Research began at the NWT LTER site in the 1940's with the return of World War II veterans with extensive experience in cold-region logistics. By the early 1950's a series of climate stations and ecological index sites were established along an elevational transect in four major ecological zones: lower montane (2,200 m), upper montane (2,621 m), subalpine forest (3,021 m), and alpine tundra (3,739 m). The Indian Peaks Wilderness Area was designated by Congress in 1978, with the boundary lines drawn around the Niwot Ridge research area. In 1979 approximately 1,775 acres centered on Niwot Ridge was designated a Biosphere Reserve by the US Congress. This Biosphere is managed by the Arapahoe-Roosevelt National Forest. The Niwot Ridge LTER site was established in 1980 with funding from the National Science Foundation (NSF). The LTER program is based at the University of Colorado-Boulder and is administered through the Institute of Arctic and Alpine Research (INSTAAR) and in cooperation with the Mountain Research Station, with special use permits from the US Forest Service. The NWT LTER site extends up to the Continental Divide at elevations greater than 4,000 m, with snowfall accounting for more than 80% of annual precipitation. The NWT LTER has a cooperative agreement with the adjacent City of Boulder watershed, which is closed to the general public. The NWT LTER site is surrounded by designated Wilderness Areas and by public closures, which allows research into one of the most pristine areas in the US. The NWT LTER program welcomes visitors and researchers who may wish to develop independent or collaborative work at the field site, located about 40 km west of Boulder, Colorado (40° 3' N; 105° 36 ' W).

Photo: John Marr

D-2 meteorological station in 1953.

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- Caine, N. 2002. Declining ice thickness on an alpine lake is generated by increased winter precipitation. Climatic Change v. 54 pp. 463-470.
- Schadt, C.W., A.P. Martin, D.A. Lipson, S.K. Schmidt. 2003. Seasonal Dynamics of Previously Unknown Fungal Lineages in Tundra Soils. Science v. 301 pp. 1359-1361.
- Seastedt, T.R., W.D. Bowman, T.N. Caine, D. McKnight, A. Townsend, M.W. Williams. 2004. The Landscape Continuum: A Model for High Elevation Ecosystems. Bioscience vol. 54 no. 2 pp. 111-121.

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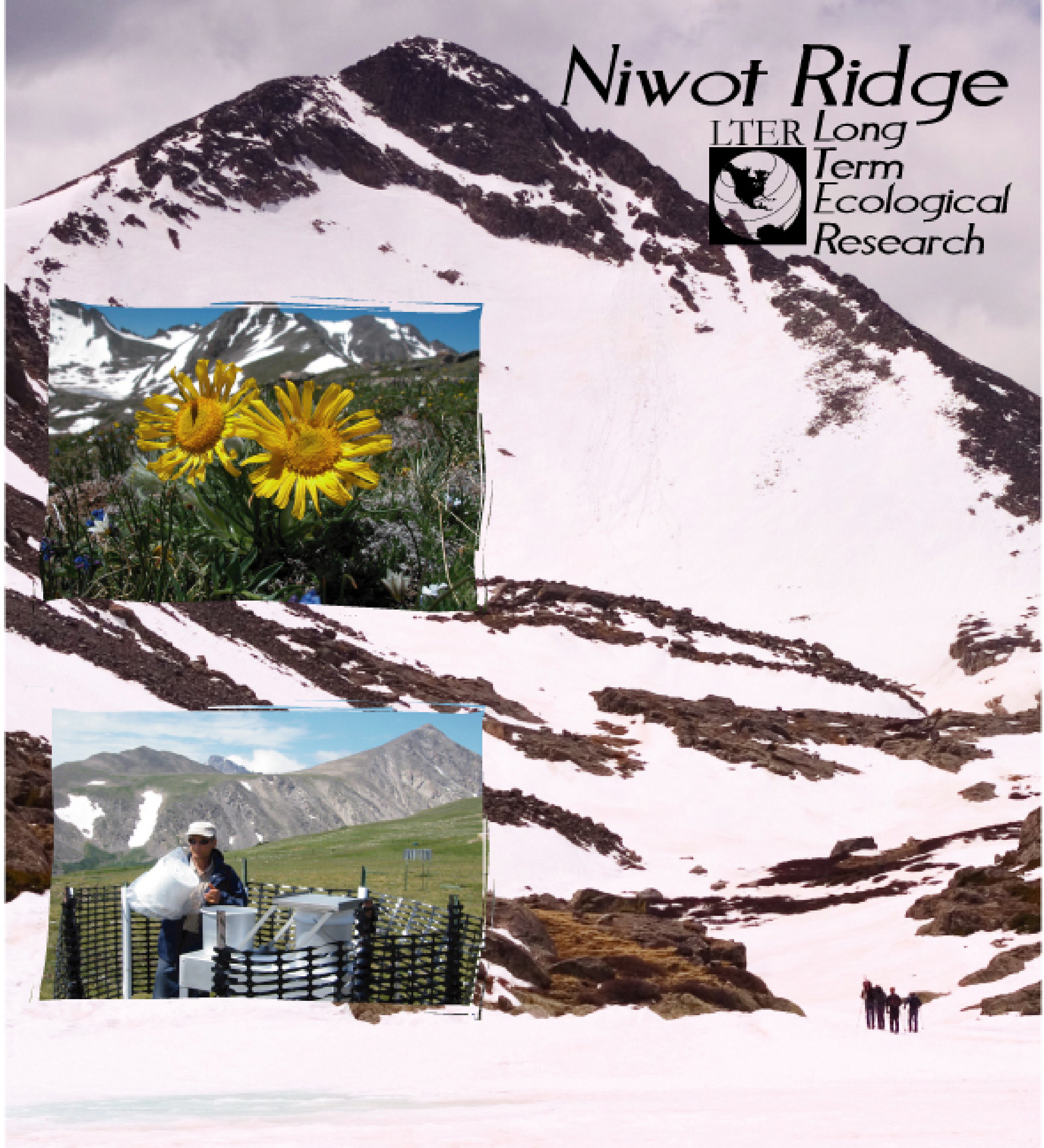
http://www.nsf.gov   http://www.lternet.edu   http://www.colorado.edu   http://instaar.colorado.edu   http://www.colorado.edu/mrs

The Niwot Ridge LTER is part of a coordinated network of research sites. For more information see:

http://www.lternet.edu

Front Cover: Green Lakes Valley Snow Survey; Photo: Todd Ackerman; Top: "Old-Man-of-the-Mountain" (Hymenoxys grandiflora); Photo: William Bowman; Bottom: Highest Elevation NADP Site (11,548 ft); Photo: Kurt Chowanski.



Niwot Ridge
Long Term Ecological Research

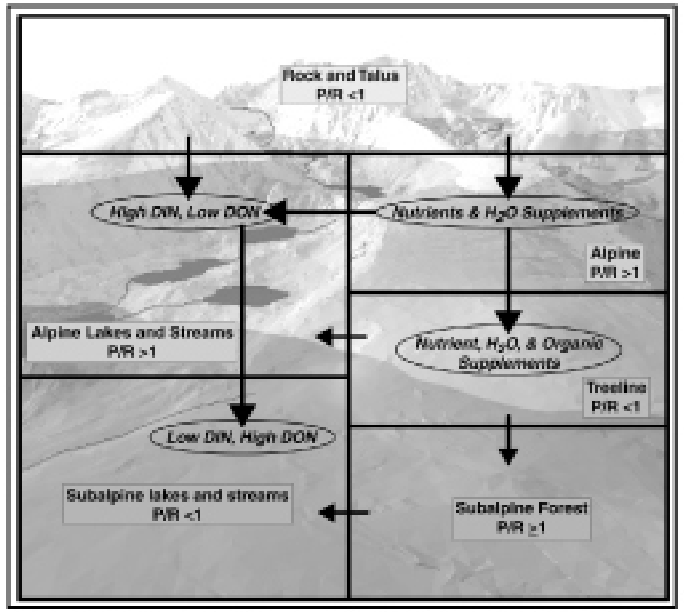
Photo: David Foster

Tundra lab located at 11,500 ft.

The panoramic splendor and complexity of high-elevation ecosystems have inspired and challenged humans for centuries. In our time, the perception that the mountains 'are forever' may provide solace to those seeking stability in a rapidly changing world. However, changes in the abundance and species composition of the native flora and fauna of these mountain ecosystems are potential bellwethers of global change. The basic goal of the Niwot Ridge (NWT) LTER is to understand the causes and ecosystem responses of climate change in high-elevation, seasonally snow-covered catchments.

THE LANDSCAPE CONTINUUM MODEL (LCM)

The LCM provides the conceptual framework to understand high-elevation systems from a biogeochemical perspective, and sheds light on potential changes in these systems in response to directional change in precipitation and atmospheric chemistry (Seastedt et al., 2004). The heart of the model is that strong linkages are generated among landscape components as a result of transport processes caused by the extreme topography. These transport agents cause biogeochemical amplification and attenuation of processes not observed in most landscapes. Mountaintops are "water towers" that export water, solutes, nutrients, and sediment to downslope areas.



High-elvation areas have Net Primary Production (P) greater than Animal and Microbial Respiration (R) and are thus exporters of nutrients such as Dissolved Inorganic Nitrogen (DIN) to down gradient sites, where inorganic nutrients are assimilated, R exceeds P and Dissolved Organic Nitrogen (DON) is exported.

LIFE IN EXTREME ENVIRONMENTS

Photo: Steven Schmidt

Sampling for novel microbes.

Microbes are churning away under the snow in the dead of winter, breaking down organic and inorganic material and recycling carbon and nitrogen at a higher than expected rate. Our finding that microbial communities are active under snow has changed the estimated global rates of biogeochemical processes beneath seasonal snow packs. Unexpectedly, our results show that tundra soil microbial biomass reaches its annual peak under snow and not during the warmer summer months, and that fungi account for most of the biomass. Phylogenetic analysis of tundra soil fungi using microbiological and molecular techniques revealed a high diversity of fungi and three novel clades that constitute major new groups of fungi, divergent at the subphylum or class level (Schadt et al., 2003). These results have caused us to rethink the classic Linnean classification system for biological organisms.

Photo: Jane Larson

K-12 Outreach program field identification.

ALPINE VEGETATION

Alpine tundra is among the most beautiful ecosystems in the world, with the highest plant diversity within Rocky Mountain ecosystems. Alpine vegetation is sensitive to environmental change, particularly changes in Nitrogen (N) deposition and climate. Alpine plant diversity is changing in a manner consistent with increasing N deposition effects. The threshold of N inputs required to cause changes in plant species is lower than most other ecosystems, and appears to have been exceeded in the Colorado Front Range (Bowman et al., in press). These experiments, along with watershed chemistry measurements, have been used by the National Park Service to determine critical loads for alpine vegetation in Colorado.

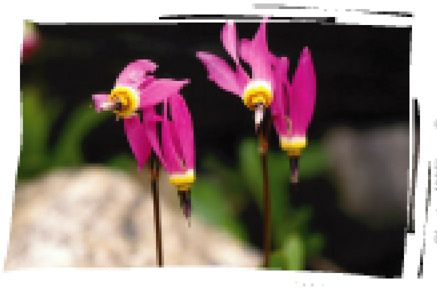


Photo: William Bowman

Shooting Stars (*Dodecatheon pulchellum*)

CLIMATE AND HYDROLOGIC STUDIES

Much of our research at NWT LTER is related to how changes in climate may affect snow properties, and in turn how changes in snow properties relate to ecosystem changes. Five decades of results from the highest-elevation climate station in the US show an annual precipitation increase but no change in air temperature. Ice thickness measured in late March over a 20-year interval shows a statistically significant thinning of winter lake ice cover that is best explained by increased winter snowfall and warmer water temperatures, leading to increased flows into the lake in fall and winter (Caine, 2002). New isotopic and geochemical measurements provide unique fingerprints of different water sources, and show that high-altitude aquifers honeycomb parts of the Colorado Rockies, trapping snowmelt and debunking the myth that high mountain valleys act as "Teflon basins" to rush water downstream.

Photo: David Foster

Snow-fence global warming climate change experiment.

OUTREACH ACTIVITIES

Our schoolyard LTER program brings environmental science education to thousands of K-12 students, teachers, and the public annually. The NWT LTER has published a children's book entitled "My Water Comes from the Mountains" that describes the flow path of water from snow in the alpine to streams in the plains, as well as with the plants, animals, and communities that live near or use the stream along the way. The book's author, Tiffany Fourment, is a former student of NWT LTER's summer field class on Alpine Ecology and Experiential Learning that is taught for inservice and preservice teachers from throughout the US. The book currently has a 5-star rating on Amazon.com.