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From free-flowing and dynamic to backed-up and stagnant: How do milldams alter denitrification and nitrogen processing in riparian soils and terraces?

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By virtue of their landscape position between terrestrial and aquatic ecosystems, riparian zones are a key biogeochemical interface for nitrogen (N) cycling. This transitional setting results in a dynamic exchange of water, energy, and nutrients producing hotspots and hot-moments of N processes such as nitrification and denitrification. How dams and other barriers alter this dynamic N regime and affect nitrogen processing in riparian zones is however poorly understood. We investigated the effects of low head (< 7 m) milldams on riparian soil denitrification for two riparian sites in the mid-Atlantic USA. The Roller milldam (height 2.4 m) site was located Chiques Creek in Pennsylvania, a predominately agricultural watershed, while the Cooch milldam (4 m) site was on Christina River in Delaware, a more urban-influenced watershed. The Christina River riparian site was also impacted by road salt inputs from a multilane interstate (I95) immediately upstream of the dam. We hypothesized that dams would back-up stream water and raise riparian groundwater levels increasing anoxic soil conditions that would enhance denitrification and nitrate-N removal. Soils were assessed for C:N, organic matter contents, inorganic N (nitrate-N and ammonium-N), N process rates (denitrification enzyme assay), grain size, and various element concentrations (e.g., Fe, S, & Na). We tracked patterns of N cycling using stable isotopes of N ($\delta^{15}N$), finding that enrichment of ^{15}N corresponded to areas of denitrification. Dentification occurred in surface sediments where nitrate-N concentrations are highest. At depths below 1 m, nitrate-N concentrations substantially decrease while ammonium-N concentrations increase, indicating either suppression of ammonium consumption by nitrification or dissimilatory nitrate reduction to ammonium. Additionally, runoff from agricultural (nitrate-N concentration) and urban (Na content and its influence on Fe and S release) areas appear to impact these N processes, thus highlighting the importance of considering interactions between current land use and legacies such as dams. These results will improve understanding of the long-term effects on hydrologic and nutrient regimes in riparian soils impacted by milldams.