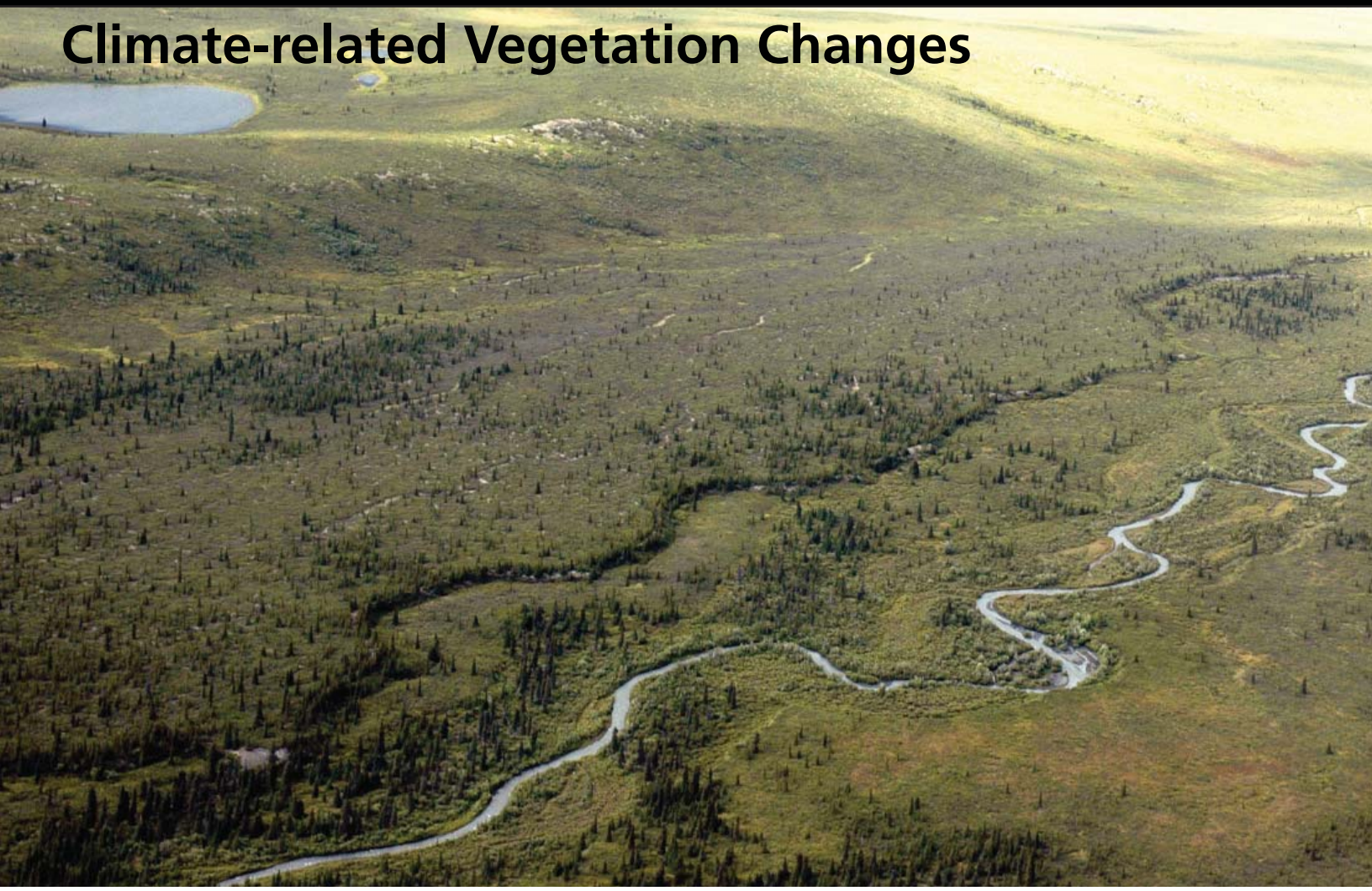
National Park Service
U.S. Department of the Interior

Denali National Park and Preserve

Climate-related Vegetation Changes



Repeat photography provides dramatic visual evidence of recent vegetation changes. This photo was taken in 2005. Compare the vegetation to what is in the same landscape in 1976 (see photo on reverse).

Plants and the landscape. Perhaps we would do well to change one word... and write plants are the landscape.

—Gleason and Cronquist
*The Natural Geography of Plants (*1964)

The vast landscapes of interior Alaska are changing: large glaciers are melting and rapidly receding up valleys, ancient permafrost is degrading and turning frozen soils into soupy gelatin, woody vegetation is spreading dramatically into open areas, and boreal ponds and wetlands are shrinking. Climate data for interior Alaska show a pronounced warming trend over the past several decades. A growing scientific consensus suggests that this tide of warming is bringing many changes to Alaska's ecosystems. While what will happen to these ecosystems is unknown, what is almost certain is that the changes will have profound consequences for all life in the far north.

Using historical photographs

In 2005, the Central Alaska Network received a serendipitous gift of several hundred 35-mm slides, photographed from the backseat of a two-seater airplane in 1976. The donor, Dr. Fred Dean (professor emeritus of wildlife biology at the University of Alaska, Fairbanks) and his graduate student, Debbie Heebner, used these photographs to help produce the first land cover map of what was then McKinley National Park.

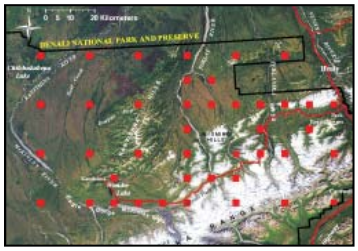
Soon after receiving this unexpected photographic bounty, Central Alaska Network staff scanned the slides at high-resolution and entered the locations of the photos into GIS. Printed hard copies of the photographs, along with location maps, were used to assist the field-season mission by helicopter—to repeat the original photographs as closely as possible. Now examined and analyzed, these photo pairs are a treasure trove of information about visible vegetation changes over the last 30 years.

Photo pairs and vegetation change

The repeat photo pairs (1976 and 2005) provide dramatic visual evidence of recent vegetation changes. Researchers were surprised by the magnitude of the observed changes in many of these photo pairs. The primary types of changes were (1) expansion of spruce into formerly treeless areas, (2) invasion of open wetland areas by woody vegetation, and (3) widespread colonization of formerly open floodplains and terraces by vegetation. In many cases, these changes were not simply a shift in vegetation due to succession, but could be called "directional," i.e., replacement of one vegetation type by another. Over the past 30 years many such examples appear to have impacted park landscapes.

Photo credit: Fred Dean

Between 1976 (above) and 2005 (photo on reverse), white spruce trees (*Picea glauca*) have colonized a subalpine terrace along the upper Savage River in Denali.



Vegetation monitoring in Denali uses a multi-scale grid design: *plot* (where ecologists gather data), *mini-grid* (red squares that are each an array of 25 plots), and *macro-grid* (the spacing of minigrids at 6.2 or 12.4 miles (10 or 20 km) across the park).

Monitoring landscape-scale change

Understanding these changes requires more rigorous and detailed information. To gather the necessary data, the Central Alaska Network Inventory and Monitoring Program is implementing intensive, landscape-scale monitoring of vegetation across the three parks in the network (Denali, Yukon-Charley Rivers National Preserve, and Wrangell-St. Elias National Park and Preserve). Monitoring according to this design began in Denali in 2006, Yukon-Charley Rivers in 2006, and Wrangell-St. Elias in 2007). The goals of the vegetation monitoring are to detect and quantify vegetation changes like those captured anecdotally by repeat photography, and to document the magnitude (dimensions) and ecological consequences of these changes using reproducible, statistically rigorous protocols.

Carl Roland, Denali's botanist, led the Central Alaska Network in establishing a sampling design based on a systematic grid (see figure at left). Changes can be detected at multiple spatial scales from individual sample plots to across-park landscapes.

At each plot, ecologists measure and record the types and abundances of vascular plants (flowering plants, conifers, ferns, and fern-allies), mosses, and lichens; dimensions and locations of all trees; and physical attributes, including soil properties. Ecologists also collect cores from trees just outside the permanent plots and mark each plot's center with a monument.

To detect long-term trends in the vegetation cover at both small (the plot) and large (landscape) scales, ecologists will resample each plot on seven-year rotation schedule (six to measure plus a year between cycles for data analysis).

Patterns of vegetation on the landscape

Nearly 500 permanent vegetation plots have been installed so far in Denali. From data collected at these plots, ecologists are already learning a great deal about vegetation-landscape relationships and the distribution and diversity of vascular plants across the landscape. For example, across all spatial scales, the average species richness of plant communities increases dramatically with increasing elevation (highest in the high alpine zone of the park).

Alpine areas not only support plant communities of high species richness, these areas also claim hold to the greatest diversity of rare and endemic plants. These vegetation patterns signal an early warning of potential threats to plant conservation. With continued warming, woody vegetation will increasingly invade alpine tundra, thereby displacing these highly diverse plant communities.

Management response to changes in vegetation

In interior Alaska, the landscapes are dramatically changing. Both what can be gleaned from comparisons of then-and-now repeat photography, and the data from multi-scale monitoring, are strands woven into a comprehensive monitoring program that should allow detection, understanding, and potential management of vegetation change.

For more information

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Invasion of this open sedge meadow (light-colored area) by trees and shrubs had initiated prior to 1976 (left photo), but was well-advanced by 2005 (right). This wetland near Corner Lake (in Denali's northern lowlands) had likely supported open sedge meadow for centuries before the recent "woody" invasion.

Photo credit: Fred Dean