# Mapping Critical Loads of Nitrogen Deposition for Aquatic Ecosystems in the Rocky Mountains, USA

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Aquatic ecosystems at high elevations in the Rocky Mountains are sensitive to adverse effects of inorganic nitrogen (N) deposition, including nutrient enrichment and acidification. The objective of this study was to develop spatially explicit estimates of critical loads of N deposition ($CL_{Ndep}$) for nutrient enrichment in aquatic ecosystems of the Rocky Mountains, USA. Surface water nitrate ($NO_3$) concentrations were statistically modeled based on observed surface water $NO_3$ concentrations, estimated inorganic N deposition, and basin characteristics (topography, landcover, and soil characteristics). The $NO_3$ model was used to map estimated surface water $NO_3$ concentrations for high-elevation basins in the study area. Threshold values of $NO_3$ at which nutrient enrichment causes ecological effects were identified and substituted for observed $NO_3$ in the model to estimate and map $CL_{Ndep}$. The $CL_{Ndep}$ maps indicate that the lowest $CL_{Ndep}$ values (< 1.5 kg N $ha^{-1}$ $yr^{-1}$) are located in high-elevation basins with steep slopes, sparse vegetation, and an abundance of exposed bedrock and talus. These areas often correspond with areas of high N deposition (> 3 kg N $ha^{-1}$ $yr^{-1}$), resulting in exceedances greater than 2 kg N $ha^{-1}$ $yr^{-1}$. Critical loads and exceedances exhibit substantial spatial variability related to basin characteristics, and are highly sensitive to estimates of the $NO_3$ threshold value at which ecological effects are thought to occur. Based on a $NO_3$ threshold of 0.4 µmol $L^{-1}$, N deposition exceeds the $CL_{Ndep}$ in 29% of the high-elevation areas of the Rocky Mountains. Thus, broad areas of the Rocky Mountains may be impacted by excess N deposition, with greatest impacts likely at high elevations.

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