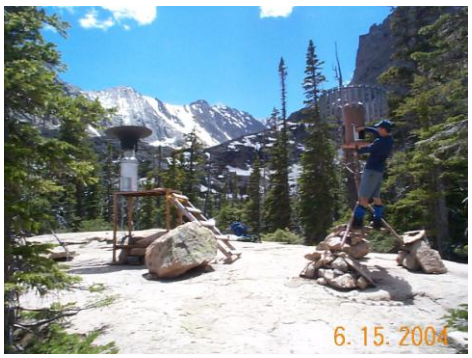
Rocky Mountain National Park
Fact Sheet
May 2006

Title: Critical Loads of Nitrogen Deposition

Status/Background
At Rocky Mountain National Park, there is a large body of evidence that indicates nitrogen deposition has affected, and continues to affect, ecosystems within the park. Over 23 years of scientific research has documented air pollution impacts to water, soils, aquatic plants, and trees at high elevation areas on the east side of the park. Current nitrogen deposition levels are estimated at about 4 kgN/ha/yr, which is around 20 times greater than natural background levels of nitrogen estimated for the western U.S. around the turn of the century.



Air quality technicians collecting precipitation samples and data at Loch Vale, Rocky Mountain National Park.

What Does "Critical Load" Mean? – The term critical load is used to describe the amount of air pollution deposition that first initiates harmful changes to sensitive resources in an ecosystem. Critical loads can be developed for a variety of types of sensitive resources: from shifts in microscopic aquatic plant species, to reductions in alpine wildflowers, to water chemistry acidification levels at which fish die. The National Park Service (NPS) has an affirmative responsibility to protect national park resources as mandated by several legislative acts of Congress. Specifically, the NPS has a responsibility under the Clean Air Act to protect and enhance air quality related values and to fulfill our obligation under the Organic and Wilderness Acts to conserve national park resources unimpaired for future generations. In addition, the 1915 enabling legislation of Rocky Mountain National Park states that it was set aside "for the preservation of the natural conditions and scenic beauties" contained within the park. Because of these responsibilities, the NPS is most interested in the critical load above which sensitive ecosystems began to change their "state" or "function", meaning the pollution loading at which they first became unhealthy or changed in an unnatural way.

How are "Critical Loads" Developed? –
The critical load concept has been used widely in Europe as a means for understanding the effects of air contaminants on ecosystems, and relating these effects to land management objectives and the regulation of atmospheric pollution (Porter et. al, 2005). Scientific research conducted in Rocky Mountain National Park has shown that the first significant ecosystem changes from nitrogen deposition occurred in the 1950s, when total wet nitrogen deposition levels were approximately 1.5 kgN/ha/yr (Baron, 2006). By examining layers of soil found in high elevation lakes, scientists were able to examine aquatic plant remains dating back thousands of years. The species of aquatic plants inhabiting high-elevation lakes in the park remained relatively unchanged for around 14,000 years; then in the 1950s the number and types of plants shifted relatively quickly from 'nitrogen limited' to weedy 'nitrogen loving' species. This shift serves as an indicator of negative changes in overall aquatic system health. Therefore the loading at which this shift occurred, 1.5kg/ha/yr of wet nitrogen deposition, can be considered the critical load that would be protective of the park's sensitive ecosystems. Nitrogen deposition was not directly monitored in the park in the 1950s, so the deposition at that time has been estimated by a method called "hindcasting." Note that wet deposition only includes pollutants deposited by rain or snow, not those that fall as "dry" deposition , so this number is most comparable to the 3.1 kg wet N and 0.9kg dry N that have been deposited to the park annually, over the last 5 years (4.0 kgN/ha/yr).

Baron, JS. 2006. Hindcasting Nitrogen Deposition to Determine an Ecological Critical Load. Ecological Applications 16(2): pp 433-439.

Porter E, Blett T, Potter DU, Huber C. 2005. Protecting Resources on Federal Lands: Implications of Critical Loads for Atmospheric Deposition of Nitrogen and Sulfur. BioScience 55(7): pp 603-612.