IRON'S IMPACT ON NITROGEN CYCLING IN AN OPEN WATER WETLAND TO PROMOTE SUSTAINABLE WATER TREATMENT

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Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt)

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Background

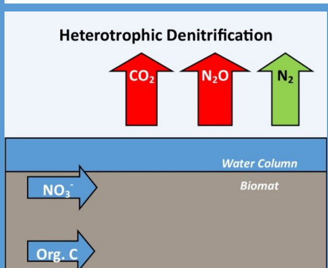
- Microorganisms in constructed wetlands anaerobically remove nitrate from the water.
- Nitrate removal can take the form of various pathways including denitrification, DNRA, anammox, and abiotic pathways.
- Microorganisms can use organic carbon (heterotrophy) or inorganic carbon (autotrophy).
- The role of ferrous iron in these processes was previously unknown.

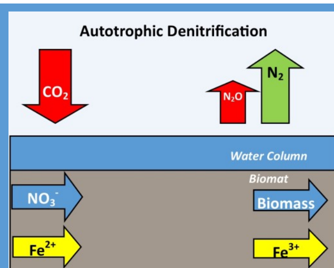
Methods

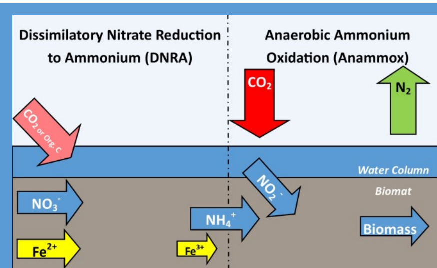
- Anaerobic slurry microcosms with wetland biomat, differing concentrations of ferrous iron given at 15 days
- Sampling:
  - Aqueous: nitrogen species, sulfide, iron, organic and inorganic carbon, acetate
  - Gas: nitrous oxide and methane
  - Mineral: ferric oxides
  - Microbial: functional genes for nitrogen cycling processes

Hypothesis

- Heterotrophic denitrification will dominate.
- Secondarily, low iron concentrations will experience autotrophic denitrification.
- High iron concentrations will cause a shift towards DNRA (and anammox).

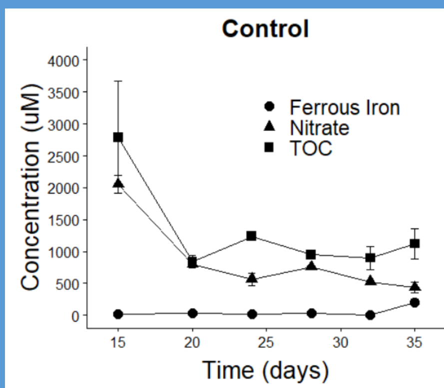


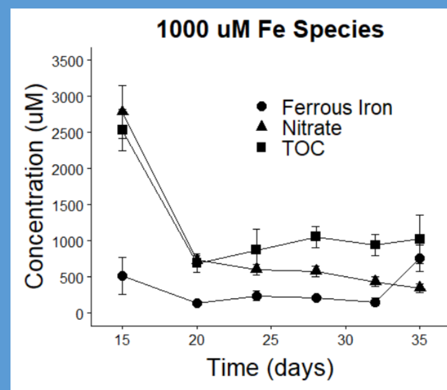


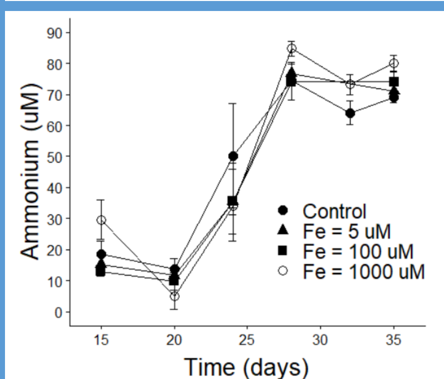


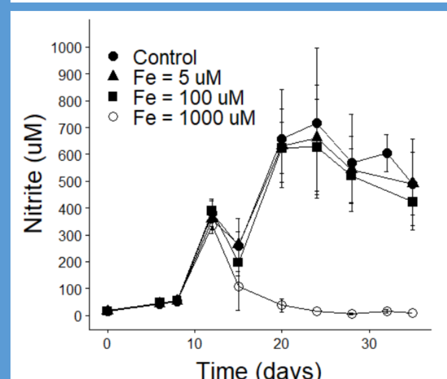
Results

- Reduction in nitrate that corresponds with reduction in organic carbon
- No significant difference in ammonium production among iron concentrations
- More nitrite reduction with high concentration of ferrous iron
- Little difference between control, 5 ppm, and 100 ppm iron microcosms with all species



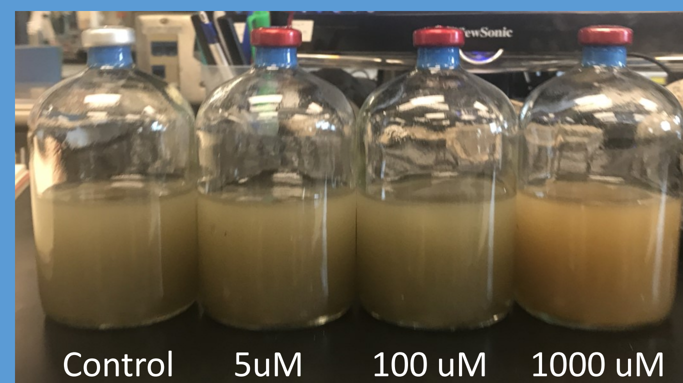






Conclusions

- Hypothesis:
  - •Heterotrophic denitrification will dominate.
    Supported.
  - •Secondarily, low concentrations will experience autotrophic denitrification.
    No Evidence.
  - •High iron concentrations will cause a shift towards DNRA (and anammox).
    Refuted.
- Likely that abiotic nitrite reduction occurs beyond a threshold iron concentration.



Unfoiled microcosms at the final time point. The red hue in the high iron condition indicates iron oxidation