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In-Stream Denitrification: Pilot Studies and Site Characteristics on a Headwater Stream

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Abstract Text:

Increased loads of nitrogen (N) are a major cause of water quality degradation. Only 20-30% of watershed N inputs reach coastal waters indicating the presence of N "sinks". Headwater streams can generate substantial N processing; however several studies observed minimal N retention within streams. Using the constant rate injection method, we tracked the fate of isotopically enriched nitrate along a 500-m headwater stream reach in Rhode Island. Our objectives were to assess the resolution of this method for use in Rhode Island, the method's sensitivity to seasonal variation, and the extent of intra-seasonal variation. We estimated in-stream nitrate removal using three approaches in summer and fall with three trials per season. A solute transport model (OTIS) estimated stream hydrologic parameters. Uptake length, the average distance traveled by a nitrate molecule before denitrification, was calculated. We observed minimal denitrification (based on analysis of denitrification gases) during the constant rate injection trials in both summer and fall trials. In one trial of both seasons, the nitrate disappearance estimates (based on nitrate-N : conservative tracer ratios) indicated significant N removal, but there was high variability within the reach and season. OTIS indicated that the stream storage zone area and storage zone exchange were small, and the observed uptake length was greater than 170 km. Seasonal and intra-seasonal variation in stream hydrologic and chemical conditions did not affect the consistent, negligible N removal rates. The minimal denitrification rates coupled with the low retention times associated with this headwater stream argue that it is a negligible sink for watershed N. The uncertainties surrounding in-stream N removal warrant further investigation, with consideration given to headwater streams with extended retention times and benthic interactions.

Impact Statement:

Outcomes of this research will contribute to better watershed management by improving the knowledge base for the selection of locales for individual and public investment of pollution control and restoration, thereby advancing stream/riparian restoration and management practices.