**Annual Report for Period:** 12/2000 - 12/2001

**Principal Investigator:** Seastedt, Timothy R.

**Organization:** U of Colorado Boulder

**Title:**

### Project Participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Worked for more than 160 Hours:</th>
<th>Contribution to Project:</th>
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<tbody>
<tr>
<td>Seastedt, Timothy</td>
<td>Yes</td>
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<tr>
<td>Townsend, Alan</td>
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<td>Wessman, Carol</td>
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<td>Williams, Mark</td>
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<td>Bowman, William</td>
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<td>Caine, Nel</td>
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<td>Diggle, Pamela</td>
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<td>Elias, Scott</td>
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<td>Monson, Russell</td>
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<td>Sanford, Robert</td>
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Name: Schmidt, Steven  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Sievering, Herman  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Walker, Donald  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: McKnight, Diane  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Losleben, Mark  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**  
Niwot Ridge Climatologist. Responsible for all LTER climate records.

Name: Bourgeron, Patrick  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**  
Treeline studies; regional assessments

Name: Suding, Katie  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**  
Postdoctoral researcher in charge of plant community analyses

**Post-doc**  
Name: Suding, Katie  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

**Graduate Student**  
Name: Carrasco, Jon  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Costello, Elizabeth  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Name: Damm, Mary  
**Worked for more than 160 Hours:** Yes  
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<td>Dykstra, Gamlyn</td>
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<td>Ley, Ruth</td>
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<td>Liptzin, Dan</td>
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<td>Liu, Fenjing</td>
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<td>Manthorne, David</td>
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<td>Meloche, Chris</td>
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Contribution to Project:
Name: Meyer, Allen
Worked for more than 160 Hours: Yes

Contribution to Project:
Name: Miller, Amy
Worked for more than 160 Hours: Yes

Contribution to Project:
Name: Mujica-Crpanzano, Laura
Worked for more than 160 Hours: Yes

Contribution to Project:
Name: Nemergut, Diana
Worked for more than 160 Hours: Yes

Contribution to Project:
Name: Schadt, Christopher
Worked for more than 160 Hours: Yes

Contribution to Project:
Name: Sherriff, Rosemary
Worked for more than 160 Hours: Yes

Contribution to Project:
Name: Torrizzo, Andreas
Worked for more than 160 Hours: Yes

Contribution to Project:
Name: Tomaszewski, Tim
Worked for more than 160 Hours: Yes

Contribution to Project:
Name: Turner, Paul
Worked for more than 160 Hours: Yes

Undergraduate Student

Research Experience for Undergraduates
Name: Renaud, Carrie
Worked for more than 160 Hours: Yes

Research Experience for Undergraduates
Name: Scott, Alexis
Worked for more than 160 Hours: Yes
Name: Polling, Elizabeth
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Froeschner, Holly
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Baer, Rory
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Clark, Adrian
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Janik, Caroline
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Linsenbart, Amy
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Major, Sheridan
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Yablonski, Adam
Worked for more than 160 Hours: Yes
Contribution to Project:

Organizational Partners

Other Collaborators or Contacts

Recent Synthesis, Cross-site, and LTER Network Activities

The completion of the Niwot Ridge ecosystem volume as part of the Oxford University LTER publications series represents a major accomplishment by the site PIs. To our knowledge, this is the first comprehensive summary of terrestrial alpine ecology in North America. While the focus is on Niwot Ridge, most chapter authors attempted a strong comparative approach whenever possible, which allows us to make statements regarding the generality of findings. We emphasize that most of the research used to form the basis of our conclusions in that effort came from earlier LTER activities. Our perspectives on a few of the issues have already changed, but the summaries presented in this volume remain valid for focusing current and future efforts. In addition, former NWT graduate student David Bryant has written a synthesis effort comparing arctic and alpine decomposition patterns using the extensive LTER LIDET data set (Bryant et al. in press).

Mark Williams et al. have obtained a cross-site LTER NSF grant to expand upon activities to quantify the relationships between organic N and organic carbon in soils and streams of diverse ecosystem types. This effort follows up on the creation of an organic N and organic C analytical facility at CU-INSTAAR. The combined laboratories of LTER PIs McKnight, Townsend, and Williams are developing a suite of analytical procedures to evaluate the fate of organic N and C generated in soils, sediments, and surface waters, that have been transformed into a variety
of recalcitrant organic fractions. This activity is particularly timely and appropriate at our site where enhanced N deposition and enhanced precipitation are directly modifying N inputs and indirectly modifying transformations by affecting species composition and productivity of the site.

The NWT LTER will host the 2002 fall LTER network Coordination Committee meeting and be in charge of developing its science program. The proposed subject will emphasize LTER contributions to the analysis of species change as both a causal mechanism and consequence of various aspects of global change. Seastedt is also chair of the LTER network invasive species working group.

William Bowman participated in three European activities in 2000 and one in 2001. These included: 1) Bowman and Suding. Biotic Influences on the Response of the Rocky Mountain Alpine to Environmental Change. Third Annual ILTER workshop, Central and Eastern Europe, Nitra, Slovak Republic. 2) Bowman, On the role of biotic interactions in structuring alpine plant communities- keynote address in Community Ecology, Third Annual Conference on the Physiology, Ecology and Evolution of Alpine Plants, Lautaret Alpine Field Station, France, 3) Bowman and Damm. Causes and consequences of vascular plant diversity in the Rocky Mountain alpine, workshop on Global Mountain Biodiversity Assessment, Rigi, Switzerland. 4) Bowman, Plant control of ecosystem processes in the alpine: implications for response to environmental change. The 4th Central and East European Regional Meeting of the ILTER. Bowman is on the Global Mountain Biodiversity Assessment Steering Committee, and has remained active in collaborative efforts with European scientists.

Patrick Bourgeron was host for a group of potential ILTER scientists from France in summer, 2000. He reciprocated by organizing an ILTER workshop activity in France in January, 2001. Seastedt also participated in the workshop, and several projects involving Bourgeron and French scientists have been proposed from this effort.

Activities and Findings

Research and Education Activities:
The Niwot Ridge LTER prepared for its midterm, formal NSF site review by developing a 'new' model that describes the biogeochemistry of high elevation systems. This model will be the subject of a BioScience article to be submitted in the coming year.

THE LANDSCAPE CONTINUUM MODEL: A BIOGEOCHEMICAL PARADIGM FOR HIGH ELEVATION ECOSYSTEMS

Interactions between a cold, wet, and windy environment and steep elevation gradients generate unique source and sink areas for water and nutrients as a result of water, energy and resource redistribution.

These redistribution patterns structure nival, (highest elevation areas generally lacking rooted vegetation) alpine, and subalpine communities as a result of the coupled response of these three systems to the climatic and atmospheric inputs.

1. Nival systems largely lack biotic mechanisms of water or nutrient retention. This material becomes redistributed to downslope communities. The general absence of primary producers means that heterotrophic processes dominate this system generated from organic material accumulated from atmospheric deposition in protected sites. Hence, in this system, the ratio of NPP/heterotrophic respiration, like a headwater stream, is hypothesized to be <1.

2. The alpine, while receiving subsidies from the nival zone, is suggested to be a 'source ecosystem' of organic matter and nutrients to the subalpine. This means that, overall, NPP/Heterotrophic respiration >1. The dry meadow community in particular is suggested to strongly exhibit this property, contributing both a high fraction of aboveground NPP and the largest amounts of organic matter to lower elevation systems. This pattern also generates a nutrient limitation, particularly in the dry meadow areas.

3. Zones within the alpine are potential recipients of nival redeposition in addition to redeposition from alpine sources. Snowfield and wet meadow sites are subsidized with water and nutrients from other sites. Selection for rapid growth and development due to the short growing season should select for species with high nutrient requirements. Dry meadows should represent the most intensively nutrient limited sites, both because of the lack of subsidies, but also because these are hypothesized as source communities for organics and therefore lose nutrients via a fairly unique mechanism (aerial transport!).

4. There exists an inverse relationship between solar energy inputs and water and nutrient inputs in the alpine system. Following the Chapin (1990) model, species should attempt to minimize the extent to which any single resource is limiting and allocate resources
accordingly. This pattern should be evident in the composition of the various alpine communities in terms of root/shoot ratios and nutrient composition.

5. Redeposition of water, nutrients and particulates is maximized at the alpine-subalpine interface. The trees themselves provide the mechanism to scavenge these materials by functioning as windbreaks and collectors. In the absence of a developed treeline, these materials are transported further downslope. Overall, the subalpine is hypothesized to be a 'sink' ecosystem for both nutrients and organic matter. If organic subsidies are large, then the potential for the relationship NPP/heterotrophic respiration <1 exists, and the site should exhibit characteristics of high nutrient availability.

Overall, the above concepts link Billing's (1973) mesotopographic alpine model with ideas developed in the Vannote et al.(1980) river continuum hypothesis. The two models collectively provide both the landscape and elevational components required to understand high elevation systems from a biogeochemical perspective. The model explains overall patterns of biogeochemical cycles, carbon fluxes, NPP, and makes predictions about growth strategies of plants. The model easily integrates with similar concepts and principles required to understand high-elevation catchments and watersheds, and provides a mechanistic interpretation for how components of the high-elevation landscape can be experiencing both excesses and deficiencies of the same nutrient.

What is particularly exciting and compelling about this model is that, for the first time, we are able to integrate both terrestrial and aquatic processes across diverse ecosystem types. The relevance of this model can be discerned from research findings cited below.

While our educational mission remains secondary to our research mission, we're very proud of our outreach and have documented recent activities in that section of this report.

Findings:
Niwot Ridge LTER investigators produced 50 research articles that have been published or in press since 2000. The sythesis volume, 'Structure and function of an alpine ecosystem', (Bowman and Seastedt, eds., Oxford Univ. Press 2001) has provided a summary of our science through about 1998. Unresolved science questions identified in that work, in addition to the model described above, provides the basis for our current and future science initiatives.

1. Research highlights:
1. Nitrogen (N) deposition. Efforts to understand sources and fates of nitrogen inputs have remained an active area of research. Continued monitoring of N inputs from NADP sources indicates an increase of about 0.05 g N . m-2 . y-1. Previous and ongoing studies document vegetation responses to changes in N availability.

2. Climate change. Work by Nel Caine (submitted) has independently documented enhanced precipitation in the highest regions of Niwot Ridge. (Previously, this observation was based solely on time-series data from a single climate station.) This work provides justification for the ongoing snowfence manipulation, and suggests that increased precipitation in the southern Rockies may be more significant to high elevation ecosystems than increased warming.

3. Phosphorus - Nitrogen interactions. Concurrently with the N deposition work, preliminary sampling for plant-available phosphorus in alpine and subalpine soils suggests that the age of these soils influences the strength of P limitation (Townsend et al., unpublished results). We see this line of research as one that's critically important to predict species composition shifts associated with the reduction of N limitation in these ecosystems.

4. Ecosystem responses to climate and atmospheric changes. Ongoing studies of the snowpuck manipulation site (snowfence) continue to define and expand upon earlier studies. These results support the contention that increased moisture can enhance the carbon flux from the soil, thus converting alpine regions into a carbon source under a wetting but otherwise unchanged climate. Ongoing vegetation studies will be continued to see if productivity changes in the plant community can compensate for enhanced decomposition losses.

5. Understanding of alpine-subalpine linkages. Studies initiated in summer of 1999 include a) variation in ecosystem sensitivity to N additions, b) analysis of factors controlling treeline, c) comparisons of soil carbon and N characteristics across an altitudinal gradient and among ecosystem types in snow. These studies have been continued, with two Ph.D. students continuing work on consequences of treeline establishment in terms of both vegetation composition and ecosystem processes.

Training and Development:
At our recent site review, we reported 26 graduate students (currently involved or 2001 graduates)participating with the Niwot LTER program. Our LTER invests only about 80k per year in graduate student stipends, but the 26 students represent a minimum investment of 468k per year
in graduate education. The majority of graduate student training is accomplished by using LTER graduate student summer stipends to leverage additional support from Colorado resources, or the students are funded through programs that are linked to LTER efforts but have been funded from sources outside the core LTER grant.

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 EPO 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 many of these students senior-authoring or co-authoring research efforts published in national and international journals.

**Outreach Activities:**

The NWTLTER has carried out a K-12 outreach program from 1998 through the present time by collaborating with existing programs for children in the Denver/Boulder area and by working specifically with the Boulder Valley School District. The conceptual theme of the outreach is the connection between the alpine systems in the mountains and the communities of the Rocky Mountain Front Range. These communities are located at the intersection of the Great Plains and the Rocky Mountains, and have been expanding in population and development. We have found that in elementary and middle school years, children are particularly receptive to environmental education that emphasizes discovery, exploration and empathy with their local environment.

Current K-12 Outreach Program

The NWTLTER has an outreach program to elementary and middle school students in the Boulder/Denver area through a collaborative effort with Science Discovery (1998-2001) a local program based at the University of Colorado, Bixby School (1999-2001) in Boulder, and Wild Bear Science School (1999-2000) in Nederland, a mountain town located near the Mountain Research Station (MRS). The age range of the children is 5-12 years and the group size for summer field trips is 12-18 children, with 4-6 scientists and student teachers as leaders. Each of these programs and schools serves children with different backgrounds and interests. Science Discovery offers a wide range of summer science programs for children, including one-day programs, one-week classes based in Boulder and one-week field trips within the Rocky Mountains. The program with Science Discovery offered two Saturday field classes in conjunction with our NWTLTER program, one for elementary and one for middle school children. Bixby School is a private elementary school that uses an experiential theme for all their classes during the academic year and the students attending Bixby School in the summer have been in an informal experiential learning environment. Bixby teachers integrate the students' experiences from the field trips to the MRS into subsequent activities during the school year. The Wild Bear Science School has a two-week session for elementary students on an ecological theme, and a one-week session for middle school students. These students are primarily from the mountain communities. The field trip to the MRS is integrated into the middle of the program for each week of these classes, as a component that emphasizes observations and recording by sketches and note taking.

All of these field trips are coordinated with a MRS summer course- 'Alpine Ecology and Experiential Learning'. Five-fifteen students have taken this course each year, with about half of the students being in-service teachers. The course is taught by NWTLTER scientists (e.g. Diane McKnight, Susan Sherrod and Hector Galbraith) and by Dr. Jane Larson, an expert in science education from the College of Education at the University of Colorado. Hector Galbraith, Diane McKnight and Jane Larson will teach the class this summer. As the service learning aspect of the summer course, the undergraduate and graduate students, along with the course instructors, lead the field trips described above. In some cases, the instructors from the school programs participate as well. Prior to leading the field trips, the undergraduate students lead 'practice' field trips with children of friends and colleagues at the University of Colorado.

Virtual Field Trip to Niwot Ridge- The NWTLTER has developed a virtual field trip to Niwot Ridge with support from the University of Colorado. The prototype of this field trip is now posted on the web site at http://culter.colorado.edu/Field_trip. The virtual field trip provides background information, and then 3 field trips that emphasize the mammals, plants and the effect of nitrogen on biodiversity. Essays written by environmental journalists funded through the REU program have provided text. The trip is structured with pictures of the animals and plants that can be enlarged. The virtual field trip complements the experiential field trips in many ways: providing a back-up should inclement weather limit the trip, providing access for children in a group who may have a handicap limiting the possibility for a hike, providing follow-up and refresh material for students after the trip which they can access at school or at home; providing material that the students could use in later classroom activities and projects in later grades. We hope to upgrade and revise this effort in the coming year.

Children's book: 'My Water Comes from Silver Lake'- Another accomplishment of the NWTLTER K-12 program has been the completion of a text and pictures for a children's book describing the ecology of the Green Lakes valley and the hydrologic cycle which supplies water from the valley to the City of Boulder. A former student from the MRS summer course prepared the text and the pictures are brilliant water colors painted by students in her third grade class. This material has been submitted to several potential publishers. We believe that support from several sources can be found to support the publication.
of the initial edition. A web version is also being considered.

Science Library Video- Last fall, Diane McKnight and INSTAAR scientists provided technical support and coordinated local arrangements for a video production company preparing a series on biomes of the world for Schlessinger Science Library. NWT LTER scientists and elementary and middle school students participating in our outreach effort last year were filmed. This footage was used extensively in three tapes: Biomes of the World in Action: Tundra, Biomes of the World in Action, Coniferous Forest, and Forest Ecosystems for Children. These videos are sold to middle school and k-4 educators and audiences worldwide.

A major use of outreach funds has been and will continue to be for stipends to support the participation of current elementary school teachers in this program. We use funds to enroll teachers for the summer program in the subsequent year (July 2002). We support the teachers for a month while they take the MRS class, and stipends are provided to seven teachers. We have found that providing stipends greatly encourages participation. We expect that the interest in the outreach program in future years will also be sustained by word of mouth based on the experience of the teachers who have participated in the course.

With funds provided by an additional previous supplement we are also providing computers to the teachers who have participated in the class. This allows the teachers to access the NWTLTER database and use other materials with which they became familiar during their classes during the school year. For example, the teachers can access the images from the Tundracam, a camera located at the top of the Tundra lab that provides continuous images of the surrounding alpine area and can be steered by remote access over the web.

We have conducted an additional outreach activity that more directly reaches middle school students. For the past two years INSTAAR has held an event in which 200-500 middle school students come to INSTAAR for a half-day of lab tours and a science lecture. As part of the INSTAAR event in the fall 1999, 2000, and 2001. NWTLTER scientists conducted 5 sessions of an activity for the students at Boulder Creek (located two blocks from INSTAAR) in which we demonstrated methods for stream flow measurement, water quality sampling and measurement, and collection of aquatic biota, and discussed the connections between Boulder Creek as it travels through the city and its origins in Green Lakes Valley. The activity is completed in about 45 minutes, with stops at 3 stations along the creek. The activity at the creek is followed by a tour of the limnology laboratory at INSTAAR, including looking at algae in a microscope. Some of the students who took the middle school Science Discovery class had participated in the field activity at INSTAAR. From this activity, one middle school student conducted a science fair project with a NWTLTER graduate student, and she won an award at the state competition.

During the summer and fall of 2000, the involvement of elementary and middle school students in NWTLTER outreach activities was as follows (the 2001 program has just finished and statistics have not been summarized):

Summer field trips to the MRS: 12 groups, about 180 children
Field trips by teachers with their classes: 4 classes, about 120 children Field sampling exercise in Boulder Creek at INSTAAR for middle school students: about 300 students

Because we provide teacher training and computer resources, all of these activities involve some continuing opportunities for in-class involvement by the teachers and the students. This approach has applications to other communities in the Rocky Mountain Region.

Journal Publications


Williams, M.W. and K.A. Tonnessen, "Critical loads for inorganic nitrogen deposition in the Colorado Front Range, USA", Ecological applications, p. 1648, vol. 10(6), (2000). Published


Fox, A., M. W. Williams, and N. Caine, "Equivalent permeability of a continental, alpine snowpack in the Colorado Front Range, USA", Water Resources Research, p. , vol. , ( ). Accepted


Books or Other One-time Publications

Editor(s): Coleman, D.C., and P. Hendrix
Collection: Invertebrates as webmasters in Ecosystems
Bibliography: Univ. Georgia Press.

Editor(s): Robertson, G.P., et al.
Collection: Standard Soil Methods for Long-Term Ecological Research
Bibliography: Oxford Press

Editor(s): Robertson, G.P., et al.
Collection: Standard Soil Methods for Long-Term Ecological Research
Bibliography: Oxford Press

Editor(s): Robertson, G.P., et al.
Collection: Standard Soil Methods for Long-Term Ecological Research
Bibliography: Oxford Press

Editor(s): In Inderjit, S., K.M.M. Dakshini and C.L. Foy
Bibliography: CRC Press, Boca Raton.

Editor(s): Bowman, W.D. and T.R. Seastedt
Collection: Structure and Function of an Alpine Ecosystem: Niwot Ridge, Colorado
Bibliography: Oxford University Press, New York

Elias, S.A., "Natural History of the Rocky Mountains.", ( ). Book, Accepted
Editor(s): Jones, H.G., J. Pomeroy, D.A. Walker, and R. Wharton
Collection: Snow Ecology
Bibliography: Cambridge University Press

Editor(s): Jensen, M.E., and P.S. Bourgeron
Bibliography: Springer-Verlag, New York, NY

Editor(s): Jones, H.G., J. Pomeroy, D.A. Walker, and R. Hoham
Bibliography: Cambridge University Press

Editor(s): Bowman, W.D. and T.R. Seastedt
Collection: Structure and function of an alpine ecosystem: Niwot Ridge, Colorado
Bibliography: Oxford University Press

Editor(s): Bourgeron, P.S. and M.E. Jensen
Collection: An Integrated Ecological Assessment Protocols Guidebook
Bibliography: Springer-Verlag, New York, NY

Editor(s): V. Dale and R. Haeuber
Collection: Applying Ecological Principles to Land Management
Bibliography: Springer-Verlag, New York, NY

Bowman, W.D. and M.C. Fisk, "Primary production", (2001). Book, Published
Editor(s): Bowman, W.D. and T.R. Seastedt
Collection: Structure and function of an alpine ecosystem: Niwot Ridge, Colorado
Bibliography: Oxford University Press

Editor(s): Bowman, W.D. and T.R. Seastedt
Collection: Structure and function of an alpine ecosystem
Bibliography: Oxford University Press

Editor(s): Bowman, W.D. and T.R. Seastedt
Collection: Structure and function of an alpine ecosystem: Niwot Ridge, Colorado
Bibliography: Oxford University Press

Dearing, D, "Plant-herbivore interactions", (2001). Book, Published
Editor(s): Bowman, W.D. and T.R. Seastedt
Collection: Structure and
function of an alpine ecosystem: Niwot Ridge, Colorado
Bibliography: Oxford University Press.

Editor(s): Bowman, W.D. and T.R. Seastedt
Collection: Structure and function of an alpine ecosystem: Niwot Ridge, Colorado
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Bibliography: Oxford University Press

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Collection: Structure and function of an alpine ecosystem: Niwot Ridge, Colorado
Bibliography: Oxford University Press
Editor(s): Jones, H.G., J. Pomeroy, D.A. Walker, and R. Wharton
Collection: Snow Ecology: An interdisciplinary examination of snow-covered ecosystems
Bibliography: Cambridge University Press

Editor(s): Bowman, W.D. and T.R. Seastedt
Collection: Structure and function of an alpine ecosystem: Niwot Ridge, Colorado
Bibliography: Oxford University Press

Editor(s): Bowman, W.D. and T.R. Seastedt
Collection: Structure and function of an alpine ecosystem: Niwot Ridge, Colorado
Bibliography: Oxford University Press


Bibliography: Ph.D. Dissertation University of Colorado, Boulder


Bibliography: M.A. Thesis. University of Colorado, Boulder

Bibliography: M.A. Thesis. University of Colorado, Boulder

Buttenfield, B.P, "Mapping ecological uncertainty", ( ). Book, Accepted
Editor(s): Hunsaker, C., Goodchild, M.F., Friedl, M. and Case, T
Collection: Uncertainty in spatial data for ecological analyses
Bibliography: New York: Springer-Verlag

Web/Internet Site

URL(s):
http://culter.colorado.edu/
Description:
Contributions within Discipline:
The recent Science article (293: 624, July 27 2001) summed up our contribution nicely:

'Mountain of data. Research at the Niwot Ridge LTER in Colorado has yielded decades' worth of insights into an alpine ecosystem.'

We are the benchmark high elevation ecology and biogeochemistry site in North America. We hope that at least some of this message was captured in the recent Niwot volume edited by Bowman and Seastedt.

Contributions to Other Disciplines:
We are learning that the alpine, similar to the tropical rain forest, holds a special value to the public. Our tundracam (http://tundracam.colorado.edu) is currently experiencing 2000 hits per day. This interest strongly suggests that we can greatly increase the use the alpine as a model system for general educational purposes. We will have to recruit new personnel with new expertise to exploit this potential. Nonetheless, we believe that the beginnings of this have been achieved by our outreach efforts.

Contributions to Human Resource Development:
Our program currently involves 23 ongoing graduate students and 12 undergraduates (either directly or indirectly associated with the LTER REU effort). Previous students that have come through our system have had or currently have positions at Berkeley, Stanford, UCSD, and a number of smaller universities and colleges.

Contributions to Resources for Research and Education:
Please see the outreach section of our activities.

Contributions Beyond Science and Engineering:
Our virtual fieldtrip (http://culter.colorado.edu:1030/Field_trip) and tundra-cam (http://tundracam.colorado.edu) provides aesthetic dimensions not normally included in scientific investigations.

Recently we were contacted by a local sculptor who proposed to make us some snow markers for our tree island studies. The prototypes of these sculptures can be viewed at http://culter.colorado.edu/~tims/sculpture.jpg

These markers would allow us to measure both snowdepth and tree movement. While final decisions regarding placement of these have not been made, we hope to place at least one of these in view of the tundracam, so that the public can view this mix of art and science.

Special Requirements

Special reporting requirements: None
Change in Objectives or Scope: None
Unobligated funds: less than 20 percent of current funds
Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Organizational Partners
Any Product