Assimilatory uptake rather than nitrification and denitrification determines nitrogen removal patterns in streams of varying land use

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ABSTRACT: Agricultural and urban land use increase nitrogen (N) concentrations in streams, which can saturate biotic demand by plants, algae, and bacteria via assimilative uptake, and by nitrification and denitrification. We studied six streams per year in each of three land-use categories (agricultural, urban, and forested) for 3 yr (n = 18 streams), and we compared whole-stream N uptake and microbial N transformation rates during spring, summer, and autumn. We measured whole-stream removal of added ammonium (NH_4^+) and nitrate (NO_3^-) in the field and quantified sediment nitrification and denitrification rates in laboratory assays. Relative demand for NNH_4^+ (as uptake velocity, Vf) was highest in spring and in streams with open canopies, implying a link with aquatic autotrophy. In agricultural and urban streams, whole-stream removal (as areal uptake, U) of NH_4^+ and NO_3^-, nitrification, and denitrification rates approached saturation at higher inorganic N concentrations. Nitrification and denitrification rates measured in redox-optimized laboratory assays were roughly equivalent, suggesting that in situ redox conditions will determine whether stream sediments are a net source or sink of NO_3^-. Though nitrification and denitrification rates were measured under ideal redox conditions, they were always more than an order of magnitude lower than whole-stream NO{3 uptake, demonstrating their limited influence on wholestream NO_3^- dynamics. Assimilatory processes, which temporarily store N removed from the water column, dominated whole-stream N demand and controlled downstream N flux. The ultimate fate of assimilated N remains unknown; in-channel storage cannot account for it, and thus a key question is what fraction may eventually be stored in downstream depositional zones or denitrified upon remineralization.

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