



# Reservoir sediment nutrient flux analysis and model

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# Nutrients in the environment

Excess nutrients in aquatic environments can be harmful

- Degrading habitat
- Fueling nuisance algal blooms
  - Depleting water column oxygen
  - Stimulating toxin production
- Ecosystem-wide impacts

Understanding nutrient inputs and outputs and drivers of water quality impairment is *critical* to produce accurate models and maintain ecological function of aquatic systems



Eroded marsh platform, Deegan et al. 2011



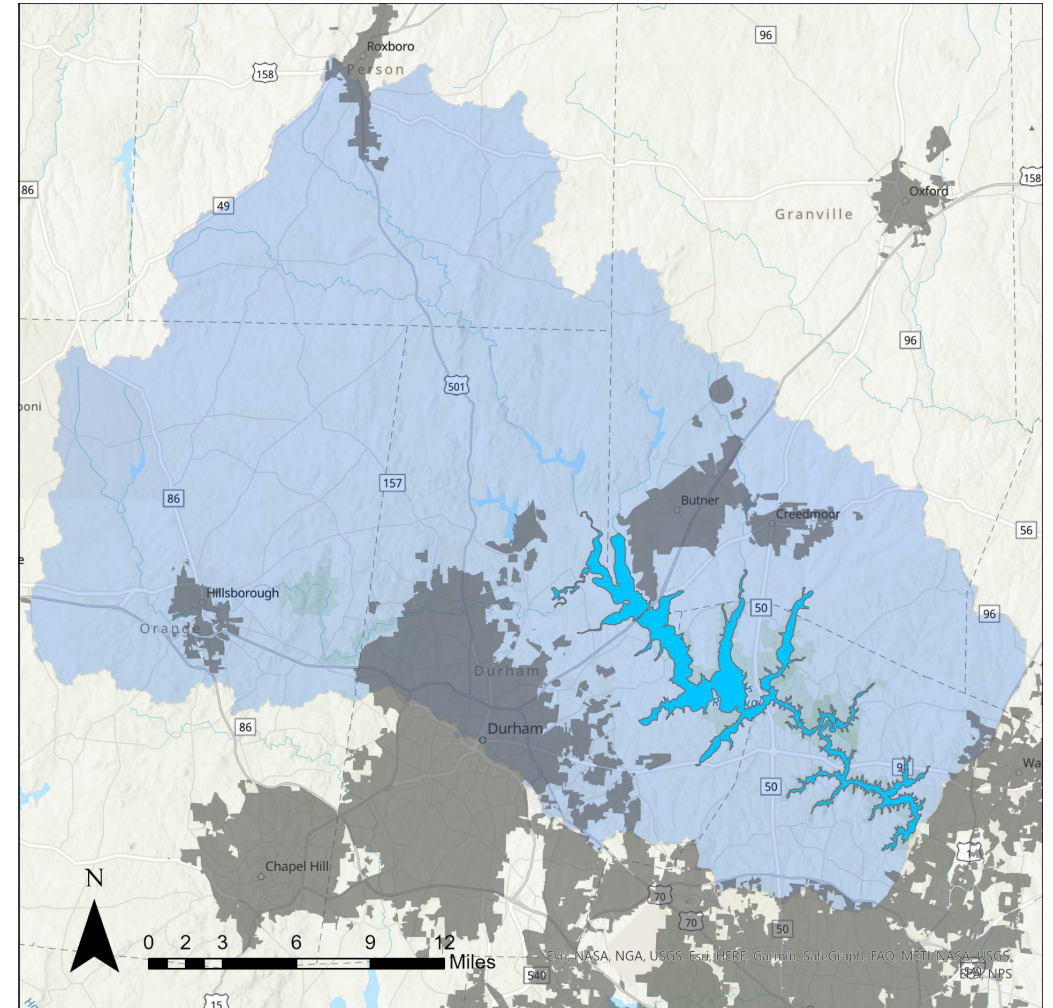
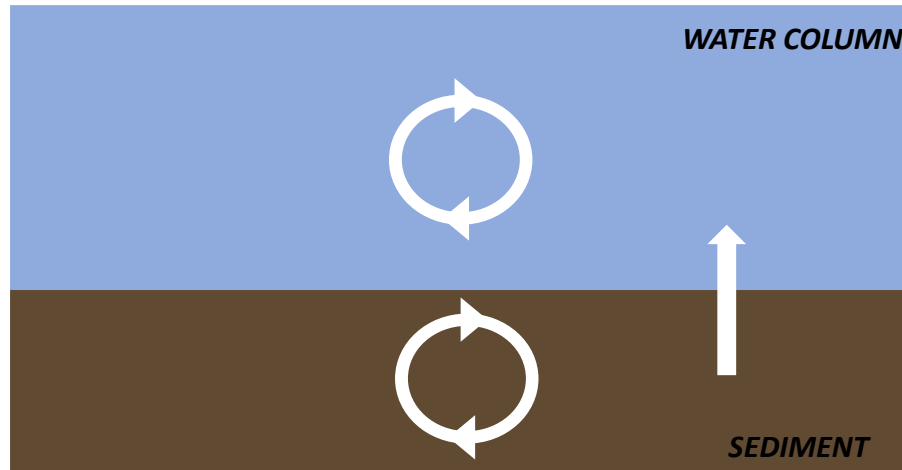
Fish kill



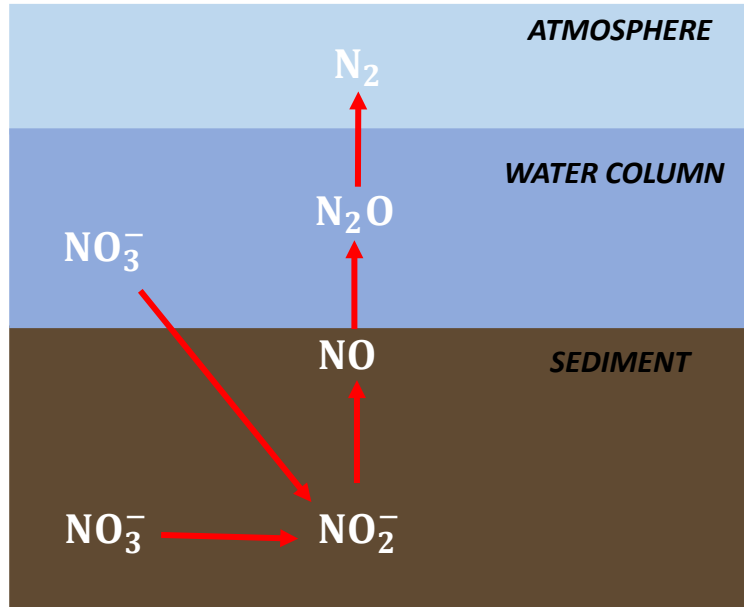
Algal bloom

# Nutrient sources in aquatic systems

- Internal cycling
- Stormwater runoff
  - Urban development
- Legacy nutrients



# Nitrogen sinks in aquatic systems



**Denitrification:** a natural process that converts reactive nitrogen to inert dinitrogen gas, which is permanently lost to the atmosphere

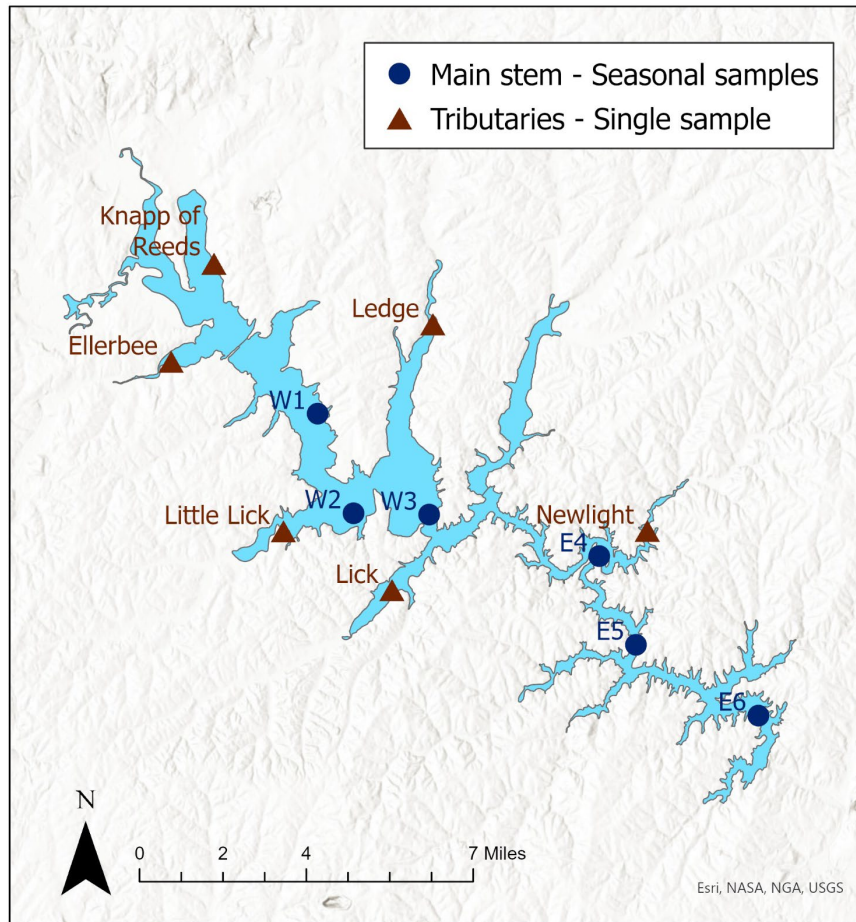


Less is known about nutrient dynamics in an urban reservoir

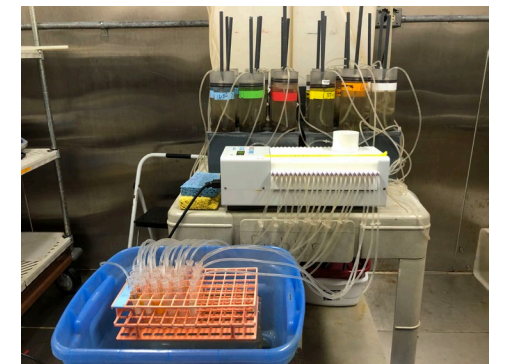
# Research questions

1. Are there environmental predictors (e.g., temperature and dissolved oxygen) of nutrient fluxes in the main stem of Falls Lake?
2. How does development affect nutrient cycling in Falls Lake tributaries?

# Experimental design



- Collected sediment cores and site water
  - Sampled main stem sediments in October 2019, May 2020, August 2020
  - Sampled tributary sediments July 2021
- Transport sediments and water to UNC Institute of Marine Sciences in Morehead City, NC
- Samples were kept in an environmental chamber set to in situ temperature

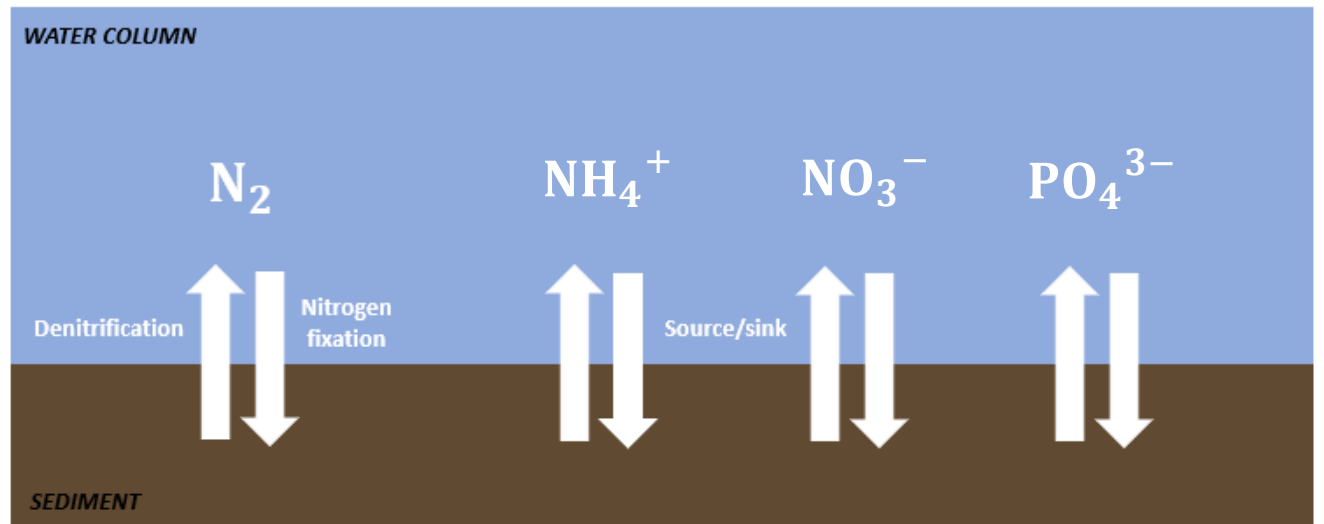
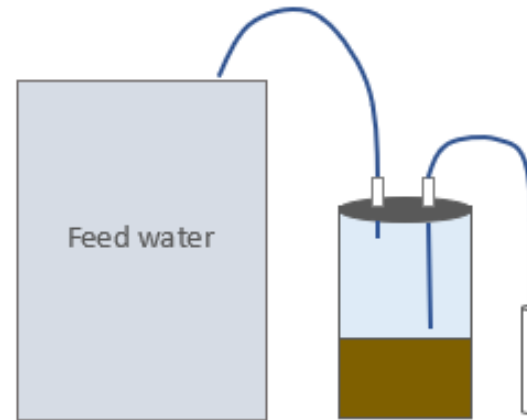


# Experimental design

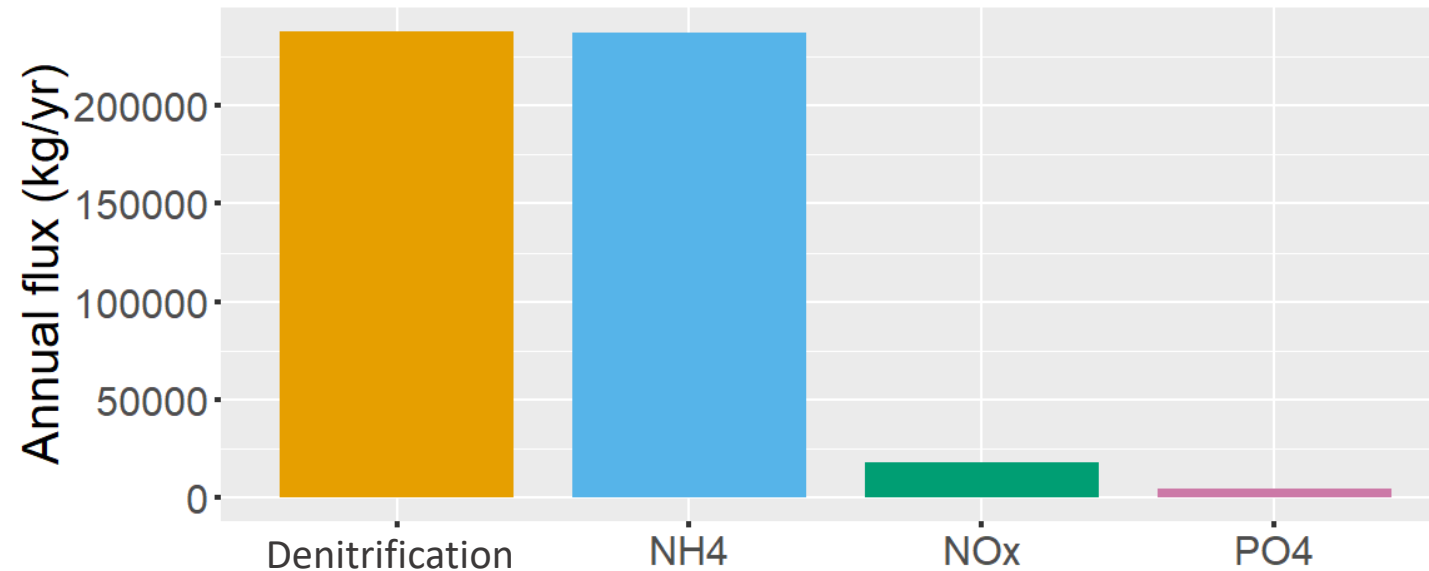
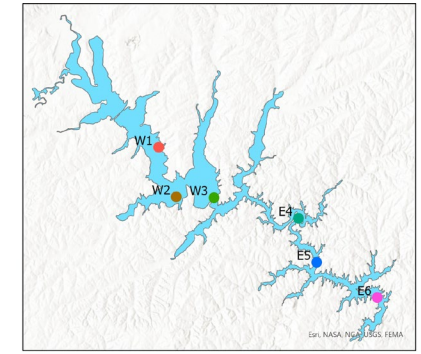
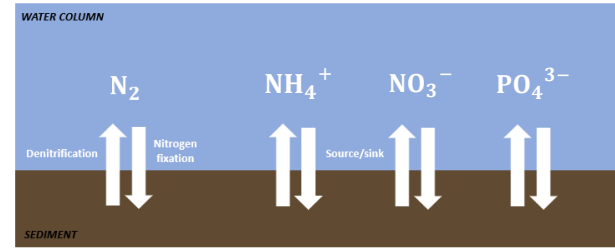
- Continuously pump water through sediment cores
- Collected water samples at three timepoints
- Measured concentrations of dissolved gases and nutrients in water samples
- Calculated flux rates across sediment-water interface

(+) sediment -> water

(-) water -> sediment



## Nitrogen removal via denitrification roughly offsets inorganic nitrogen inputs from sediments

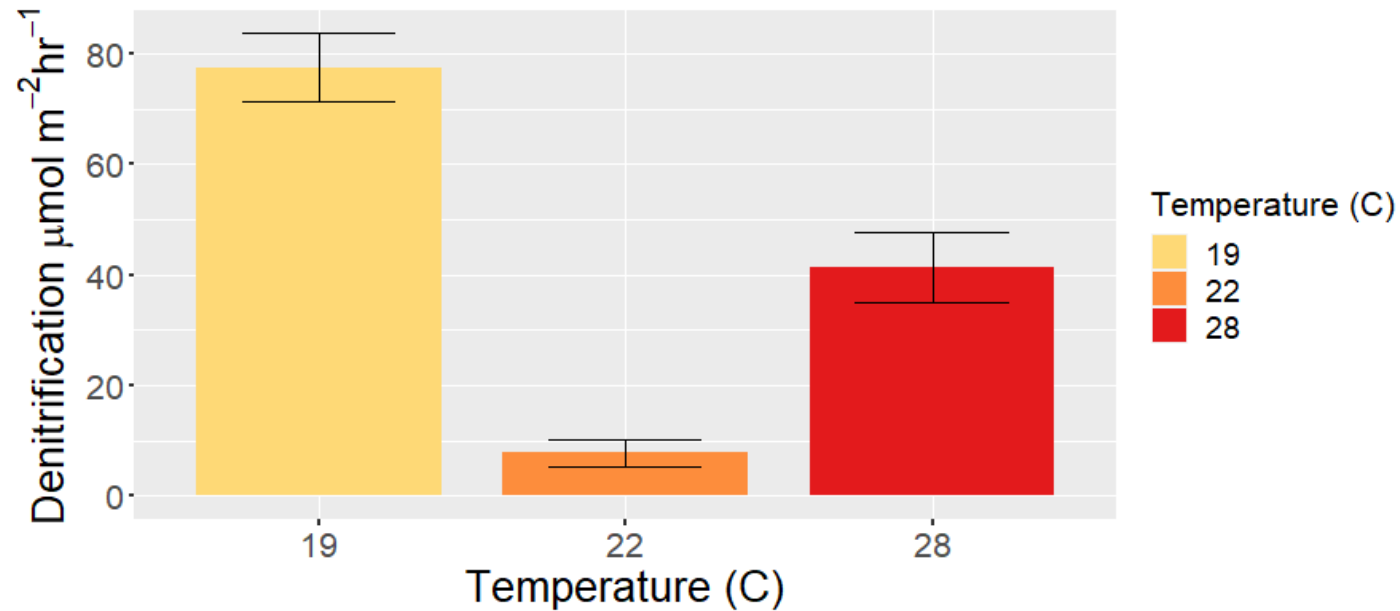
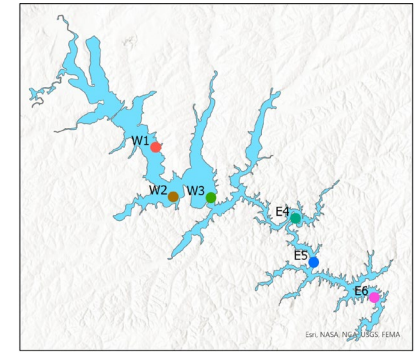


- Averaged seasonal fluxes from main stem, extrapolated across area of Falls Lake
- ~240,000 kg of  $NH_4$  flux out of the sediments per year
- ~240,000 kg of nitrogen removed via denitrification per year

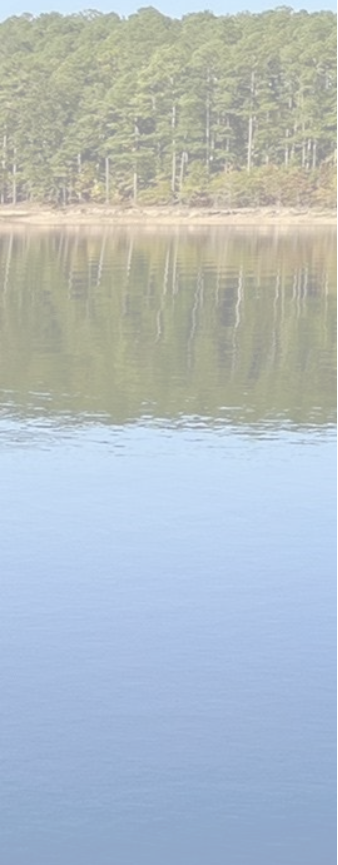
*What environmental variables are driving these processes?*



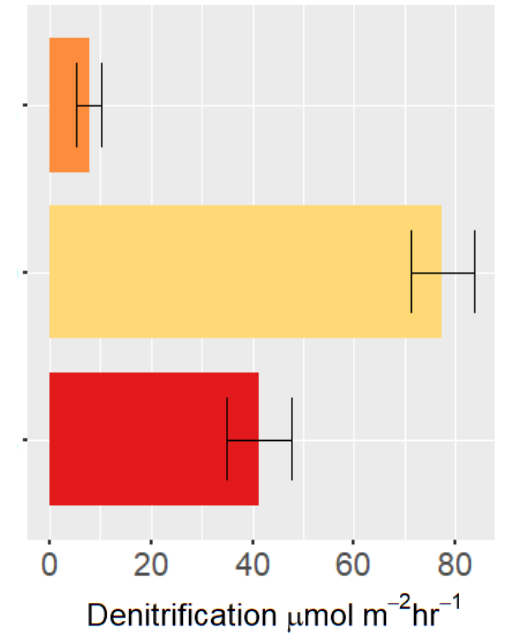
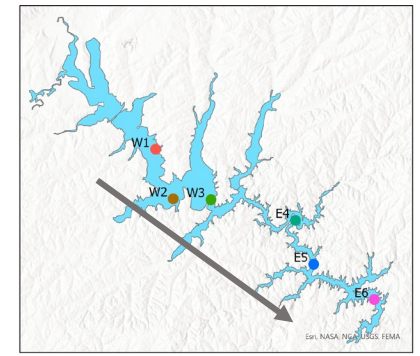
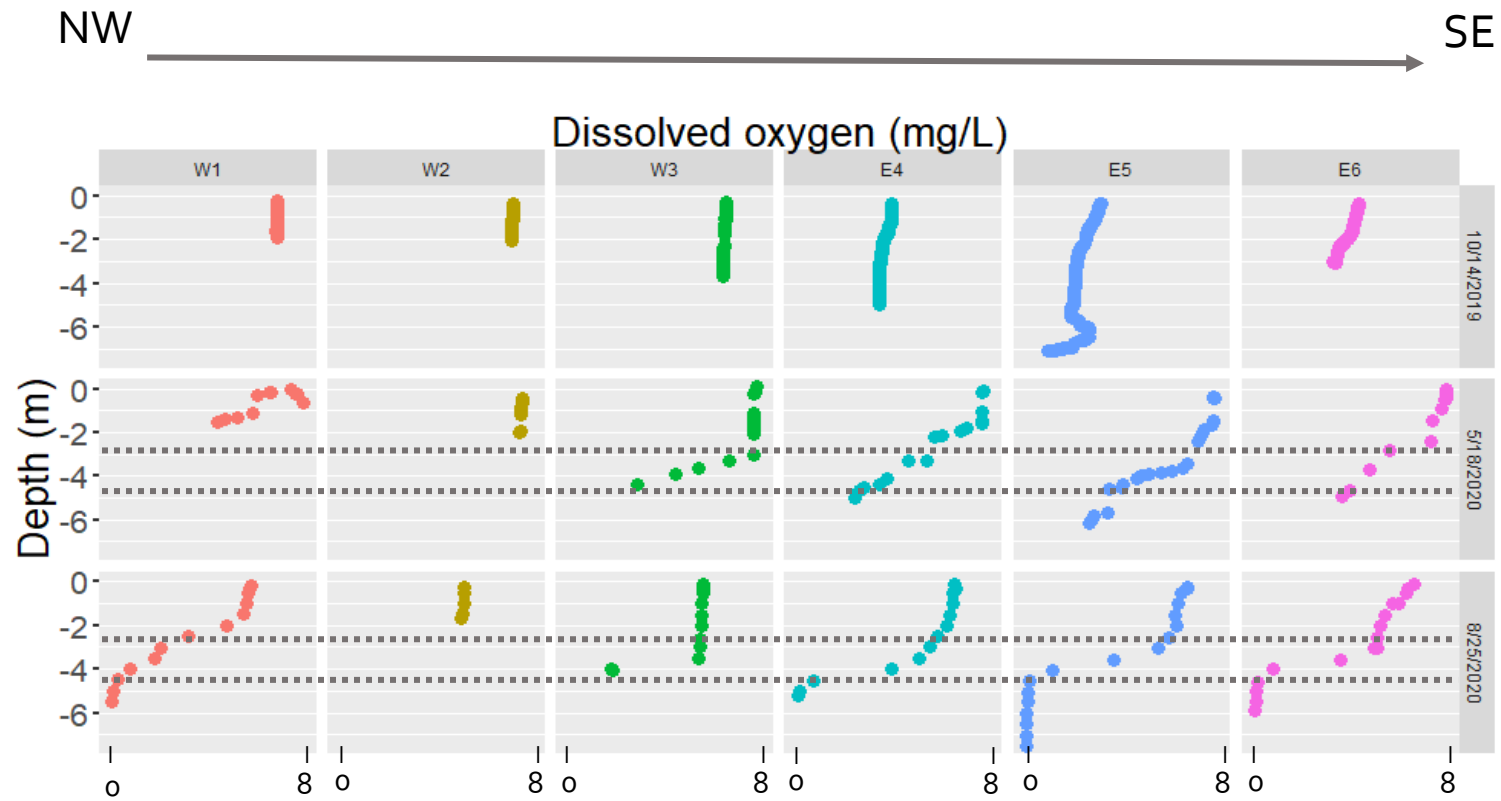
# There are seasonal differences in denitrification



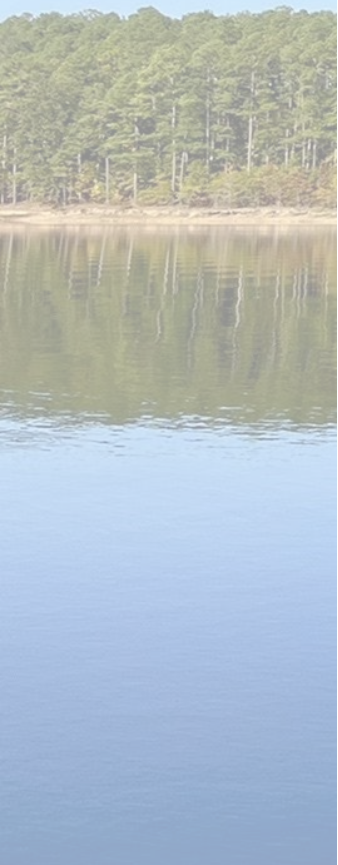
- Net denitrification on all sampling dates
- Highest rates observed at lowest temperature, but relationship is not linear
- Likely other, seasonally specific, factors influencing rates

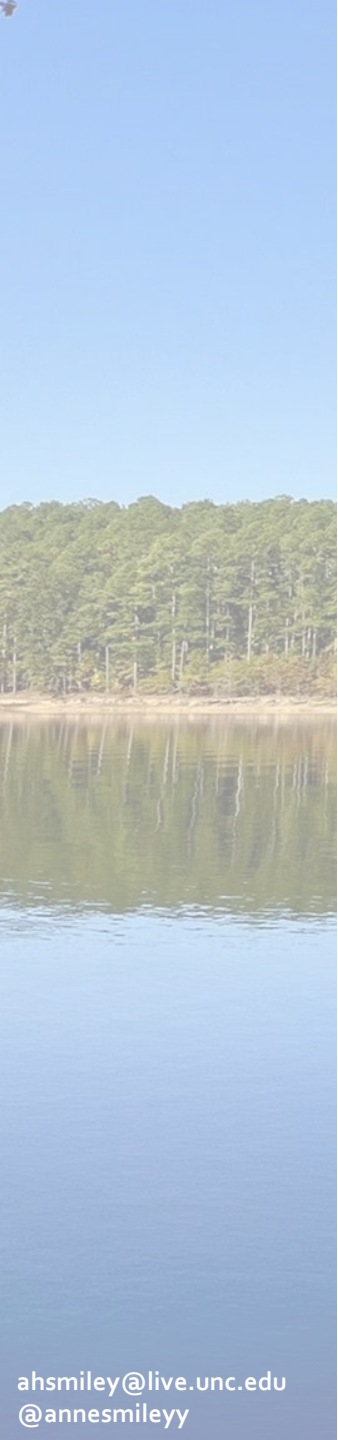


# Presence of an oxycline is important for denitrification

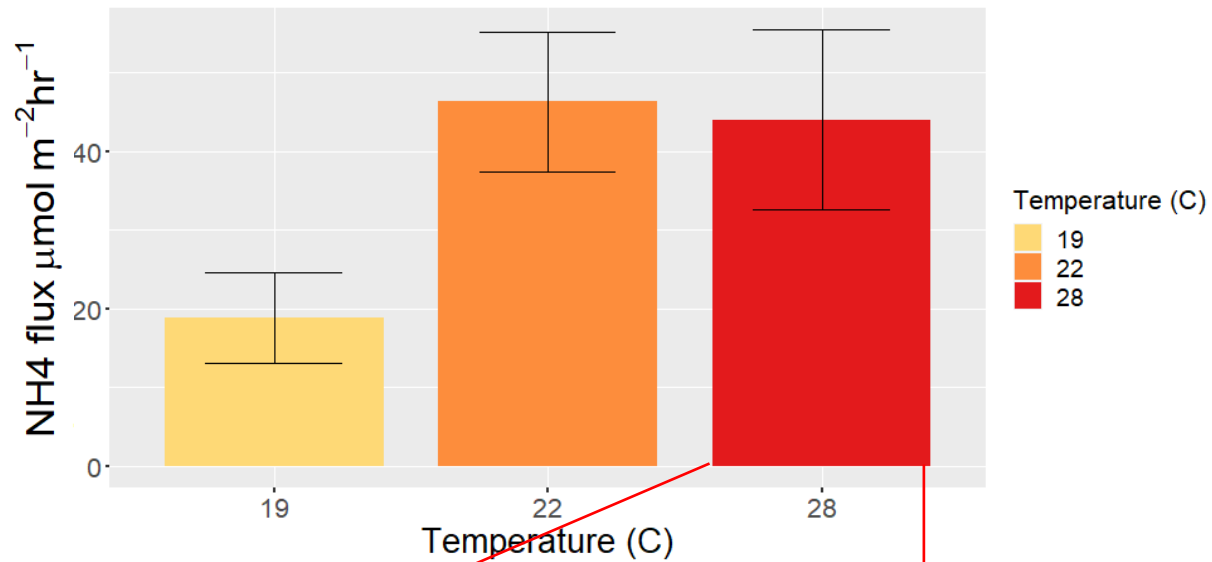
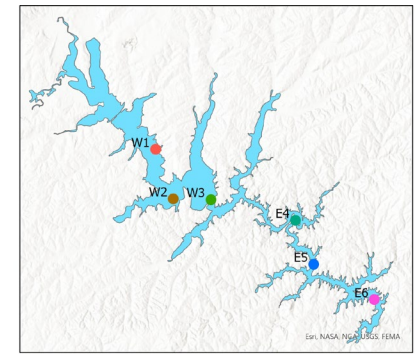


Highest denitrification rates observed when oxycline was present

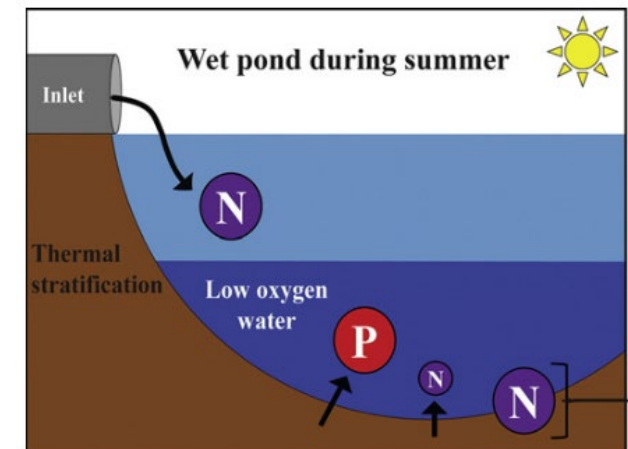
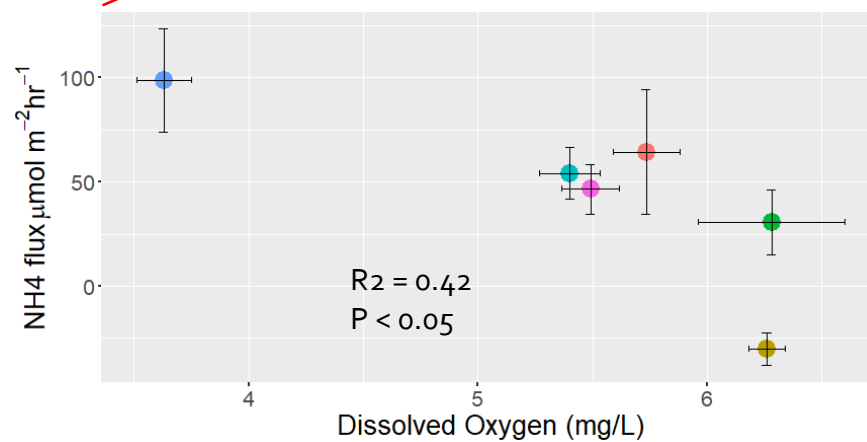




# Increased NH<sub>4</sub> flux at higher temperatures, anoxia in summer is an important driver

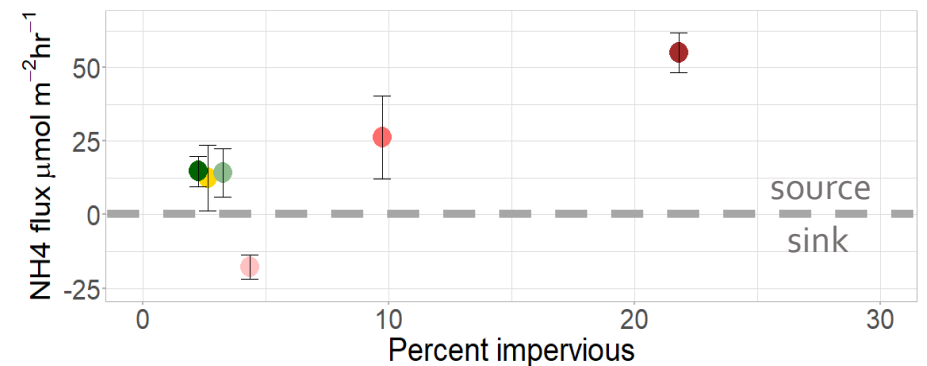
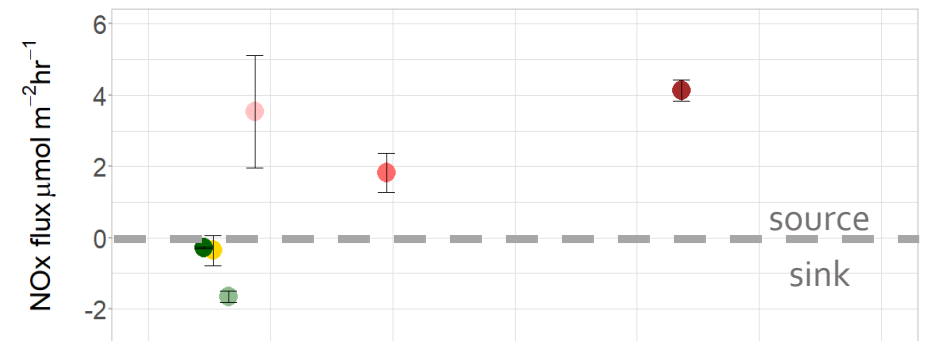
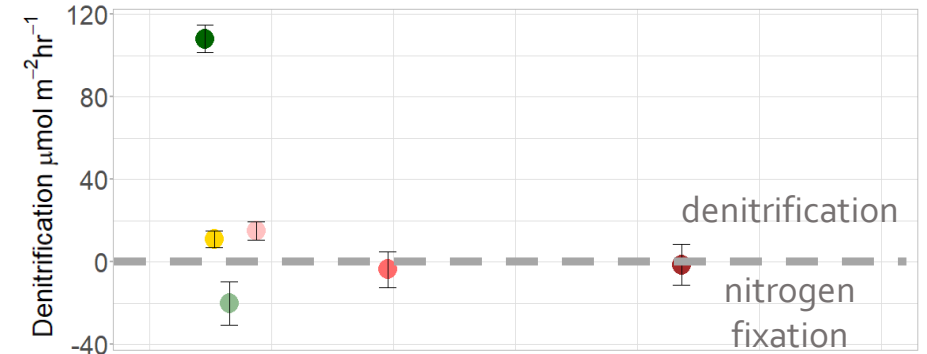
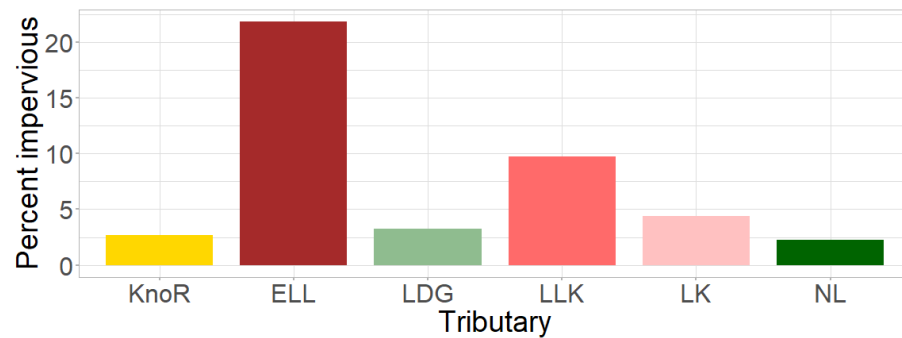
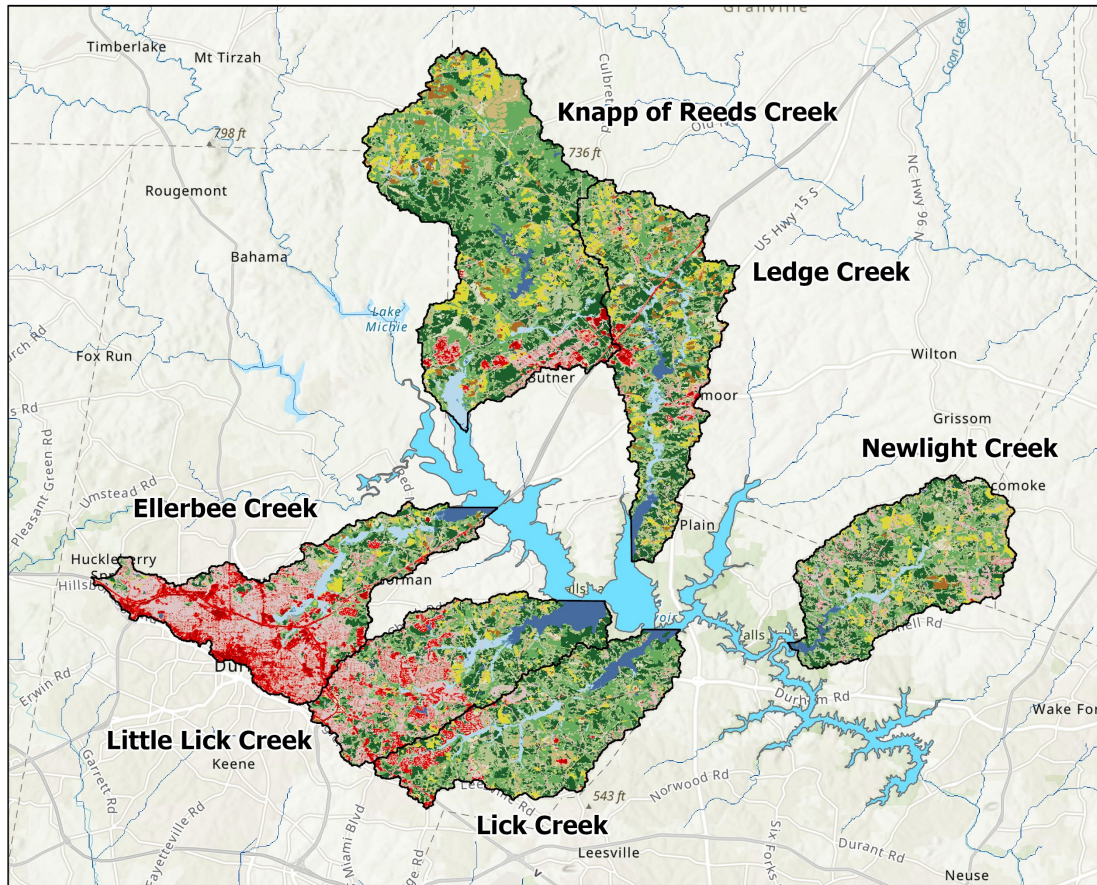


- Sediments act as a source of NH<sub>4</sub> year-round
- Increased fluxes at higher temperatures
- In summer, low DO associated with high NH<sub>4</sub> flux



Gold et al. 2017

# Decreased denitrification and increased nutrient fluxes in more developed tributaries



# Conclusions

1. Are there environmental predictors (e.g., temperature and dissolved oxygen) of nitrogen fluxes in the main stem of Falls Lake?
  - Seasonal differences in denitrification and  $\text{NH}_4$  flux
  - Highest denitrification rates observed when oxycline is present
  - Elevated  $\text{NH}_4$  fluxes observed at higher temperatures
2. How does development affect nitrogen cycling in Falls Lake tributaries?
  - Highest denitrification rates observed in least developed tributary
  - Elevated nutrient fluxes from sediments to water associated with increased development



Questions?

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