Bonanza Creek

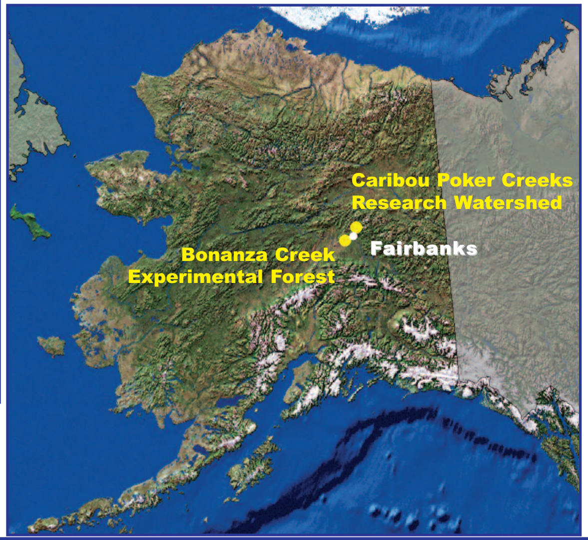
Long Term Ecological Research

The boreal forest is a unique ecosystem featuring low species diversity, vast carbon stocks in its soils and peatlands, and an annual soil temperature near the melting point of permafrost. Researchers have observed changes in wildfire regimes, in animal and insect populations, and a 5º C temperature increase in Alaska in the past 150 years, which indicate that global climate change is already affecting this environment. Evidence of these changes include increased species diversity, release of carbon into the atmosphere during fire, and more standing water. This one-of-a-kind biome provides a unique "laboratory" to study the effects of global climate change.

Jamie Hollingsworth downloading data from a climate station in January. Photo: Brian Charlton.

Succession

Succession is the predictable change in the dominant vegetation of a given area that occurs over time following a disturbance such as wildfire or flooding. Primary succession on the Tanana River floodplain proceeds from a newly deposited silt bar with the establishment of scattered herbaceous and shrub species (horsetail and willow), to dense shrubs (alder), to deciduous trees (balsam poplar), and finally, to a mature "old growth" forest of coniferous trees (white and black spruce). Previous studies have shown that permafrost development, population dynamics for a wide range of animal and plant species, nutrient cycling, and hydrologic patterns all change in predictable ways through succession. However, recent warming has altered the frequency and severity of wildfire and flooding, impacting the successional patterns of the boreal forest. For example, changes to the fire regime could expand the range of lodgepole pine into interior Alaska, changing the successional patterns and altering ecosystem structure and function.



Above: The circum-polar distribution of the boreal forest. Right: Location of the BNZ LTER study sites in Alaska. Figures: J. Hollingsworth.

The boreal forest covers millions of acres in a circum-polar band across North America, Asia, and Europe. The Alaskan boreal forest is composed of a mosaic of white and black spruce, paper birch, aspen, balsam poplar, alder, and willows. It is largely free of roads and industrial development and is home to many native Alaskan villages that rely on the forest to sustain their traditional lifestyles.

Climate Sensitivity

How sensitive is the boreal forest to climate change? To investigate the sensitivity of biological and physical processes, LTER researchers use long-term monitoring of climate (e.g. air and soil temperatures, rainfall, and snow depth) at our experimental sites. This long-term monitoring provides baseline climate data for our on-going research projects as well as a historic record of climate change. In addition, paleoecological records of pollen abundance are used to reconstruct the past history of vegetation and climate over longer time scales, such as thousands to tens of thousands of years. On a broad spatial scale, researchers use satellite imagery to detect changes in vegetation, water bodies, and fire perimeters.

Neville Millar installing soil sensors in the Alaska Peatland Experiment, which looks at peatland carbon cycling through a series of water and thermal experiments. Photo: Molly Conlin.

Thresholds

Thresholds have ecological significance because they represent the point at which a system makes an irreversible shift from its natural successional state. BNZ LTER is studying thresholds in boreal forest ecosystems in two ways. First, we are reconstructing periods when vegetation composition of interior Alaska changed dramatically in the past. Second, we are conducting experiments in which we alter factors that might cause shifts in biological and physical processes. Studies include: Alteration of the water table in a wetland environment, manipulation of key species (through moose and hare exclosures, outplanting of native tree seedlings, and moss translocations), and the introduction of new, functionally distinct species such as lodgepole pine. By understanding the past and manipulating the present, we hope to predict future thresholds before they are irrevocably crossed. In this way, we can provide information on both the positive and negative implications of climate and threshold change.

Integration and Synthesis

A final aspect of BNZ LTER research is to integrate our knowledge of climate, disturbance, and ecosystem processes to project how the boreal biome will look in the future. We use landscape and regional models to incorporate information from our sites and experiments. In particular, we are interested in the societal consequences of ecological change. Examples include: changes in flooding and wildfire risks to human communities, effects of permafrost melting on infrastructure (such as roads and buildings), and availability of subsistence resources (such as salmon, berries, moose, etc.).

Children from White Mountain School collecting data for the GLOBE program. Photo: Ed Silcox.

Education and Outreach

Our program includes K-12, undergraduate and graduate students, and outreach to communities, agencies, and the general public. In our Schoolyard LTER program, participants from 38 urban and rural schools are engaged in long-term ecological studies that contribute to science literacy and skills development. Through partnerships with other science education programs, BNZ LTER provides information and education to a variety of audiences and welcomes **your** participation.

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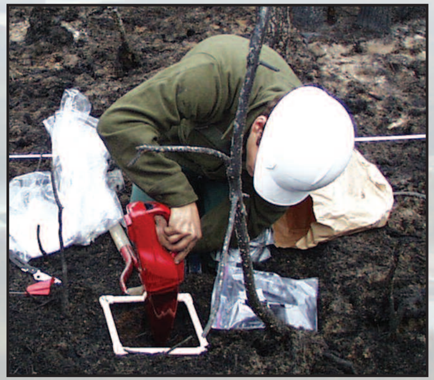
The Bonanza Creek Long-Term Ecological Research program (BNZ LTER) focuses on the interactions between climate and disturbance, and their effects on ecosystem processes in the boreal forests of interior Alaska. The program began in 1987 and is jointly managed by the University of Alaska Fairbanks and the Boreal Ecology Cooperative Research Unit, the northernmost outpost of the USDA Forest Service Pacific Northwest Research Station. BNZ LTER research is concentrated in two sites near Fairbanks, Alaska (64° 48'N, 147° 52'W): the Bonanza Creek Experimental Forest includes the Tanana River floodplains, upland forests, and wetlands; and the Caribou Poker Creeks Research Watershed, which is a network of upland forested watersheds.



Ted Schuur sampling ash following wildfire. Photo: Wendy Davis.

Interior Alaska has a continental climate, with long cold winters and short warm summers. January and July temperatures average -24°C and +16°C respectively, with extremes of -54°C and +38°C. Permafrost is common, often occurring on the north-facing slopes, lowlands, and valley bottoms. (Permafrost is soil that has remained below 0°C continuously for two or more years. This excludes the overlying ground surface layer, which thaws every summer). Average annual precipitation is less than 30 cm, one third of which falls as snow that remains for 7 months a year. Low sun angles create dramatic differences in heat received by north and south facing slopes. The sun stays above the horizon for nearly 22 hours on the summer solstice, but for less than 4 hours on the winter solstice.

Nan Werdin-Pfisterer collecting soil samples in a black spruce stand. Photo: Karl Olson.

Jay Jones and Knut Kielland use snowmachines for field work on the Tanana River in winter. Photo: Karl Olson.

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Cover: Tanana River. Photo: Roger Ruess.