IOWA STATE UNIVERSITY
Department of Agricultural and Biosystems Engineering

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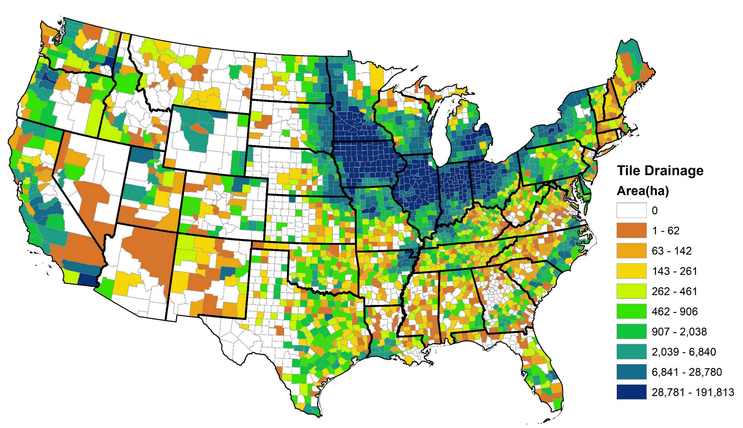
Taylor Vroman, Dr. Michelle Soupir

Microbial Communities as a Pathway to Improved Woodchip Bioreactor Design and Performance

Background and Motivation

- Nutrient loading in waterways creates limitations for recreational and drinking water usage
- Iowa contributes an average of 55% of the long-term nitrate load to the Missouri River Basin[i]
- Woodchip bioreactors are an edge-of-field practice that intercept tile drained fields before reaching waterways
- Woodchips provide an enhanced carbon source for agricultural water to interact with to result in heightened denitrification



Tile drainage across the United States[ii]

Experimental Design

- Pilot scale bioreactors contain four sampling locations, distributed along the length of the system
- Woodchip extractions will be taken at various points during the denitrification process to understand the dynamics of the microbial community present
- Microbial composition of ground woodchip samples will be determined through isolated DNA analysis of extractions

Hypothesis and Objectives

Hypothesis

- There are key microbes present in every woodchip bioreactor that originate from the carbon source and the agricultural environment feeding into the system
- These key microbes react with the composition in nitrate loaded freshwater and can be manipulated by design to improve effectiveness

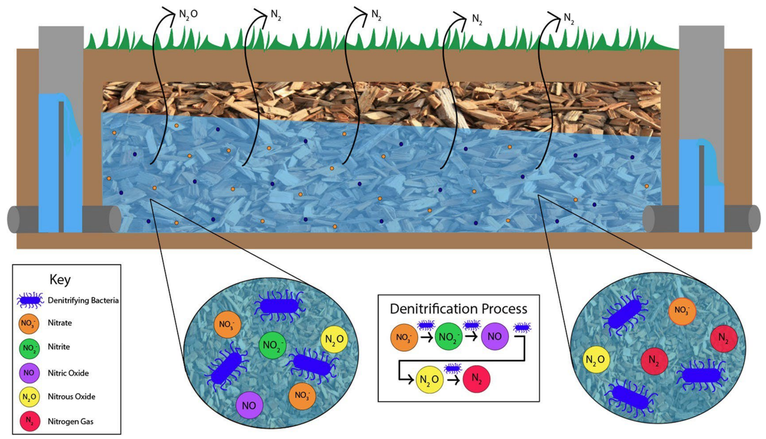
Objectives

- Identify key components of microbial communities and optimize design
- Analyze interactions of microbes to allow for system improvement

Construction of nine pilot scale woodchip bioreactors at Iowa State University

Expected Results

- Microbial communities will vary as samples are taken at various stages in the denitrification process
- Microbial communities will be dynamic through time
- Key microbes will be found across all woodchip bioreactors that are found to be necessary for heightened denitrification
- The interaction between agricultural water and woodchips as a carbon source is key to enhanced denitrification
- Design structure, temperature, and hydraulic residence times will impact the microbial community composition through dynamic interactions of carbon source and agricultural water



Denitrification process in woodchip bioreactors[iii]

Resources

[i] Jones, C. S., Nielsen, J. K., Schilling, K. E., & Weber, L. J. (2018). Iowa stream nitrate and the Gulf of Mexico. PLOS ONE, 13(4). https://doi.org/10.1371/journal.pone.0195930
[ii] Valayamkunnath, P., Barlage, M., Chen, F., Gochis, D. J., & Franz, K. J. (2020). Mapping of 30-meter resolution tile-drained croplands using a geospatial modeling approach. Scientific Data, 7(1). https://doi.org/10.1038/s41597-020-00596-x
[iii] Hartfiel, L. M., Schaefer, A., Howe, A. C., & Soupir, M. L. (2021). Denitrifying bioreactor microbiome: Understanding pollution swapping and potential for improved p erformance. Journal of Environmental Quality, 51(1), 1–18. h ttps://doi.org/10.1002/jeq2.20302