

## LTERR: The Niwot Ridge LTER Research Program 1998-2004: Controls on the Structure, Function & Interactions of Alpine & Subalpine Ecosystems of the Colorado Front Range

### **Collaborators:**

Dr. Rick Boyce, Northern Kentucky University, continues working with Dr. Herman Sievering on N uptake in the subalpine forest. Preliminary results from their studies indicate that canopy uptake of N provides ~ 15% of N requirements for this forest.

Dr. Barry Rosenbaum, Univ. Puget Sound, conducted small mammal surveys at NWT this summer. These are the first quantitative data obtained on small mammals in over a decade, and results will be evaluated with respect to a substantive historical database to evaluate what, if any changes in species composition or abundances have occurred during this interval.

### **Research and Education Activities:**

During 2002 and 2003, we published or have in press 17 papers in refereed journals and had 1 article published as a book chapter. The most significant of these is a report due to be published in Science in September 2003. We have about a dozen manuscripts in review. Approximately 20 LTER presentations were made at national and regional scientific meetings this past year. During this period we had 1 graduate student complete a thesis. Two REU students were funded by the LTER-REU program in the 2003, and another five REU students worked on LTER-related projects as part of the REU program funded to the Department of Ecology and Evolutionary Biology at CU. The K-12 Outreach effort had another successful season, and the popular 'Tundracam' was replaced with a second-generation system.

### **Findings:**

A. An important research article generated by the LTER-Microbial observatory group will be published in Science on 5 Sept. 2003 (Schadt et al., in press). Microbial communities are active under snow, changing estimated global rates of biogeochemical processes beneath seasonal snow packs. The group used microbiological and molecular techniques to elucidate the phylogenetic composition of under-snow microbial communities in Colorado, USA. They demonstrated that tundra soil microbial biomass reaches its annual peak under snow, and that fungi account for most of the biomass. Phylogenetic analysis of tundra soil fungi revealed a high diversity of fungi, and three novel clades that constitute major new groups of fungi (divergent at the

subphylum or class level). An abundance of hitherto unknown fungi that are active beneath the snow significantly broadens our understanding of both the diversity and biogeochemical functioning of fungi in cold environments.

B. The senior PIs of the NWT LTER have written a synthesis article that refocused and refined the unifying ecological theme for the site (Seastedt et al., in press). Our work has attempted to quantify the extent to which climatic and atmospheric chemistry changes are and will be influencing high elevation ecosystems. This theme, like those of many other sites, often has conceptual difficulties in integrating the terrestrial and aquatic components of the science. The BioScience article demonstrates that strong linkages are generated amongst the landscape components as a result of transport processes. The interaction of extreme winds and extreme topography result in biogeochemical amplification and attenuation processes not observed in most landscapes. This model predicts which sites are the most sensitive to climatic and atmospheric chemistry drivers, and predicts which sites are least likely to be affected by these changes. LTER studies have and continue to test these predictions.

### **Training and Development:**

We presently have 15 graduate students participating with the Niwot LTER program. In addition to training several undergraduates annually as part of the LTER-REU supplement, the LTER researchers also form a large portion of the faculty involved in a CU Dept. of Ecology and Evolutionary Biology REU summer research program. These students are housed at the field station and work on their own projects, alongside graduate students and faculty. This program has been remarkably productive, with a significant portion of these students senior-authoring or co-authoring research efforts published in national and international journals.

### **Outreach Activities:**

Our outreach program is a continuation of the involvement of teachers from the Boulder/Denver area achieved through our LTER Schoolyard LTER program. This program has four aspects: 1) teaching in-service and pre-service teachers alpine ecology in a summer course at the Mountain Research Station (MRS) 2) bringing elementary and middle school students to the MRS for field trips in the summer 3) development of a

schoolyard monitoring program for streams on the lowlands to follow the spring flush of colored organic material (DOC) from the alpine and sub-alpine and 3) development of instructional materials about the Colorado alpine to be used by educators that complement the summer field programs.

The children's book: 'My Water Comes from the Mountains'- Another accomplishment of the NWTLTER K-12 program - was delayed in publication but will be out soon. We have a distribution plan so that the book will be used in all Boulder elementary schools. Hard copies will be submitted to the NSF LTER Program Officer.

### **Journal Publications:**

Gross, K.L, M.R. Willig, L. Gough, R. Inouye, and S.B. Cox., "Patterns of species density and productivity at different spatial scales in herbaceous plant communities.", *Oikos*, vol. 98, (2000), p. 417. Published

Baron, J.S. and N. Caine., "Temporal coherence of two alpine lake basins of the Colorado Front Range, U.S.A.", *Freshwater Biology*, vol. 43, (2000), p. 463. Published

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Losleben, M.V., N. Pepin, S. Pedrick, "Relationships of precipitation chemistry, atmospheric circulation, and elevation at two sites on the Colorado Front Range", *Atmospheric Environment*, vol. 34, (2000), p. 1723. Published

Addington, R.N. and T.R. Seastedt, "Activity of soil microarthropods beneath snowpack in alpine tundra and subalpine forest", *Pedobiologia*, vol. 43, (1999), p. 47. Published

Bowman, W.D., A. Keller, and M. Nelson, "Altitudinal variation in leaf gas exchange, nitrogen and phosphorus concentrations and leaf mass per area in populations of *Frasera speciosa*", *Arctic, Antarctic, and Alpine Research*, vol. 31, (1999), p. 191. Published

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Hood, E., M. W. Williams, and D. Cline, "Sublimation from a seasonal snowpack at a continental, mid-latitude alpine site.", *Hydrologic Processes*, vol. 13, (1999), p. 1781. Published

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### **Internet Dissemination:**

<http://culter.colorado.edu/>

This is our core LTER website

### **Contributions within Discipline:**

Cross-site, Synthesis and LTER Network Activities

Our LTER hosted the 2002 fall LTER Coordination Committee meeting, which included a day-long science presentation. The topic of this presentation 'Causes and consequences of species change in ecosystems: An LTER perspective' highlighted LTER contributions to our understanding of both why changes in dominant species composition occur, and the consequences that these changes have on biotic conservation and ecosystem services issues. Two NWT-LTER investigators presented summaries from LTER-cross site working groups. This thematic element will again be revisited at the 2003 All-Scientists Meeting in Seattle.

Dr. Katie Suding, (U. of Colo until 7/1/03, at which time she became an assistant professor at U.C. Irvine) has chaired a LTER working group involving NWT, the SGS (Daniel Milchunas), ARC (Laura Gough), KBS (Kay Gross), KNZ (Scott Collins), GCE/SBC (Steven Pennings), and CDR (Chris Clark). The purpose of the group is to ask the question, given results from long-term studies of nitrogen enrichment at LTER sites (Gough et al. 2000), are the species identified to be nitrogen-loving species from the experimental studies also increasing in the 'controls' monitored at these sites? In other words, do changes in vegetation patterns show consistencies with the general hypothesis that nitrogen deposition levels and other factors that affect nitrogen availability are increasing across most of these sites? The project will be involved in workshop and synthesis effort at the All-Scientist's Meeting next month.

In addition to the above activities, NWT LTER personnel continued to lead cross-site activities on soil, DOC and DON projects.

NWT LTER investigators Suding and Bourgeron presented papers at the EU-LTER joint meeting, Motz, France, July 2003. Investigator Bill Bowman presented a paper at the CEE-ILTER meeting, Warsaw, Poland, August, 2003, and his lab participated in a cooperative study with Polish ILTER researchers.

Participation and activities associated with the fall 2003 All-Scientists Meeting will be covered in our 2003-2004 annual report.

NWT LTER personnel are taking the lead or co-lead on six workshops.

#### **Contributions to Other Disciplines:**

Our tundraCAM (<http://tundracam.colorado.edu>) was destroyed in a lightning strike in April, 2003, and was replaced with new equipment in June. The new system requires faster computers to view the site, and we're currently attempting to develop some software interfaces that allow viewing by modem access.

#### **Contributions to Education and Human Resources:**

Our program currently involves 15 graduate students and 5 undergraduates (either directly or indirectly associated with the LTER REU effort). The LTER site and its databases have been and continue to be used in a number of courses taught at CU, including a very popular alpine research course taught by a non-NWT LTER faculty member.

A new undergraduate scholars program at CU has been initiated that will involve both NWT LTER investigators and NWT LTER data sets. Funded through the NWT LTER as an Undergraduate in Biology and Mathematical Sciences (UBM) Supplement, faculty in the departments of applied math and biology will teach short-courses and train students in models applicable to the analysis and interpretation of complex data sets. Undergraduates will work in pairs (one with a mathematics major, one with a biology major) using LTER data. The program is beginning fall semester, 2003 and includes the participation of three CU faculty not formerly associated with the LTER program.

#### **Contributions to Resources for Science and Technology:**

Niwot Ridge LTER site continues to be a leader on data availability and data transfer. We have initiated wireless data transmission from remote sites on Niwot Ridge and the Green Lakes Valley, which are

currently being imported into a relational database where a web interface will allow a user to query specific dates and variables more efficiently. Our plan is to connect these to a wireless transmission system to our central facility at the University in Boulder. This should result in a superior, real-time data collection system and eliminate costs associated with phone line connections.

All GIS coverages have been converted into a common projection, and the metadata has been made FGDC compliant. An online map server has been developed to allow researchers to generate maps and query locations of their research plot at the Niwot Ridge and Green Lakes Valley sites.

This year marked the first year of Niwot Ridge participating in the HydroDB Network Information System module. The Green Lake 4 gauging station was added to the database, with plans to add the Albion Town site gauging station once a wireless link is installed.