## CLIMATE CHANGE: Alaska's National Wildlife Refuges Arctic National Wildlife Refuge

**Climate and Ecology:** The arctic climate is a complex system characterized by a low amount or absence of sunlight in winter and long days during summer, strong winds, low temperatures and little rainfall.<sup>1</sup> Ice, present as snow, ice sheets, glaciers, sea ice, and permafrost, is a prominent feature in the arctic and is sensitive to small temperature increases. The arctic climate exhibits significant spatial and temporal variability, resulting in a collection of regional climates with different ecological and physical climatic characteristics. Increasing temperatures,



melting glaciers, reductions in extent and thickness of sea ice, thawing permafrost, and rising sea level all provide evidence of recent warming in the Arctic. Limited observational data indicate winter temperatures have increased as much as 3 to 4° C in the past 50 years.<sup>3</sup> Although precipitation trends are hard to assess in cold windy environments, observations suggest that precipitation has increased by about 8% over the past century, with much of the increase occurring as rain-on-snow during the winter.<sup>3</sup> Areal extent of snow covered land in the Arctic has declined by about 10% over the past 30 years<sup>6</sup>. Permafrost temperature profiles obtained from refuge boreholes in 1985, 1998, and 2004 showed an increase of 2-3° C near Kaktovik between 1985 and 2004, and, farther inland, there was 1.5-2° C warming between 1985 and 1998.



The Arctic Refuge contains undisturbed lands across five different ecological regions: lagoons, beaches and saltmarshes of coastal marine areas; coastal plain tundra; alpine tundra of the Brooks Range; the forest-tundra transition south of the mountains; and tall spruce, birch, and aspen of the boreal forest, and is home to 36 fish species, 36 land mammals, nine marine mammals, and more than 160 migratory and resident bird species. Species, including mosses, lichens, vascular plants, some herbivores and their predators, that are adapted to the cold arctic environment are especially at risk to climate change-related impacts including habitat degradation, reduction, or loss leading to displacement from present distributions, population declines or local extirpation.<sup>2</sup> River deltas, barrier islands, lagoons, and other coastal habitats are selected by shorebirds and waterfowl for nesting and staging. These areas are vulnerable to predicted, although not yet documented, effects of climate change, including inundation by rising sea level and disturbance associated with increased storm surges (related to increased storminess and increased open water). The period of record for Arctic Refuge is brief; further data will be needed to detect with a high degree of certainty climatechange effects on wildlife and wildlife habitats.

#### **Conservation and Management:**

In collaboration with our partners, we monitor the population status, trends, and distribution of numerous species that could be affected by climate change, including:

Polar bears (w/ USGS and USFWS-MMM): changes to sea-ice habitat, prey availability, denning habitat. Caribou (w/ ADFG, USGS, CWS, Environment Yukon): changing vegetation phenology on calving grounds (nutritional concerns), forage availability, insect harassment.

Muskoxen (w/ ADFG, NSB, CWS, Environment Yukon): availability of preferred forage species, energetic consequences of icing and changing snow accumulation.

Waterfowl and shorebirds (w/ Manomet Center for Conservation Science, USGS, Univ. of Alaska-Fairbanks, USFWS-MBM): nesting habitat quality/availability, synchrony of food availability with critical life stages, e.g., nesting, brood rearing, migration, changes in coastal staging habitats.

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We've worked with USGS to establish 4 remote climate stations since 2001. Data collected at climate stations include: soil and air temperature, wind speed and direction, soil moisture, snow depth, cloudiness, and albedo. At each site we also monitor active layer depth, a measure of seasonal thaw, and we maintain long-term vegetation monitoring plots. At additional sites we monitor soil and air temperatures throughout the year with automatic temperature loggers.

We've established a network of permanent vegetation plots, some of which date back over 20 years. We visit each plot periodically (every 1-5 years) to collect data on species composition and characteristics of plant growth, and to measure depth to permafrost (i.e., thickness of active layer).

We are participating in the Global Observation Research Initiative in Alpine Environments (GLORIA), an international long-term observation network for comparative study of climate change impacts on mountain biodiversity.



In collaboration with UAF, permafrost temperature profiles are monitored at 3 boreholes on the refuge, and at one borehole on Barter Island.

We have retaken over 50 historical photographs, most originally taken in 1908, 1952, or 1956. We are working with a graduate student to develop a method to detect and quantify changes over time from the photographs. We are obtaining historical aerial photographs and current satellite images at locations throughout the refuge for landcover change analysis.

We are collaborating with ABR, Inc., International Permafrost Association, NSB, and others to study dynamics of the Beaufort Sea coast. This project includes quantification of erosion and accretion from field measurements and repeat aerial photography, plus measurement of sea levels, storm surges, thaw depths, and permafrost temperatures. There is also a major focus on environmental education in Kaktovik and other North Slope coastal villages.

We are working with University of Alaska's Geographic Information Network of Alaska to use remote sensing as a means of documenting sea surface temperature in nearshore marine waters along the northern boundary of the refuge. Changes in seas surface temperature have been documented west of the refuge in the Prudhoe Bay area, but the significance for aquatic organisms is unknown. In partnership with the Fairbanks Fish and Wildlife Field Office and the University of Alaska-Fairbanks, we are also investigating the correlation between nearshore sea-surface temperatures and condition of fish important for subsistence harvest.

We are collaborating with the Marine Science Institute, University of Texas at Austin to study biodiversity and nutrient cycling in benthic communities in Arctic coastal lagoons. This baseline work will be essential for understanding changes in the nearshore ecosystem, which supports numerous trust species and is particularly sensitive to disturbance and climate change.

We have facilitated the work of University of Alaska-Fairbanks researchers to monitor mass balance of McCall glacier and other glaciers in the Brooks Range. McCall Glacier is one of the best-studied high-latitude glaciers in the world, having been monitored intensively since approx. 1956, and photographed in the early 1900s by Leffingwell.

Researchers from the Arctic Long-Term Ecological Research (LTER) program based at Toolik Lake in the northern Brooks Range are conducting studies of arctic stream and spring ecology on the refuge. The goals of LTER studies are to predict future ecological conditions and to increase basic understanding of ecological relationships.

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#### Sources:

<sup>1</sup> The National Snow and Ice Data Center, <u>http://nsidc.org/arcticmet/basics/arctic\_climate.html</u>

<sup>2</sup> Weller, Gunter . <u>Arctic Climate Impact Assessment: Summary and Synthesis</u>. Cambridge University Press, 2004. 1009- 1013

<sup>4</sup> "Impacts of a Warming Arctic": <u>Arctic Climate Impact Assessment</u>. Cambridge University Press, 2004. pg 28
<sup>5</sup> "Impacts of a Warming Arctic": <u>Arctic Climate Impact Assessment</u>. Cambridge University Press, 2004. pg 29
<sup>6</sup> "Impacts of a Warming Arctic": <u>Arctic Climate Impact Assessment</u>. Cambridge University Press, 2004. pg 31
<sup>7</sup> "Impacts of a Warming Arctic": <u>Arctic Climate Impact Assessment</u>. Cambridge University Press, 2004. pg 29

<sup>8</sup> "Impacts of a Warming Arctic": <u>Arctic Climate Impact Assessment</u>. Cambridge University Press, 2004. pg 50-51
<sup>9</sup> US Fish and Wildlife Service: Region 7. 2008 http://alaska.fws.gov/fisheries/mmm/polarbear/issues.htm

<sup>10</sup> Arctic National Wildlife Refuge. Website- polar bear <u>http://alaska.fws.gov/nwr/arctic/pbdenning.htm</u>

<sup>11</sup> "Impacts of a Warming Arctic": <u>Arctic Climate Impact Assessment</u>. Cambridge University Press, 2004. pg 58

<sup>12</sup> "Impacts of a Warming Arctic": <u>Arctic Climate Impact Assessment</u>. Cambridge University Press, 2004. pg 58

<sup>13</sup> Arctic National Wildlife Refuge. Website- Arctic Birds <u>http://alaska.fws.gov/nwr/arctic/birdlist.htm</u>

<sup>14</sup> "Impacts of a Warming Arctic": <u>Arctic Climate Impact Assessment</u>. Cambridge University Press, 2004. pg 77
<sup>15</sup> Monda, M.J. 1991. Reproductive ecology of tundra swans on the Arctic NWR. Ph.D. thesis. Univ. Idaho, Moscow, Idaho. 94 pp.

### **Related Links:**

Summary: Arctic Climate Impact Assessment- Chapter 18

Polar Bear Fact Sheet

Arctic Climate Research at the University of Illinois-

http://www.iop.org/EJ/article/1748-9326/2/4/045018/erl7\_4\_045018.pdf?request-id=a2826785-7d39-4077-9329-4e0fc77c5a6b –water and food security in a changing arctic climate

