Effects of Land Use on Denitrification Potential in Oak Creek

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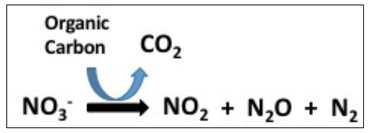
Introduction

Denitrification is a microbial process in which nitrate (NO_3^-) is Reduced to dinitrogen gas (N_2).



This process is considered desirable in streams that are polluted by NO_3^-, which can lead to eutrophication and associated ecological disruptions. Previous work suggests that areas with high concentrations of ambient NO_3^- are likely to have higher denitrification rates than areas that are nitrogen-limited. Our experiment examines how potential denitrification rate in Oak Creek (a tributary of the Verde River in Northern Arizona) is influenced by a land-use (rural-urban-agricultural) gradient.

PRIMARY RESEARCH QUESTION: How do changes in NO_3^- inputs along a land use gradient influence stream denitrification?

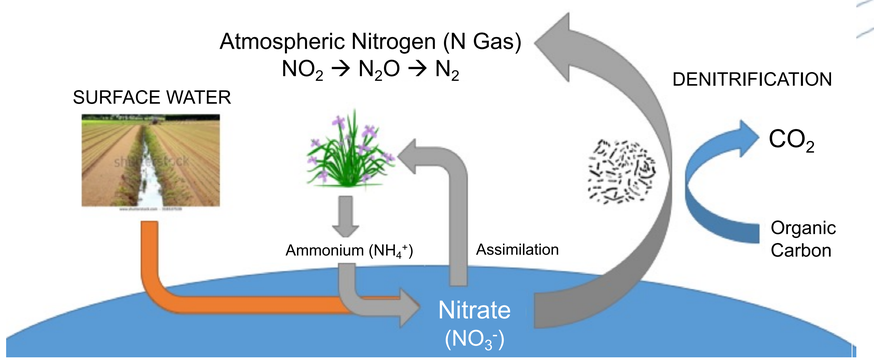


Figure 1. Inputs to the nitrogen cycle & denitrification

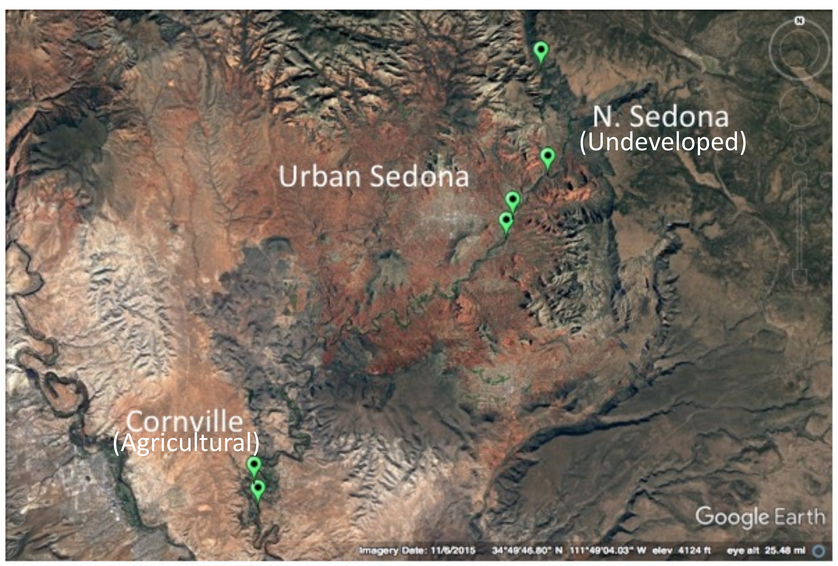


Figure 2. Map of six study sites, labeled by land use area

Hypotheses

H1: NO_3^- is an important limiting factor to denitrifiers in Oak Creek.

- NO_3^- concentration in undeveloped sites is low relative to that in other land uses (urban, agricultural)
- Additions of NO_3^- will increase potential denitrification rate

H2: Difference in NO_3^- inputs between land uses will result in the following pattern:

- Undeveloped sites: lowest pot. denitrification rate
- Urban sites: intermediate pot. denitrification rate
- Agricultural sites: highest pot. denitrification rate

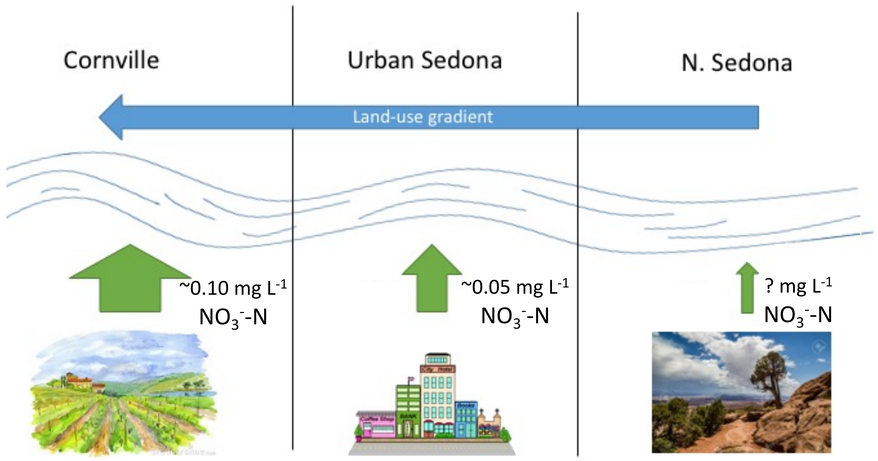
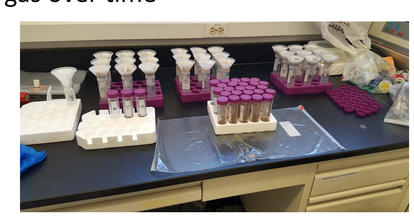


Figure 3. Land use gradient and nitrate concentration

Methods

- Two study sites established in each land use zone (Figure 2)
- Sediment and water samples collected from each site
- Extractable NO_3^- and organic matter content of sediment measured prior to analysis
- Sediments assessed for potential denitrification rate using a denitrification enzyme assay (DEA) (Figure 3)
  - Acetylene blocks the final denitrification step $N_2O \rightarrow N_2$ and the N_2O produced is proportional to enzyme activity
  - Additions of NO_3^- and labile C assess potential limitation to denitrifiers
  - Gas samples taken from each microcosm at four time points, capturing production of N_2O gas over time



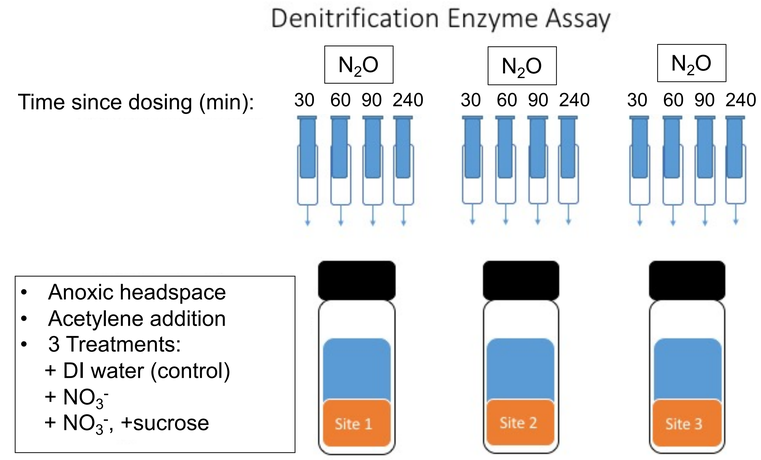


Figure 4. Denitrification Enzyme Assay (DEA)

Future Work

- DEA gas samples and soil extracts will be analyzed using a gas chromatograph and LACHAT, respectively.
- ANOVAs (analysis of variance) will assess potential significant differences between sites
- Regression analysis will assess significant drivers of potential denitrification in Oak Creek
- Potential denitrification rates will be used to assess the merit of measuring in situ whole-reach denitrification in Oak Creek

Implications

- This project advances knowledge regarding nitrogen inputs and processing in urban and peri-urban land use types in Arizona
- Future development and land use changes could have implications for nitrogen cycling and microbial processes in streams
- Development of desert streams (which are historically highly nitrogen-limited) shifts limitation regimes, altering the base structure of ecosystems
- As part of the long-term Stream PULSE research project, this study helps link denitrification to stream metabolism and carbon cycling

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