nation. A better understanding of sea ice must be combined with an understanding of ecological responses and adaptation. We believe that coupled physical-biological forecasting approaches, as presented in recent USGS polar bear reports, will better prepare decision makers as they address climate adaptation. Such forecasting will require continued long-term monitoring, focused studies of process, and the application of new and emerging modeling approaches implemented through collaborative efforts among Federal, academic and other partners.

Thank you for the opportunity to present this testimony. I am pleased to answer any questions you and other Members of the Committee might have.

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