



# Climate Change and the Arctic National Wildlife Refuge

## *Which Species Are Most At Risk?*



CARIBOU, ARCTIC NATIONAL WILDLIFE REFUGE © MARK KELLY/ALASKASTOCK LLC/NATIONAL GEOGRAPHIC STOCK

The Arctic National Wildlife Refuge is in meltdown mode. Like much of its home state of Alaska, the 19-million-acre refuge—America’s second largest—has warmed more than 4 degrees Fahrenheit over the last 50 years, according to the U.S. Global Change Research Program. The northern part of the state, where the refuge is located, is projected to warm more quickly than anywhere on the continent. As a result of warmer air, which holds more moisture, the refuge is already seeing more snow and freezing rain events that leave vital food plants thickly encased in ice. Coastal erosion is also

on the rise as protective sea ice retreats earlier, exposing the region’s shores to damaging storm surges. And this is just the beginning: Climate models project that Alaska’s average annual temperature could be 3.5 F to more than 7.0 F higher by mid-century.

What will these changes mean for the wildlife that live in the refuge, a harsh and beautiful land of forests, mountains, tundra, rivers and coastlines? In particular, how will the impacts of climate change affect the large and small mammals, most of them year-round residents and all of them critical to the fragile Arctic food web? Are some more vulnerable than others?



**Left: A polar bear naps with her cub. The coastal plain of the Arctic refuge is an important denning and birthing site for polar bears. Right: The arctic ground squirrel, a hibernator that can cool its body to record lows, is highly vulnerable to changes in temperature, moisture and snow cover.**

THE ARCTIC NATIONAL WILDLIFE REFUGE supports an array of very specialized mammals—from the sea-ice- and seal-dependent polar bear, one of the largest carnivores on Earth at up to 1,600 pounds, to the pygmy shrew, a subterranean insect-eater that barely outweighs a penny, making it the smallest mammal in North America. The adaptations to life at high latitude exhibited by the refuge’s animals are as varied as their body sizes. Some spend the winters hibernating, like the arctic ground squirrel that can “supercool” its body to 27 F, a record low among mammals. Others stay active all winter, like the caribou that can cover 2,500 miles each year as it travels with its herd between winter grazing grounds and summer calving grounds, the longest migration of any land mammal.

Because the animals of the Arctic are so specialized to the extreme conditions in which they live, species diversity is low and the food web is relatively simple. The depletion of even one species when those conditions change could have a ripple effect on the entire food web. To avert disaster in the future, we need to know now which refuge mammals are most at risk as temperatures continue to rise and determine how we can best help them survive. With that in mind, Defenders conducted a preliminary assessment of the vulnerability of Arctic refuge mammals to climate change.

## METHOD | Assessing Vulnerability

To get some answers about how the mammals of the Arctic refuge will fare as the world warms, Defenders’ climate change science team used the Climate Change Vulnerability Index, a modeling and assessment tool developed by NatureServe, a nonprofit that provides information and technical tools to guide science-based conservation.

Using the index, we categorized the climate change threat to each of the 38 mammals found on the refuge based on:

- **Exposure.** The magnitude of the changes directly related to changes in climate conditions (temperature, moisture, ice and snow) the species will face.
- **Sensitivity.** The degree to which the changes will affect the species based on its habitat requirements, diet and other factors.

The index incorporates species characteristics that research shows have affected—or will potentially affect—its sensitivity to climate change. These include dispersal ability, versatility of diet and habitat, dependence on cold or snowy areas, response to changes in natural disturbances such as floods and fires, and genetic variation within the population, a factor that influences whether or not individuals will adapt to change and survive.

The index also includes indirect exposure factors that result from climate change, such as sea-level rise, and factors not directly tied to climate change that may contribute to the sensitivity of a species, such as natural and man-made barriers to species movement.



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**Top: A muskox sports a dense, woolly coat, small comfort as more frequent ice storms glaze over tundra vegetation and make it more difficult for this grazer to feed. Bottom: An arctic fox blends into the background on the snow-covered tundra, the better to hunt lemmings and voles. Climate change threatens the habitat and the prey of this top predator.**

## RESULTS

### 16 of 38 Refuge Mammals Extremely or Highly Vulnerable.

Sixteen of the Arctic National Wildlife Refuge's 38 mammals may be heading for serious trouble. Our Climate Change Vulnerability Index assessment found six species—polar bear, arctic fox, muskox, tundra vole, brown lemming and collared lemming—“extremely vulnerable” to climate change, indicating an extremely high likelihood that their numbers or range within the refuge will substantially decrease or disappear by 2050. Ten species—lynx, wolverine, caribou, Dall sheep, Alaska marmot, arctic ground squirrel, singing vole, northern bog lemming, tundra shrew and barren ground shrew—were assessed as “highly vulnerable,” their abundance or range likely to decrease significantly by 2050.

With the threat of climate change imminent for highly and extremely vulnerable species alike, refuge management priorities should focus on the animals of both designations—the 16 most vulnerable mammals in the Arctic National Wildlife Refuge.

Three Arctic refuge mammals—brown bear, marten and taiga vole—were projected to be “moderately vulnerable,” meaning that the changes within the refuge may have some effect on their population and range, but not likely a severe one. These species may be more sensitive to climate change in other parts of their range.

Nineteen of the 38 Arctic refuge mammals assessed were found “not vulnerable” to climate change, at least within the refuge. These are mainly species with wide distributions across a variety of habitats and climate zones, such as red fox, black bear, coyote, beaver and river otter.

Other observations drawn from our climate-change vulnerability assessment include:

- The species most vulnerable to climate change in the Arctic National Wildlife Refuge are the ones specially adapted to the cold, snow and ice. For the most part, species that live in the boreal forest in the southern portion of the refuge, have flexible habitat needs—or a distribution that extends well into warmer areas—tend to be less vulnerable.
- The refuge's tundra-dependent animals are particularly at risk from changes in precipitation type, especially a shift from dry snow to freezing rain and ice that coat important grazing areas or collapse small mammal tunnels under the snow. Tundra species are also sensitive to warming trends that encourage the expansion of boreal forest into areas that are currently open tundra, eliminating vital habitat.
- The particular geography of the Arctic National Wildlife Refuge may itself be a contributing factor: The strip of coastal plain tundra at the northern extent of the Brooks Range in the refuge is narrower than it is elsewhere in the North Slope of Alaska and adjacent areas of Canada. Consequently, climate-mediated habitat changes could quickly squeeze out tundra between the encroaching boreal forest and the sea.



See the charts on the next two pages for brief background information and a summary of climate-related contributing factors for each of the 16 most vulnerable species.

# SPECIES MOST VULNERABLE TO CLIMATE CHANGE IN THE ARCTIC NATIONAL WILDLIFE REFUGE

## EXTREMELY VULNERABLE SPECIES

- Greatly increases vulnerability
- Increases vulnerability
- Somewhat increases vulnerability

### CONTRIBUTING FACTORS

		Sea level rise	Natural barriers to range shift	Sensitivity to rising temperature	Sensitivity to moisture change	Sensitivity to changes in fires and floods	Dependence on ice and snow	Habitat versatility	Dietary versatility	Genetic factors
 <p><b>Polar Bear</b> Adapted to life on Arctic sea ice and classified as marine mammal. Hunts preferred prey, seals, from ice. Dens and gives birth along coast of refuge, where sea-ice loss is already accelerating. Population predicted to decline by two-thirds over next 50 years as sea ice continues to disappear.</p>		●	●	●			●		●	●
 <p><b>Arctic Fox</b> Turns white in winter. Acute hearing helps locate small rodents under snow. Habitat in refuge confined to narrow strip of tundra bordered by the ocean. Faces competition from larger red fox as boreal forest expands northward with climate change.</p>		●	●	●			●		●	●
 <p><b>Muskox</b> Grazes on tundra vegetation that freezing rains can encase in ice. Also vulnerable to parasites that thrive in warmer temperatures. With fewer than 300 in refuge, lacks genetic variation that facilitates adaptability.</p>		●	●	●	●	●			●	●
 <p><b>Collared Lemming</b> Feeds on plants and twigs in upland areas of tundra. Only rodent that turns white in winter. Depends on snow cover for insulation and to avoid predators. Ocean limits ability to shift northward.</p>			●	●			●			
 <p><b>Brown Lemming</b> Found in moister areas of tundra, not as far north as collared lemming. Relies on snow cover for winter insulation and predator avoidance. Habitat sensitive to drying out as snowpack and other variables change.</p>			●	●	●		●		●	
 <p><b>Tundra Vole</b> Lives in dense vegetation at edges of streams and marshes. Eats grasses and sedges in summer and stores roots and seeds for later. Lower survival documented in warmer winters due to freeze-thaw cycle icing over feeding areas. Encroachment of forest on tundra also a threat.</p>			●	●	●		●		●	●

# SPECIES MOST VULNERABLE TO CLIMATE CHANGE IN THE ARCTIC NATIONAL WILDLIFE REFUGE

## HIGHLY VULNERABLE SPECIES

- Greatly increases vulnerability
- Increases vulnerability
- Somewhat increases vulnerability

### CONTRIBUTING FACTORS

		Sea level rise	Natural barriers to range shift	Sensitivity to rising temperature	Sensitivity to moisture change	Sensitivity to changes in fires and floods	Dependence on ice and snow	Habitat versatility	Dietary versatility	Genetic factors
<b>Lynx</b>  <p>Solitary boreal forest cat. Snowshoe hares preferred prey, but also hunts rodents, aided by big feet and light build that offer advantage over other predators in snow. Changes in snowpack bring coyotes and other competitors to lynx habitat.</p>		●			●	●	●			
<b>Wolverine</b>  <p>Largest terrestrial member of weasel family. Hunts small mammals and scavenges carrion in forested mountains. Young born in den dug by female in snow for insulation and protection. Requires persistent spring snow for denning and cannot tolerate hot summers.</p>		●	●			●			●	
<b>Caribou</b>  <p>Migratory grazer already declining due to ice storms glazing over tundra vegetation; more frequent fires that kill lichens it eats; peaking of best spring forage before herd arrives in refuge to breed; and increase in mosquitoes significant enough to interfere with feeding.</p>		●	●	●	●			●		
<b>Dall Sheep</b>  <p>High mountain slopes of Brooks Range in refuge northernmost extent of population. Forages in alpine meadows and avoids deep snow. Vulnerable due to narrow habitat requirements and potential increase in parasites.</p>		●	●	●					●	
<b>Alaska Marmot</b>  <p>Larger rodent found only on slopes of Brooks Range. Spends most of year in hibernation, emerging in late spring to feed on vegetation until first snow sends back underground. Small window for feeding and breeding and dependence on sensitive alpine tundra pose risk.</p>		●	●		●	●				
<b>Arctic Ground Squirrel</b>  <p>Lives on upland ridges and tundra. Needs well-drained soils for burrowing. In hibernation has lowest body temperature of any mammal. Sensitive to changes in temperature, moisture and snow cover and limited by narrow habitat range.</p>		●	●	●		●				
<b>Singing Vole</b>  <p>Named for characteristic vocalization. Active year-round in moist areas of tundra. Feeds on plants it gathers and dries on rocks. Threats include encroachment of shrubs on tundra, increased flooding, and icing of food stores.</p>		●	●	●		●				
<b>Northern Bog Lemming</b>  <p>Lives near bogs and in damp meadows. Eats mostly grasses and sedges. Nests in underground burrows or under logs, hummocks or snow. Already rare, specific habitat requirements and reliance on snow cover for insulation leave highly susceptible to climate change.</p>		●	●	●		●	●			
<b>Tundra Shrew</b>  <p>Tiny insect-eater found in shrubby areas, especially on hillsides. Consumes up to three times weight in food per day. Vulnerable due to narrow range of potential habitats and limited dispersal ability.</p>		●	●			●				
<b>Barren Ground Shrew</b>  <p>Wet area counterpart to tundra shrew. Poorly studied insectivore, but likely vulnerable due to narrow habitat range on coastal plain of refuge.</p>		●	●			●				

The only definitive way to address climate change in the long run is to cut significantly the greenhouse gas emissions that cause it. But even if we were to stop burning fossil fuels today, the level of emissions already in the atmosphere ensures warming will continue for decades to come. To help wildlife cope and to reduce the potential for irrevocable losses, we must act immediately.

Based on the species vulnerability information yielded by our Climate Change Vulnerability Index assessment, management of the Arctic National Wildlife Refuge should focus on three crucial objectives to improve the resiliency and survival odds of the 16 most vulnerable mammals:

### 1. Protect the North Slope from disturbance.

One way to help preserve the refuge's most vulnerable species is to limit oil and gas exploration and development and other activities that disturb wildlife and destroy habitat on the coastal plain tundra. Drilling in the 1002 area, which includes most of refuge's coastal plain, with its attendant noise, spills, transportation and industrial development, should be permanently prohibited. The effects of shipping, visitation and other potentially disturbing activities should also be carefully monitored.

### 2. Maintain linkages to areas of tundra adjacent to the refuge.

Although climate change projections indicate that the Arctic region will warm more than much of the rest of the country, it does have the advantage of habitats that are relatively pristine and more connected than in many other areas. Some of the more threatened species may move to the broader expanses of tundra outside the refuge that may persist longer than the refuge's narrow strip. Given the large barrier to the west already presented by oil development in the Prudhoe Bay region, maintaining connectivity between the refuge and suitable habitat in Canada to the east is vital.

### 3. Invest in research and monitoring of vulnerable species.

While our vulnerability assessment helps identify contributing factors and focuses attention on potentially vulnerable species, real on-the-ground data and better modeling to understand exactly how climate change is affecting wildlife is critical. Research and monitoring efforts focused on the extremely and highly vulnerable species will help conserve these animals and provide valuable information about the impacts of climate change on wildlife. In particular, a better understanding of the adaptive capacity of each of the 16 most vulnerable species will ensure that management actions enhance their ability to respond to climate variability and change in a manner that reduces their vulnerability.

By zeroing in on these objectives and identifying more specific steps necessary to protect species and habitat under changing conditions, refuge management can get a headstart on helping the wildlife most threatened by climate change—before it is too late.



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**From vibration-sensitive ear tufts to snowshoe-like feet, the lynx is made for hunting in the deep snows of the boreal forest. As rising temperatures change the type and amount of snow, this highly specialized cat loses its competitive edge.**

#### REFERENCES

American Society of Mammalogists. Mammalian Species Series. <http://www.science.smith.edu/departments/Biology/VHAYSEN/msi/msiaccounts.html>

Nature Conservancy Climate Wizard. <http://www.climatewizard.org>

NatureServe Climate Change Vulnerability Index. <http://www.natureserve.org/prodServices/climatechange/ccvi.jsp>

NatureServe Explorer Database. <http://www.natureserve.org/explorer/>

U.S. Global Change Research Program 2009. *Global Climate Change Impacts in the United States*. <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts>



DEFENDERS OF WILDLIFE

1130 17th Street, N.W. | Washington, D.C. 20036 | 202.682.9400

[www.defenders.org](http://www.defenders.org)