Nitrogen Cycling in Headwater Wetlands across Condition Gradients in Pennsylvania and Ohio

J.B. Moon, D.H. Wardrop, M.S. Fennessy, H.M. Ingram, and N. Kirchner
Wetland Condition: Landscape Context
Low Condition

Landscape

Wetland

Soil Maps

NH4⁺  SOM  pH

Water Table Depth (cm)

Percent Ground Cover

Microbial Community Biomarkers

- Suburban
- Water
- Pasture
- Wetland
- Row Crop
- Forest
- Commercial

Other
Invasive
Introduced
Herbaceous Generalists
Herbaceous
Herbaceous Specialists
Shrub Seedling
Tree Seedling
Moss
Bare

Landscape Wetland

Forest
Wetland
Commercial
Pasture
Row Crop
Water
Study Objective

Build models that describe the relationships between landscape context and ecosystem services through links among intermediate structural wetland components.

Talk Focus

Determine if any signals exists between general landscape context and nitrogen cycling pathways (i.e., denitrification, nitrogen mineralization).
Headwater Wetland Study Sites

- Sites
- Cities
- Ecoregions
- State Boundaries

Map showing study sites in the eastern United States, including cities like Cleveland, Akron, Pittsburgh, and Philadelphia, as well as ecoregions such as the Erie Drift Plain and Western Allegheny Plateau.
Landscape Context for Study Sites

Percent Landscape Cover

Forest
Development
Agriculture

200 m
Nitrogen Cycling: Sampling Scheme

- Denitrification Potential: Push-Pull (n = 2-3)
- Denitrification Potential: Acetylene Block (n = 5)
- Nitrogen Mineralization (n = 4)
- Monitoring Well (n = 3)
Nitrogen Cycling: Sampling Scheme

- 20 atom % $^{15}$N-Enriched KNO$_3$ (32 mg N • L$^{-1}$)
- ~4 Hours
  - $^{15}$N as N$_2$ and N$_2$O
- ~30 Days
  - NO$_2^-$ + NO$_3^-$ and NH$_4^+$
- ~2 Hours
  - N$_2$O
  - 0.85 g • L$^{-1}$ KNO$_3$
  - 1.00 g • L$^{-1}$ Glucose

Denitrification Potential: Push-Pull

F-statistic = 4.57
df = 2
P-value = 0.039

μg N • kg soil⁻¹ • day⁻¹

N₂O
N₂

Forest Development Agriculture
Denitrification Potential: Acetylene Block

μg N • kg soil⁻¹ • day⁻¹
Denitrification Potential
Push-Pull vs. Acetylene Block

Acetylene Block (μg N • kg soil\(^{-1}\) • day\(^{-1}\))

Push Pull (μg N • kg soil\(^{-1}\) • day\(^{-1}\))

Forest
Development
Agriculture
Denitrification Potential vs. Ambient Conditions

**Push-Pull Ambient Conditions**
- **DO**
- **pH**
- **Temperature**
- **Conductivity**

**DOC (mg C • L⁻¹)**

\[
\text{DOC} = 28.217(\text{Denitrification}) + 64.728 \quad R^2 = 0.445
\]

**Graph**
- **X-axis:** DOC (mg C • L⁻¹)
- **Y-axis:** μg N • kg soil⁻¹ • day⁻¹

**Legend**
- Forest
- Development
- Agriculture
Nitrogen Cycling: Mineralization

![Graph showing Ammonification and Nitrification rates with F-statistic and P-value](image)

- Ammonification
- Nitrification

F-statistic = 4.31
df = 2
P-value = 0.019

μg N • m² • day⁻¹
Mixed Landscape: Nitrification

Nitrification

\[ R^2 = 0.943 \]

\[ \text{AIC} = 171.25 \]
Next Steps for Nitrogen Cycling Component

Finish data collection, processing, and analysis

Construct/test models that describe the relationships among denitrification and structural components of wetlands

Compare denitrification methods, including soil $\text{N}^{15}$ values, which were also collected in the recent National Wetland Condition Assessment
Acknowledgements

Melanie Harrison
Gregory Noe

Cary Institute
Peter Groffman
Kate Shepard
Lisa Martel

Penn State Crew
Kyle Martin
Marla Korpar
Brett Dietz
Aliana Reichert-Eberhardt
Becca Baker
Joseph Bishop

Kenyon Crew
Sally Wilson
Sally Mosley
Sabrina Arora
Zack Morrow