

Annual Report for Period:12/2003 - 11/2004**Submitted on:** 09/28/2004**Principal Investigator:** Seastedt, Timothy R.**Award ID:** 9810218**Organization:** U of Colorado Boulder**Title:**

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

Project Participants**Senior Personnel****Name:** Seastedt, Timothy**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Townsend, Alan**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Wessman, Carol**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Williams, Mark**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Bowman, William**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Caine, Nel**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Diggle, Pamela**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Elias, Scott**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Monson, Russell**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Sanford, Robert**Worked for more than 160 Hours:** Yes**Contribution to Project:**

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
Contribution to Project:

Name: Dykstra, Gamlyn
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Erickson, Tyler
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Forbis, Tara
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Gardner, Eileen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Gartner, John
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Hamann, Hillary
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Hood, Eran
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Larson, Julia
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Ley, Ruth
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Liptzin, Dan
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Liu, Fenjing
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Manthorne, David
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Meloche, Chris
Worked for more than 160 Hours: Yes

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-Crapanzano, 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:** Torrizo, 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**Contribution to Project:****Name:** Raby, Kim**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Hanne, Ingrid**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Cordalis, Dan**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Name: Nanus, Leora

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Anderson, Craig

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Meier, Courtney

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Miller, Matt

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Abood, Paul

Worked for more than 160 Hours: Yes

Contribution to Project:

Undergraduate Student

Technician, Programmer

Name: Ackerman, Todd

Worked for more than 160 Hours: Yes

Contribution to Project:

Data Manager/GIS Coordinator

Name: O'Reilly, Andrew

Worked for more than 160 Hours: Yes

Contribution to Project:

Field Technician

Name: Seibold, Christine

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Carbone, Mariah

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Chowansky, Kurt

Worked for more than 160 Hours: Yes

Contribution to Project:

Field Technician

Other Participant

Name: Litaor, M.

Worked for more than 160 Hours: Yes

Contribution to Project:

International scholar here on sabbatical. Supported by his home institution supplemented with LTER support

Research Experience for Undergraduates

Name: Renaud, Carrie

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: University of Denver

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2001

REU Funding: REU supplement

Name: Scott, Alexis

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2000

REU Funding: REU supplement

Name: Polling, Elizabeth

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Vanderbilt

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2000

REU Funding: REU supplement

Name: Froeschner, Holly

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 1998

REU Funding: REU supplement

Name: Baer, Rory

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior
Home Institution: Same as Research Site
Home Institution if Other:
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 1998
REU Funding: REU supplement

Name: Clark, Adrian

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Freshman
Home Institution: Same as Research Site
Home Institution if Other:
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2001
REU Funding: REU supplement

Name: Janik, Caroline

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Western Colorado
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 1999
REU Funding: REU supplement

Name: Linsenbart, Amy

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Western Missouri
Home Institution Highest Degree Granted(in fields supported by NSF): Master's Degree
Fiscal year(s) REU Participant supported: 1999
REU Funding: REU supplement

Name: Major, Sheridan

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Clark University
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 1999
REU Funding: REU supplement

Name: Yablonski, Adam

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Sophomore

Home Institution: Other than Research Site

Home Institution if Other: Washington and Lee

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2000

REU Funding: REU supplement

Name: Tucker, Colin

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2002

REU Funding: REU supplement

Name: Ordoyne, Calley

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Mt. Holyoke

Home Institution Highest Degree Granted(in fields supported by NSF): Associate's Degree

Fiscal year(s) REU Participant supported: 2002

REU Funding: REU supplement

Name: Albright, Meredith

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Colorado College

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2002

REU Funding: REU supplement

Name: Thacher, Chessie

Worked for more than 160 Hours: Yes

Contribution to Project:

Chessie Thatcher, a junior at Colorado College, worked with Tim Seastedt on the effects of snowpack change on plant species richness and diversity. The student is expected to continue this project as a senior thesis.

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Colorado College

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2002

REU Funding: REU supplement

Name: Vergera, Sintana

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Cornell

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2002

REU Funding: REU supplement

Name: Portmess, Kim

Worked for more than 160 Hours: Yes

Contribution to Project:

Kim Portmess studied the effect of nutrients (N and P) and benthic grazers on the growth of benthic algae in Green Lake 4. She worked in collaboration with another REU student and two graduate students, and her results will be integrated with those from other experiments conducted during the summer.

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Cornell

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2002

REU Funding: REU supplement

Name: MacDougall, Sarah

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: University of New Hampshire

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2003

REU Funding: REU supplement

Name: Heigle, Dawn

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2003

REU Funding: REU supplement

Organizational Partners

Other Collaborators or Contacts

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 in 2003 and 2004. In 2004 he was assisted by Dr. Norman Clippinger and two REU students supported by a non-LTER source. 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.

Dr. Iggy Litaor of Tel-Hai University, Israel, rejoined the NWT LTER group through the summer of 2004. Dr. Litaor was one of NWT LTER's most prolific scientists during the late 1980s, with expertise in soils, especially soil phosphorus, and geostatistics. He's recently written several papers using Niwot data (Litaor et al. 2003; Litaor et al., in review). He worked with Drs. Townsend, Bowman, and Seastedt on landscape patterns of phosphorus availability to plants. These data are critically important as our biogeochemical focus moves from one that emphasizes carbon and nitrogen to one that emphasizes carbon, nitrogen and phosphorus amounts, ratios, and interactions.

Dr Patricia Weigant (RUI supplement to LTER 2000) presented her findings on 'Vascular plant diversity of mafic and felsic fellfields: A preliminary report of comparisons between sites at Niwot Ridge and Rocky Mountain National Parks to the Botanical Society of America annual meeting in August, 2004. These data should prove particularly valuable in a) regionalization efforts and b) collaborations with the Park Service (via CESU funding) of nutrient impacts in national parks.

NWT LTER collaborator Katie Suding (Univ. California, Irvine, formerly of CU) remained active in important global biodiversity initiatives. These included: a) conference organizer, Borchard Colloquium, 'How can we forecast global change impacts on biological diversity and ecosystem health? Chateau de la Breteshe, France, June 27-30, 2004. Funded by the Borchard Foundation. B) GCTE/NCEAS working group 'The role of biodiversity in ecosystem functioning: what can be learnt from community reduction studies.' L. Huenneke, S. Diaz, F.S. Chapin III, leaders. Santa Barbara, CA. April 2002, Sept 2003, July 2004. c) Participant, 'SEEK: Science Environment for Ecological Knowledge' NSF-ITR workshop at the Supercomputer Center, San Diego, CA. Sept 2004 and d) Speaker, 'Collaboration in Ecology: A Workshop' NSF CISE/IIS sponsored workshop at the National Academy of Science, Beckman Center. October 2004.

Activities and Findings

Research and Education Activities:

A subset of the senior PIs of the NWT LTER wrote a synthesis article that refocused and refined the unifying ecological theme for the site (Seastedt et al., 2004). This paper also composed much of the core integrative science component for the 2004-2010 renewal. Our work has attempted to quantify the extent to which climatic and atmospheric chemistry changes are and will be influencing high elevation ecosystems. 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.

Findings:

A review of our recent publications demonstrates substantial advancement of knowledge in all areas of high elevation ecology and high elevation biogeochemistry. The total number of peer-reviewed publications, books and book chapters, and graduate dissertations has exceeded 200 contributions for the 1998-2004 interval. All of our senior scientists have or are in the process of contributing findings published in national and international journals. Our synthesis activity, first summarized by the edited Springer-Verlag volume on the NWT LTER program, has continued with our 2004 BioScience articles.

Major 'offshoots' of the LTER program include the Schmidt lab soil microbiology biodiversity effort, and the Monson lab vegetation-atmosphere interaction projects. Those projects, although largely funded through other programs, have relied and continue to rely heavily on LTER programs and infrastructure for their success.

Training and Development:

We presently have 14 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 participate 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 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 finally appeared in 2004. Books were distributed to all schools in the Boulder Valley School District. Hard copies were 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*, p. 417, vol. 98, (2000). Published

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

Conley, A.H., E.A. Holland, T.R. Seastedt and W.J. Parton, "Simulation of carbon and nitrogen cycling in an alpine tundra", *Arctic, Antarctic, and Alpine Research*, p. 147, vol. 32, (2000). Published

Lipson, D.A., S.K. Schmidt and R.K. Monson, "Carbon availability and temperature control the post-snowmelt decline in alpine soil microbial biomass", *Soil Biology and Biochemistry*, p. 441, vol. 32, (2000). Published

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*, p. 1723, vol. 34, (2000). Published

Addington, R.N. and T.R. Seastedt, "Activity of soil microarthropods beneath snowpack in alpine tundra and subalpine forest", *Pedobiologia*, p. 47, vol. 43, (1999). 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*, p. 191, vol. 31, (1999). Published

Brooks, P.D., M.W. Williams, "Snowpack controls on nitrogen cycling and export in seasonally snow-covered catchments", *Hydrologic Processes*, p. 2177, vol. 13, (1999). Published

Chase, T.N., R.A. Pielke, T.G.F. Kittel, J.S. Baron, and T.J. Stohlgren, "Potential impacts on Colorado Rocky Mountain weather and climate due to land use changes on the adjacent Great Plains", *Journal of Geophysical Research*, p. 16673, vol. 104, (1999). Published

Greenland, D., "ENSO-related phenomena at long-term ecological research sites", *Physical Geography*, p. 491, vol. 20, (1999). Published

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

Lipson, D.A., T.K. Raab, S.K. Schmidt, and R.K. Monson, "Variation in competitive abilities of plants and microbes for specific aminods", *Biology and Fertility of Soils*, p. 257, vol. 29, (1999). Published

Lipson, D.A., C.W. Schadt, S.K. Schmidt, and R.K. Monson, "Ectomycorrhizal transfer of amino acid-nitrogen to the alpine sedge *Kobresia myosuroides*", *New Phytologist*, p. 163, vol. 142, (1999). Published

Lipson, D.A., S.K. Schmidt, and R.K. Monson, "Links between microbial population dynamics and nitrogen availability in an alpine ecosystem", *Ecology*, p. 1623, vol. 80, (1999). Published

- Parker, E.R., and R.L. Sanford, "The effects of mobile tree islands on soil phosphorus concentrations and distribution in an alpine tundra ecosystem", *Arctic, Antarctic, and Alpine Research*, p. 16, vol. 31, (1999). Published
- Raab, T.K., D.A. Lipson and R.K. Monson, "Soil amino acid utilization among species of the Cyperaceae: Plant and soil processes", *Ecology*, p. 2408, vol. 80, (1999). Published
- Reich, P.B., D.S. Ellsworth, M.B. Walters, J.M. Vose, C. Gresham, J.C. Volin, and W.D. Bowman, "Generality of leaf traits: a test across six biomes", *Ecology*, p. 1955, vol. 80, (1999). Published
- Soranno, P.A., K.E. Webster, J.L. Riera, T.K. Kratz, J.S. Baron, P.A. Bukaveckas, G.W. Kling, D.S. White, N. Caine, R.C. Lathrop, and P.R. Leavitt, "Spatial variation among lakes within landscapes: Ecological organization along lake chains", *Ecosystems*, p. 395, vol. 2, (1999). Published
- Toetz, D., "Multiple limiting nutrients in a subalpine stream, Colorado Front Range", *Journal of Freshwater Ecology*, p. 349, vol. 14, (1999). Published
- Welker, J. M., Brown, K. A., and Fahnestock, J. T., "CO₂ flux in arctic and alpine dry tundra: comparative field responses under ambient and experimentally warmed conditions", *Arctic, Antarctic and Alpine Research*, p. 308, vol. 31, (1999). Published
- West, A.E., P.D. Brooks, M.C. Fisk, L.K. Smith, E.A. Holland, C.H. Jaeger III, S. Babcock, R. Lai, and S.K. Schmidt, "Landscape patterns of CH₄ fluxes in an alpine tundra ecosystem", *Biogeochemistry*, p. 243, vol. 45, (1999). Published
- Wickland, K.P., R.G. Striegl, S.K. Schimdt and M.A. Mast, "Methane flux in subalpine wetland and unsaturated soils in the southern Rocky Mountains", *Global Biogeochemical Cycles*, p. 101, vol. 13, (1999). Published
- Williams, M.W., D. Cline, M. Hartman, T. Bardsley, "Data for snowmelt model development, calibration, and verification at an alpine site, Colorado Front Range", *Water Resources Research*, p. 3205, vol. 35, (1999). Published
- Williams, M.W., R. Sommerfeld, S. Massman, and M. Ridders, "Correlation lengths of meltwater flow through ripe snowpacks, Colorado Front Range, USA", *Hydrologic Processes*, p. 1807, vol. 13, (1999). Published
- Walker, M.D., D.A. Walker, J.M. Welker, A.M. Arft, T. Bardsley, P.D. Brooks, J.T. Fahnestock, M.H. Jones, M. Losleben, A.N. Parsons, T.R. Seastedt, and P.L. Turner, "Long-term experimental manipulation of winter snow regime and summer temperature in arctic and alpine tundra.", *Hydrological Processes*, p. 2315, vol. 13, (1999). Published
- Arft, A.M., et al., "Responses of tundra plants to experimental warming: Meta-analysis of the international tundra experiment", *Ecological Monographs*, p. 491, vol. 69, (1999). Published
- Calanni, J., E. Berg, M. Wood, D. Mangis, R. Boyce, W. Weathers, and H. Sievering, "Atmospheric nitrogen deposition at a conifer forest: response of free amino acids in engelmann spruce needles", *Environmental Pollution*, p. 79, vol. 105, (1999). Published
- Gonzalez, G. and T.R. Seastedt, "Comparison of the abundance and composition of soil fauna in tropical and subalpine forests", *Pedobiologia*, p. , vol. , (). Accepted
- Gough, L., C.W. Osendberg, K.L. Gross, and S.L. Collins, "Fertilization effects on species density and primary productivity in herbaceous plant communities", *Oikos*, p. 428, vol. 89 (3), (2000). Published
- Meixner, T. M., R. C. Bales, M. W. Williams, D. H. Campbell, and J. S. Baron, "Stream chemistry modeling of two watersheds in the Front Range, Colorado", *Water Resources Research*, p. 77, vol. 36, (2000). Published
- West, A.E. and S.K. Schmidt, "Acetate stimulates atmospheric CH₄ oxidation by an alpine tundra soil", *Soil Biology and Biochemistry*, p. 1649, vol. 31 (12), (1999). Published

- Sievering, H., "Nitrogen deposition and carbon sequestration", *Nature*, p. 629, vol. 400, (1999). Published
- Gonzalez, G. and T.R. Seastedt, "Soil fauna and plant litter decomposition in tropical and subalpine forests", *Ecology*, p. 955, vol. 82, (2001). Published
- Inyan, B. and M.W. Williams, "Protecting headwater catchments from future degradation, San Miguel River, CO", *Mountain Research and Development*, p. 71, vol. 21(1), (2001). Published
- Ley, R.E., D.A. Lipson, and S.K. Schmidt, "Microbial biomass levels in barren and vegetated high altitude talus soils", *Soil Science Society of America Journal*, p. 111, vol. 65, (2001). Published
- Lipson, D.A., T.K. Raab, S.K. Schmidt, and R.K. Monson, "An empirical model of amino acid transformation in an alpine soil", *Soil Biology & Biochemistry*, p. 189, vol. 33, (2001). Published
- Rattray, G. and H. Sievering, "Dry deposition of ammonia, nitric acid, and nitrate to alpine tundra at Niwot Ridge, CO", *Atmospheric Environment*, p. 1085, vol. 35, (2001). Published
- Seastedt, T.R. and G.A Adams, "Effects of mobile tree islands on alpine tundra soils", *Ecology*, p. 8, vol. 82, (2001). Published
- Baron, J.S. and M.W. Williams, "Preface, recent Loch Vale Watershed Research", *Water Resource Research*, p. 11, vol. 36(1), (2000). Published
- Bilbrough, C.J., J.M. Welker, and W.D. Bowman, "Early spring nitrogen uptake by snow-covered plants: a comparison of arctic and alpine plant function under the snowpack", *Arctic, Antarctic, and Alpine Research*, p. 404, vol. 32(4), (2000). Published
- Bowman, W.D., "Biotic controls over ecosystem response to environmental change in alpine tundra of the Rocky Mountains", *Ambio*, p. 396, vol. 29, (2000). Published
- Buttenfield, B.P. and M. Tsou, "Distribution of an internet-based GIS to remote college classrooms", *Proceedings, ESRI user conference, San Diego, California.*, p. 24, vol. , (2000). Published
- Erickson, T.A.; Williams, M.W. ; Sommerfeld, R.A., "Spatial statistics of snowmelt", In: Bentley, L.R., J.F. Sykes, C.A. Gray and G.F. Pinder. *Proceedings of the XIII International Conference on Computational Methods in Water Resources*, Calgary, Canada, June 2000. A.A. Balkema publishers, Rottendam., p. 1147, vol. 2, (2000). Published
- Losleben, M.V, "Snowpack, ENSO, and atmospheric circulation on the Colorado Front Range", In *Proceedings of the 16th annual Pacific Climate Workshop, Technical report 65 of the Interagency Ecological Program for the Sacramento-San Joaquin Delta*, May 2000, p. 136, vol. , (2000). Published
- Schmidt, S.K.; Lipson, D.A.; Raab, T.K., "Effects of willow (*Salix brachycarpa*) on populations of salicylate-mineralizing microorganisms in alpine soils", *J. Chem. Ecol*, p. 2049, vol. 26, (2000). Published
- Toetz, D, "Decomposition in an alpine wetland brook, Colorado Front Range", *Verh. Internat. Verein. Limnol*, p. 748, vol. 27, (2000). Published
- 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
- Williams, M.W., M.R. Ridders, and W.T. Pfeffer, "Ice columns and frozen rills in a warm snowpack, Green Lakes Valley, Colorado, USA", *Nordic Hydrology*, p. 169, vol. 31(3), (2000). Published
- Bugmann, H., "A comparative analysis of forest dynamics in the Swiss Alps and the Colorado Front Range", *Forest Ecology and Management*, p. 43, vol. 145, (2001). Published

- Bowman, W.D. and C.J. Bilbrough, "Influence of a pulsed nitrogen supply on growth and nitrogen uptake in alpine graminoids", *Plant and Soil*, p. 283, vol. 233, (2001). Published
- Bechtold, H.A., T.A. Forbis and P.K. Diggle, "Lack of reproductive plasticity in *Saxifraga rhomboidea* Greene (Saxifragaceae)", *Canadian Journal of Botany*, p. , vol. , (). Submitted
- Bryant, D.M., E.B. Rastetter, K.J. Nadelhoffer, M.D. Walker and J.L. Laundre, "Litter decomposition of the Arctic and Alpine LIDET data", *Ecosystems*, p. , vol. , (). Accepted
- Duguay, C.R., "An approach to the estimation of surface net radiation in mountain areas using remotely sensed and digital terrain data", *Theoretical and Applied Climatology*, p. 55, vol. 52(1-2), (1995). 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
- Hood, E., M.W. Williams, and N. Caine, "Outputs of organic nutrients from a high-elevation catchment, Green Lakes Valley, Colorado", *Arctic, Antarctic, and Alpine Research*, p. , vol. , (). Accepted
- Meloche, C.G. and P.K. Diggle, "Patterns of carbon allocation in *Acomastylis rossii* (Rosaceae) an alpine plant exhibiting extreme preformation", *Ecology*, p. , vol. , (). Submitted
- Peddle, D.R., and C.R. Duguay, "Incorporating topographic and climatic GIS data into satellite image analysis of an alpine tundra ecosystem, Front Range, Colorado Rocky Mountains", *GeoCarto Internationa*, p. , vol. , (). Accepted
- Raab, T.K., and M.C. Martin, "Visualizing rhizosphere chemistry of legumes with mid-IR synchrotron radiation", *Planta*, p. 881, vol. 213(6), (2002). Published
- Sherrod, S.K., T.R. Seastedt, and M.D. Walker, "The northern pocket gopher (*Thomomys talpoides*) as an organizer of alpine plant community structure, Niwot Ridge, CO", *Oecologia*, p. , vol. , (). Accepted
- Brooks, P.D.; McKnight, D.M.; Bencala, K.E, "The relationship between soil heterotrophic activity, soil dissolved organic carbon (DOC) leachate, and catchment-scale DOC export in headwater catchments", *Water Resources Research*, p. 1895, vol. 35, (1999). Published
- Colores, G.M.; Schmidt, S.K, "Colonization of contaminated soil by an introduced bacterium: effects of initial pentachlorophenol levels on the survival of *Sphingomonas chlorophenolica* strain RA2", *Journal of Industrial Microbiology and Biotechnology*, p. 1649, vol. 31, (1999). Published
- Yulsman, T, "Twisted trees", *Audubon*, p. 30, vol. nov-dec, (1999). Published
- Jaeger, C.H., R.K. Monson, M. Fisk, and S. Schmidt, "Seasonal partitioning of nitrogen by plants and soil microorganisms in an alpine ecosystem", *Ecology*, p. 1883, vol. 80(6), (1999). Published
- Lipson, D., Nasholm, T., "The unexpected versatility of plants: organic nitrogen use and availability in terrestrial ecosystems", *OECOLOGIA*, p. 305, vol. 128(3), (2001). Published
- Forbis, T.A., Diggle, P.K., "Subnivean embryo development in the alpine herb *Caltha leptosepala* (Ranunculaceae)", *Canadian Journal of Botany*, p. 635, vol. 79, (2001). Published
- Gonzalez, G., Ley, R.E., Schmidt, S.K., Zou, X., Seastedt, T.R., "Soil ecological interactions: comparisons between tropical and subalpine forests", *Oecologia*, p. 549, vol. 128, (2001). Published
- Korb, J.E., Ranker, T.A., "Changes in stand composition and structure between 1981 and 1996 in four Front Range plant communities in Colorado", *Plant Ecology*, p. 1, vol. 157, (2001). Published

- Mast, M.A., Turk, T.K., Ingersoll, G.P., Clow, D.W., Kester, C.L., "Use of stable sulfur isotopes to identify sources of sulfate in Rocky Mountain snowpacks", *Atmospheric Environment*, p. 3303, vol. 35, (2001). Published
- McKnight, D.M., Kimball, B.A., Runkel, R.L., "pH dependence of iron photoreduction in a rocky mountain stream affected by acid mine drainage", *HYDROLOGICAL PROCESSES*, p. 1979, vol. 15(10), (2001). Published
- Meloche, C.G., Diggle, P.K., "Preformation, architectural complexity, and developmental flexibility in *Acomastylis rossi* (Rosaceae)", *American Journal of Botany*, p. 908, vol. 88, (2001). Published
- Schadt, C.W., Mullen, R.B., Schmidt, S.K., "Isolation and phylogenetic identification of a dark-septate fungus associated with the alpine plant *Ranunculus adoneus*", *New Phytologist*, p. 747, vol. 150, (2001). Published
- Seastedt, T.R., Vaccaro, L., "Plant Species Richness, Productivity, and Nitrogen and Phosphorus Limitations across a Snowpack Gradient in Alpine Tundra, Colorado, U.S.A.", *Arctic, Antarctic, and Alpine Research*, p. 100, vol. 33(1), (2001). Published
- Sherrod, S.K., Seastedt, T.R., "Effects of the northern pocket gopher (*Thomomys talpoides*) on alpine soil characteristics, Niwot Ridge, CO", *Biogeochemistry*, p. 195, vol. 55(2), (2001). Published
- Shiels, A.B., Sanford, R.L., "Soil nutrient differences between two krummholz-form tree species and adjacent alpine tundra", *GEODERMA*, p. 205, vol. 102(3-4), (2001). Published
- Sievering, H., Kelly, T., McConville, G., Seibold, C., Turnipseed, A., "Nitric acid dry deposition to conifer forests: Niwot Ridge spruce-fir-pine study", *Atmospheric Environment*, p. 3851, vol. 35, (2001). Published
- Turk, J.T., Taylor, H.E., Ingersoll, G.P., Tonnessen, K.A., Clow, D.W., Mast, M.A., Cambell, D.H., Melack, J.M., "Major-ion chemistry of the Rocky Mountain snowpack, USA", *Atmospheric Environment*, p. 3957, vol. 35, (2001). Published
- Williams, M.W., Hood, E., Caine, N., "Role of organic nitrogen in the nitrogen cycle of a high-elevation catchment, Colorado Front Range", *Water Resources Research*, p. 2569, vol. 37(10), (2001). Published
- Williams, M.W., Hood, E.W., Ostberg, G., Francou, B., Galarraga, R., "Synoptic survey of surface water isotopes and nutrient concentrations, paramo high-elevation region, antisana ecological reserve, Ecuador", *Arctic, Antarctic, and Alpine Research*, p. 397, vol. 33(4), (2001). Published
- Caine, N., "Declining ice thickness on an alpine lake is generated by increased winter precipitation", *Climatic Change*, p. 463, vol. 54, (2002). Published
- Diggle, P.K., Meixner, M.A., Carroll, A.B., Aschwanden, C.F., "Barriers to sexual reproduction in *Polygonum viviparum*: a comparative developmental analysis of *P. viviparum* and *P. bistortoides*", *Annals of Botany*, p. 145, vol. 89, (2002). Published
- Hazen, J.H., Williams, M.W., Stover, B., Wireman, M., "Characterisation of Acid Mine Drainage using a Combination of Hydrometric, Chemical and Isotopic Analyses, Mary Murphy Mine, Colorado", *Environmental Geochemistry and Health*, p. 1, vol. 24, (2002). Published
- Ley, R.E., Schmidt, S.K., "Fungal and bacterial responses to phenolic compounds and amino acids in high altitude barren soils", *Soil Biology and Biochemistry*, p. 989, vol. 34, (2002). Published
- Lipson, D.A., Schadt, C.W., Schmidt, S.K., "Changes in Soil Microbial Community Structure and Function in an Alpine Dry Meadow Following Spring Snow Melt", *Microbial Ecology*, p. 307, vol. 43(3), (2002). Published
- Litaor, M.I., Seastedt, T.R., Walker, D.A., "Spatial analysis of selected soil attributes across an alpine topographic/snow gradient", *Landscape Ecology*, p. 71, vol. 17, (2002). Published
- Miller, A.E., Bowman, W.D., "Variation in ^{15}N natural abundance and nitrogen uptake traits among co-occurring alpine species: do species partition by nitrogen form?", *Oecologia*, p. 609, vol. 130, (2002). Published

- Pepin, N., Losleben, M.V., "Climate change in the Colorado Rocky Mountains: Free air versus temperature trends", *Journal of Climatology*, p. 311, vol. 22, (2002). Published
- West, A.E., Schmidt, S.K., "Endogenous methanogenesis stimulates oxidation of atmospheric CH₄ in alpine tundra soil", *Microbial Ecology*, p. 408, vol. 43, (2002). Published
- Monson, R.K., Turnipseed, A.A., Sparks, J.P., Harley, P.C., Scott-Denton, L.E., Sparks, K., Huxman, T.E., "Carbon sequestration in a high-elevation, subalpine forest", *Global Change Biology*, p. 459, vol. 8(5), (2002). Published
- Meloche, C.G. and P. K. Diggle, "The pattern of carbon allocation supporting growth of preformed shoot primordia in *Acomastylis rossii*", *American Journal of Botany*, p. 1313, vol. 90(9), (2003). Published
- Miller, A.E. and W.D. Bowman, "Alpine plants show species-level differences in the uptake of organic and inorganic nitrogen", *Plant and Soil*, p. 283, vol. 250(2), (2002). Published
- Neff, J.C., A.R. Townsend, G. Gleixner, S.J. Lehman, J. Turnball, and W.D. Bowman, "Variable Effects of Nitrogen Additions on the Stability and Turnover of Soil Carbon", *Nature*, p. 915, vol. 419, (2002). Published
- Raab, T.K., and M.C. Martin, "Visualizing rhizosphere chemistry of legumes with mid-IR synchrotron radiation", *Planta*, p. 881, vol. 213(6), (2001). Published
- Sherriff, R.L., T.T. Veblen, and J.S. Sibold, "Fire history in high elevation subalpine forests in the Colorado Front Range", *Ecoscience*, p. 369, vol. 8(3), (2001). Published
- Bowman, W.D., Bahn, L., Damm, M., "Alpine landscape variation in soil N and P availability and its relation to foliar concentrations", *Arctic, Antarctic, and Alpine Research*, p. , vol. , (). Submitted
- Suding, K.N., Larson, J.R., and W.D. Bowman, "Effect on N cycling rates and mechanisms of resource depletion for two co-dominant alpine species", *Oikos*, p. , vol. , (). Submitted
- Summer B. Waters, Diane M McKnight, Alexander P. Wolfe, Rolf Vinebrooke, Sean Sunderman, and Meagan O'Brian, "Algal and Biogeochemical responses to environmental change in an alpine lake.", *J. Phycology*, p. , vol. , (). Accepted
- Wolfe, A.P., S.S. Kaushal, J.R. Fulton, and D.M. McKnight, "Spectrofluorescence of sediment humic substances and historical changes of lacustrine organic matter in response to atmospheric nutrient enrichment.", *ENVIRONMENTAL SCIENCE & TECHNOLOGY*, p. 3217, vol. 36(15), (2002). Published
- Torrizo, J., C. Seibold, T. Tomaszewski, A. Turnipseed, and H. Sievering, "Nitrogen Deposition to a Coniferous, Subalpine Forest at Niwot Ridge, CO", *Atmospheric Environment*, p. , vol. , (2002). Accepted
- Gonzalez, G., T.R. Seastedt, and Z. Donato, "Earthworms, arthropods and plant litter decomposition in aspen (*Populus tremuloides*) and lodgepole pine (*Pinus contorta*) forests in Colorado, USA.", *Pedobiologia*, p. 863, vol. 47(5-6), (2003). Published
- Greenland, D. and T.G.F. Kittel
, "Temporal variability of climate at the US Long-Term Ecological Research (LTER) sites.", *Climate Research*, p. 213, vol. 19, (2002).
Published
- Ebersole, J.J, "Recovery of alpine vegetation on small, denuded plots, Niwot Ridge, Colorado, U.S.A", *Arctic, Antarctic, and Alpine Research*, p. 389, vol. 34(4), (2002). Published
- Hood, R.W.; Williams, M.W.; Caine, N., "Yields of dissolved organic C, N, and P, from three high-elevation catchments, Colorado front range, U.S.A.", *Water, Air, and Soil Pollution: Focus*, p. 165, vol. 2, (2002).
Published

- Kolesar, S.E.; McKnight, D.M.; Waters, S.B., "Late fall phytoplankton dynamics in three lakes, Rocky Mountain National Park", *Hydrobiologia*, p. 249, vol. 472, (2002). Published
- Toetz, D.W.; Mihuc, T.B., "Effects of ultraviolet radiation on algae and chironomids in a subalpine stream, Colorado Front Range", *Verh. Internat. Verein. Limnol*, p. 1095, vol. 28, (2002). Published
- Winstral, A; Elder, K.; Davis, R.E., "Spatial Snow Modeling of Wind-Redistributed Snow Using Terrain-Based Parameters", *Journal of Hydrometeorology*, p. 524, vol. 3, (2002). Published
- Burns, D.A., "Atmospheric nitrogen deposition in the Rocky Mountains of Colorado and southern Wyoming- a review and new analysis of past study results.", *Atmospheric Environment*, p. 921, vol. 37, (2003). Published
- Greenland, D.; Hayden, B.P.; Magnuson, J.J.; Ollinger, S.V.; Pielke Sr., R.A.; Smith, R.C, "Long-Term Research on Biosphere-Atmosphere Interactions", *Bioscience*, p. 33, vol. 53 (1), (2003). Published
- Hobbie, J.E.; Carpenter, S.R.; Grimm, N.B.; Gosz, J.R.; Seastedt, T.R., "The US Long Term Ecological Research Program", *BioScience*, p. 21, vol. 53(1), (2003). Published
- Hood, E.W.; Williams, M.W.; Caine, N., "Landscape Controls on Organic and Inorganic Nitrogen Leaching across an Alpine/Subalpine Ecotone, Green Lakes Valley, Colorado Front Range", *Ecosystems*, p. 31, vol. 6, (2003). Published
- Williams, M.W.; Losleben, M.V.; Hamann, H.B., "Alpine Areas in the Colorado Front Range as Monitors of Climate Change and Ecosystem Response", *The Geographic Review*, p. 180, vol. 92, (2003). Published
- Bowman, W.D., H. Steltzer, T.N. Rosenstiel, C.C. Cleveland, and C.L. Meier., "Litter effects of two co-occurring alpine species on plant growth, microbial activity and immobilization of nitrogen", *Oikos*, p. 336, vol. 104, (2001). Published
- Fenn, M.E., J.S. Baron, E. B. Allen, H. M. Rueth, K. R. Nydick, L. Geiser, W. D. Bowman, J. O. Sickman, T. Meixner, D. W. Johnson, and Neitlich, P., "Ecological Effects of Nitrogen Deposition in the Western United States", *BioScience*, p. 404, vol. 53, (2003). Published
- Miller, A.E.; Bowman, W.D., "Alpine plants show species-level differences in the uptake of organic and inorganic nitrogen", *Plant and Soil*, p. 283, vol. 250, (2003). Published
- Bowman, W.D.; Bahn, L.; Damm, M., "Alpine landscape variation in foliar nitrogen and phosphorus concentrations and the relation to soil nitrogen and phosphorus availability", *Arctic, Antarctic and Alpine Research*, p. 144, vol. 35, (2003). Published
- T. Seastedt, B. Bowman, N. Caine, D. McKnight, A. Townsend, and M. W. Williams, "The landscape continuum: A conceptual model for high elevation ecosystems", *BioScience*, p. 111, vol. 54:2, (2004). Published
- Ley, R., M. W. Williams, and S. Schmidt, "Microbial population dynamics in an extreme environment: controlling factors in talus soils at 3750m in the Colorado Rocky Mountains", *Biogeochemistry*, p. 313, vol. 68, (2004). Published
- Hood E., McKnight, D., and Williams, M.W., "Sources and chemical character of dissolved organic carbon (DOC) across an alpine/subalpine ecotone, Green Lakes Valley, Colorado Front Range, USA", *Water Resources Research*, p. 1188, vol. 39:7, (2003). Published
- Schadt, C.W., Martin, A.P., Lipson, D.A. and Schmidt, S.K., "Seasonal dynamics of previously unknown fungal lineages in tundra soils", *Science*, p. 1359, vol. 301, (2003). Published
- Sievering, H., J. Torizzo, C. Seibold, T. Tomaszewski, and A. Turnipseed, "Nitrogen deposition to a coniferous forest at Niwot Ridge, Colorado", *Environmental Pollution*, p. , vol. , (2004). Accepted

- Tomaszewski, T., R. Boyce, and H. Sievering, "Canopy uptake of atmospheric nitrogen and new growth nitrogen requirement at a Colorado subalpine forest", *Can. J. of Forest Research*, p. 2221, vol. 3 (11), (2003).
Published
- Forbis, T.A.; Larmore, J.; Addis, E., "Temporal patterns in seedling establishment on pocket gopher disturbances", *Oecologia*, p. 112, vol. 138, (2004). Published
- Lipson, D.A.; Schmidt, S.K., "Seasonal changes in an alpine soil bacterial community in the Colorado Rocky Mountains", *Appl. Environ. Microbiol.*, p. 2867, vol. 70, (2004). Published
- Liu, F.; Williams, M.W.; Caine, N., "Source waters and flow paths in an alpine catchment, Colorado Front Range, United States.", *Water Resources Research*, p. , vol. 40, (2004). Accepted
- Meyer, A.F.; Lipson, D.A.; Schadt, C.W.; Martin, A.P.; Schmidt, S.K., "Molecular and metabolic characterization of cold tolerant, alpine soil *Pseudomonas*, sensu stricto.", *Appl. Environ. Microbiol.*, p. 483, vol. 70, (2004). Published
- Nemergut, D.R.; Martin, A.P.; Schmidt, S.K., "Integron diversity in heavy metal contaminated mine tailings and inferences about integron origin and evolution.", *Appl. Environ. Microbiol.*, p. 1160, vol. 70, (2004). Published
- Schmidt, S.K.; Lipson, D.A., "Microbial growth under the snow: Implications for nutrient and allelochemical availability in temperate soils", *Plant and Soil*, p. 1, vol. 259, (2004). Published
- Schmidt, S.K.; Lipson, D.A.; Ley, R.E.; Fisk, M.C.; West, A.E., "Impacts of chronic nitrogen additions vary seasonally and by microbial functional group in tundra soils", *Biogeochemistry*, p. 1, vol. 69, (2004). Published
- Toetz, D.; Payton, M. E., "Synergism of Nutrients and Humic Acid in Accrual of Periphytic Biomass in a Subalpine Stream, Colorado Front Range", *Journal of Freshwater Ecology*, p. 35, vol. 19:1, (200). Published
- Burns, D.A., "The effects of atmospheric nitrogen deposition in the Rocky Mountains of Colorado and southern Wyoming, USA- a critical review", *Environmental Pollution*, p. 257, vol. 127, (2004). Published
- Forbis, T.A., "Seedling Demography in an Alpine Ecosystem", *American Journal of Botany*, p. 1197, vol. 90:8, (2004). Published
- Forbis, T.A.; Doak, D.F., "Seedling establishment and life history trade-offs in alpine plants", *American Journal of Botany*, p. 1147, vol. 91 (7), (2004). Published

Books or Other One-time Publications

- Seastedt, T.R., "Soil Fauna and controls of carbon dynamics: comparisons of grasslands and forests across latitudinal gradients", (2000). Book, Published
Editor(s): Coleman, D.C., and P. Hendrix
Collection: Invertebrates as webmasters in Ecosystems
Bibliography: Univ. Georgia Press.
- Groffman, P.M., E.A. Holland, D.D. Myrold, G.P. Robertson, "Denitrification", (1999). Book, Published
Editor(s): Robertson, G.P., et al.
Collection: Standard Soil Methods for Long-Term Ecological Research
Bibliography: Oxford Press
- Holland, E.A., G.P. Robertson, J. Greenberg, P.M. Groffman, R.D. Boone, and J.R. Gosz, "Soil CO₂, N₂O, and CH₄ exchange", (1999). Book, Published
Editor(s): Robertson, G.P., et al.
Collection: Standard Soil Methods for Long-Term Ecological Research
Bibliography: Oxford Press

Robertson, G.P., D. Wedin, P.M. Groffman, J.M. Blari, E.A. Holland, K.J. Nadelhoffer, D. Harris, "Soil carbon and nitrogen availability: Nitrogen mineralization, nitrification and soil respiration potentials", (1999). Book, Published
 Editor(s): Robertson, G.P., et al.
 Collection: Standard Soil Methods for Long-Term Ecological Research
 Bibliography: Oxford Press

Schmidt, S. K. and R.L. Ley, "Microbial competition and bioavailability limit the expression of allelochemicals in natural soils", (1999). Book, Published
 Editor(s): In Inderjit, S., K.M.M. Dakshini and C.L. Foy
 Collection: Principles and Practices in Plant Ecology: Allelochemical Interactions
 Bibliography: CRC Press, Boca Raton.

Bowman, W.D. and T.R. Seastedt, "Structure and Function of an Alpine Ecosystem: Niwot Ridge, Colorado", (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, New York

Elias, S.A., "Natural History of the Rocky Mountains.", (). Book, Accepted
 Bibliography: Smithsonian Institution Press.

Jensen, M.E., and P.S. Bourgeron, "An Integrated Ecological Assessment Protocols Guidebook", (2001). Book, Published
 Editor(s): Jensen, M.E., and P.S. Bourgeron
 Bibliography: Springer-Verlag, New York, NY

Jones, H.G., J. Pomeroy, D.A. Walker, and R. Hoham, "Snow Ecology: An interdisciplinary examination of snow-covered ecosystems", (2001). Book, Published
 Editor(s): Jones, H.G., J. Pomeroy, D.A. Walker, and R. Hoham
 Bibliography: Cambridge University Press

Armstrong, D.M., J.C. Halfpenny, and C.H. Southwick, "Vertebrates", (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

Bourgeron, P.S. and M.E. Jensen, "An introduction to integrated regional ecological assessments", (2001). Book, Published
 Editor(s): Bourgeron, P.S. and M.E. Jensen
 Collection: An Integrated Ecological Assessment Protocols Guidebook
 Bibliography: Springer-Verlag, New York, NY

Bourgeron, P.S., H.C. Humphries, M.E. Jensen, and B.A. Brown, "Integrated regional ecological assessments and land use planning", (2001). Book, Accepted
 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

Bowman, W.D., "Introduction: Historical perspective and significance of alpine ecosystem studies", (2001). Book, Published

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

Caine, N, "Geomorphic systems of Green Lakes Valley", (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

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.

Elias, S.A, "Paleoecology and late quaternary environments of the Colorado Rockies", (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

Fisk, M.C., P.D. Brooks, and S.K. Schmidt, "Nitrogen Cycling", (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

Greenland, D. and M.V. Losleben, "Climate", (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

Monson, R.K., R. Mullen, and W.D. Bowman, "Plant Nutrient Relations", (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

Schmidt, S.K., A.E. West, P.D. Brooks, L. Smith, C. Jaeger, M.C. Fisk and E. Holland, "Soil-atmosphere gas exchange across an alpine tundra landscape", (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

Seastedt, T.R, "Soils", (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

Seastedt, T.R., M.D. Walker, and D.M. Bryant, "Controls on Decomposition Processes in Alpine Tundra", (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

Sievering, H, "Atmospheric Chemistry and Deposition", (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

Walker, M.D., D.A. Walker, T.A. Theodose, and P.J. Webber, "The vegetation: Hierarchical species-environment relationships", (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

Walker, D.A., J.G. Molenaar, W.D. Billings, "Snow-vegetation interactions in tundra environments", (2001). Book, Published
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

Welker, J.M. W.D. Bowman, and T.R. Seastedt, "Environmental change and future directions in alpine research", (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

Williams, W.M. and N. Caine, "Hydrology and hydrochemistry", (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

Meloche, C.G., "Preformation and carbon allocation in Alpine Avens (*Acomastylis rossii*)", (2001). Thesis, Published
Bibliography: Ph.D.
Dissertation. University of Colorado, Boulder

Turner, L., "Influence of snow augmentation on alpine plant composition", (2001). Thesis, Published
Bibliography: Ph.D.
Dissertation. University of Colorado, Boulder

Davinroy, T, "Hydrological and biogeochemical characteristics of alpine talus, Colorado Front Range", (2000). Thesis, Published
Bibliography: Ph.D. Dissertation University of Colorado, Boulder

Hazen, J.M., "An evaluation of the importance of dissolved organic nitrogen in snowmelt runoff and its qualitative characteristics, Como Creek, Front Range, Colorado", (2000). Thesis, Published
Bibliography: M.A. thesis. University of Colorado, Boulder

Sherriff, R.L., "Fire history at high elevation in the Colorado Front Range", (2000). Thesis, Published
Bibliography: M.A. Thesis. University of Colorado, Boulder

Wahlquist, A., "The abundance and diversity of autohydrogenotrophic denitrifying bacteria in four aquifers", (2000). Thesis, Published
Bibliography: M.A. Thesis. University of Colorado, Boulder

Bowman, W.D., Cairns, D. M., Baron, J.S., Seastedt, T.R., "Islands in the sky: Tundra and treeline", (2002). Book, Published
 Editor(s): Baron, J.S., D. Fagre, and R. Hauer
 Collection: Rocky Mountain Futures: an Ecological Perspective
 Bibliography: Island Press

Buttenfield, B.P., "Chapter 6: Mapping ecological uncertainty", (2001). Book, Published
 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

Ackerman, T.M., Erickson, T., Williams, M.W., "Combining GIS and GPS to improve our understanding of the spatial distribution of snow water equivalence (SWE)", (2001). Conference Proceedings, Published
 Collection: Proceedings, ESRI user conference
 Bibliography: San Diego, California

Fourment, T., Emerling, D (illus.), "My Water Comes from the Mountains", (2003). Book, Published
 Bibliography: Roberts Rinehart Publishers, Rowman and Littlefield Publishing Group

Manthorne, D., "Mercury deposition in alpine lakes, Colorado", (2002). Thesis, Published
 Bibliography: M.S. Thesis. University of Colorado, Boulder

Miller, A., "Uptake of organic and inorganic nitrogen by alpine tundra plants", (2002). Thesis, Published
 Bibliography: Ph.D. Dissertation. University of Colorado, Boulder

Schadt, C.W., "Studies on the fungal associations of the alpine sedge *Kobresia nyosuroides* in Colorado", (2002). Thesis, Published
 Bibliography: Ph.D. Dissertation. University of Colorado, Boulder

Hood, E.W., "Ecological controls on the source and character of dissolved organic matter in an alpine/subalpine watershed, Green Lakes Valley, Colorado Front Range", (2001). Thesis, Published
 Bibliography: Ph.D. Dissertation. University of Colorado, Boulder

Meloche, C.G., "Preformation and carbon allocation in Alpine Avens (*Acomastylis rossii*)", (2001). Thesis, Published
 Bibliography: Ph.D. Dissertation. University of Colorado, Boulder

Bowman, W.D., M. Damm, "Causes and Consequences of Alpine Vascular Plant Diversity in the Rocky Mountains.", (). Book, Accepted
 Editor(s): C. Korner, E. Spehn
 Collection: Mountain Biodiversity-A Global Assessment. Chapter 3
 Bibliography: Permagon Press, London

Liu, F., M. Williams, R. Webb, and T.M. Ackerman, "of XTOP_PRMS model in Green Lakes Valley, Colorado Front Range: Runoff simulation and flowpath identification", (). Conference Proceedings, Accepted
 Collection: Proceedings of 70th US Western Snow Conference, May 20-23, 2002, Granby, Colorado.
 Bibliography: Granby, Colorado

Seastedt, T.R., "Base camps of the Rockies: The Intermountain Grasslands", (2002). Book, Published
 Editor(s): J.S., D. Fagre, and R. Hauer
 Collection: Rocky Mountain Futures: an Ecological Perspective
 Bibliography: Island Press.

Williams, M.W., Hood, E., and Caine, N., "Headwater catchments of the Boulder Creek Watershed: Chapter 8", (2003). Book, Accepted
 Editor(s): Murphy, S.F., Verplanck, P.L., and Barber, L.B.
 Collection: Comprehensive water quality of the Boulder Creek Watershed, Colorado, during high-flow and low-flow conditions, 2000: U.S. Geological Survey Water Resources Investigations Report
 Bibliography: U.S. Geological Survey Water Resources Investigations Report

Bowman, W.D., "The response of alpine plants to environmental change - Feedbacks to ecosystem function", (2003). Book, Published
 Editor(s): Huber, U., Buggmann, H. and Reasoner, M.
 Collection: Global Change and Mountain Regions: A State of Knowledge Overview
 Bibliography: Kluwer Academic Press

Torrizo, A., "Sensitivity of high-elevation catchments in Rocky Mountain National Park to atmospheric deposition of nitrogen", (2002). Thesis, Published
 Bibliography: M.A. thesis. University of Colorado, Boulder

Hamann, H.B., "The ionic pulse, snowmelt flowpaths, and surface water chemistry in two alpine basins, Colorado Rocky Mountains, USA", (2002). Thesis, Published
 Bibliography: Ph.D. Dissertation. University of Colorado, Boulder

Forbis, T.A., "Seedling Establishment on Alpine Tundra: Community Patterns, Population Demography, and Disturbance Effects", (2003). Thesis, Published
 Bibliography: Ph.D. Dissertation, University of Colorado, Boulder.

Larsen, J.R., "Plant Species Effects on Microbial Nutrient Limitations in the Alpine Moist Meadow", (2003). Thesis, Published
 Bibliography: M.S. Thesis. University of Colorado, Boulder.

Erickson, T.A., "Development and application of Geostatistical Methods to Modeling Spatial Variation in Snowpack Properties, Front Range, Colorado", (2004). Thesis, Published
 Bibliography: Ph.D. Dissertation, University of Colorado, Boulder.

Liu, F., "Hydrological Controls on Stream Water Chemistry in Alpine Catchments, Colorado Front Range, U.S.A.", (2004). Thesis, Published
 Bibliography: Ph.D. Dissertation, University of Colorado, Boulder.

Mujica-Crapanzano, L., "Landscape Analysis of Vegetation and Diversity Patterns at Niwot Ridge, Colorado", (2004). Thesis, Published
 Bibliography: Ph.D. Dissertation, University of Colorado, Boulder.

Withington, C.L., "The Forest-Alpine Tundra Ecotone Influences Decomposition and the Nitrogen and Phosphorus Status of Picea Engelmannii", (2004). Thesis, Published
 Bibliography: M.S. Thesis. University of Denver.

Bowman, W.D., "The response of alpine plants to environmental change: Feedbacks to ecosystem function", (2005). Book, Accepted
 Editor(s): U. M. Huber, H. K. M. Bugmann, and M. A. Reasoner
 Collection: Global Change and Mountain Regions (A State of Knowledge Overview)
 Bibliography: Springer, Dordrecht

Web/Internet Site

URL(s):

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

Description:

This is our core LTER website

Other Specific Products

Contributions

Contributions within Discipline:

Cross-site, Synthesis and LTER Network Activities

Our 2003 report was submitted prior to our participation in the fall 2003 All Scientists meeting in Seattle. At that meeting we presented 13 posters. Our PIs sponsored or co-sponsored six workshops, and these workshops provided follow-up documentation used to develop the LTER Network Coordination Planning Grant.

Niwot LTER Scientist Patrick Bourgeron became the co-leader of the US program that interfaces with the ILTER effort. Dr. Bourgeron spent about half of the 2004 year as the International Visiting Research Chair, Ecole Normale Supérieure, Paris, France.

Contributions to Other Disciplines:

Our tundra.cam (<http://tundra.cam.colorado.edu>) remains one of the most popular web sites at CU.

Our field site has always suffered from the lack of year-around facilities. At long last, the first year-around lodge has been completed at the Mountain Research Station. This building was the result of a consortium of NSF, Colorado, and private funding. This lodge will be used by LTER scientists as needed, but its main function is to provide teaching, education, and outreach functions beyond those provided by our LTER effort.

Contributions to Human Resource Development:

Our program currently involves 14 graduate students and a number of undergraduates, many of which participate in the LTER or Departmental 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.

An undergraduate scholars program at CU has been initiated that 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 in 2003, faculty in the departments of applied math and biology teach short-courses and train students in models applicable to the analysis and interpretation of complex data sets. Undergraduates work in pairs (one with a mathematics major, one with a biology major) using LTER data. Individual projects are also underway. The program includes the participation of three CU faculty not formerly associated with the LTER program. Initial feedback from the students about this activity appears very positive.

Contributions to Resources for Research and Education:

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. These can now be imported into a relational database where a web interface allows users 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. Additional real-time weather data are now available on our web site.

This year marked the second year of Niwot Ridge participating in the HydroDB Network Information System module. New sites have been added this year.

Contributions Beyond Science and Engineering:

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

Contributions: To Any Beyond Science and Engineering