Nitrogen dynamics at the ground water-surface water interface of a degraded urban stream

Paul M. Mayer, Sujay S. Kaushal, Peter M. Groffman, Elise A. Striz

Urbanization degrades stream ecosystems by altering hydrology and nutrient dynamics. We investigated temporal and spatial patterns in biogeochemistry and hydrology in and near the stream channel of a geomorphically degraded urban stream of Baltimore County, Maryland, USA. Our objectives were to examine relationships among biogeochemistry, denitrification enzyme activity, and hydrologic characteristics including stream discharge and water table elevation to characterize N dynamics in at the ground water-surface water interface of a degraded urban stream so that we could investigate factors that showed potential to influence denitrification rates.

Our results showed that chemistry and hydrology were closely related spatially and temporally at the ground water-stream interface of this urban stream. There were large changes in stream flow and ground water table depth during the study period due to drought during 2002 and a very wet year in 2003. DOC, NO_3^-, Cl^- concentrations in stream water and shallow ground water fluctuated in response to discharge and water table fluctuations. There were positive relationships between stream discharge, ground water elevation and NO_3^-. NO_3^- : Cl^- ratios suggested nitrogen processing in the subsurface related to ground water fluctuations. A significant inverse relationship between NO_3^- and DOC suggested that carbon availability also influenced nitrogen transformations, which was corroborated by denitrification enzyme assays that showed positive relationships between microbial respiration and biomass in sediments. High ground water nitrate (NO_3^-) levels corresponded to high ground water levels over time. Spatial patterns of NO_3^- corresponded to regions of the stream with high oxidation-reduction potential indicative of high ground water-surface water exchange.

Our results indicate that subsurface flow paths contribute to hyporheic mixing, DOC decline, and N transformation. Degraded urban streams retain the capacity to transform nitrogen and thus, exhibit remnant ecosystem functions suggesting that such streams remain candidates for management that enhances nitrogen uptake. For example, management or restoration efforts that increase DOC availability to denitrifiers and which reduce stream flow velocities and/or increase ground water residence time in hyporheic zones may likely influence the nitrogen uptake capacity of urban stream channels.