Project Summary
Rocky Mountains Cooperative Ecosystem Studies Unit

Project Title: Determination of Available Phosphorus in Frost Affected Tundra and Alpine Soils and the Factors Affecting Phosphorus Transport.

Discipline: Natural
Type of Project: Research
Funding Agency: National Park Service
Other Partners/Cooperators: Metropolitan State College of Denver
Effective Dates: 5/1/2011 - 12/31/2012
Funding Amount: $17,894

Investigators and Agency Representative:
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Project Abstract: Nitrogen (N) is generally considered to be the most limiting nutrient for both plant and aquatic productivity in most northern ecosystems due to the complex biological processes involved in the capture of atmospheric N and its conversion into plant available N (Aerts and Chapin 2000, Vitousek and Howarth 1991). Recent published research has suggested that critical loading of atmospheric N deposition in alpine watersheds within Rocky Mountain National Park, have been exceeded (Baron, et al. (1994); Elser, et al. (2009), and that phosphorus has become the limiting nutrient in this aquatic systems.

A growing number of studies suggest that phosphorus (P) limits or co-limits the biological production in alpine tundra systems (Bowman (1994); Seastedt and Vaccaro (2001); Soudzilovskaia et al., (2005). Limitations on phosphorus bioavailability have been related to various abiotic soil processes such as sorption, Kaňa et al. (2011), and mineral transformations (Griffin and Jurinak, 1973). Several studies have suggested that alpine soils may be more susceptible to extreme freeze thaw cycles, particularly in years having little snow in the late winter and early spring periods, Freppaz et al. (2007), resulting in elevated P and N concentrations during episodic pulses. Such freeze thaw episodes have been shown to be responsible for a substantial increase in soluble phosphorus (P) in organic soil, suggesting weathering/structural changes in soil organic matter; solubilization of organic compounds and/or lysing of microbial cellular structures (Ron Vaz et al., 1994). Recent findings by Evans et al. (2012) and Janke et al. (2012) have indicated that sufficiently high exchangeable P concentrations exist in tundra and frost affected soils adjacent to Trail Ridge Road. Increasing soil solution P concentrations could adversely impact the existing structure of tundra/alpine plant communities in Rocky Mountain National Park, while the mobilization and transport of exchangeable P into high altitude aquatic systems may significantly alter their trophic status

This study will provide spatial data related to the quantity and distribution of exchangeable P in both tundra and alpine soils. It is important to determine the overall P potential of these high altitudes sites, since these sites often serve as the headwaters for both ephemeral and permanent streams within the RMNP. In addition, shifts within the various soil P fractions with depth could provide important information related to the impact of climate change on biogeochemical cycling within these ecosystems, and shifts in plant diversity and population.

The objectives of this project are as follows:
1. Determine the spatial distribution of extractable P within permafrost, frost affected and alpine soils, and within ecological transition zones of these soils.
2. Collected soil samples will be fractionated with depth, to assess P bioavailability.
3. Evaluate the chemical and physical factors affecting P bioavailability and distribution at various sampling locations.
4. Provide laboratory, field sampling and research experience for STEM majors and underrepresented MSCD students to better prepare them graduate school and future employment.

Outcomes with Completion Dates: January 15, 2014

Keywords: Phosphorus, soils, alpine tundra, Rocky Mountain National Park, Metropolitan State College of Denver