Evaluating In-Stream Denitrification: Pilot Studies and Site Characterization

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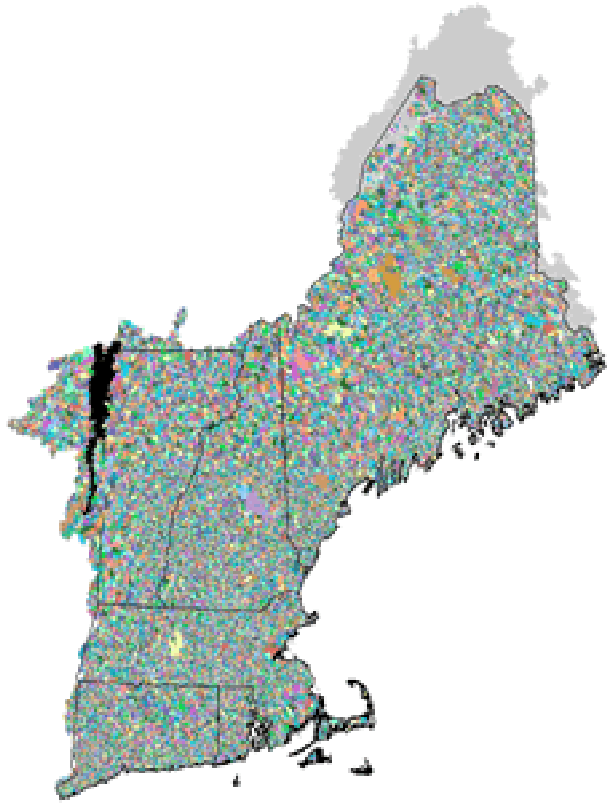
Objectives

- What factors affect the extent of nitrate removal in streams?
- Does the reach-scale isotope method have the resolution necessary to evaluate in-stream denitrification rates in the settings and conditions found within lower-order streams in Rhode Island?
- How sensitive is the method to seasonal variation?
- What is the extent of the variation in the results during static stream conditions?

Justification

Sparrow model:

- Variation in risk of N delivery to coastal areas from each stream reach catchment
- Not related to distance from the shore but rather it is based on other factors such as stream size, land use and other site characteristics



Approach

Before the study:

- injected a slug of rhodamine in the first and last 10 m of the reach three times in summer and fall 2006

- assessed initial velocity and discharge along the entire stream reach using steady-state injections of rhodamine one week before the N15 study

- collected hydrologic and ambient chemical data from the stream reach:
    - nitrate
    - ammonium (NH4)
    - bromide (Br)
    - dissolved oxygen (DO)
    - pH
    - temperature

Approach

- Reach-scale isotope tracer method:
- Inject solution of 15-N labeled Nitrate, a solute conservative tracer, Bromide (Br^-), and a gas conservative tracer, sulfur hexafluoride (SF_6)
  - Collect samples at 6 downstream stations and analyze for $^{15}N_20$, $^{15}N_2$, Br^- and SF_6.
  - Three replicates in summer (low flow) and three replicates in fall (high flow, leaf fall)

Why use Isotopes?

- Nitrate to conservative tracer ratios, such as Br-, do not provide us with the necessary resolution to analyze the denitrification potential within our stream

- Accounts for in-stream cycling and groundwater inputs

- Discriminate between denitrification, uptake and retention.

Study Site

- 500 meter reach of $1^{st}/2^{nd}$ order stream in Wood-Pawcatuck watershed; Kingston, Rhode Island
- Forested watershed- some agricultural land use
- Glaciofluvial outwash
- Red maple swamp riparian area
- Low ambient nitrate

Site and Methodical Considerations

- Down gradient variability in hydrologic and chemical constituents
- In-stream and hyporheic flow paths influence nitrate retention rates and biogeochemical pathways
- Seasonal variability in flow rate, N loading and carbon dynamics

Progress to Date

- 6 reach isotope analyses completed (3 in summer, 2006; 3 in Fall, 2006)
- All samples sent off for 15-N analysis
- Initial observations of nitrate vs. Br^- ratios show possible denitrification occurring in summer samples
- 15-N analysis will provide the resolution necessary to fully assess the denitrification occurring in the stream

Applications and Future Work

- Continue working towards establishing the reach-scale isotope method
- Assess the capabilities of this method on multiple streams
- Locate areas within landscape that act as substantial N sinks
- Improve management by targeting lower water systems that have high N removal potential

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