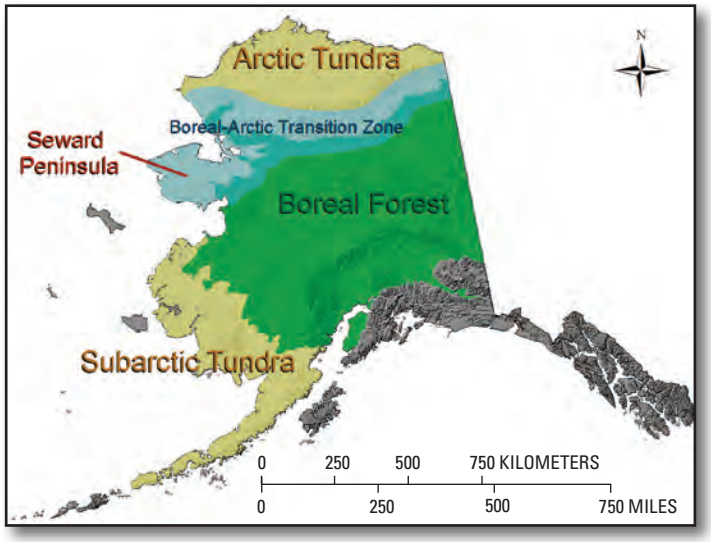
USGS
science for a changing world

Changing Arctic Ecosystems

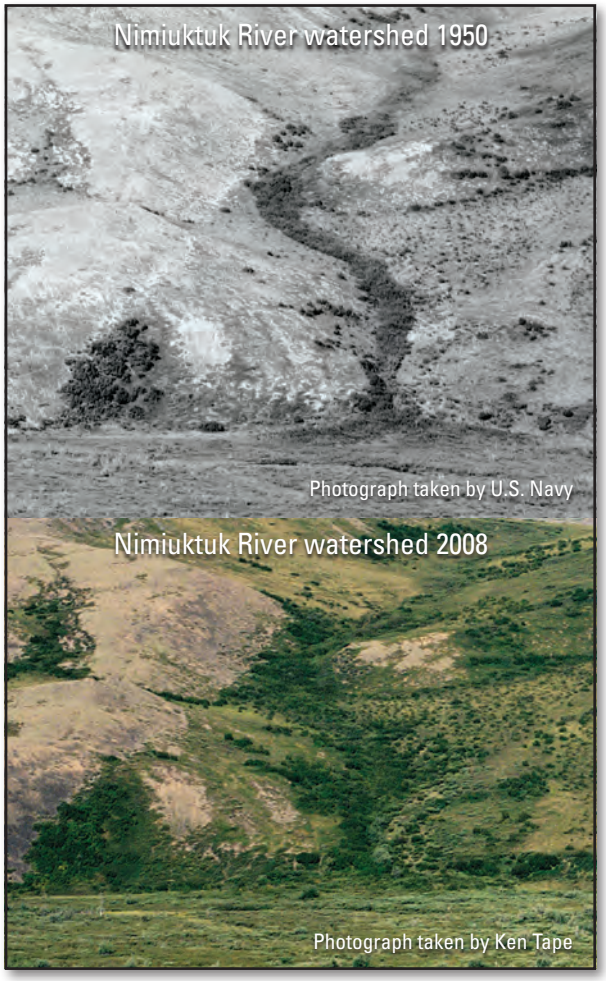
The Role of Ecosystem Changes Across the Boreal–Arctic Transition Zone on the Distribution and Abundance of Wildlife Populations

Arctic and boreal ecosystems provide important breeding habitat for more than half of North America's migratory birds as well as many resident species. Northern landscapes are projected to experience more pronounced climate-related changes in habitat than most other regions. These changes include increases in shrub growth, conversion of tundra to forest, alteration of wetlands, shifts in species' composition, and changes in the frequency and scale of fires and insect outbreaks. Changing habitat conditions, in turn, may have significant effects on the distribution and abundance of wildlife in these critical northern ecosystems. The U.S. Geological Survey (USGS) is conducting studies in the Boreal–Arctic transition zone of Alaska, an environment of accelerated change in this sensitive margin between Arctic tundra and boreal forest.

Through the Changing Arctic Ecosystems initiative, USGS strives to inform key resource decisions by providing scientific information on current and potential future ecosystem responses to a changing climate. As part of this initiative, the USGS is conducting a suite of studies in the Boreal–Arctic transition zone to evaluate (1) how the distribution, abundance, and community structure of breeding birds are related to climate-driven habitat conditions; (2) how rapidly the distributions of birds and their habitats are changing in this transition zone; and (3) how avian recruitment and survival are affected by climate and climate-driven habitat conditions. Results from these studies will be used to forecast which avian species, communities, habitats, and core geographic areas are likely to be most vulnerable to projected climate changes. This information will guide decisions for conserving biodiversity and help to discern the potential future of the Arctic tundra region.



Transition zone between boreal forest and Arctic and subarctic tundra in Alaska.



Example of long-term increase of shrubs in Arctic ecosystems. Photographs of the Nimiuktuk River watershed in 1950 and 2008. Photographs provided by Ken Tape, University of Alaska Fairbanks.

Pacific Golden-Plover. Photograph taken by Ken Archer.

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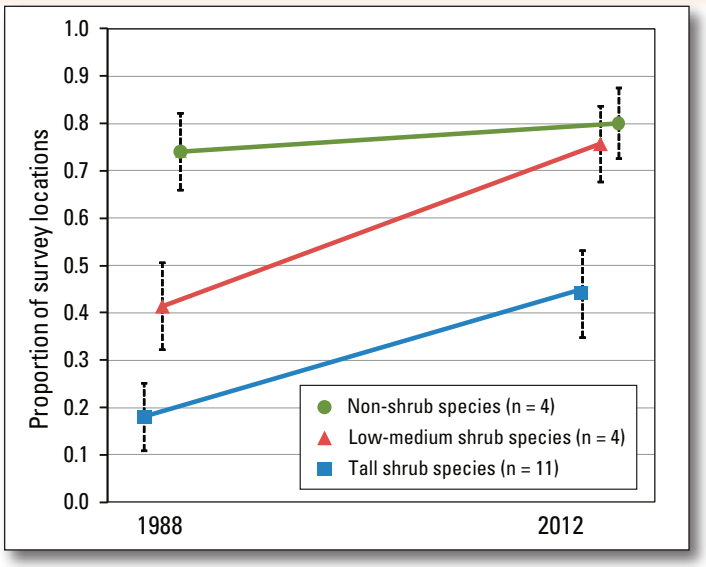
Changes in Distribution and Abundance of Terrestrial Birds Related to Climate-Driven Habitat Changes

Climatic changes already are causing significant shifts in vegetation and wildlife habitat across boreal and Arctic landscapes. In boreal forests, tree line is shifting northward and wildfires are increasing due to changes in seasonal weather. In tundra systems, shrub growth is accelerating due to changes in temperature and precipitation, increases in frequency and intensity of tundra fires, thawing of permafrost, changes in snow conditions, and increases in microbial activity due to increased soil temperatures.

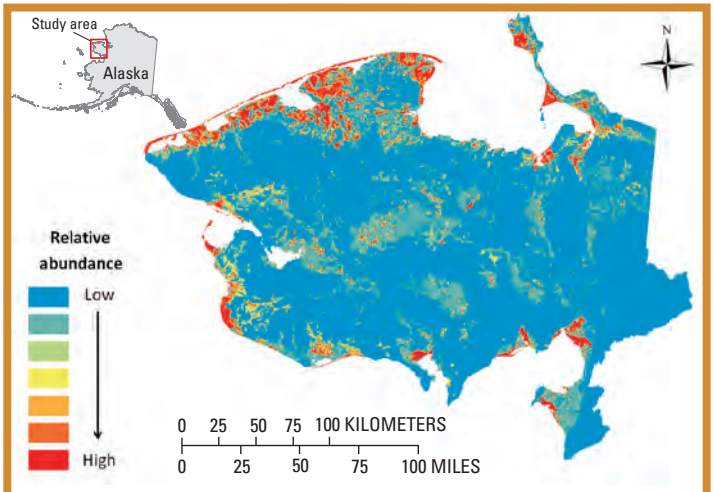
The USGS conducted surveys of landbirds and shorebirds over gradients of habitat conditions in the western Boreal–Arctic transition zone during 1988–92 and again in 2000. During 2012–13, USGS scientists replicated these multispecies bird and habitat surveys, and will complete the surveys again in 2014. Historical and modern surveys will be used to quantify rates of change in occurrence of birds relative to changes in vegetation, identify key habitats for sensitive species, and build historical and contemporary distribution maps for species with varying habitat requirements and migration patterns.

Changes in Recruitment and Survival in Avian Populations Across the Boreal–Arctic Transition Zone

Wildlife populations are influenced by environmental factors through effects on their abilities to survive and reproduce, which ultimately determine their patterns of occurrence and abundance. Knowledge of these demographic processes is required to understand how well wildlife populations can adapt to changing environmental conditions. The USGS is evaluating relationships between environmental and ecological drivers, such as weather and vegetation, and the demographic responses of birds with diverse life histories. These data will be used to understand the ecological processes that govern patterns of avian abundance relative to climate change.



During the past 25 years (1988–2012), songbirds associated with shrub habitats have increased across tundra on the Seward Peninsula, Alaska, based on a comparison of surveys completed during 1988 and repeated in 2012.

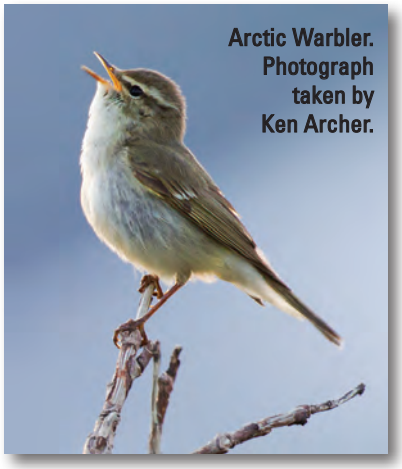


Predicted distribution and abundance of Lapland Longspur on the Seward Peninsula, Alaska, based on surveys completed during 2012.

Lapland Longspur. Photograph taken by Ken Archer.

Forecasting Future Wildlife Communities and Distributions

Through the Changing Arctic Ecosystems initiative, the USGS is building new expertise in several novel analytical techniques to combine relevant climate data, scientific information, and expert knowledge to forecast future responses of wildlife populations to ecosystem change. Bayesian networks are being used to identify what information is most critically needed to predict how wildlife populations will respond to climate change. By combining spatially explicit ecosystem models with climate projections, the USGS is identifying key environmental variables that determine important wildlife habitat and is modeling predicted future distributions of wildlife populations.



Arctic Warbler. Photograph taken by Ken Archer.

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