



Effects of Nitrogen Deposition on High Alpine Meadows

Introduction

Alpine plant communities have evolved in ecosystems with naturally low levels of reactive N. Plants have adaptations such as fixed growth rates, and slow but steady nutrient uptake and short growing seasons. Plants including conifers and forest understory plants that use N more rapidly and have faster growth rates may outcompete unique alpine and subalpine species under increased N deposition.

Increased nitrogen (N) deposition is projected to alter plant communities, soil processes, and soil carbon (C), and N storage. Anna Simpson, a PhD Candidate at University of Washington, is studying the effects of N on alpine ecosystems. Anna is identifying the critical load of N in alpine ecosystems. A critical load is defined as the threshold of deposition below which specified harmful ecological effects do not occur. For three years (2013-2015)

Research Study

Anna applied N (fertilized) plant communities at study plots in three of Washington's National Parks: North Cascades (NOCA), Olympic (OLYM), and Mount Rainier (MORA) (Figure 1). She investigated how potential future increased N-deposition could alter ecosystems using inorganic reactive (reactive, inorganic, N is the only form that can be used by plants and soil microorganisms) N specifically: nitrate (NO_3^-) and ammonium (NH_4^+) at 0, 0.3, 0.5, and 1 g N/ m^2/yr (grams of nitrogen per square meter per year).

Results

After three years, all fertilized sites showed an increase in soil NO_3^- compared to unfertilized plots, indicating that plants and soil organisms were unable to utilize all the N, this signifies the potential for leaching.

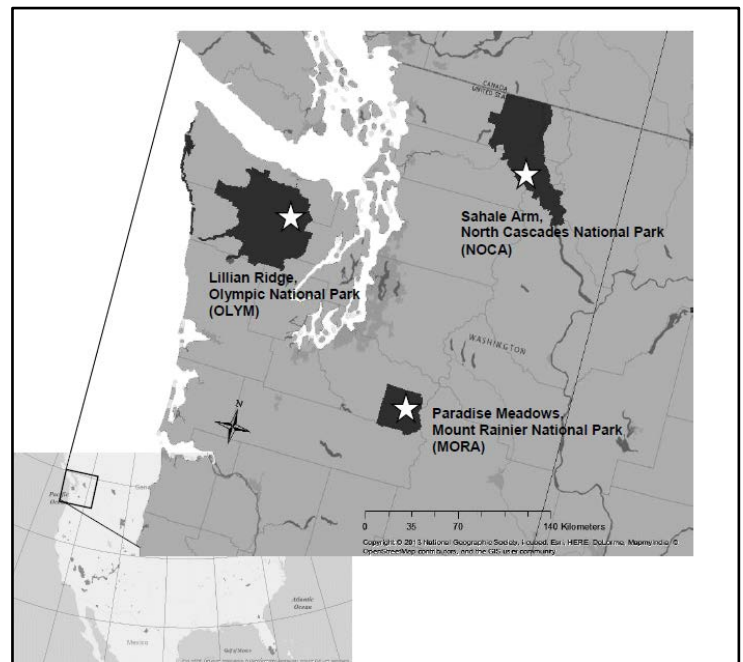


Figure 1. Locations of research sites at Olympic National Park, North Cascades National Park, and Mount Rainier National Park.

were unable to utilize all the N, this signifies the potential for leaching. Leaching is the loss of N from the soil and into waterbodies and ground water. Leaching can cause the soil to become acidified, altering soil microbes, plant nutrition, and plant health. NOCA was more sensitive to deposition, i.e., effects occurred at the 0.5 g N/ m^2/yr application rate, while MORA and OLYM responded at 1 g N/ m^2/yr

Soils are the largest sinks of N, especially meadows and grasslands where plant N storage is limited. Soil levels of reactive N were

greatest in the middle of the growing season and decreased into the fall at all three parks. OLYM, however, maintained increases in microbial and reactive N into the fall which increases leaching potential with fall rains. OLYM has different soils than MORA and NOCA, with greater potential for soil microbes to process organic and reactive N. As N deposition increases, soil microbes may become more active which releases carbon dioxide (CO₂) and nitrous oxide (N₂O) - a greenhouse gas 300 times more potent than CO₂.

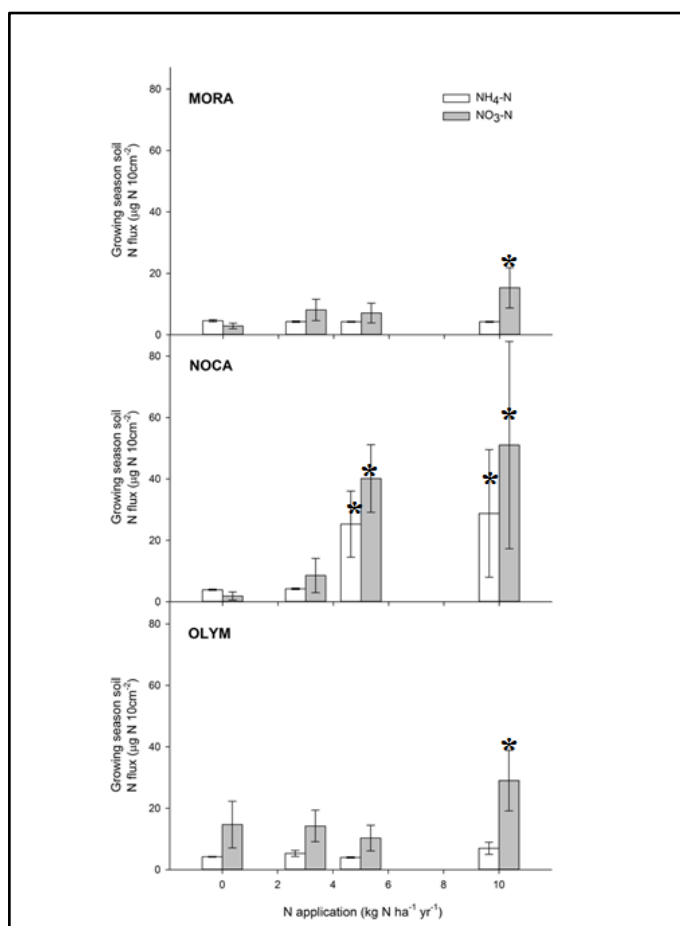


Figure 2. At 0.5 g N/m²/yr of inorganic N application NOCA communities N was in excess, and was unable to be incorporated into plants and was instead in the soil where it could be leached. At MORA and OLYM N was in excess at 1 g N/m²/yr.

Future Research Directions

Anna did not see not a change in plant community composition over the 3 years of her study, but she did see evidence that plants and soil microbes used the applied N.

Plant species composition may change slowly so continued field studies (with N deposition) and greenhouse studies are needed to identify which high-elevation plant species will be most sensitive to warming climates and increased N.

Researcher



Anna received her Bachelor's in Biology from U.C. Berkeley and did an AmeriCorps term of service at Edmonds CC's LEAF School. She is now a PhD candidate in the soil science subgroup at the School of Environmental and Forest Sciences at the University of Washington and is a member of U.W.'s graduate Astrobiology program. Her other research focuses on changes in microbial community structure with environmental variables in snowfield soils/sediments.

More Information

Regina M. Rochefort, Ph.D.
North Cascades National Park Service Complex
Email: regina_rochefort@nps.gov
Phone: 360-854-7202

Tonnie Cummings, NPS Air Resource Specialist
Pacific West Region
Email: tonnie_cummings@nps.gov
Phone: 360-816-6201

Anna Simpson, Phd Candidate
University of Washington
Email: acsimpson@gmail.com

Prepared by: Rebecca Courtney Evans
Graduate Student, Washington State University
Air Resources Assistant, GeoScientist in the Park