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A Cross-Ecoregion Evaluation of Nitrogen Fixation and Denitrification in Streams and Rivers of the United States of America

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Objective: Conduct a cross-ecoregion study to test the hypothesis that N_2 fixation and denitrification would co-occur in streams and rivers across a range of reactive N concentrations.

Background:

Typically assumed that nitrogen (N_2) fixation and denitrification do not co-occur in streams and rivers because N_2 fixation is favored in high light, low N environments but denitrification is favored under anoxic, high N conditions.

Recent work in marine and lake ecosystems has demonstrated that N_2 fixation can happen under high N conditions and in sediments, challenging this assumption.

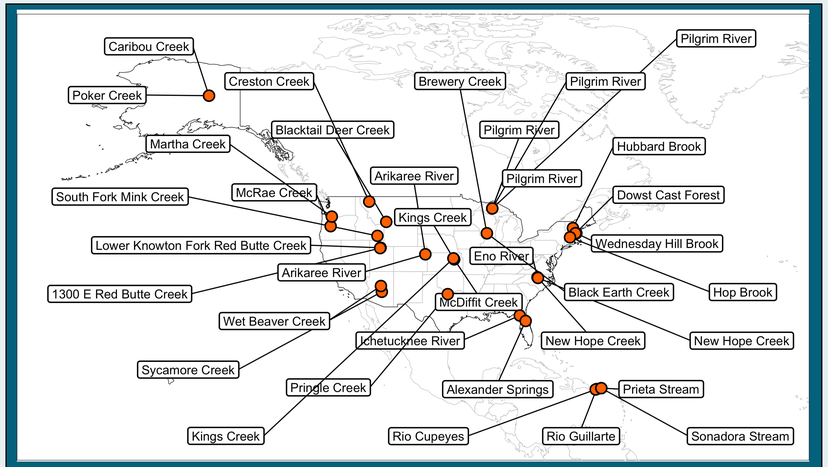

Figure 1. Stream locations sampled for this study. All sites were either part of the StreamPULSE network (https://streampulse.org/) or part of NEON (https://www.neonscience.org/), except the two Red Butte Creek sites, which were part of the iUTAH network (https://iutahepscor.org/) and South Fork Mink Creek in Idaho.

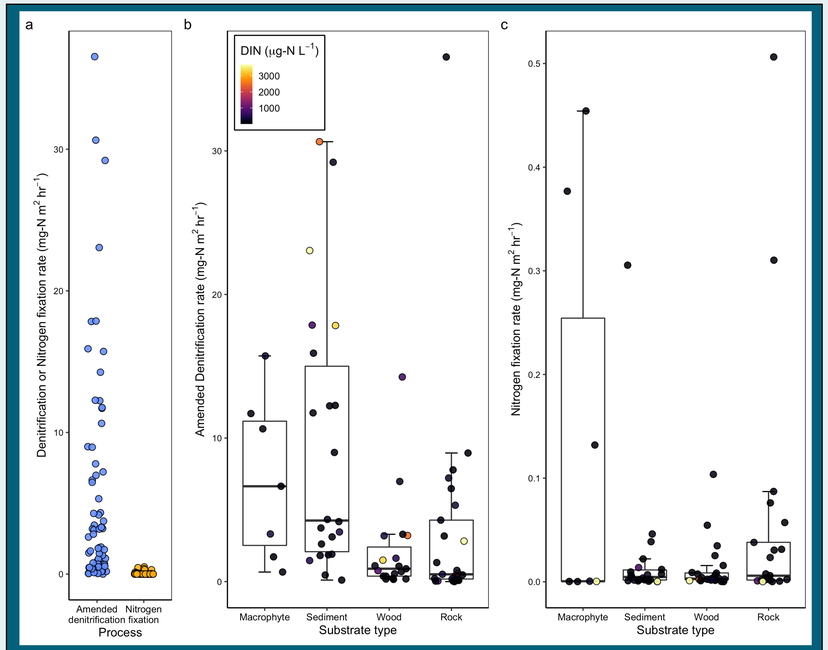

Figure 2. (a) Comparison of rates measured on all substrates, across all streams. (b) Denitrification and (c N_2 fixation rates measured on dominant substrates, with points colored to indicate dissolved inorganic nitrogen (DIN) concentration measured in the stream on that sampling date.

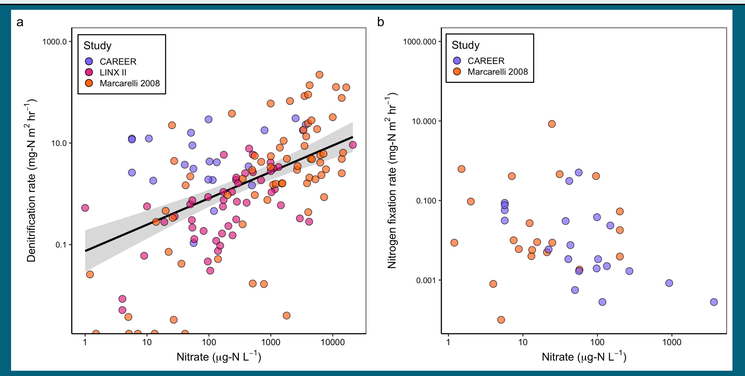

Figure 3. (a) Denitrification [regression R^2 = 0.254, p < 0.001, log(y + 1) = -0.2844 + 0.2833 log(x + 1)] and (b) N_2 fixation rates measured during this study (CAREER) vs. literature review (Marcarelli et al. 2008 https://doi.org/10.1899/07-027.1) and LINX II (Mulholland et al. 2008 https://doi.org/10.1038/nature06686)

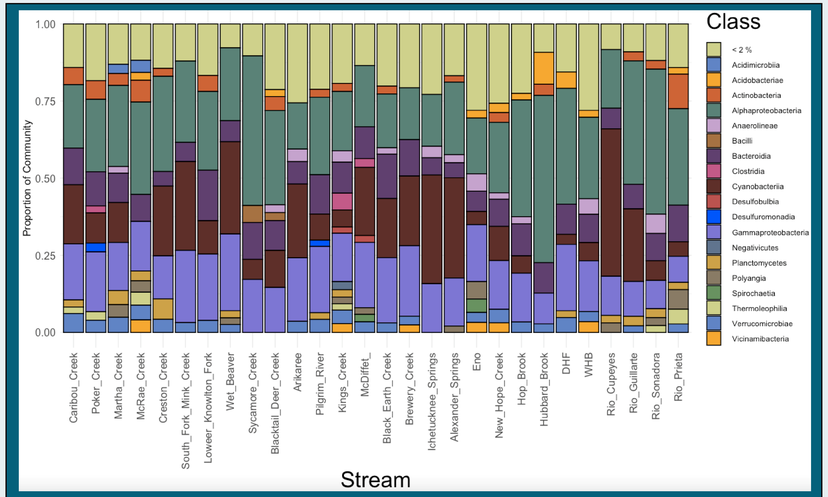

Figure 4. A taxa plot of the % proportion of the microbial community determined using 16S sequencing, represented by specific Class for each study stream. Streams are organized from West to East along the x-axis. Classes that represented < 2% of the overall proportion were grouped together.

Next steps:

Scale substrate-specific rates using benthic cover estimates to compare process co-occurrence and relative contributions at the reach scale.

Evaluate microbial diversity and composition relative to process rates across streams and biomes.

Explore interrelationships between N process rates, stream energy budgets and environmental controls across streams and biomes.

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