Long-term Research in Interior Alaska Tracks Consequences of our Changing Climate

BY JAMIE HOLLINGSWORTH

The Bonanza Creek Experimental Forest (BCEF) and Caribou-Poker Creeks Research Watershed (CPCRW) are the only designated forest research areas in the northern boreal forest zone of the United States. Bonanza Creek, located about 12 miles (20 km) southwest of Fairbanks, Alaska, was established in 1963 and encompassed approximately 8,487 acres (3,360 ha) of upland boreal forest. In 1969, the forest was enlarged to 12,486 acres (5,053 ha) to include representative floodplain forests and wetlands associated with the Tanana River. Bonanza Creek lies within the Tanana Valley State Forest, a unit managed by the Alaska Department of Natural Resources Division of Forestry. It is leased to the USDA Forest Service’s Pacific Northwest Research Station for the exclusive purpose of conducting research in forestry.

Caribou-Poker Creeks is a 25,700 acres (10,400 ha) upland research site located 28 miles (45 km) north of Fairbanks in the boreal forest of the Yukon-Tanana Uplands. Its research is focused on understanding the watershed dynamics associated with discontinuous-permafrost. In 1969, a cooperative agreement signed by the Interagency Technical Committee for Alaska and the Alaska Department of Natural Resources designated the basin as the Caribou-Poker Creeks Research Watershed. In 1996, the University of Alaska Fairbanks assumed management of the watershed.

LTER

In 1987, Leslie Viereck of the USDA Forest Service and Keith Van Cleve of the University of Alaska Fairbanks wrote the first Bonanza Creek (BNZ) proposal submitted to the National Science Foundation as part of the Long-Term Ecological Research (LTER) initiative. Initially, BNZ LTER research was designed to study floodplain and upland succession following disturbance. It was hypothesized that succession in floodplains (following fluvial disturbance) and uplands (following fire) results in a predictable development of hardwood and then coniferous stands, with black spruce stands becoming the climax species until disturbance resets the successional trajectory.

Since initial establishment, research associated with BNZ LTER has indicated that boreal forest succession following disturbance in both interior Alaskan floodplain and upland forests is more complicated than initially defined by the original models put forward by Viereck and colleagues in the 1970s. For example, research was published in 1995 emphasizing the importance of geomorphology and fire in controlling successional process in floodplain ecosystems. Other research along a 12,000-year-old geologic chronosequence of fluvial deposits in the central Alaska Range showed that while primary succession continues toward a white spruce/balsam poplar forest, there can be a convergence toward a frequently burned aspen/white spruce/ericoid community type. A recent synthesis done of the long-term vegetation data collection at the floodplain sites suggests a complex interaction between successional processes, community dynamics (in particular herbivory), and potentially directional change in cli-
mately is driving understory vegetation patterns in mid- and late-succession.

Research completed on initial successional pathways post-fire has suggested that the influence of pre-fire composition, site characteristics such as moisture, and fire severity are tightly linked to changes in post-fire trajectory. Finally, stand reconstruction and modeling of a large forest stand northeast of Fairbanks suggests that self-replacement has been the most frequent successional pathway over the last century, most likely due to site characteristics (solar insolation and altitude), not time since last fire. Collectively, these studies indicate that interactions between the timing and severity of disturbance, herbivory, pre-disturbance plant composition, and site characteristics strongly interact to allow for shifts in both community composition and successional trajectories.

**Regional expansion**

Following the reevaluation of the original models guiding boreal forest research in interior Alaska, the BNZ LTER program began a regional expansion of study sites in 2012 with the latest LTER renewal proposal submitted in 2010. The major focus of the renewal proposal is to better understand regional effects of climate change, and in particular, climate-disturbance interactions including fire, permafrost thaw, and insect/pathogen outbreaks. This regionalization resulted in a shift away from the monitoring scheme initially defined in a spatially limited area several decades ago. However, throughout the process, scientists have been extremely cognizant of the importance in maintaining the integrity of the long-term monitoring record initially established.

BNZ LTER is currently emphasizing regional dynamics and changing successional trajectories from a more spatially extensive perspective as opposed to only stand-level dynamics. To meet this challenge, measurements have been expanded to a more regional set of sites chosen to specifically address variations in site conditions driving divergence of successional pathways. This regional site network will focus on black spruce, which is the most extensive forest type in interior Alaska and is experiencing radical disturbance-driven changes in successional dynamics. Twelve of the BNZ LTER sites that were previously established are included as part of the BNZ LTER 90 regional sites. This allows for maintaining valuable long-term records while also expanding into site conditions that are common in boreal Alaska, but not available within the limited scope of BCEF or CPCRW.

Three major ecoregions in interior Alaska are accessible by road or river and encompass more than 6,200 sq. miles (1,600,000 sq. km). These ecoregions are the Ray Mountains, ~12.7 million acres (5.2 million ha); the Yukon-Tanana Uplands, ~25.3 million acres (10.2 million ha); and the Tanana-Kuskokwim lowlands, ~1.6 million acres (0.6 million ha)—each with distinct fire history, permafrost distribution, and geologic history. The regional site network encompasses sites of various times since fire disturbance, site moisture conditions, and ecoregion.

**Implications for managers**

Experimental forests and the research associated with them are critical for land managers. In boreal Alaska, land managers are faced with management decisions related to fire safety, wildlife habitat, and biomass production. BNZ LTER is answering questions that directly relate to these issues. For example, we know the degree of warming and drying after fire on sites with permafrost will affect both tree recruitment and growth rates in those areas. Another example is a PNW Research Station General Technical Report produced by LTER researchers that provides a dichotomous key for determining potential successional trajectory at a given site immediately post-fire.

As with all long-term data, the value is in the length of the record. Bonanza Creek Experimental Forest and Caribou-Poker Creeks Research Watershed have vegetation, animal population, and climate datasets that date back to the 1950s. These data are available to managers and can be used in climate and fire prediction models, stand composites for fire, habitat loss and gain, and biomass estimates.

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**Bibliography Available**

For additional information on the research cited in this article, please visit the Bonanza Creek LTER online bibliography at www.lter.uaf.edu/pubs/bibliography_search_master.cfm.

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