Nitrogen cycling in stormwater control measures: Implications for coastal water quality

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Outline

1. Nitrogen (N) pollution and SCMs
2. Methods
3. Effects of **Age**
4. Effects of **Temperature**
5. Implications for Management

Stormwater nitrogen pollution

Sources in stormwater

- Wastewater (leaky sewers & septic)
- Atmospheric deposition
- Fertilizers
- Animal waste

- **Excess nitrogen** causes eutrophication

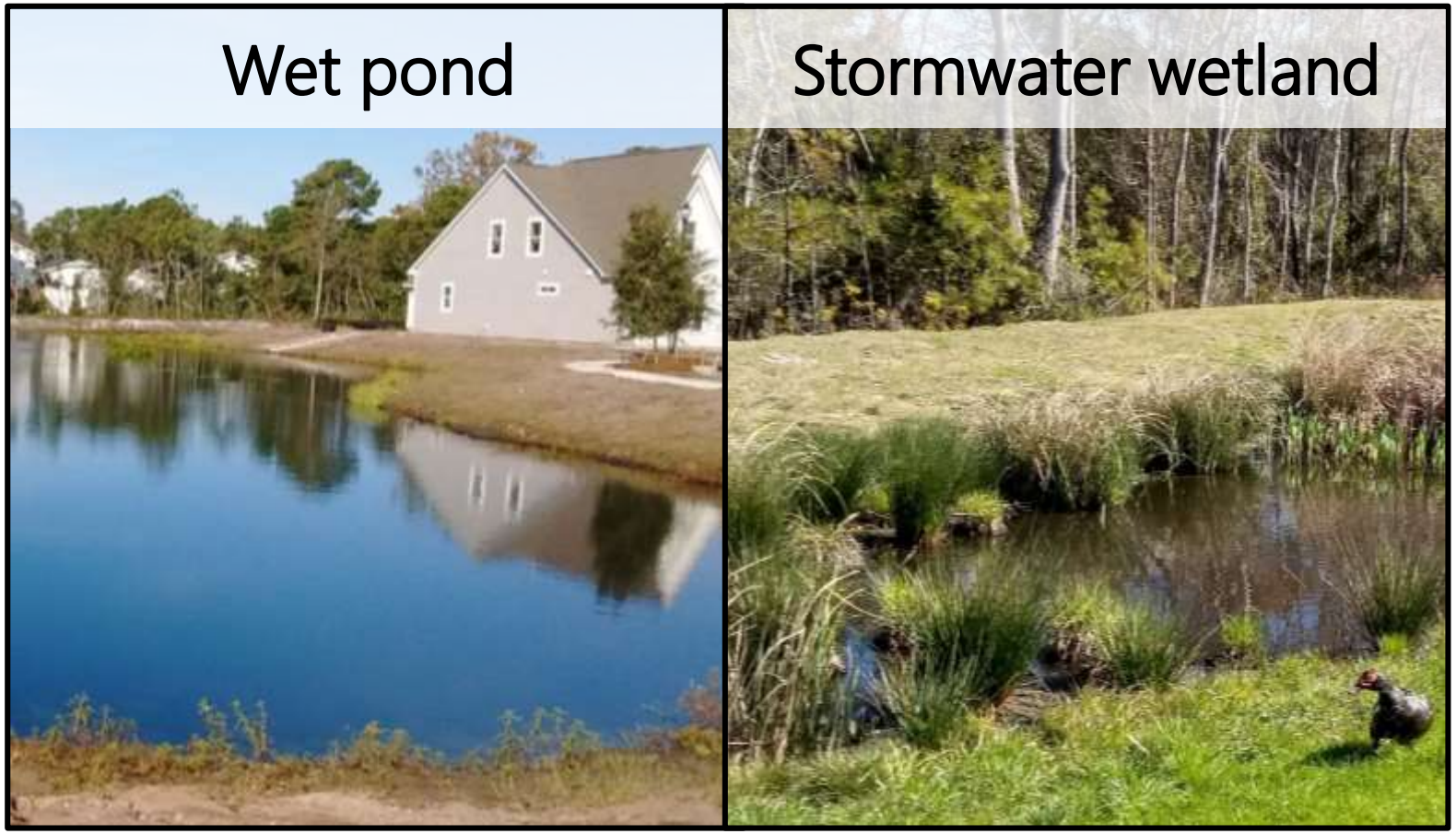
Kaushal et al., 2011

Stormwater control measures (SCMs)

- **Goal:** Mitigate negative effects of development on water quantity and quality

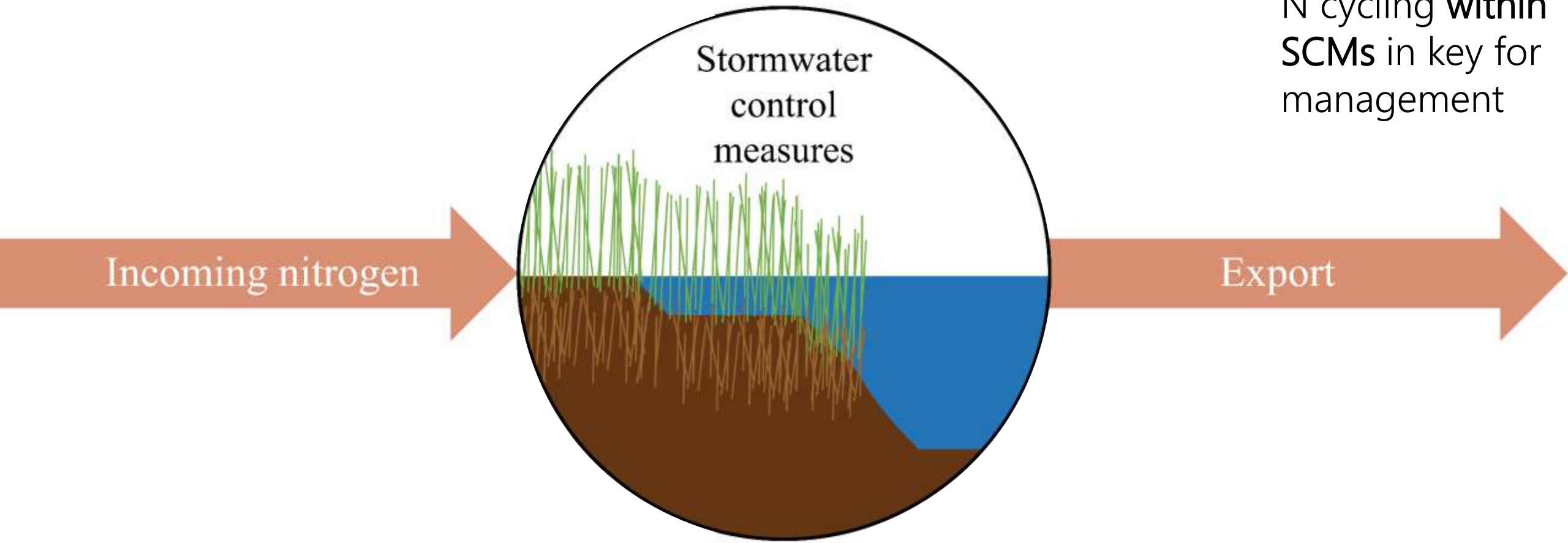
- Potentially important sites for nitrogen removal via **denitrification**

$$NO_3^- \rightarrow N_2$$



SCM nitrogen removal varies but not well understood

Understanding N cycling **within SCMs** in key for management

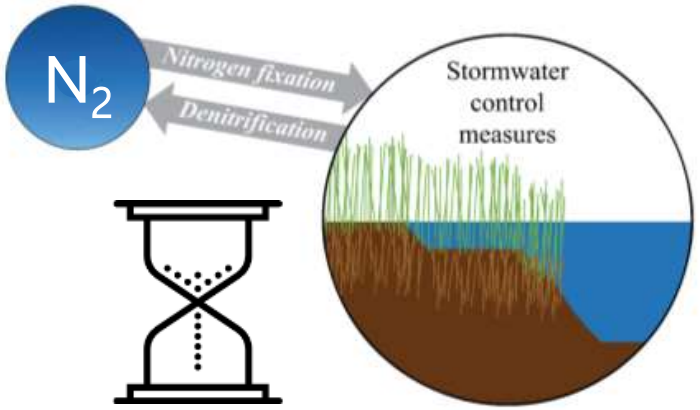


Gold et al., 2019

Research Questions

1. Does **nitrogen cycling** in SCM sediments vary with **temperature**?

2. Does **nitrogen cycling** in pond sediments vary with pond **age**?



Methods

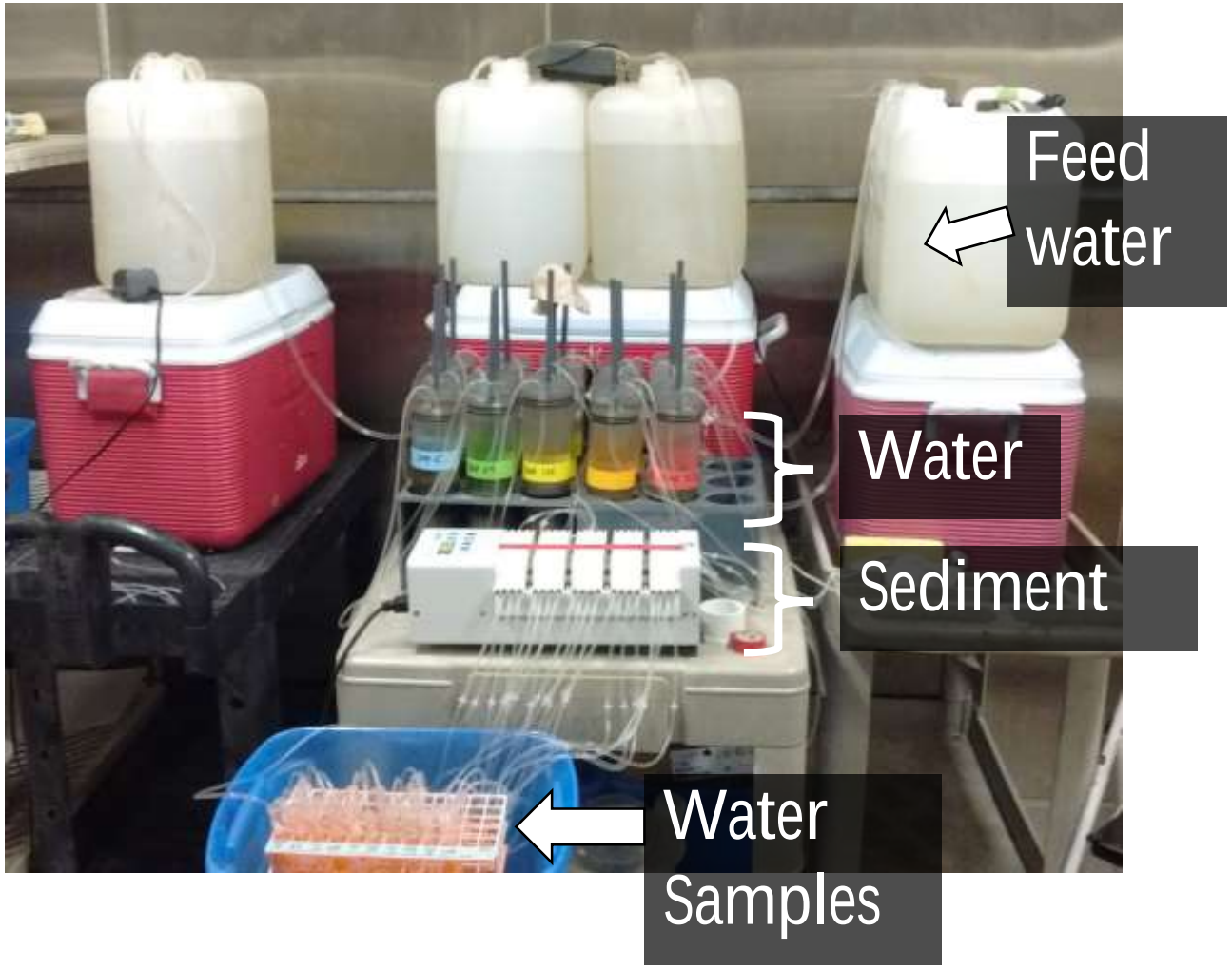
Net N_2 gas fluxes

- Ambient conditions
- "Storm" conditions (+30 uM $NaNO_3$)

Sediment nutrient fluxes

Sediment characteristics

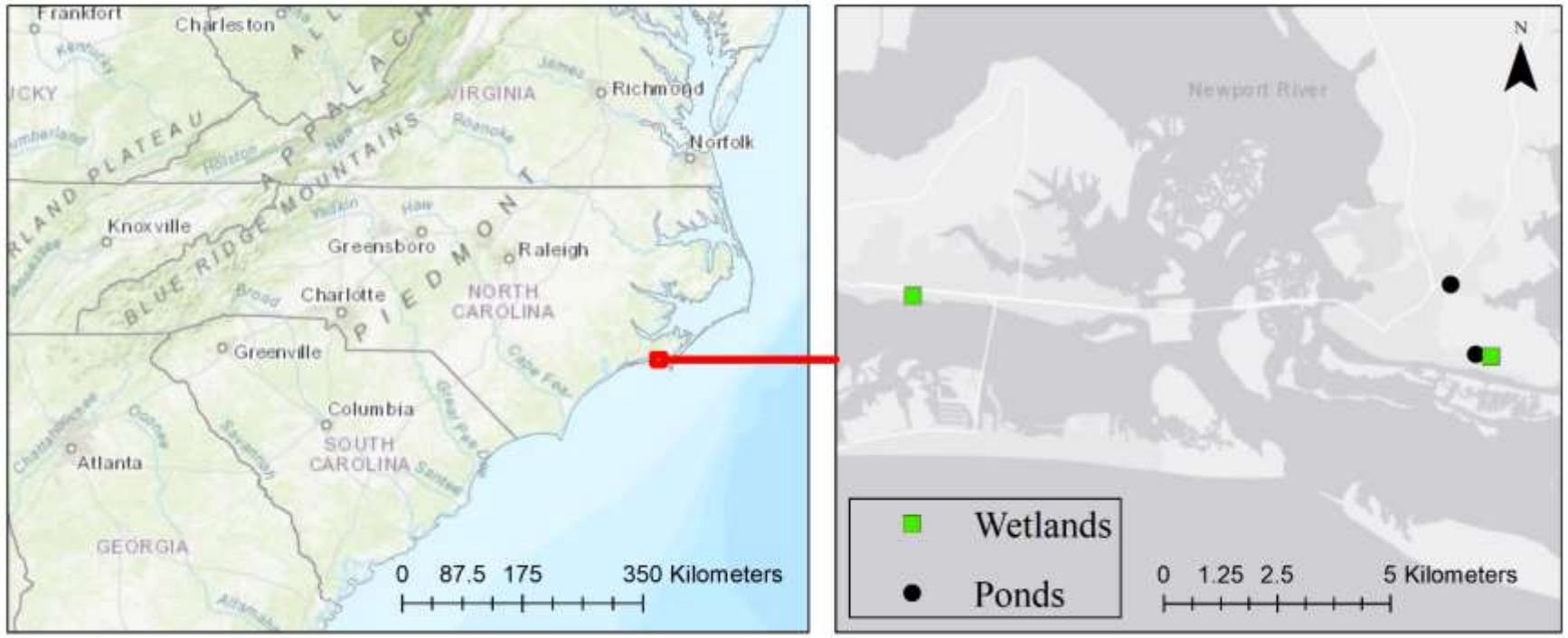
- C:N
- Sediment organic matter



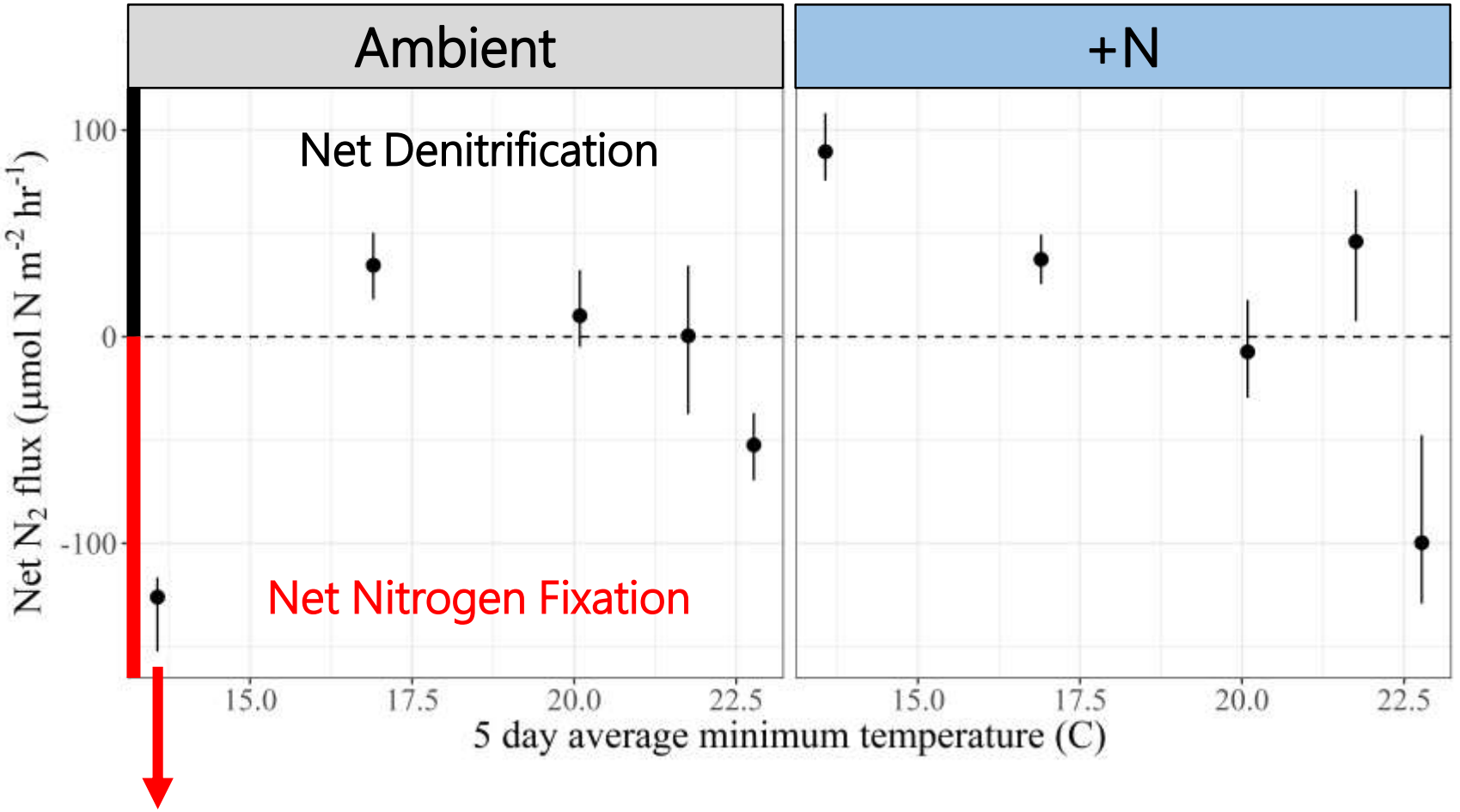
1. Does **nitrogen cycling** in SCM sediments vary with **temperature**?

Study Sites - Temperature

- Morehead City – Beaufort, NC
- 2 ponds and 2 wetlands (old & new)
- Sampled across different seasons (pond n = 5, wetland n = 3)



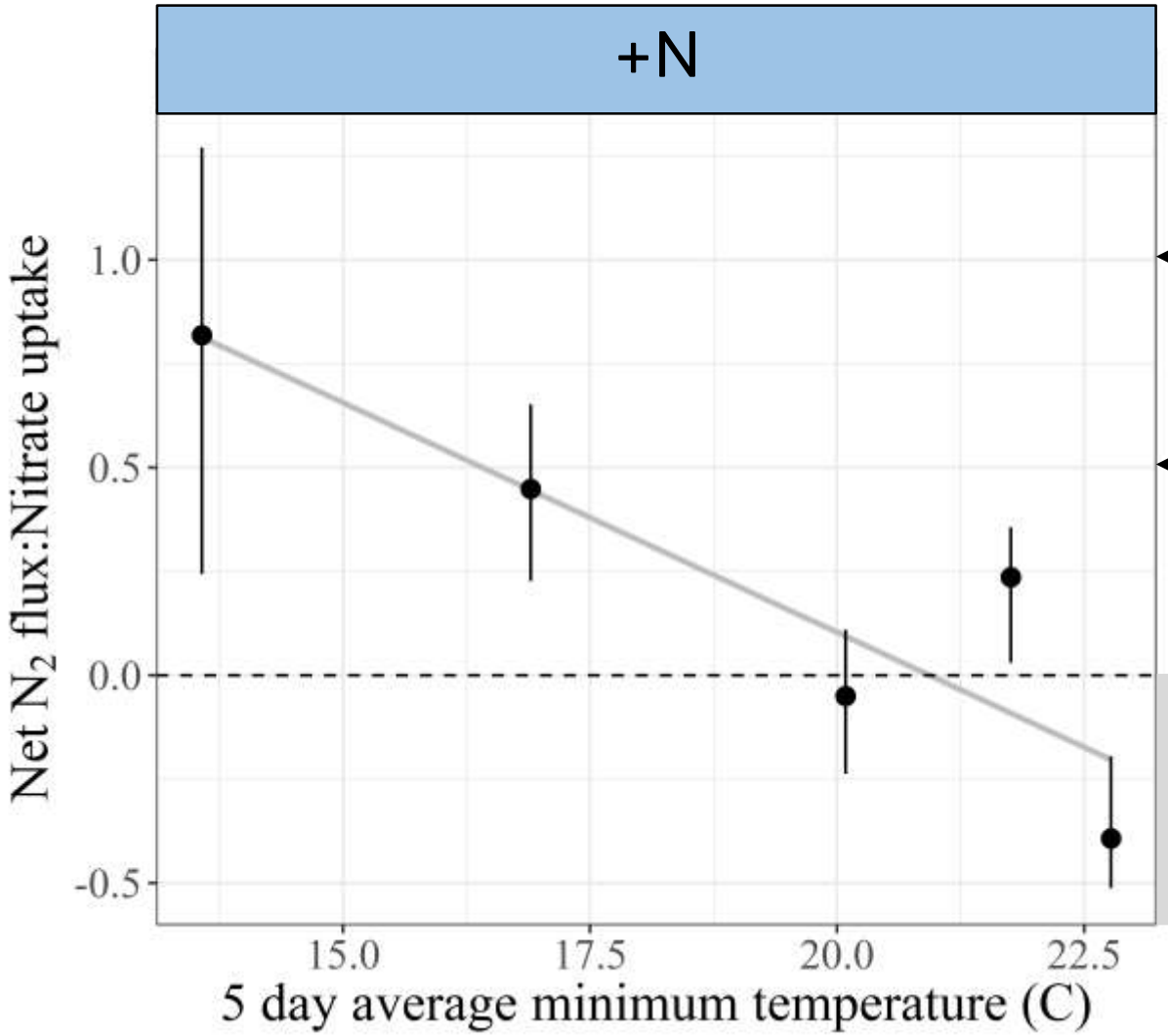
Denitrification decreased as temperatures increased



- Time since rainfall
- Average minimum **temperature** over past 5 days

7 days since last rain

Temporary uptake dominated as temperatures increased

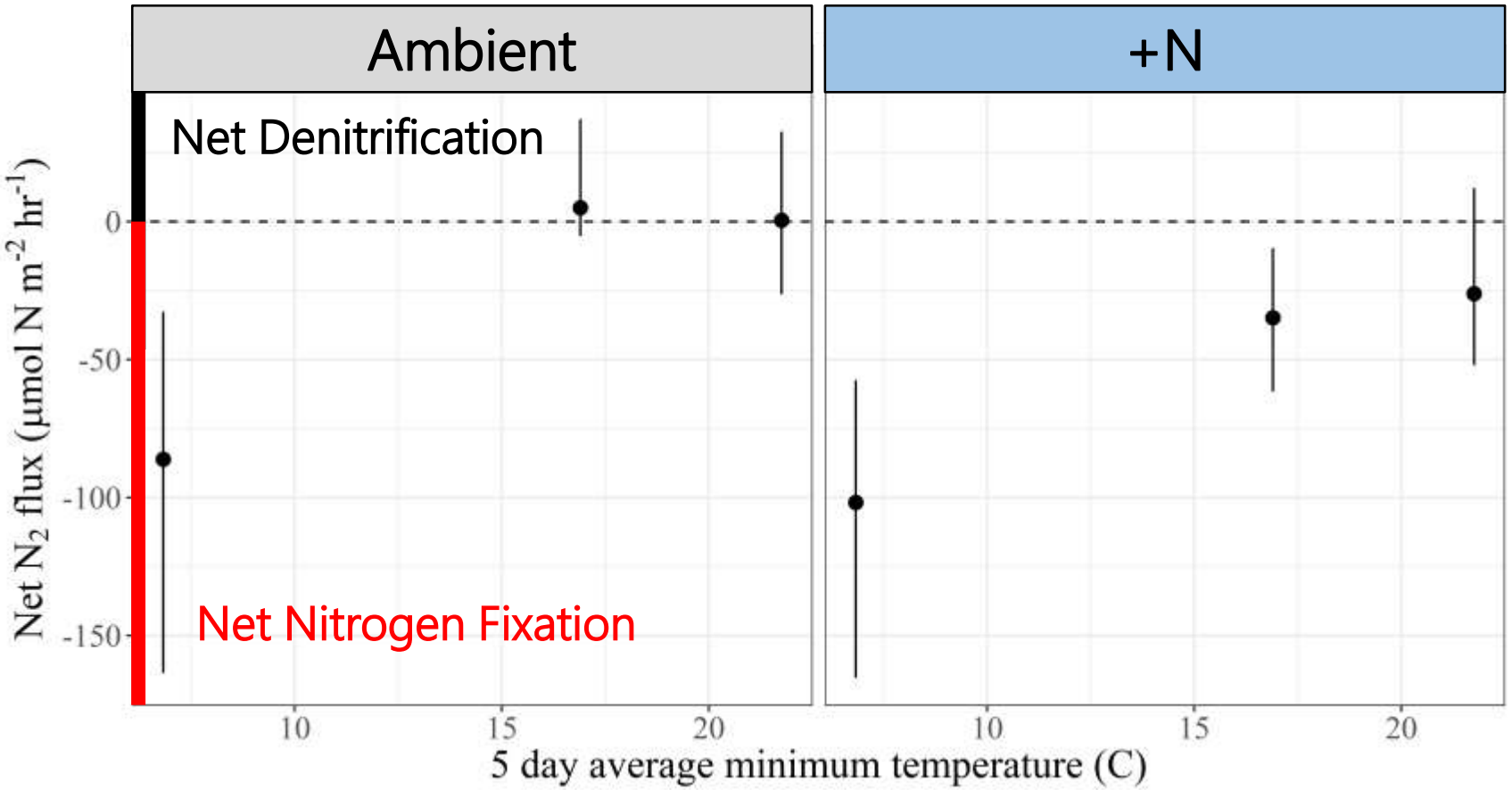


100% denitrification

50% denitrification
50% temporary uptake

Temporary uptake with net nitrogen fixation

Wetland N_2 fluxes increased with temperature



Temporary uptake still dominated

Research Questions

1. Does **nitrogen cycling** in SCM sediments vary with **temperature**?

Yes!

Different reactions to increased temperatures

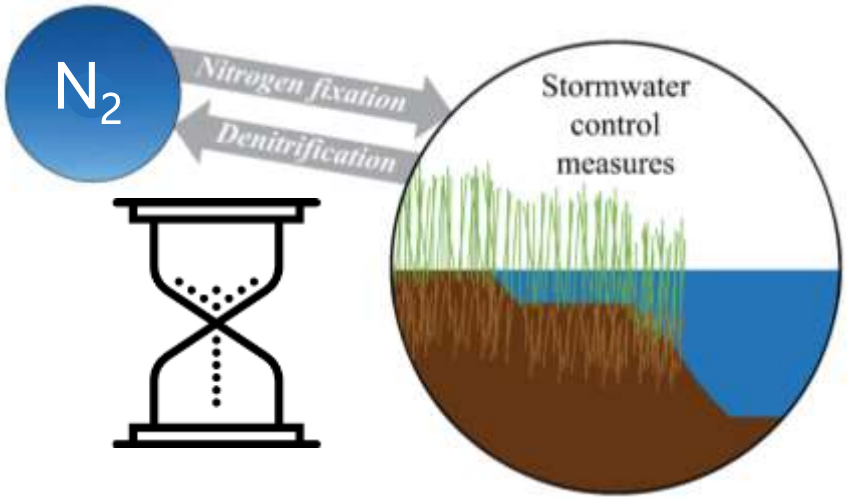
	Ponds	Wetlands
Net N_2 fluxes	↓	↑
Relative importance of denitrification	↓	Low

<u>Important factors</u>

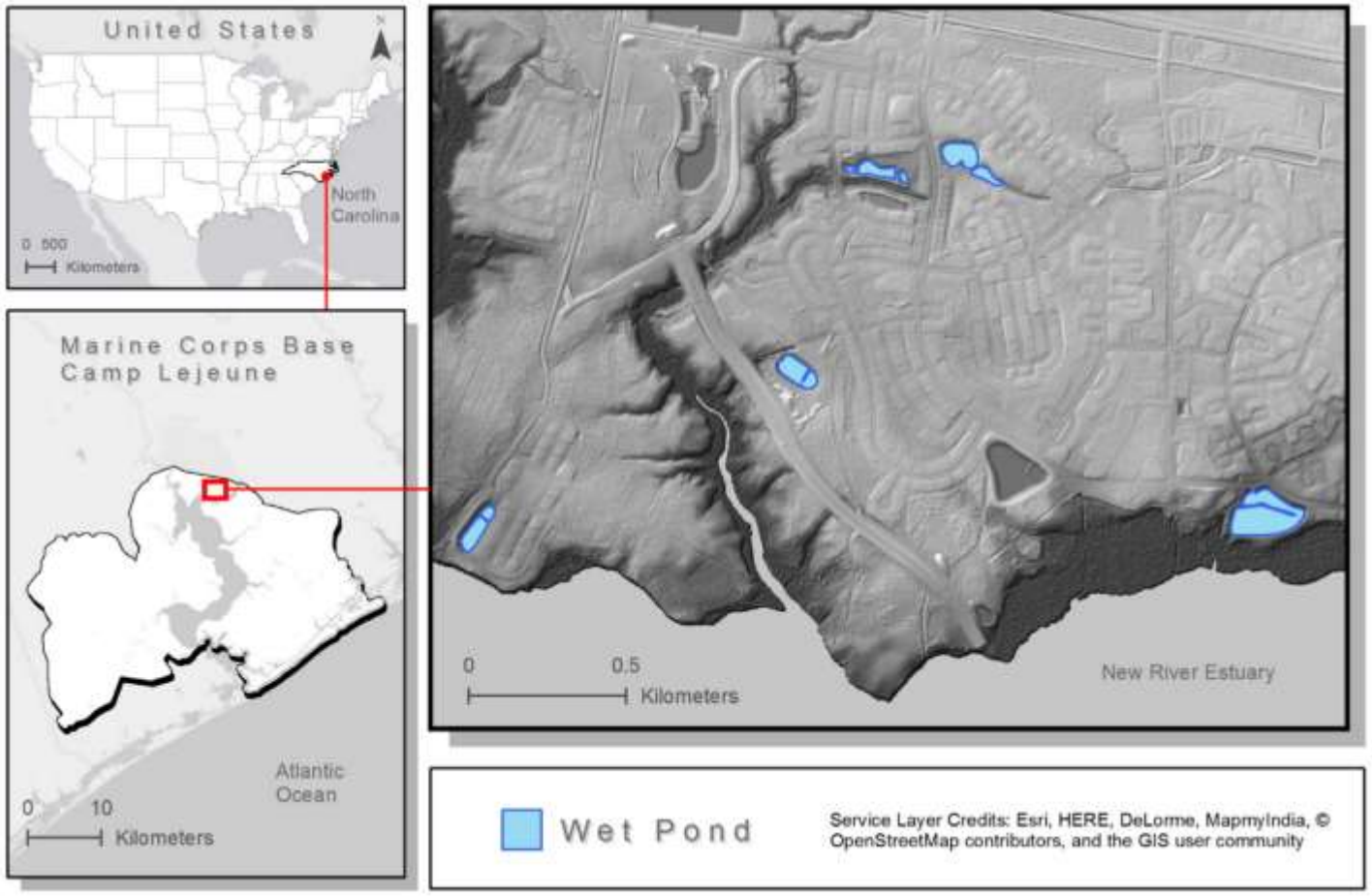
1. Antecedent temperatures
2. Nitrate availability (time since storms)

Photo by
Susan Cohen

2. Does **nitrogen cycling** in pond sediments vary with pond **age**?



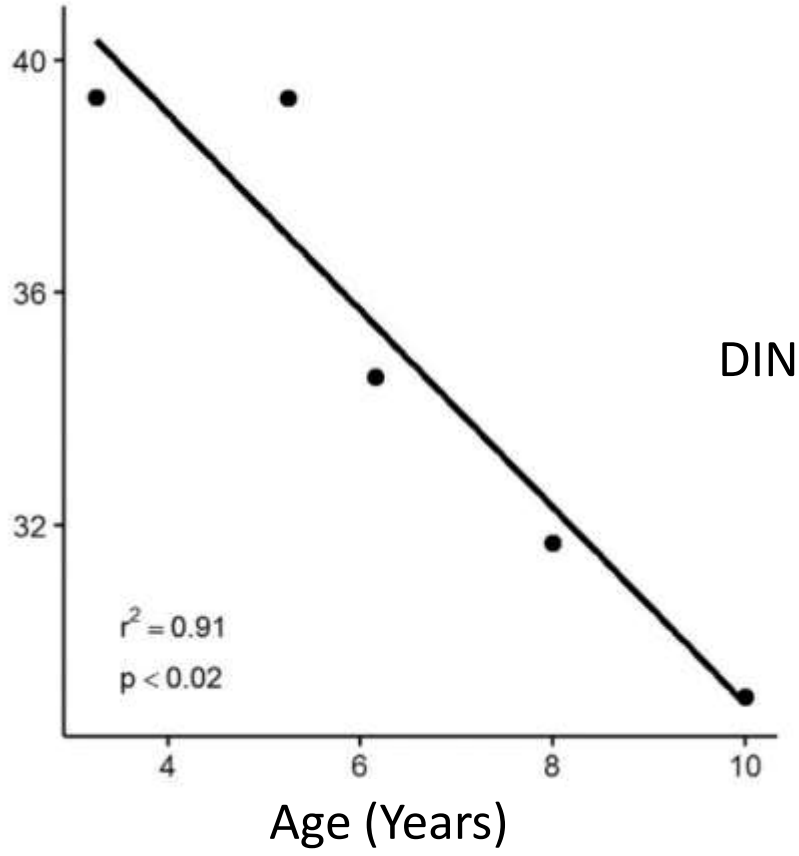
Study Sites - Age



- Camp Lejeune, NC
- 5 ponds of different ages (3 – 10 yrs)
- Late June

Older ponds had less N

Total N



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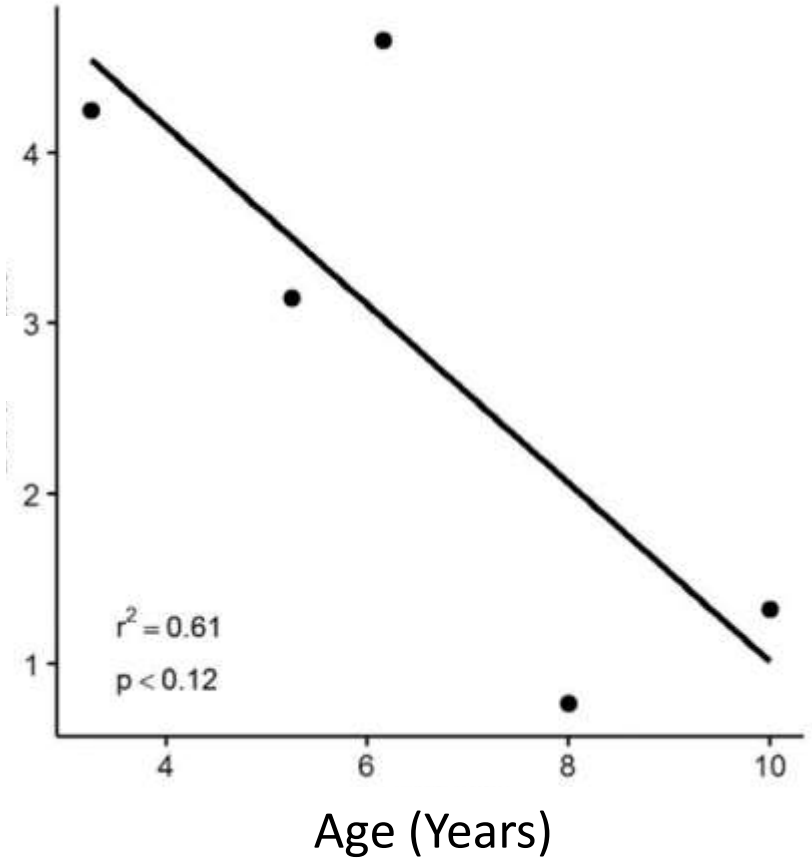

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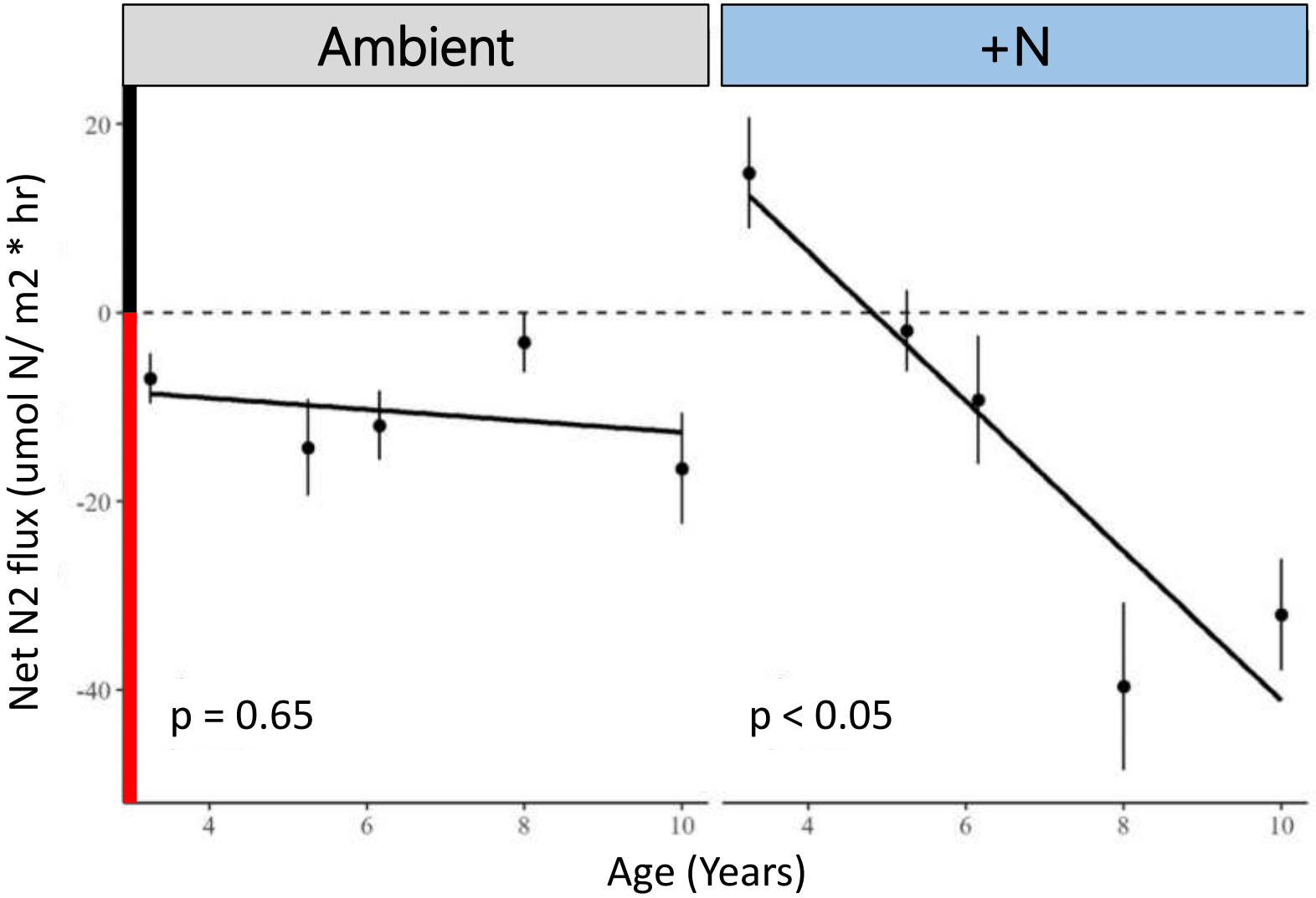
Nitrate did not promote denitrification in old ponds

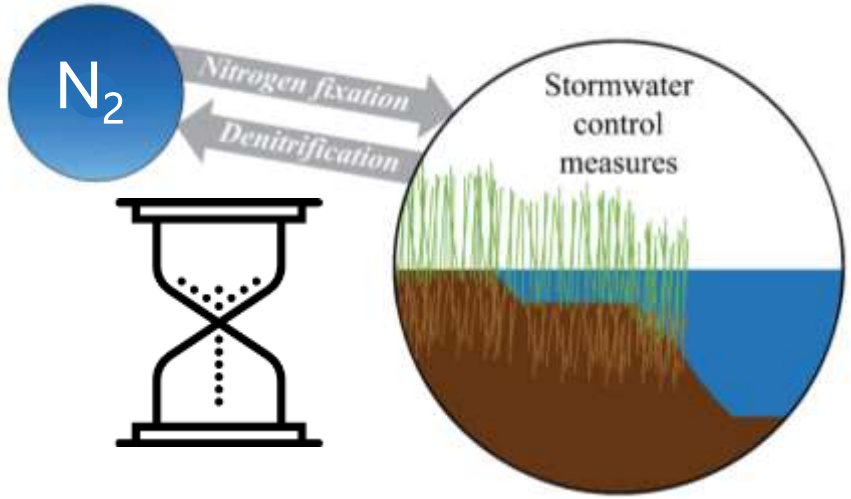


Could be due to uptake in water column

Research Questions

1. Does **nitrogen cycling** in pond sediments vary with pond **age**?

Yes! Net N_2 fluxes decreased with age



<u>Important factors</u>

1. Sediment organic matter

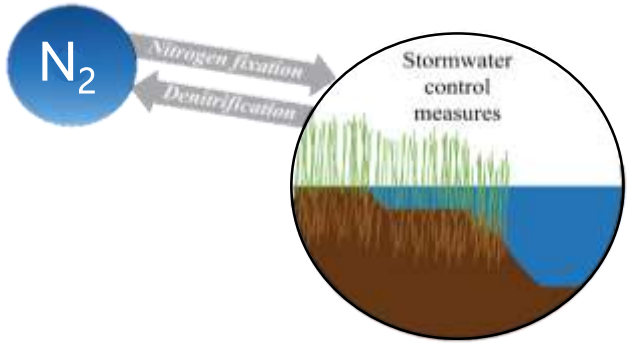
2. Low N concentrations

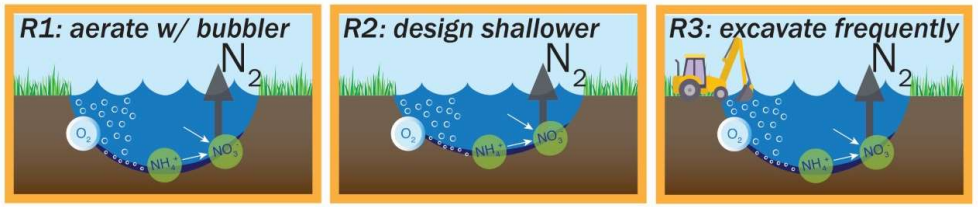
Making SCMs more efficient N sinks

Wetlands: Plants are likely dominant N sink ✓

Ponds: Need to reduce stratification and internal recycling

Conclusions





- Pond denitrification decreased with temperature
- Wetlands did little denitrification, but might increase with temperature

- Newer ponds did more denitrification compared to older ponds

- Aeration, excavation, and shallower design of ponds may promote denitrification

Questions?