WILDLIFE AND GLOBAL WARMING

Navigating the Arctic Meltdown

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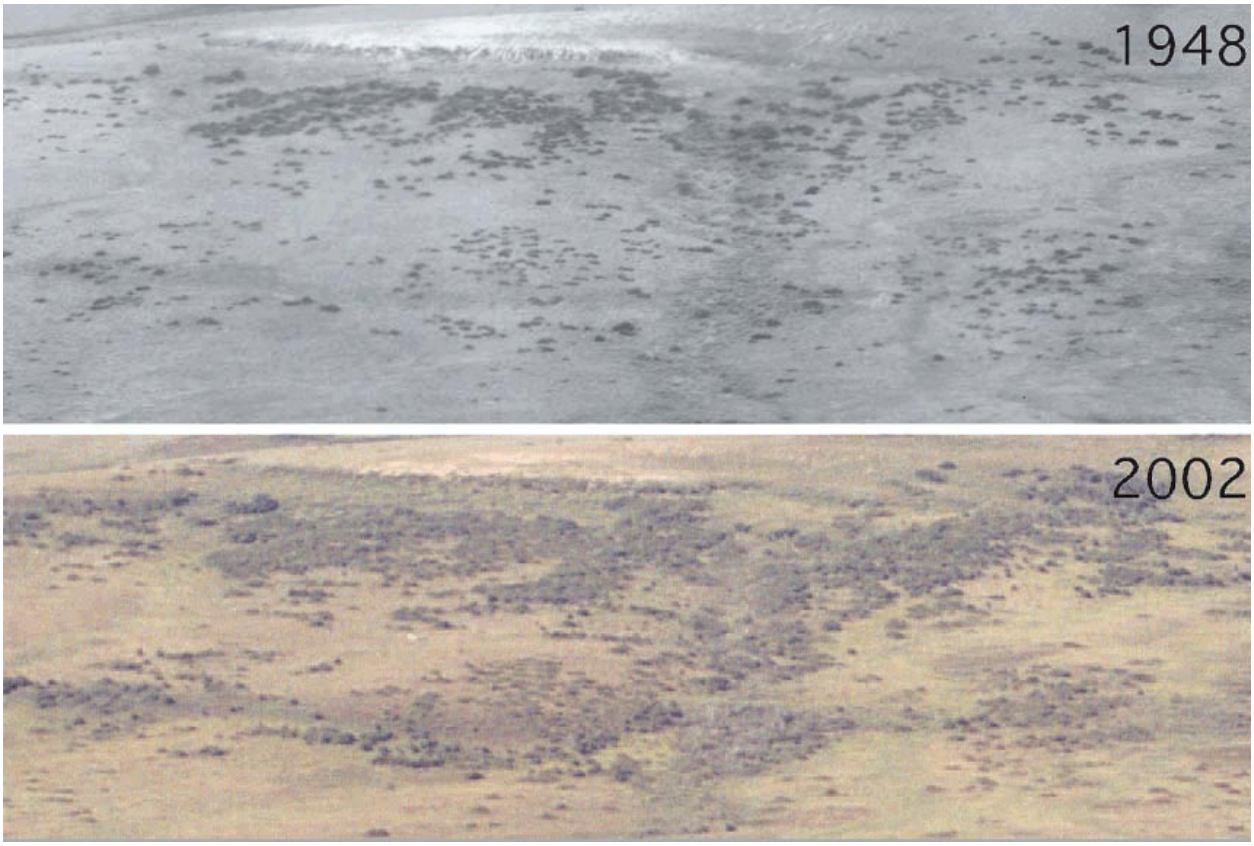
ORANGE-CROWNED WARBLERS

When climate changes, some species win, but biodiversity loses. As the Arctic "melts away" due to global warming, many of its unique species and habitats will decline and disappear. But a few opportunists will be able to expand their ranges as warming temperatures help convert fragile tundra into shrubland and forest. It will be a hollow victory for these "winners" of climate change, however, as the richness of the tundra's biodiversity fades away.

The orange-crowned warbler is one species that could benefit from the effects of global warming. This tiny songbird illustrates perfectly how some species that may benefit from climate change do so at the expense of others. The bird's current range is bounded in the north by the limit of the boreal forest. So as warmer conditions push trees and larger shrubs north into areas that are currently tundra, the warbler's potential habitat will also expand north. But the bird's summer range also extends far south of the boreal forest, into the western United States and Texas. With its wide ecological tolerance, this species may be less vulnerable to climate change and variability at the southern end of its range. The warbler's "win," however, may simply mirror a profound loss for a number of other species that currently breed on the tundra, some of which have much narrower ranges and habitat requirements.

SONGBIRD OF THE SHRUBS

The orange-crowned warbler is a small and rather drab-looking songbird. Like most warblers, it appears plump and has a short, pointed bill—but unlike most other warblers, it lacks distinctive coloration. Even the "orange crown" that gives this warbler its name is concealed by olive feathers, and is visible only when the bird is in hand. There are four subspecies of orange-crowned warblers that vary somewhat in coloration, but all are a gray to olive color, and have a yellowish belly with blurred streaks of olive, and a thin stripe of black at the eye.



As the climate warms, shrubs are beginning to displace grasses and other vegetation typical of the Arctic tundra, as shown by these photos taken more than five decades apart in northern Alaska. This and other climate-related changes may benefit the orange-crowned warbler, but many other species will suffer.

The species mainly forages in dense shrubby thickets, beneath a fairly open forest overstory. The open canopy permits enough light to reach the forest floor to allow shrubby vegetation to grow. Orange-crowned warblers use a variety of species of shrubs across their wide breeding and wintering range, and are often found in valleys or along streamsides. Research on the species in commercial forestlands in Washington and Oregon found the birds most often used habitats where at least 10 percent of the area was covered with evergreen shrubs. The birds forage among the twigs and leaves for insects, their primary food, but they also eat berries and fruits, nectar from flowers, suet at bird feeders and tree sap from holes drilled by sapsuckers.

Male orange-crowned warblers arrive at their breeding habitat as early as February in California and as late as May at the northern edge of their range. Like other songbirds, orange-crowned warblers sing to help establish territories and attract mates. Males begin singing upon arrival at the breeding area, but then enter a "silent stage" when they begin courting a female. If the male succeeds in bonding with a female, it will not sing again until nest-building begins. Apparently singing does not function as part of pair-bonding in this species.

The female selects the nest site and constructs the nest. Nests are usually built on or near the ground, hidden by moss, ferns or shrubs, or in a concealed spot on a steep streambank or hillside. The nest is small and cup-shaped, constructed of whatever vegetation is nearby—leaves and twigs, moss, pine needles or bark—and lined with materials such as dry grass, animal hair or even sheep wool. The female incubates a clutch of four to six eggs for roughly two weeks. Females care for the young, although both parents feed their chicks. The young warblers begin to leave the nest after 11 to 14 days. Predators of these young birds include blue jays, garter snakes and mammals, especially foxes. Many of these predators may also increase in numbers and range as the climate changes and habitat and species distributions shift and expand.

WARMING TRENDS

Orange-crowned warblers rely on insects for food and shrubs for nesting cover. Climate change modeling predictions and a growing body of scientific evidence indicate that both insects and shrubs may be in greater supply over a wide range of the Arctic in the near future. Since cold temperatures limit insect distribution and numbers, longer periods of warmer weather in the Arctic will mean more insects. So orange-crowned warblers at the northern edge of their range will probably have more of the beetles, bugs and caterpillars that form the mainstays of their diets as global warming heats up the Arctic.

Shrubby vegetation is beginning to displace the grasses, sedges, lichens and mosses that have long been the characteristic vegetation of the Arctic, a trend that may also benefit the warbler. The evidence of this change is mounting. One study, led by a researcher at the University of Alaska, compared 50-year-old photographs and new photographs of tundra in northern Alaska and found that alder, willow and birch have all increased considerably. Shrub expansion is also evident in Canada, Scandinavia and Russia.

One might expect that warmer summer temperatures are giving shrubs an advantage, but the full story is a bit more complicated. Warming temperatures in the Arctic have been most pronounced in winter and early spring. Warmer winter temperatures lead to increased snowfall, because warm air can hold more water vapor than cold air. The increased snow cover in turn insulates the ground and slows the rate at which the top layers of soil freeze. This insulating effect is increased around patches of existing shrubs, which catch blowing snow into drifts. Tundra soils are generally saturated with water that is unable to drain, trapped by a layer of permanently frozen ground called permafrost. Even as the ground freezes downward toward the permafrost, thin films of water remain unfrozen for weeks or months between the ice crystals and grains of soil. In mild winters, or when snow insulates the surface, these thin films persist for longer periods. Bacteria and fungi in these films remain active as long as the tiny pockets of water remain unfrozen. Through their metabolic activities these organisms produce nitrogen that is used by plants the following summer. Shrubs use nitrogen more efficiently than other plants, so increased soil nitrogen favors growth of the shrubs. Larger patches of shrubs in turn trap more insulating snow the following winter, producing a strong positive feedback loop that could potentially convert large areas of tundra to shrubland.

As the tundra shrinks, species that depend on it will also decline. Among such potential losers under this global-warming scenario are caribou, a species that feeds on the grass-like plants of the tundra during its important spring calving period. Several bird species are also losers. One, the American golden-plover, nests in low vegetation on the tundra and feeds by running along the open ground in search of insects. Increased shrub cover would interfere with this habit of feeding. Another, a small shorebird called Baird's sandpiper, also breeds on open tundra that is at risk of being replaced by shrubs. Yet another bird that will likely lose breeding habitat in the face of shrub expansion is the long-tailed jaeger, a gull-like bird of the open ocean that comes ashore only on the coastal tundra at breeding season.

If continued warming melts large areas of the permafrost, more drastic changes are in store for the tundra. Permafrost shapes the landscape of the Arctic: It prevents tree growth, because deep roots cannot take hold in the frozen ground. Permafrost is also responsible for the myriad lakes and wetlands on the tundra—water cannot drain away, so the ground remains saturated. Loss of permafrost would drain the soil and allow forest to encroach. More importantly, widespread melting of permafrost will cause thousands of years' worth of frozen plant material to decompose. This process would release massive amounts of carbon dioxide and methane, a greenhouse gas 20 times as potent as carbon dioxide, potentially creating a "runaway" warming of the globe.

Global warming is likely to affect both population numbers and species diversity as it tears apart the community structure of the Arctic. How much of the "fabric" of biological diversity will be lost, and how much the ecosystem can tolerate without collapse, are still unknown. But it is important for us to monitor species such as the orange-crowned warbler that may serve as indicators of changes due to global warming.

Among the 'losers' of the warming-induced loss of tundra is Baird's sandpiper, a small shorebird that breeds on open lands in the high Arctic.

PREPARING FOR THE MELTDOWN

The orange-crowned warbler may be a "winner" under projected climate changes as it will be able to capitalize on expanding habitat and food sources in the Arctic. To help other sensitive tundra-dwelling species that may be "losers," however, we must act now to reduce the emission of greenhouse gases that cause global warming. In addition, we should take other steps to protect the open tundra and its many wild inhabitants in the face of the complex threats posed by climate change:

- **Inventory and monitor Arctic species and establish plans for adaptive management.** Our ability to gauge the nature and extent of the impacts of climate change is only as good as our understanding of the ecosystems being affected. State and federal officials and research professionals must conduct complete wildlife, fish and plant inventories in the Arctic and establish a comprehensive monitoring system to assess the ecological impacts of climate change. We must rapidly initiate focused research on the most vulnerable species in order to develop management and policy responses to assist these plants and animals in adapting to climatic change.

- **Launch a circumpolar effort to understand and reduce threats to tundra species.** Given the global nature of predicted climate impacts, international collaboration is needed among members of the scientific community. The United States should fund a collaborative effort among international Arctic geophysical, climate and wildlife scientists to study and monitor current climate impacts, and to predict and help adapt to future climate and environmental stressors.

- **Limit other disturbances on sensitive Arctic tundra.** As shrub habitats encroach on open tundra, it will become even more important to protect remaining tundra. Oil drilling, mineral exploration, air pollution and other human disturbances destroy and degrade tundra habitats and disturb sensitive wildlife species during their breeding seasons. Increasingly scarce tundra habitats must be given extra protection.

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