Seasonal Nitrate Dynamics in an Agricultural Stream in New Hampshire

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Background on Nitrate (NO_3^-)

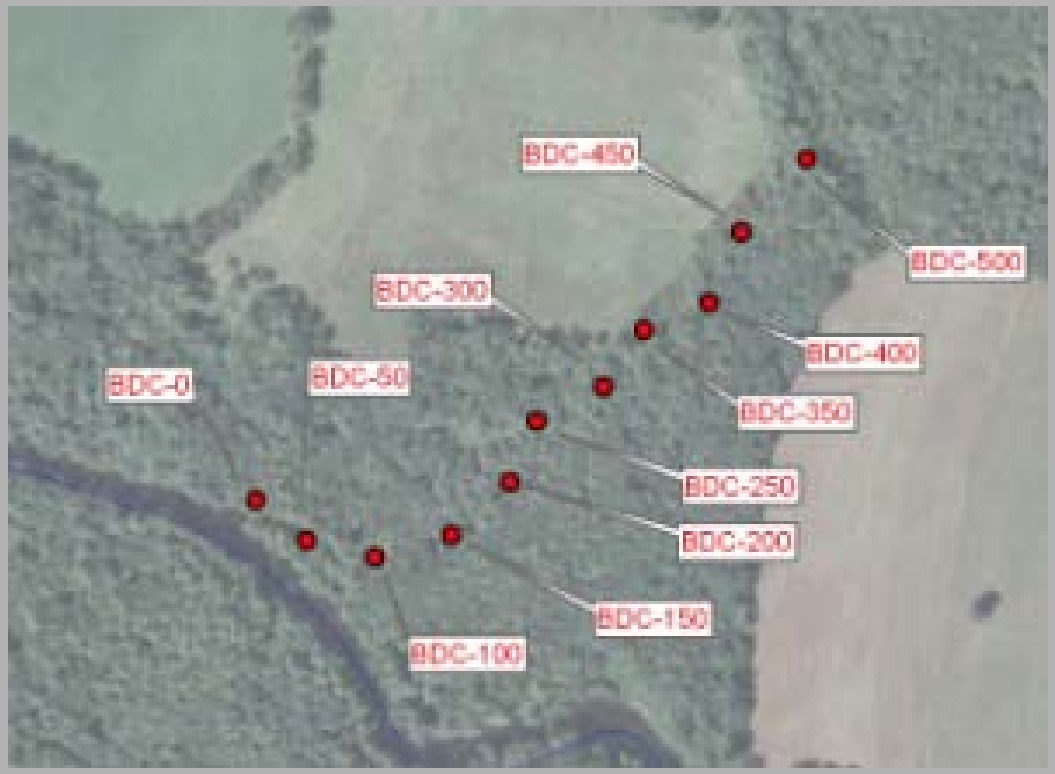
- Sources of NO_3^- to aquatic ecosystems:
  - Manure and fertilizer
  - Sewage
  - Atmospheric deposition

- NO_3^- is necessary for biological growth
  - Plant and algal uptake
    - Slows transport
  - Denitrification
    - Permanently removed from water column

- High NO_3^- loading can cause saturation, leading to reduced uptake
  - Reduced uptake can impact water quality
    - Eutrophication
    - Federally listed drinking water contaminant

Mulholland et al. 2004

Burley-Demeritt Creek (BDC)



- On the UNH Organic Dairy Farm, Lee, NH
- Discharges into Lamprey River and ultimately Great Bay Estuary

Objectives and Methods

- Measure seasonal differences in NO_3^- uptake
  - Short-term NO_3^- and conservative tracer (Br^-) additions

- Measure longitudinal differences in potential sediment denitrification
  - Denitrification Enzyme Assays

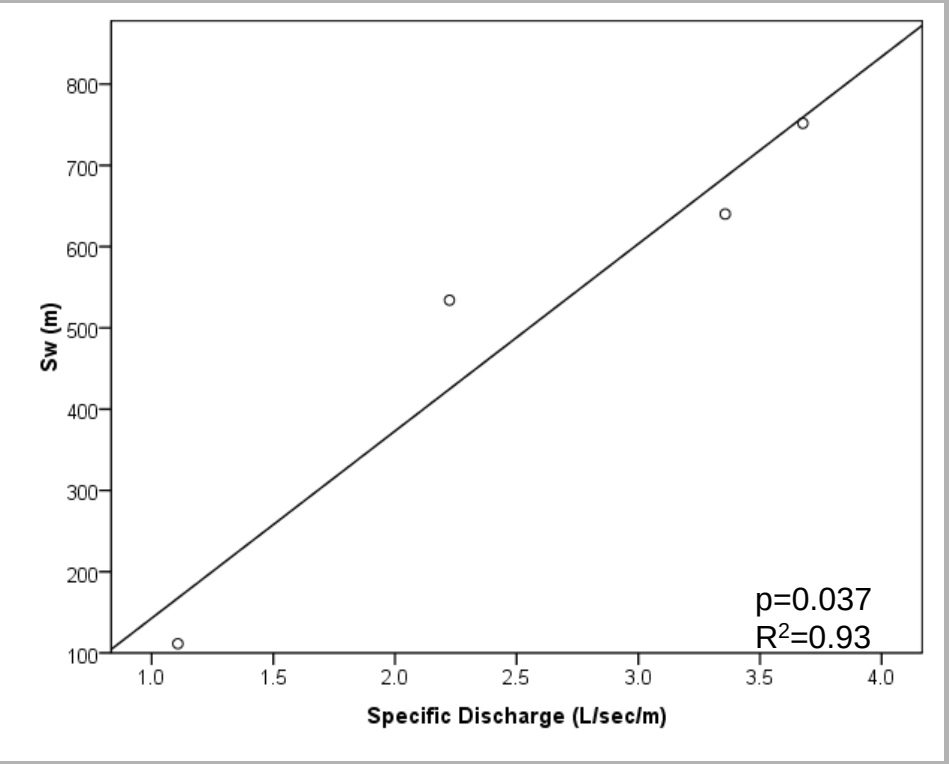
Key Results

- NO_3^- is only taken up in autumn (non-significant uptake in spring and summer)
  - Ecological implications
  - Interestingly no uptake in spring or summer, typically peak biological activity
  - Uptake in autumn may be from increased light and carbon availability

Comparison to other studies:

Study	Uptake Length m	Uptake Rate ug N/m2/min	Uptake Velocity mm/min	Notes
BDC, 2009	504	317	0.36	Mean of 4 autumn additions
Hall et al. 2009	777	Variable	0.42	Mean of 72 streams (agricultural, urban and reference)
Ensign and Doyle 2006	416	56	2.80	Mean of 53 first-order streams

Key Results (cont.)

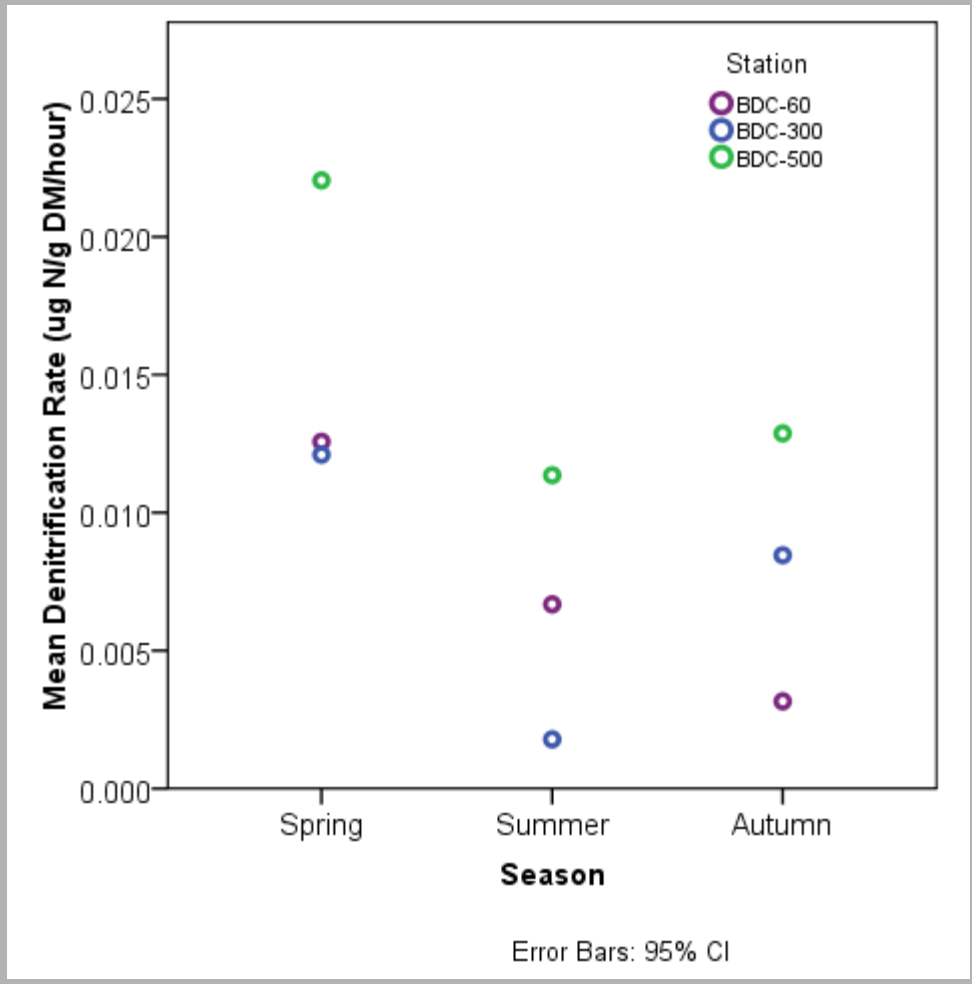


- Positive correlation between uptake length and specific discharge
  - Higher specific discharge reduces contact time with benthos, increasing uptake length

Peterson et al. 2001, Grimm et al. 2005

Key Results (cont.)

- Potential denitrification was extremely low
  - Actual rates are likely lower
- Higher denitrification rates at BDC-500 (predominantly organic matter)
- Denitrification responsible for 16% of NO_3^- removal in 72 other streams (LINX II)



Mulholland et al. 2008

Preliminary Conclusions and Potential Explanations

- Denitrification is likely not a dominant form of NO_3^- removal at BDC
- Possible light- or carbon-limitation
  - Leaf fall increases carbon and light availability
- Ammonium (NH_4^+) may be taken up prior to NO_3^-
  - NH_4^+ is more biologically available than NO_3^-

Peterson et al. 2001

Questions?