Nitrate removal in stream ecosystems measured by 15N addition experiments: Total uptake

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Limnol. Oceanogr., 54(3), 2009, 653-665 | DOI: 10.4319/lo.2009.54.3.0653

ABSTRACT: We measured uptake length of $^{15}NO_3^-$ in 72 streams in eight regions across the United States and Puerto Rico to develop quantitative predictive models on controls of NO_3^- uptake length. As part of the Lotic Intersite Nitrogen eXperiment II project, we chose nine streams in each region corresponding to natural (reference), suburban-urban, and agricultural land uses. Study streams spanned a range of human land use to maximize variation in NO_3^- concentration, geomorphology, and metabolism. We tested a causal model predicting controls on NO_3^- uptake length using structural equation modeling. The model included concomitant measurements of ecosystem metabolism, hydraulic parameters, and nitrogen concentration. We compared this structural equation model to multiple regression models which included additional biotic, catchment, and riparian variables. The structural equation model explained 79% of the variation in log uptake length (S_{wtor}). Uptake length increased with specific discharge (Q/w) and increasing NO_3^- concentrations, showing a loss in removal efficiency in streams with high NO_3^- concentration. Uptake lengths shortened with increasing gross primary production, suggesting autotrophic assimilation dominated NO_3^- removal. The fraction of catchment area as agriculture and suburban-urban land use weakly predicted NO_3^- uptake in bivariate regression, and did improve prediction in a set of multiple regression models. Adding land use to the structural equation model showed that land use indirectly affected NO_3^- uptake lengths via directly increasing both gross primary production and NO_3^- concentration. Gross primary production shortened S_{wtor}, while increasing NO_3^- lengthened S_{wtor} resulting in no net effect of land use on NO_3^- removal.

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