

# **Project Completion Report**

## **Rocky Mountains Cooperative Ecosystem Studies Unit (RM-CESU)**

**Project Title:** Collaborative Support National Atmospheric Deposition Site CO98

**Project Code:** CSURM-72/84/121; J1526075134; J1526085394

**Type of Project :** Research

**Funding Agency:** National Park Service

**Partner University:** Colorado State University

**NPS Agreement Technical Representative (with complete contact information):**

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**Principal Investigators (with complete contact information):**

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**Start Date of Project:** 4/1/2007

**End Date of Project:** 1/31/2010

**Funding Amount:** \$36,069

**Project Summary, including descriptions of products, work accomplished and/or major results. If the information is restricted (e.g. location of endangered species or cultural resources), indicate the title and location of the final report. Also add web sites where project-related information may be found.**

The objectives for this work were to 1) collect precipitation samples and analyze for concentrations of nitrate and ammonium, 2) collect and analyze lake and stream water samples at locations within Loch Vale watershed and other long-term sites in Rocky Mountain National Park, 3) contribute to an archive for historical data, and 4) report the results of analyses to Rocky Mountain National Park and the RM-CESU. We conduct this research in order to monitor changes in precipitation and surface water chemistry and interpret causal factors. Results are used by resource managers for decision-making in support of meeting mandates specified by the EPA Clean Air Act Amendments and NPS guidelines.

**Work Accomplished 2007-2009**

1. We installed and managed two prototype collectors for NADP in 2007, in addition to maintaining original equipment. The first collector was a NOAA IV rain gage operated with a particle-sensor and datalogger, and the second collector was a deeper and stronger wet deposition collector. By 2008 it was apparent that the NOAA IV gage was working fine, but the deeper wet-deposition bucket was no better than the original 5 gallon pail. The deeper bucket was discontinued in 2009 and the equipment reconfigured in late 2009 to host a second

Aerochemetrics wet-deposition collector (CO89).

2. We collected and analyzed weekly Loch outlet chemistry samples, summer synoptic lake and stream chemistry samples, and annual regional lake chemistry samples, and monthly Loch outlet algal samples. Data are accessible on the Loch Vale website, which is currently undergoing renovation (<http://www.nrel.colostate.edu/projects/LVWS>). A Quality Assurance Report of all Loch Vale data 2003-2009 is currently in review and will be available in 2011.

3. We analyzed all long-term water quality, discharge, and weather records to understand and interpret recent changes in biogeochemical cycling. Briefly, the period 1999-2006 was one of very warm summer temperatures, greater stream discharge than expected from measured precipitation, and large increases in late summer and annual lake and stream nitrate and weathering product concentrations and fluxes. We postulated the changes were due to warming-induced glacier or rock glacier melting. Actual mechanisms for the observed chemical changes are currently the subject of active research by us. These results were published in *Global Change Biology*, and as a Talkingpoint editorial piece. They were also presented to professional and public audiences. An additional Loch Vale paper using long-term data and archived samples was published in *Limnology and Oceanography*.

4. We hauled out at least a ton of old materials and equipment using horses, mules, and human power.

#### **Publications:**

- a. Baron, J.S., 2008. Interactions between atmospheric nitrogen deposition and climate change in the Colorado Front Range. Talkingpoints editorial for environmentalresearchweb.org. <http://environmentalresearchweb.org/cws/article/opinion/33501>
- b. Oropeza, J.K. 2008. Controls on soil acidity in Loch Vale watershed, Rocky Mountain National Park, Colorado. M.S. thesis, Colorado State University, 59 pp.
- c. Kleinman, Sabrina, 2008. Investigation of a Novel Soil Layer and its impact on Nitrogen Fertilization in Loch Vale Watershed, Rocky Mountain National Park, Colorado. Professional paper for submission as part of a M.Sc. degree, Northern Arizona University.
- d. Enders, S.K., M. Pagani, S. Pantoja, J.S. Baron, A.P. Wolfe, N. Pedentchouk, L. Nuñez. 2008. Compound-specific stable isotopes of organic compounds from lake sediments track recent environmental changes in an alpine ecosystem, Rocky Mountain National Park (United States of America). *Limnology and Oceanography* 53(4):1468-1478.
- e. Baron, J.S., T.W. Schmidt, M.D. Hartman. 2009. Climate-Induced Changes in High Elevation Stream Nitrate Dynamics. *Global Change Biology* 15:1777-1789.

#### **Presentations involving Loch Vale data 2007-2009**

- a. USDA Joint Agricultural Research CSREES team meeting
- b. AGU Fall meeting (two presentations, including one invited)
- c. Rocky Mountain National Park biennial research meeting
- d. Interagency Conference on Research in Watersheds
- e. USGS Microbiology Meeting
- f. Rocky Mountain National Park Lyceum public lecture
- g. Joint Global Change Research Institute seminar
- h. DU graduate ecology seminar; CSU undergraduate ecology class
- i. National Water Resources Research Institute meeting field trip
- j. Research Experience for Undergraduates field trip
- k. Wyoming Air Quality Managers meeting

**Number of students participating in this project: undergraduates, graduate students, degrees conferred.**

Six undergraduate students 2007-2009: Julie Markus, Lizzy Asher, Shenavia Balcom, Michelle Bahnik, Bill Magee

Graduate students: Sabrina Kleinman M.Sc.2009, Jill Oropeza, M.Sc. 2008, Melannie Hartman, Ph.D. current, Karen Galles, M.Sc. (degree expected 2011), Brooke Osborne, M.Sc. (degree expected 2011)

**Lessons Learned from this project.**

There are a number of lessons learned from this ongoing collaborative project:

1. There is no substitute for long-term monitoring and evaluation. We were able to catch the onset of climate-warming type biogeochemical changes that had not previously been observed. We are extremely grateful for the support that helps
2. Collaboration with Park staff is invaluable. From field volunteers to the muleteers to the Resource Management Staff. We could not accomplish our work without this help.
3. Harsh weather continues to be the greatest barrier to maintaining continuous records. Our diligent field technicians minimize the loss of data from every other possible cause, such as accidents, or human error and carelessness.