Mapping Critical Loads of Atmospheric Nitrogen Deposition
in the Rocky Mountains, USA

Atmospheric nitrogen (N) deposition can adversely affect sensitive aquatic ecosystems at high-elevations in the western United States. Critical loads are the amount of deposition of a given pollutant that an ecosystem can receive below which ecological effects are thought not to occur. GIS-based landscape models were used to create maps for high-elevation areas across the Rocky Mountain region showing current atmospheric deposition rates of nitrogen (N), critical loads of N, and exceedances of critical loads of N.

Project Background:

Atmospheric N deposition maps for the region were developed at 400 meter resolution using gridded precipitation data and spatially interpolated chemical concentrations in rain and snow. Critical loads maps were developed based on chemical thresholds corresponding to observed ecological effects, and estimated ecosystem sensitivities calculated from basin characteristics. Diatom species assemblages were used as an indicator of ecosystem health to establish critical loads of N.

Chemical thresholds (concentrations) were identified for surface waters by using a combination of in-situ growth experiments and observed spatial patterns in surface-water chemistry and diatom species assemblages across an N deposition gradient. Ecosystem sensitivity was estimated using a multiple-linear regression approach in which observed surface water nitrate concentrations at 530 sites were regressed against estimates of inorganic N deposition and basin characteristics (topography, soil type and amount, bedrock geology, vegetation type) to develop predictive models of surface water chemistry. Modeling results indicated that the significant explanatory variables included percent slope, soil permeability, and vegetation type (including barren land, shrub, and grassland) and were used to predict high-elevation surface water nitrate concentrations across the Rocky Mountains. Chemical threshold concentrations were substituted into an inverted form of the model equations and applied to estimate critical loads for each stream reach within a basin, from which critical loads maps were created.

Atmospheric N deposition maps were overlaid on the critical loads maps to identify areas in the Rocky Mountain region where critical loads are being exceeded, or where they may do so in the future. This approach may be transferable to other high-elevation areas of the United States and the world. NHD Plus provided the mechanism to allocate and accumulate variables to all catchments and stream reaches throughout the area of study.
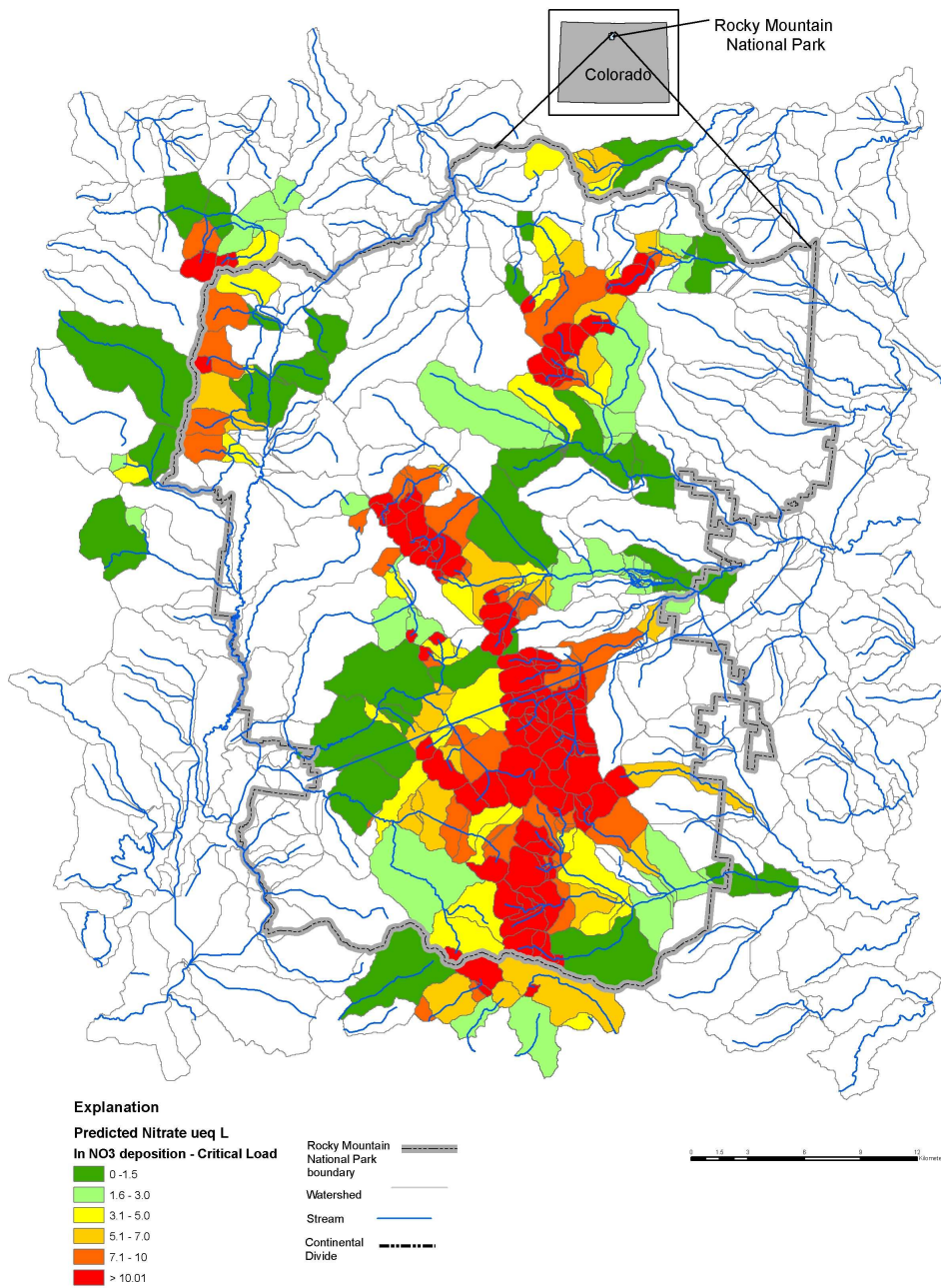
Rocky Mountain
National Park

Colorado

Explanation

Predicted Nitrate ueq L

In NO3 deposition - Critical Load

- 0 -1.5
- 1.6 - 3.0
- 3.1 - 5.0
- 5.1 - 7.0
- 7.1 - 10
- > 10.01

Rocky Mountain
National Park
boundary

Watershed

Stream

Continental
Divide

Fig. 1.-Example of model result of sensitivity applied to Rocky Mountain National Park

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