Denitrification Potential and Limitations in Small Reservoirs of Central Wisconsin

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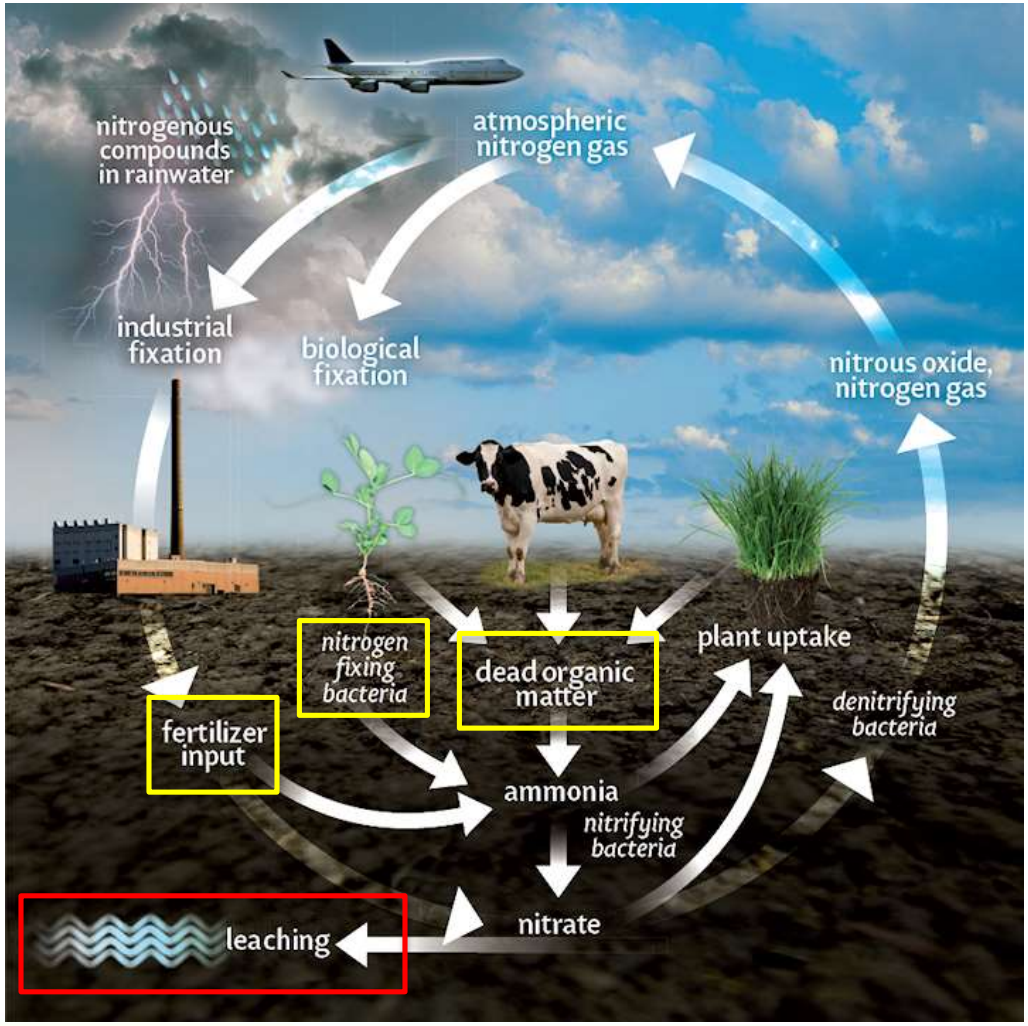
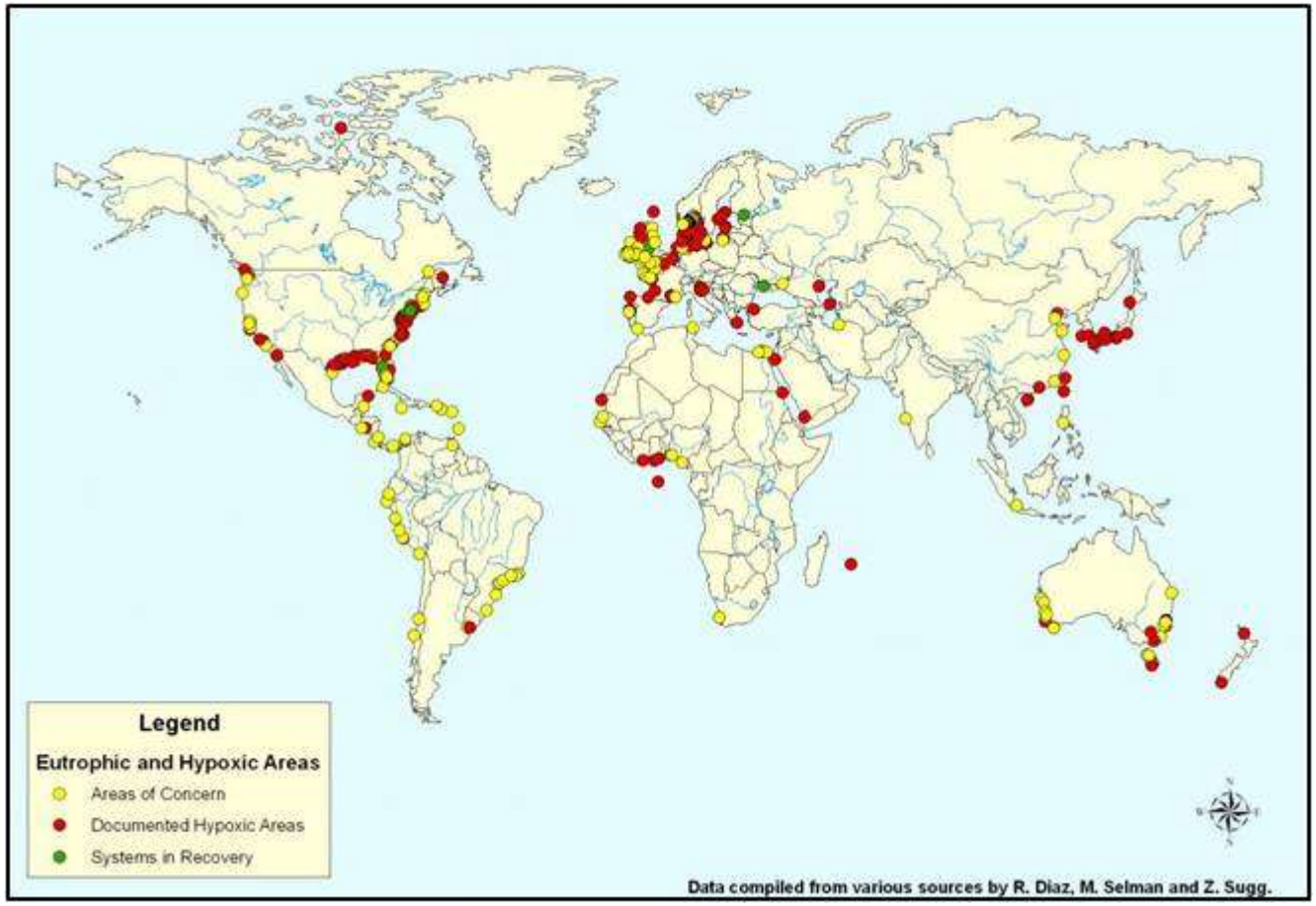
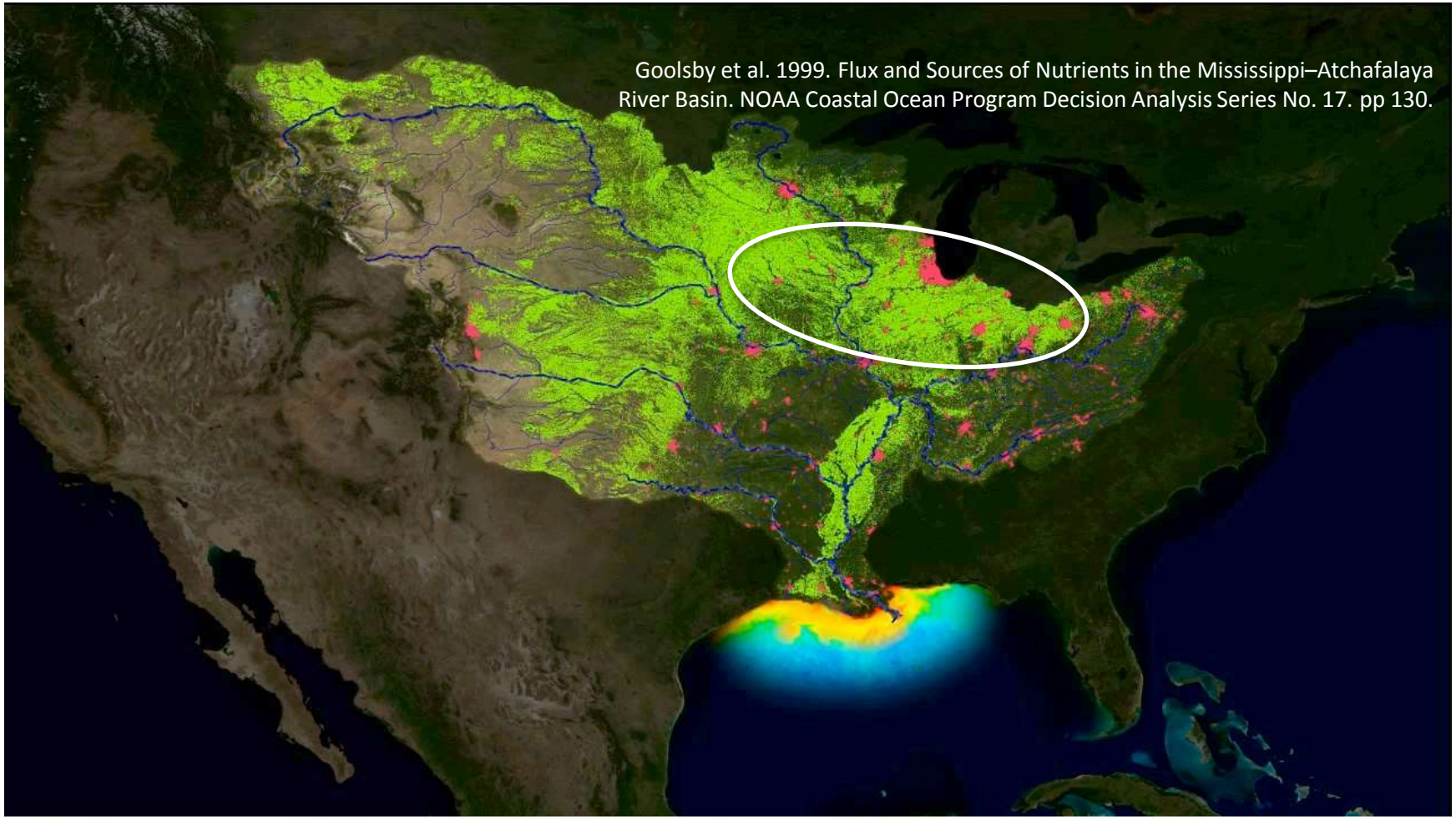
Nitrogen Cycle



Global Hypoxic Areas



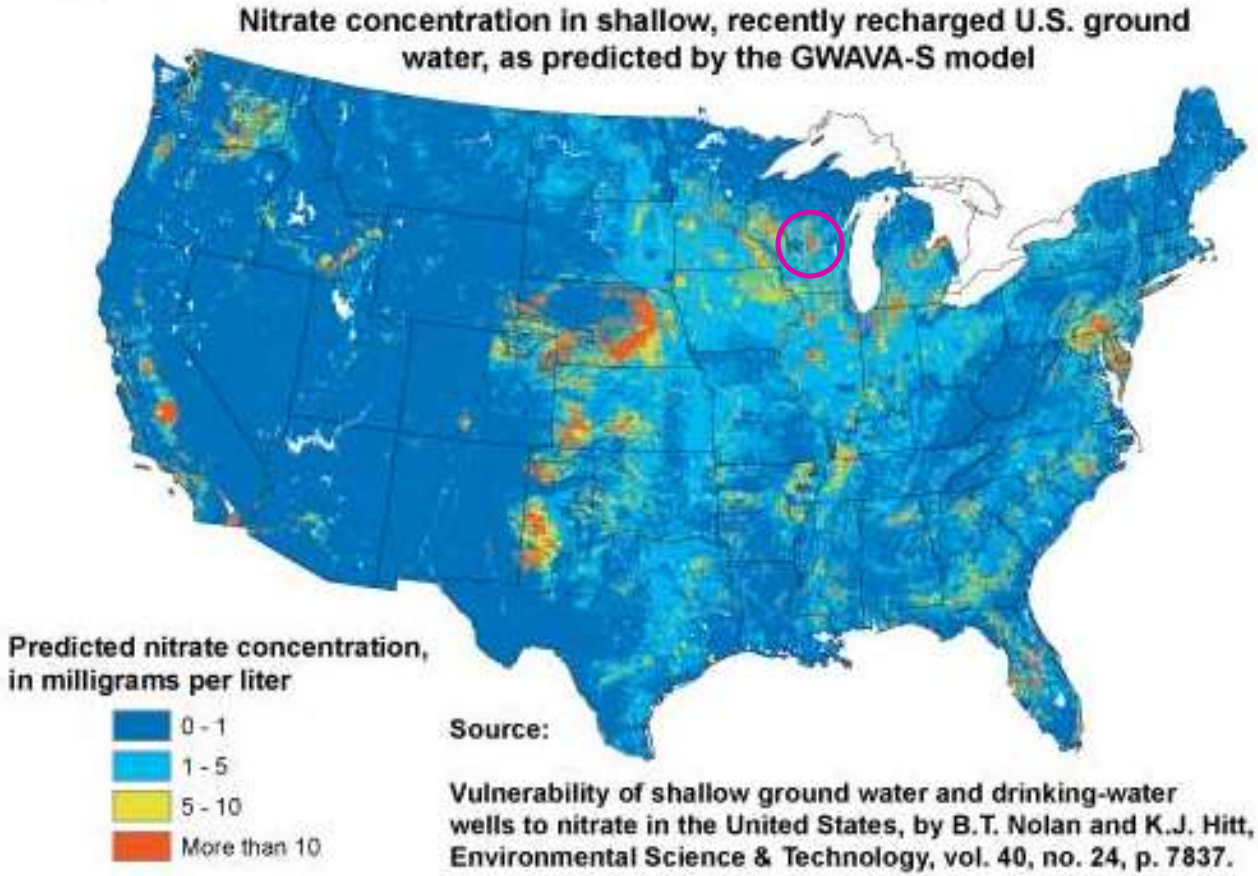
Mississippi River Basin



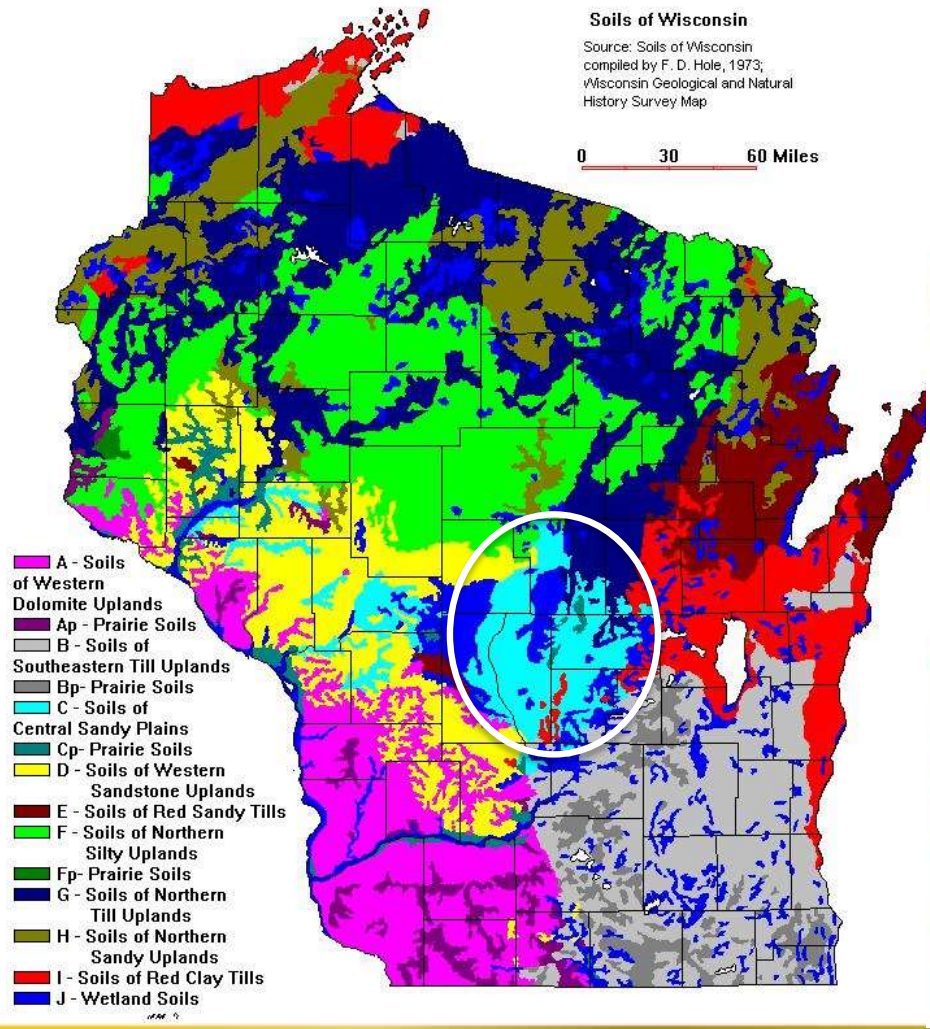
Source: National Oceanic and Atmospheric Administration

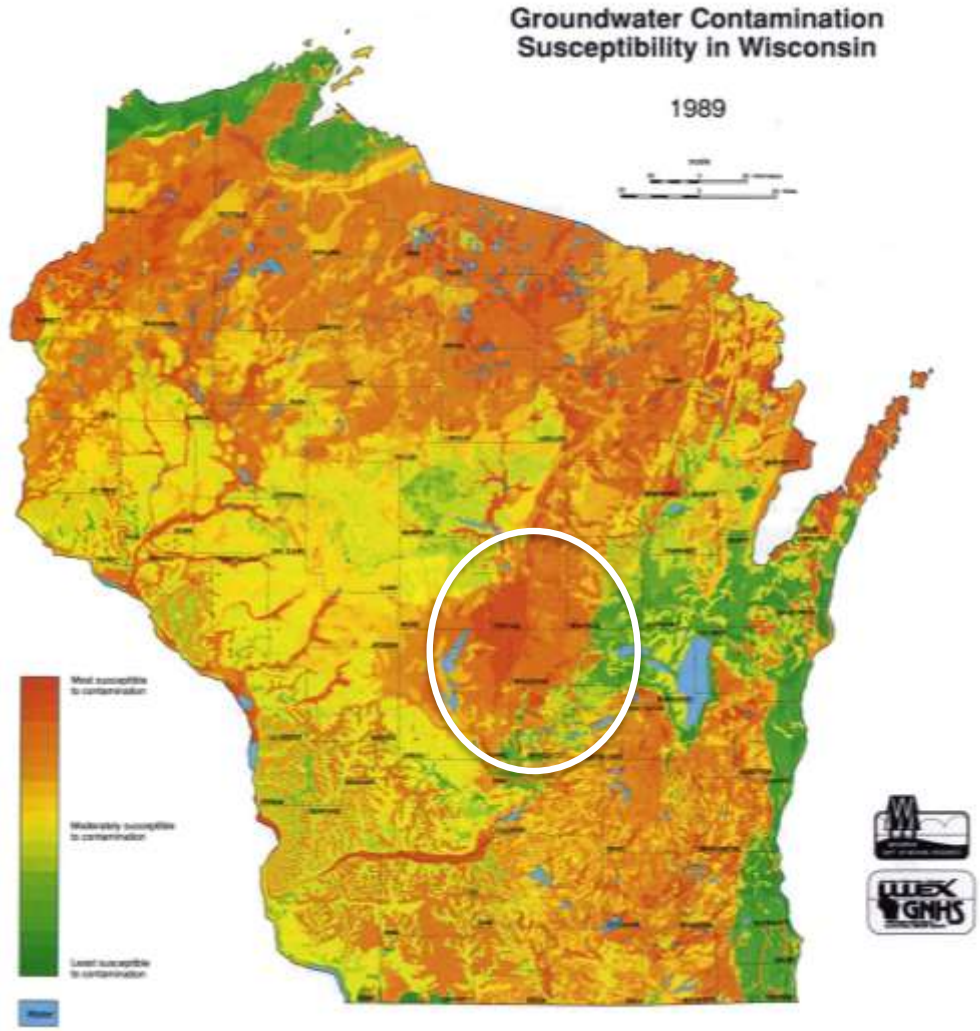
Groundwater Nitrate Levels

USGS
science for a changing world

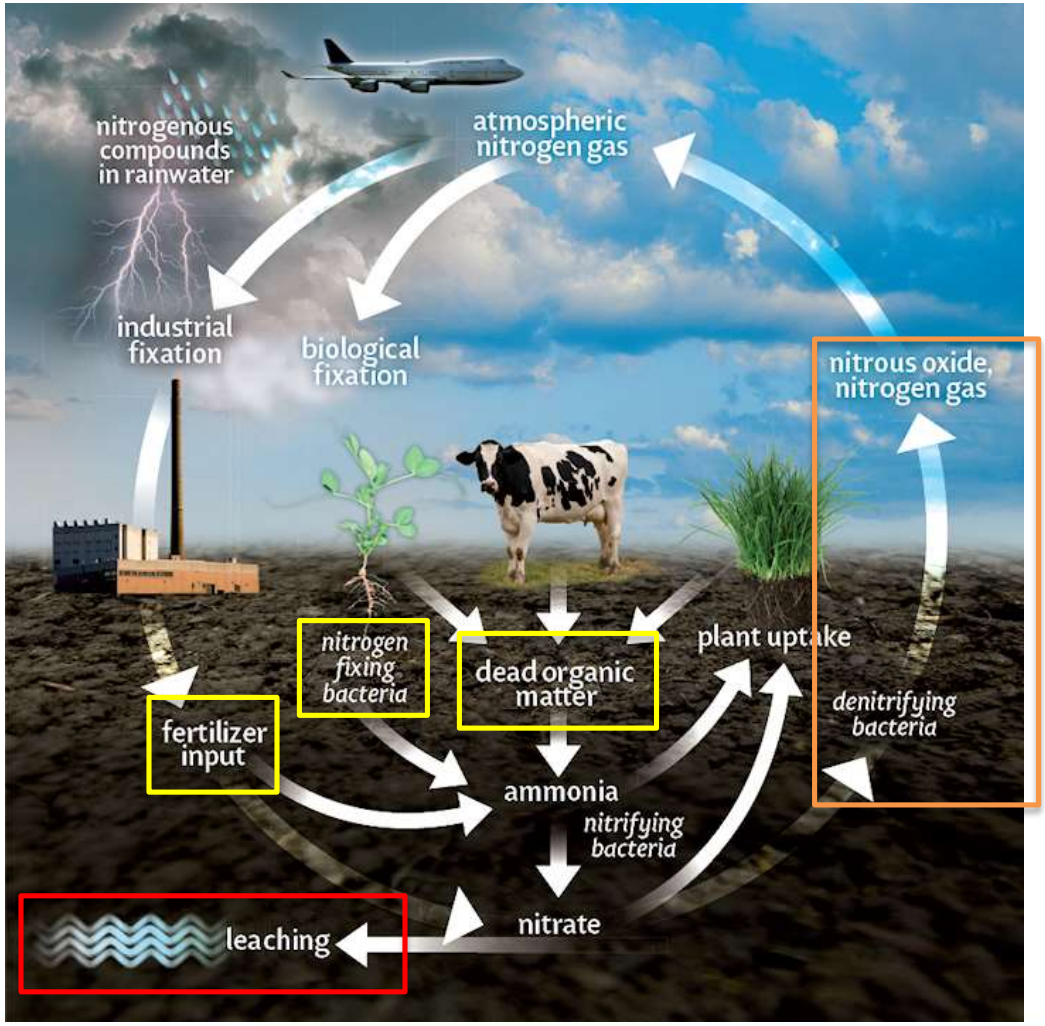


Central Wisconsin



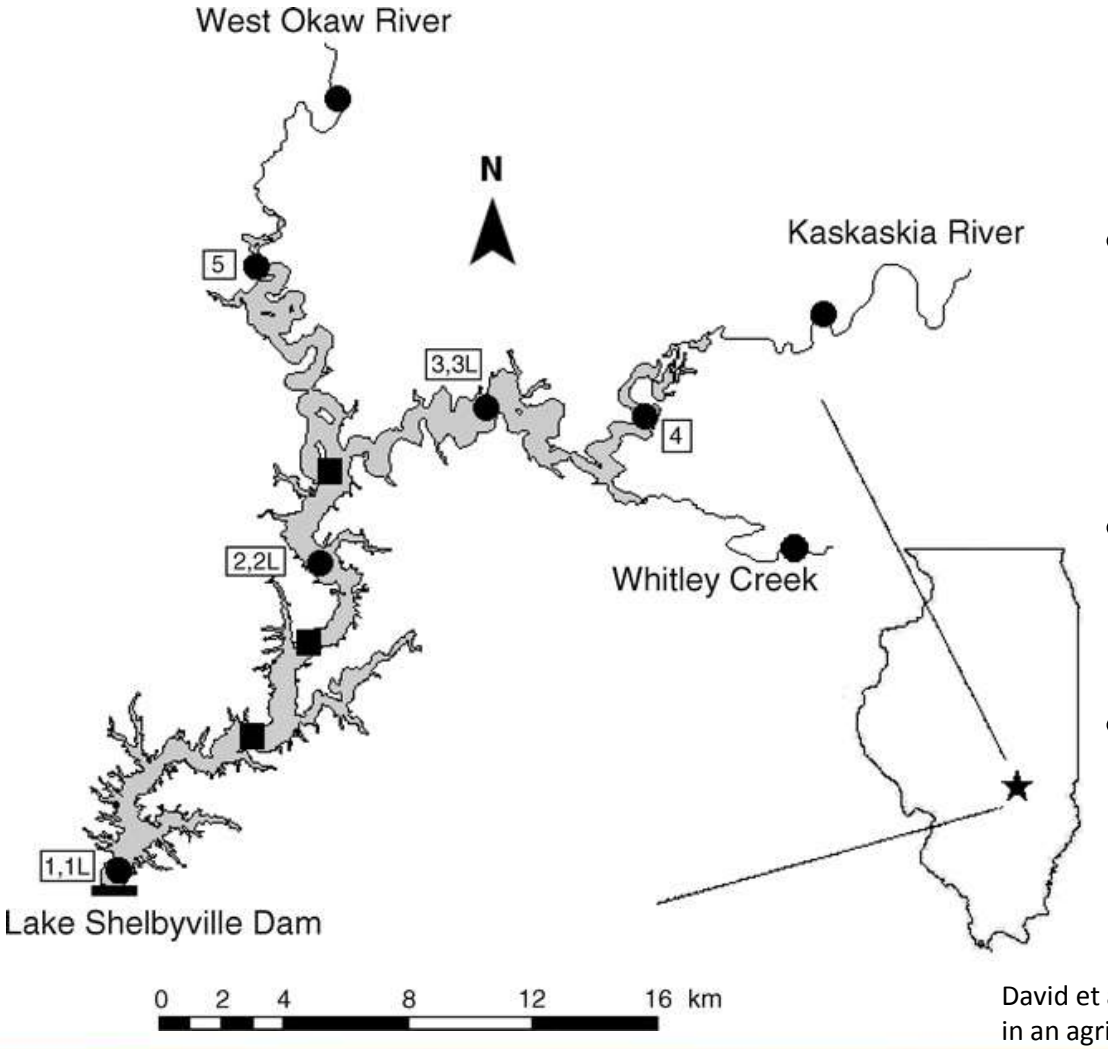


Nitrogen Cycle



Denitrification is a process by which bacteria will decompose organic matter anaerobically. Through this process nitrates are converted into nitrogen gas and released back to the atmosphere.

Lake Shelbyville



- 58% annual nitrogen removed via denitrification
- High denitrification rate (26 mg N m^{-2} hr^{-1})
- 4.3 month residence time

David et al. 2006. Denitrification and the nitrogen budget of a reservoir in an agricultural landscape. Ecological Applications 16:2177-2190

Knowledge Gap

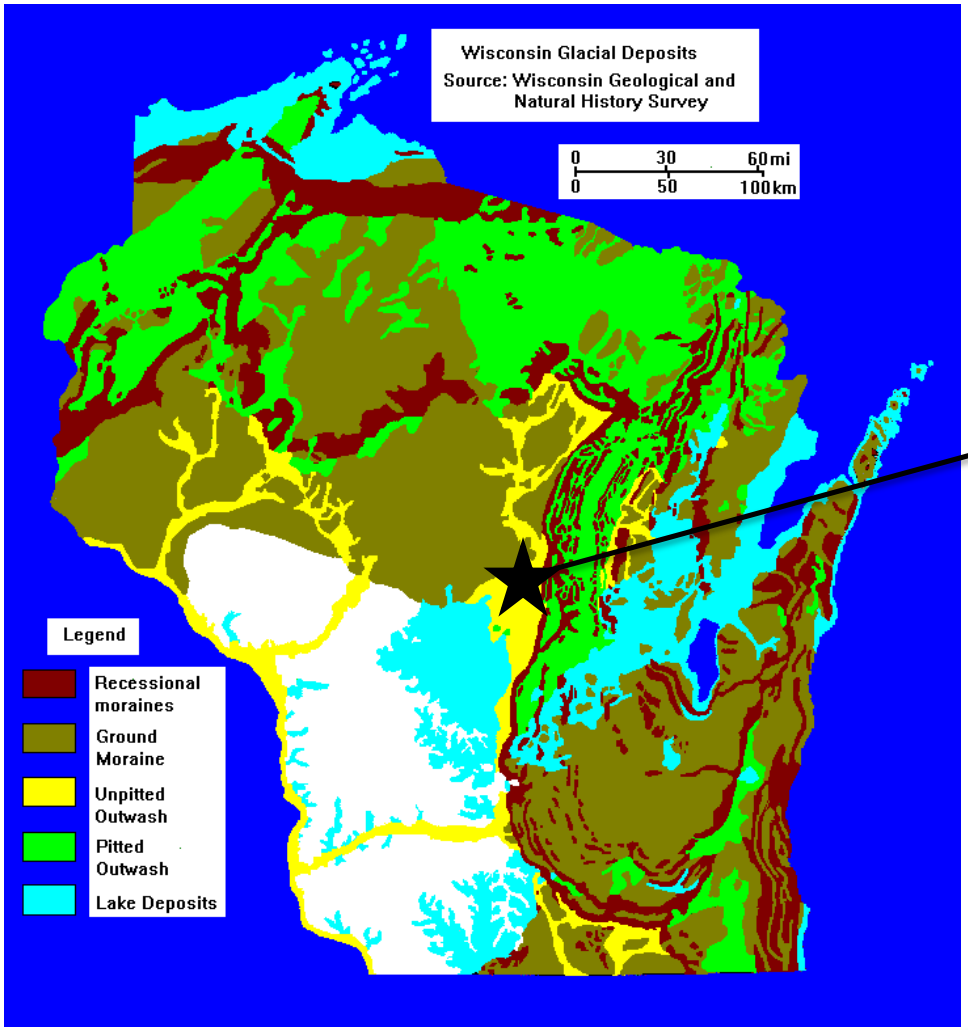
- Little is known in regards to denitrification in reservoirs


Lake Shelbyville

Objectives

- Determine nitrogen removal potential of three small reservoirs and identify any potential limitations

Methods



Sampled 3 small reservoirs of varying size in the central sands region in July of 2014

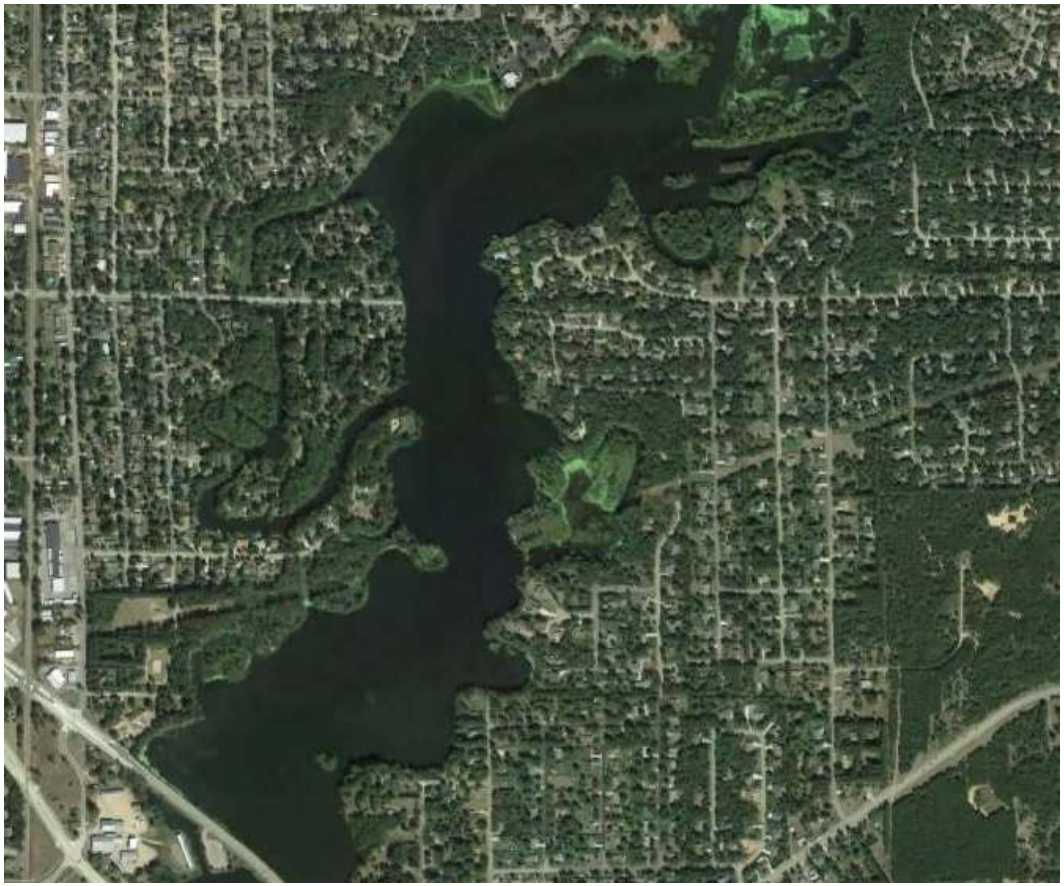
Springville Pond

Surface Area	14 acres
Incoming Discharge	6.8 ft^3 sec^{-1}
Incoming NO_3^-	8.34 mg N L^{-1}
pH	7.4
Residence Time	9.78 days
Maximum Depth	10 ft
Agricultural land use	43%

Jordan Pond

Surface Area	84.5 acres
Incoming Discharge	99.5 ft^3 sec^{-1}
Incoming NO_3^-	1.12 mg N L^{-1}
pH	8.1
Residence Time	1.51 days
Maximum Depth	7 ft
Agricultural Land Use	32%

McDill Pond

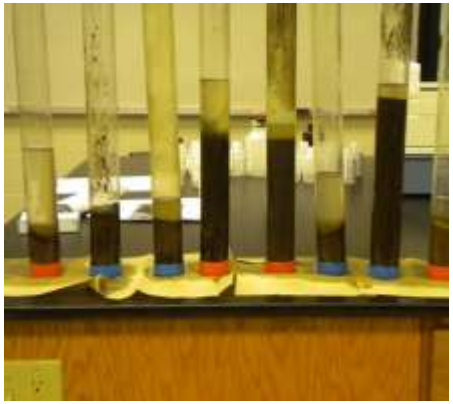


Surface Area	261.5 acres
Incoming Discharge	151.0 ft^3 sec^{-1}
Incoming NO_3^-	1.52 mg N L^{-1}
pH	7.8
Residence Time	3.93 days
Maximum Depth	19 ft
Agricultural Land Use	34%

Methods (Transects)

Methods (Collection)

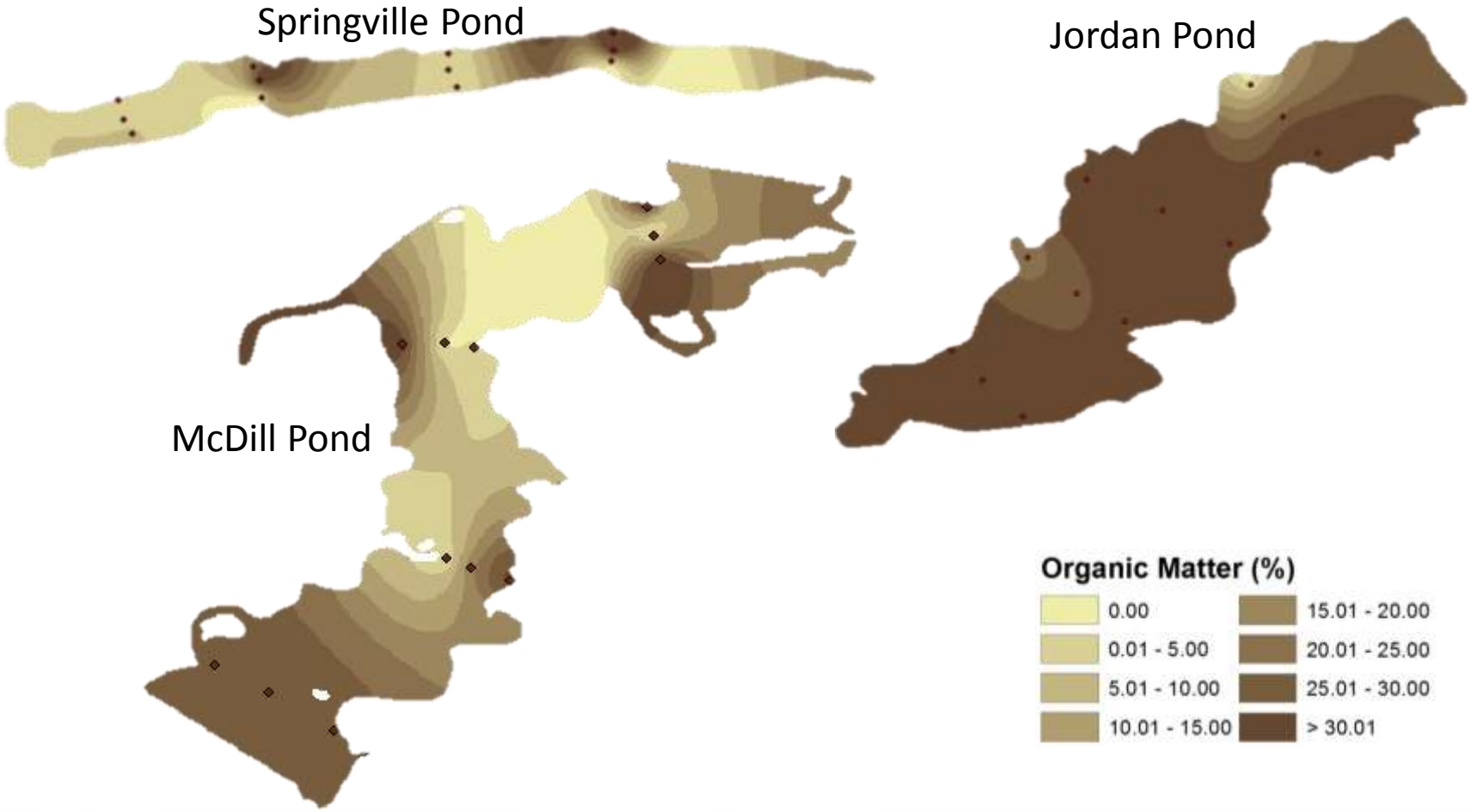
- Sediments
- Bulk Density
- Discharge
- Water Samples



Methods (Laboratory)

- Denitrification - Acetylene Inhibition and Gas Analysis on an SRI Gas Chromatograph
- Nitrate Analysis – Metrohm Ion Chromatograph
- Organic Matter - Loss on Ignition

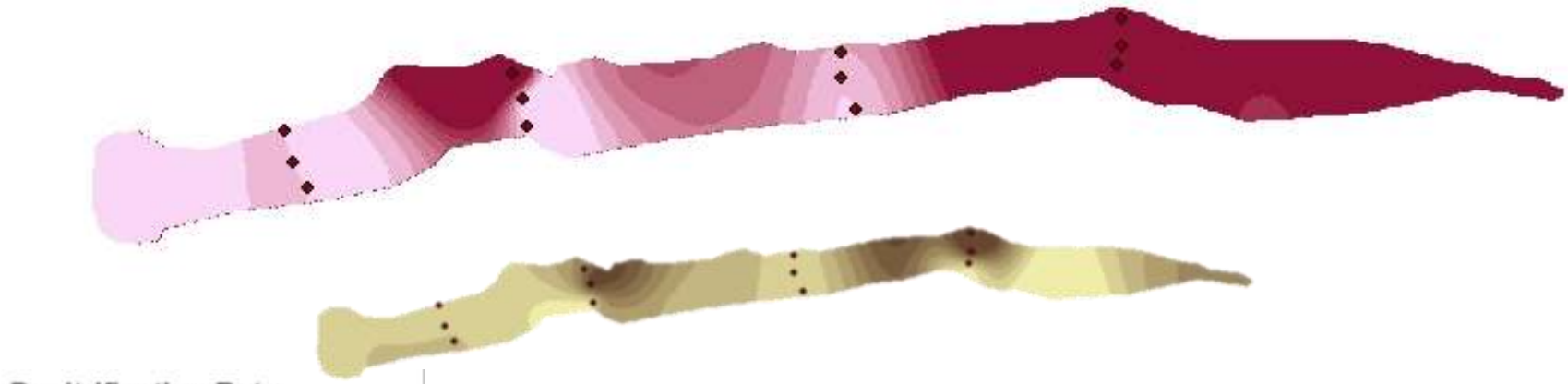
Results (Organic Matter)



Denitrification Rates

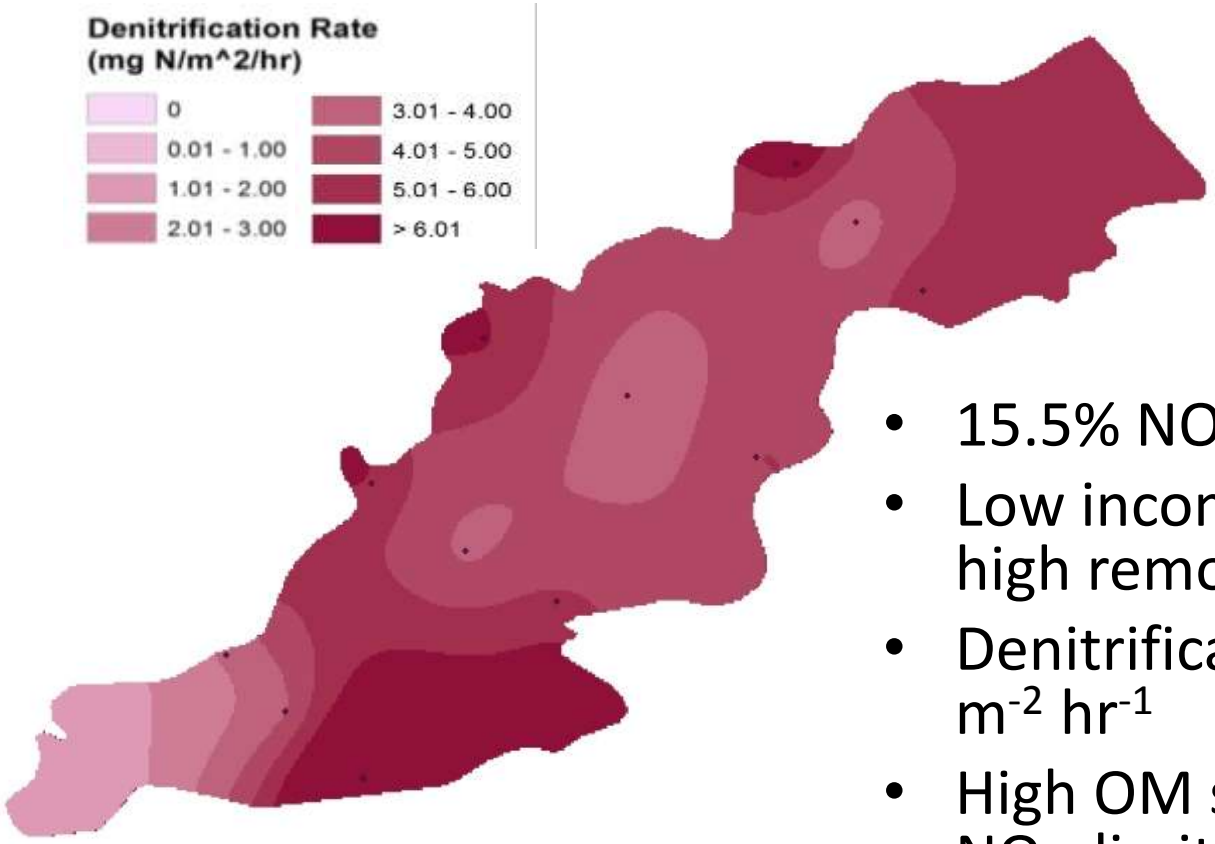
System	Rate	Citation
Rivers	5.6 mg N m^{-2} hr^{-1}	Pina-Ochoa and Alvarez-Cobelas 2006
Lakes	2.9 mg N m^{-2} hr^{-1}	Pina-Ochoa and Alvarez-Cobelas 2006
Natural Wetlands	25 mg N m^{-2} hr^{-1}	Mitsch et al. 2001
Treatment Wetlands	48 mg N m^{-2} hr^{-1}	Mitsch et al. 2001
Large Reservoir	26 mg N m^{-2} hr^{-1}	David et al. 2006
Small Reservoir (Springville Pond)	5.8 mg N m^{-2} hr^{-1}	This study
Small Reservoir (Jordan Pond)	5.2 mg N m^{-2} hr^{-1}	This study
Small Reservoir (McDill Pond)	1.5 mg N m^{-2} hr^{-1}	This study

Springville Pond



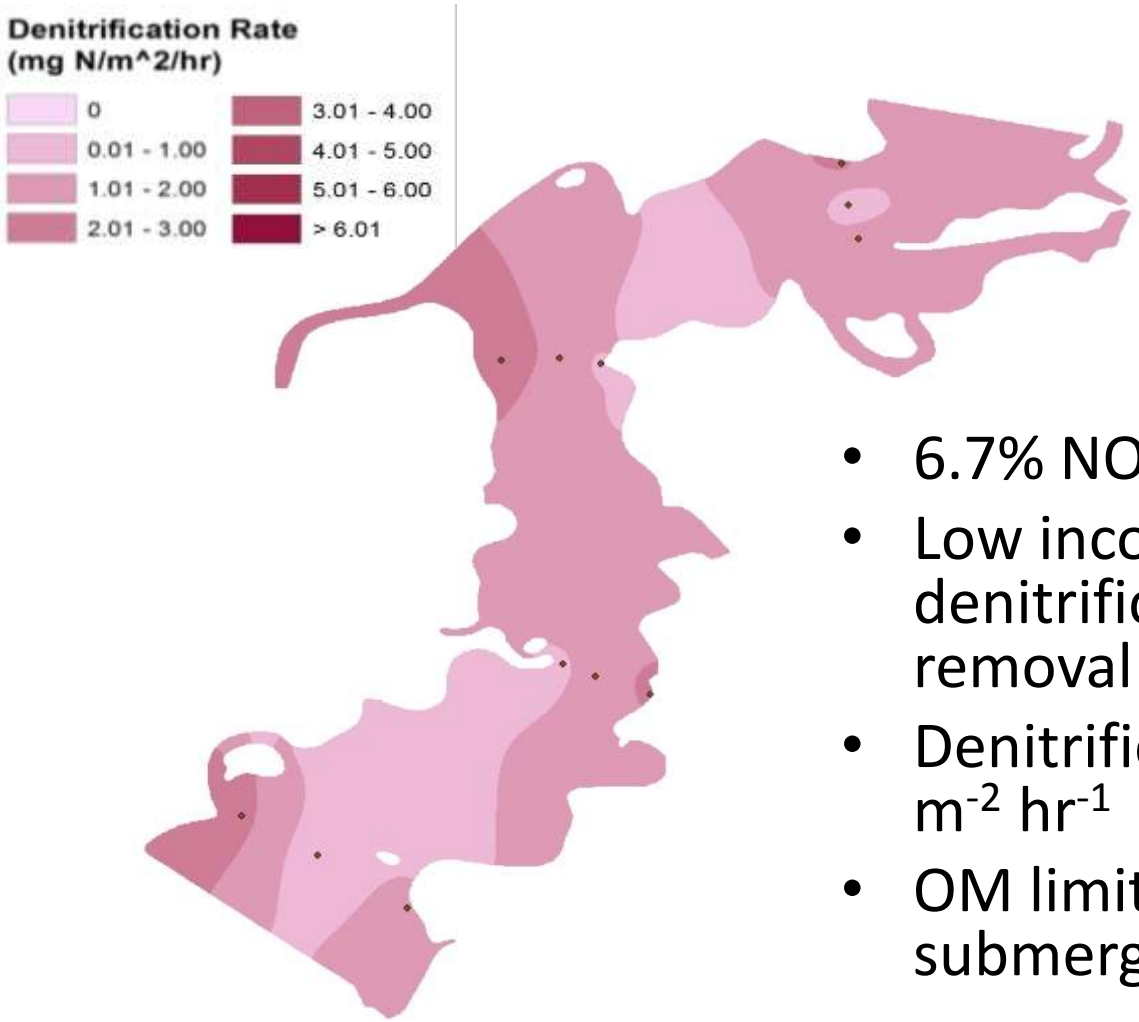
- 5.3% NO_3^- removed
- High incoming NO_3^- limited removal capacity
- Denitrification rate of 5.8 mg N m^{-2} hr^{-1}
- Patchy denitrification rates → OM limitations

Jordan Pond



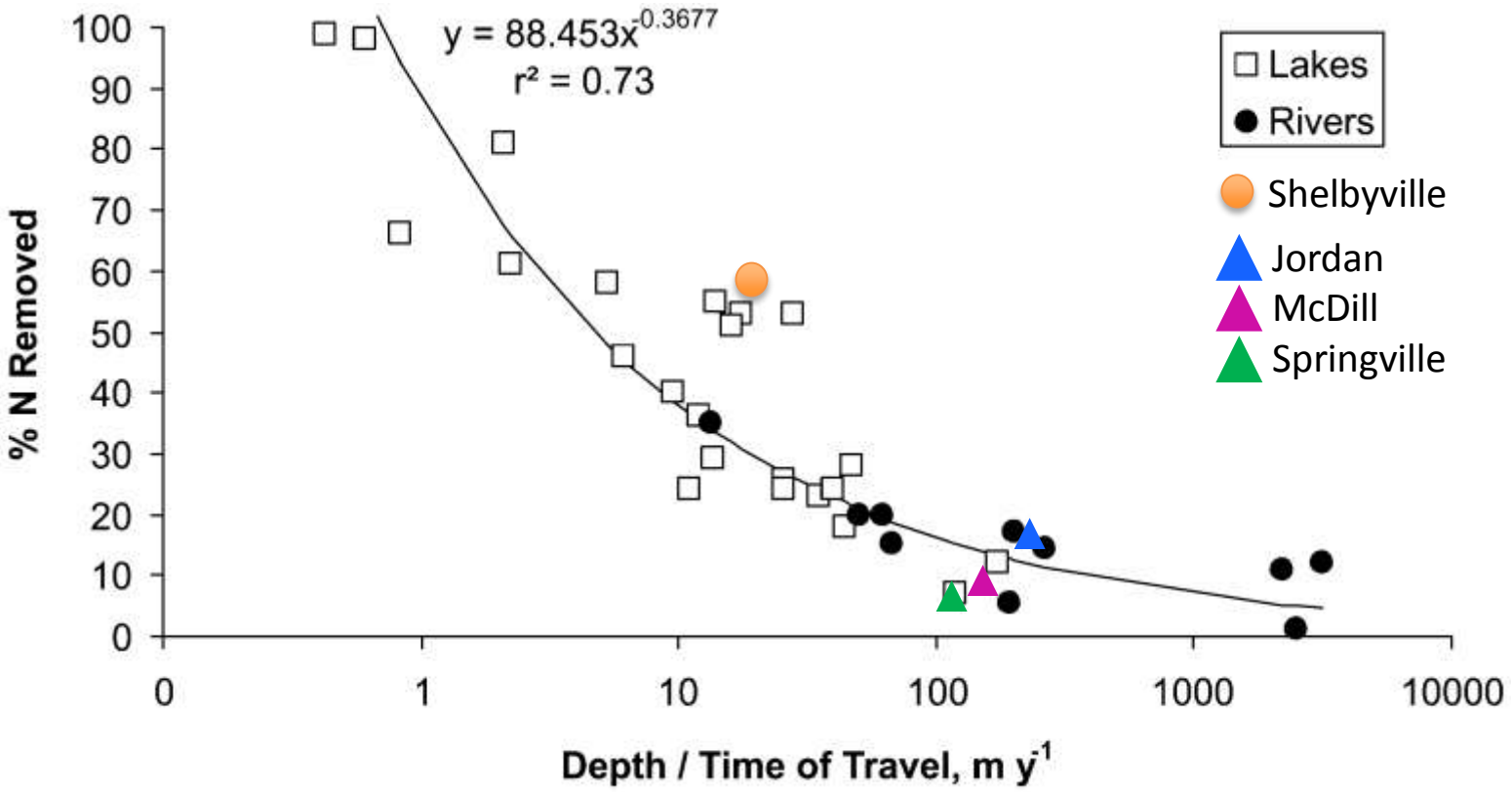
- 15.5% NO_3^- removed
- Low incoming NO_3^- resulted in high removal percentage
- Denitrification rate of 5.2 mg N m^{-2} hr^{-1}
- High OM sediment → potential NO_3^- limitation

McDill Pond



- 6.7% NO_3^- removed
- Low incoming NO_3^- but low denitrification rate yielded poor removal percentage
- Denitrification rate of 1.5 mg N m^{-2} hr^{-1}
- OM limitation and/or submergent vegetation

Discussion



Seitzinger et al. 2002. Nitrogen retention in rivers: model development and application to watersheds in the northeastern U.S.A. Biogeochemistry 57/58:199-237.

Conclusions

- No significant nitrate removal
- Site dependent limitations
  - Nitrate
  - Organic matter

Questions?

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