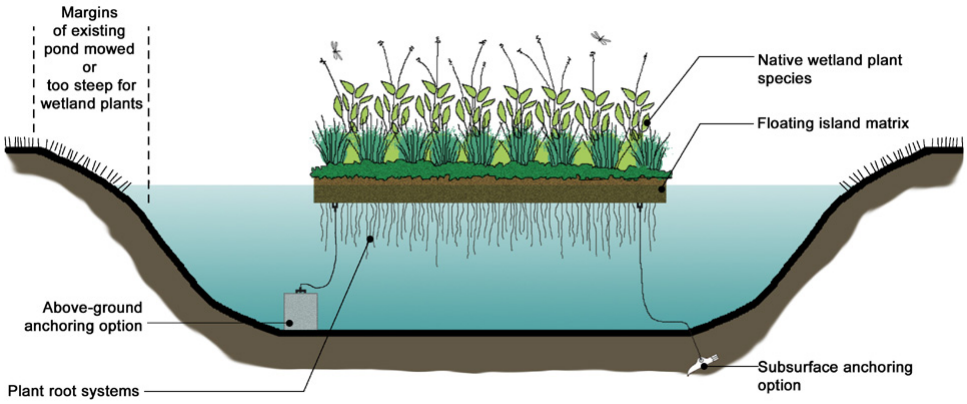
Can floating treatment wetlands improve water quality in ponds?

Bryan Maxwell, Danielle Winter, François Birgand
(and many more helpers)

What are floating treatment wetlands? (aka floating treatment islands) (aka floating islands)



https://tcwp.tamu.edu/floating-wetland-islands/

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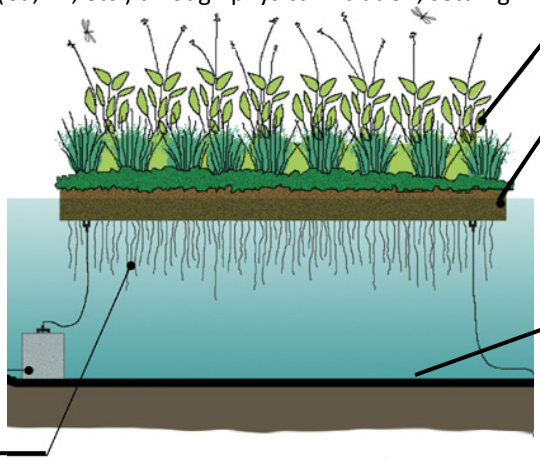
How do they work?

- Reduce nutrients (N & P) through plant uptake, denitrification, nitrification, settling
- Reduce suspended solids (TSS) through physical filtration and settling
- Reduce metals (Cu, Zn, etc.) through physical filtration, settling



Pretty similar to conventional wetlands!

*Supported in the literature

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Commercial providers of floating wetlands

Floating Islands International and Floating Wetland Solutions

- Non-woven fiber mats with pre-drilled holes for plants
- Injected foam for buoyancy
- $10 – 25 sq. ft (mats + plants)


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Commercial providers of floating wetlands

Beemats

- 4’ x 8’ closed cell mats joined along edges
- Plants are grown in containers suspended within mat
- $4 – 6 sq. ft (mats + plants)




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How much coverage ***is*** needed for treatment?

15+ mesocosm studies reporting removal rates

- Focus on plant uptake, changes in WQ

Meta-analysis by Wang and Sample (2013)

- Review of 12 mesocosm scale studies
- Determined removal kinetics for TN and TP
- Used to inform Chesapeake Bay Panel Review of FTW

Incremental Pollutant Removal Rates for FTW Pond Retrofits					
Pollutant	Raft Coverage in Pond				
	10%	20%	30%	40%	50%
TN	0.8%	1.7%	2.5%	3.3%	4.1%
TP	1.6%	3.3%	4.9%	6.5%	8.0%
TSS	2.3%	4.7%	7.0%	9.2%	11.5%

Recommendations of Expert Panel to Define Removal Rates for Floating Treatment Wetlands in Existing Wet Ponds (2016)

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Real question… Does this mean WQ improvements at the pond scale?

Real answer….. It depends, based on limited field studies

Study	Percent Coverage by FTW	TN Reduction	TP Reduction	Type
Winston et al. (2013)	9%	Not signif.	Not signif.	Year-to-year
Winston et al. (2013)	18%	Not signif.	50%	Year-to-year
Borne et al. (2014, 2013)	50%	11%	27%	Side-by-side

NC BMP Standards

Wet Ponds	Wet Ponds 5% FTW coverage	SW Wetlands
TN : 1.22 mg/L	TN : 0.85 mg/L	TN : 1.12 mg/L
TP : 0.15 mg/L	TP : 0.09 mg/L	TP : 0.18 mg/L

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Our Project : Filling the gaps in the literature

No large-scale studies in medium to large stormwater ponds comparing benefits of FTW to a control in a side-by-side comparison!

- Account for inter-annual variability
- Reduce uncertainty
- Look at FTW impacts when coverage is reasonable (<50%)

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Project Site

- Location : NCSU Campus, Wolf Village
- Pond Size : 9,000 sq. ft. (0.2 acre)
- 30-50’ width, 250’ length, 2-4’ depth
- Monitoring from October 2017 – August 2018

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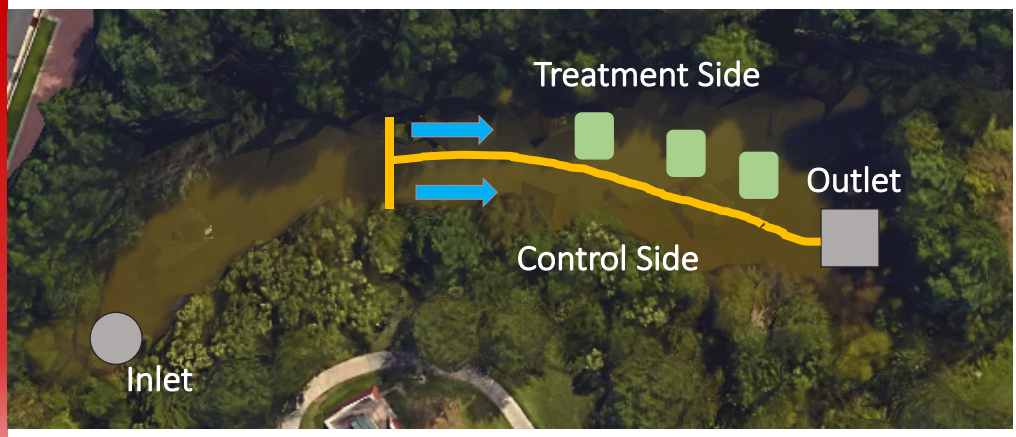
Project Site – Experimental Retrofit



- Divide pond longitudinally with impermeable barrier
- Create control and experimental treatments on either side
- Split ponds receiving similar influent from same source, same time

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Weirs at inlet
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Split
Outlet
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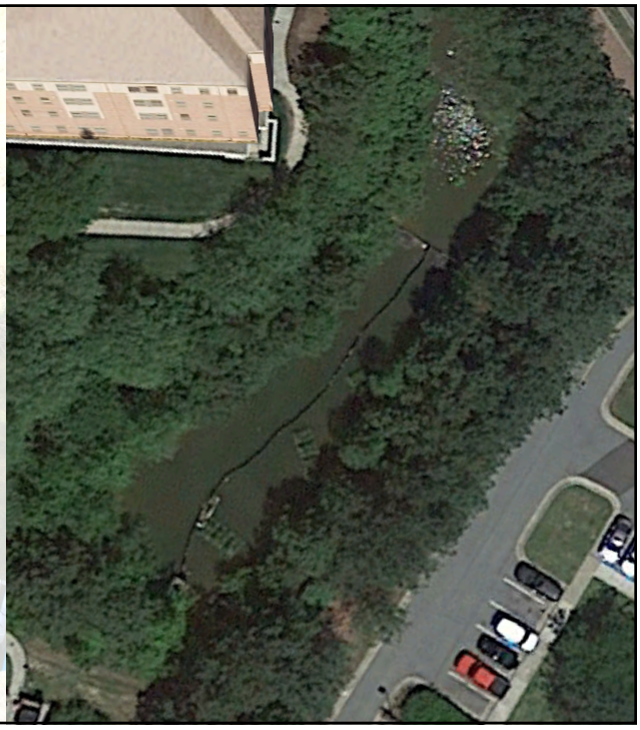
- ~ 2,500 ft^2 per side
- Sixteen 4’ x 8’ FTW mats
- ~ 20 - 25% coverage
- >1.5 years of growth
- Three FTW berms crossing entire channel



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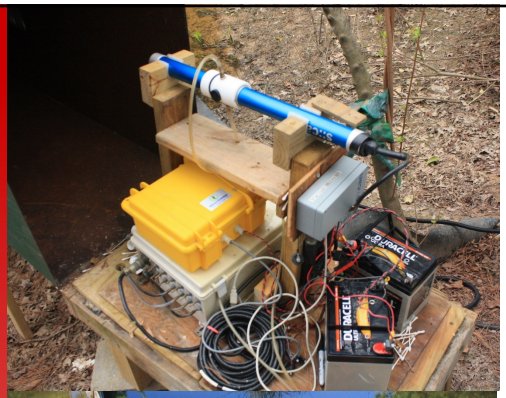

Do FTW lead to significant differences in water quality?

State-of-art sampling techniques

- Multi-point, continuous sampling
- Field spectrophotometer
- ~10 min sampling interval
- Between and during storms
- TN, NO3, TSS

Conventional sampling techniques

- Grab samples
- Flow weighted outlet samples
- TP, TN, TSS
- Monitoring water depth

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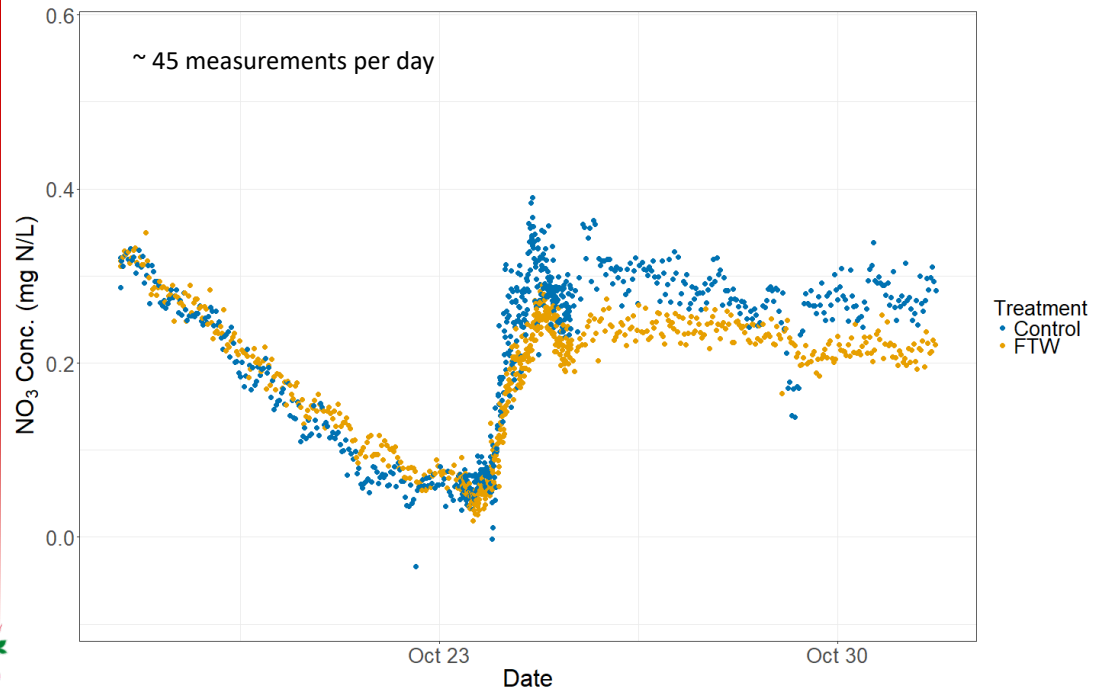

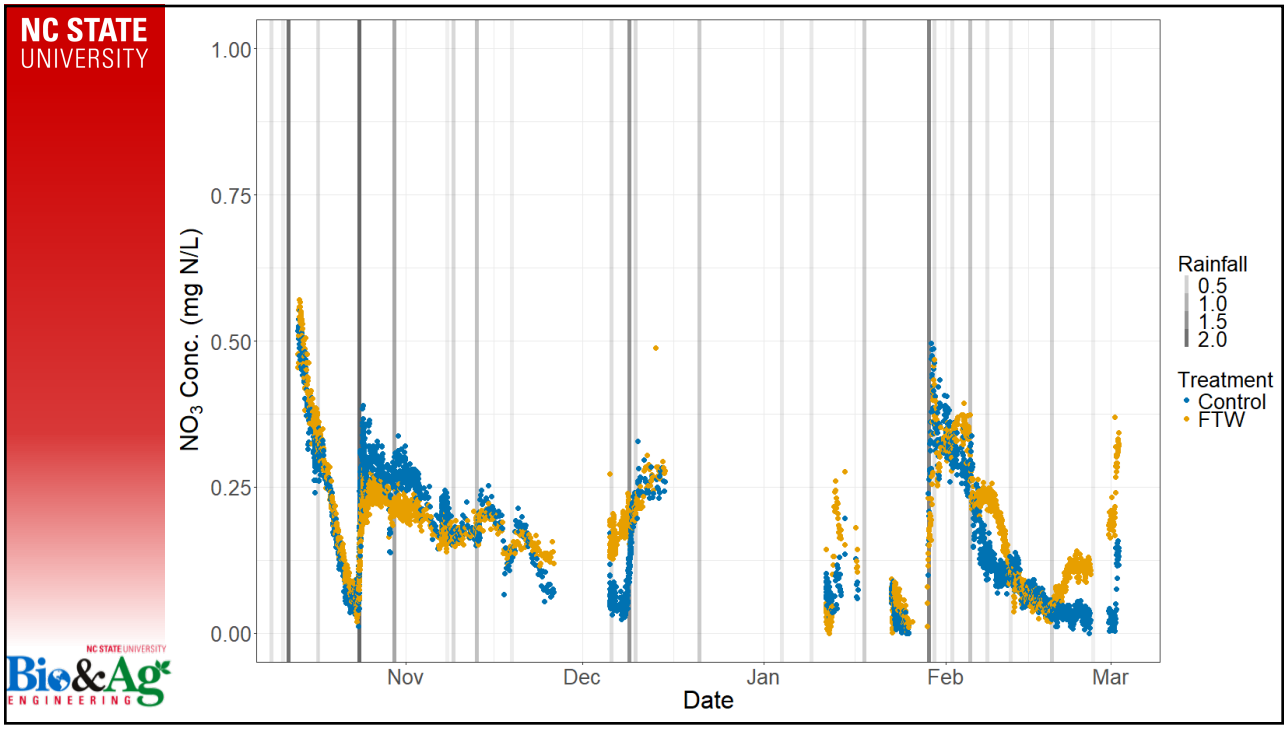
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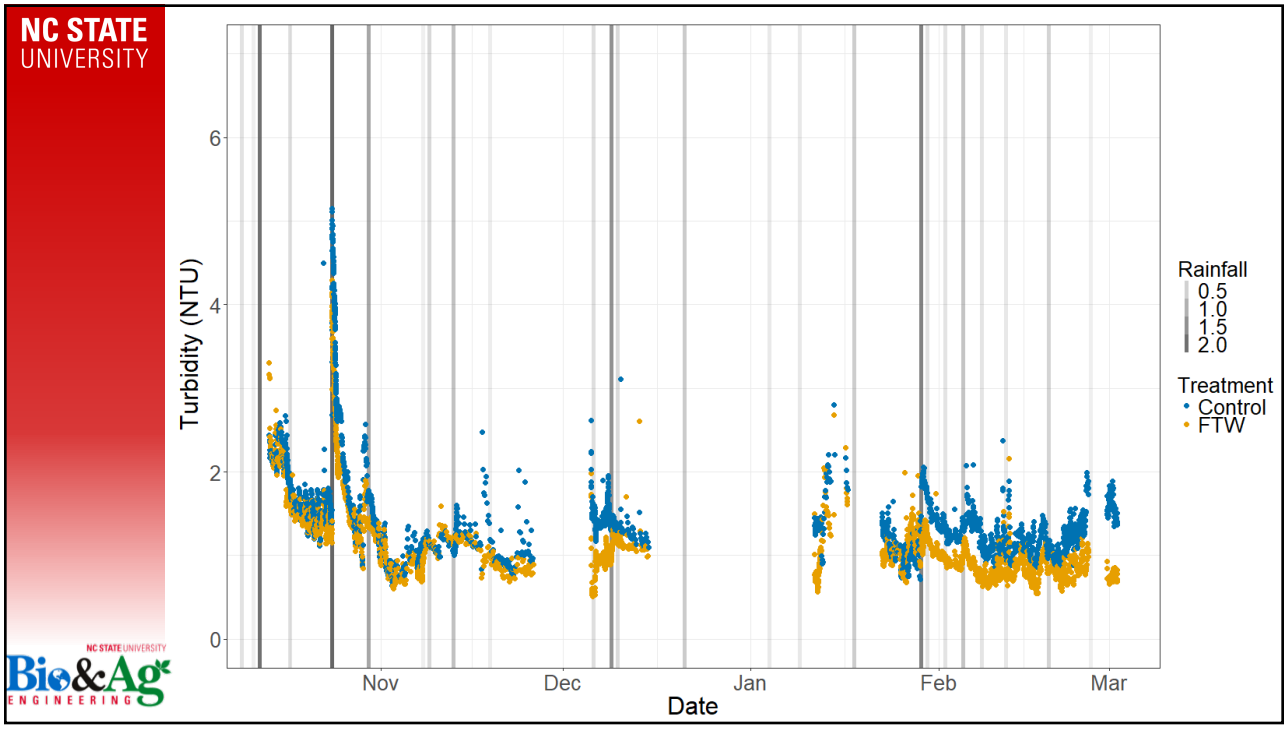
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Future Research in Floating Islands

- Side-by-side studies on medium to large wet ponds
  - Reduce inter-annual variability
  - Focus on ponds with nutrient problems
- Research on other FTW benefits
  - Habitat, biodiversity
  - Aesthetics, user perception and involvement
  - Algal control (nutrient uptake + allelopathy)

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Social Outreach

Follow us on Twitter!
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High-school campers helping out

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Multi-state modeling group

City of Raleigh Stormwater

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Acknowledgements

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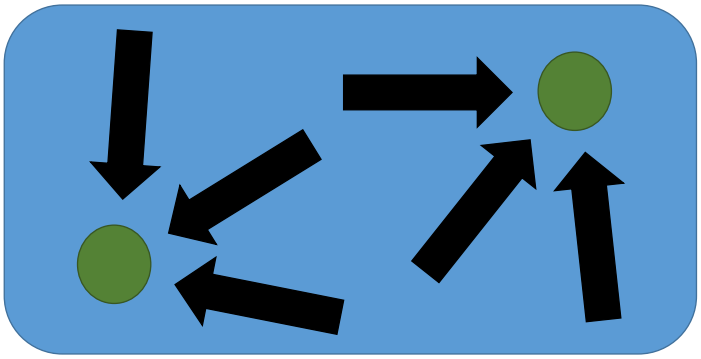
Percent coverage drives performance!

- Processes limited by **diffusion** $J = -D \frac{dC}{dx}$
  - Mostly static water bodies
  - Stormwater is relatively clean (low concentration gradient)
  - Distance to treatment zone is high (unless coverage is high!)



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Additional Funding Partners

- Two Undergraduate Research Grants, 3 Undergraduates
  - Microbial and mesocosm studies
  - $2,000
- NCSU Sustainability Fund
  - Floating wetlands for multiple ponds on campus
  - $12,600

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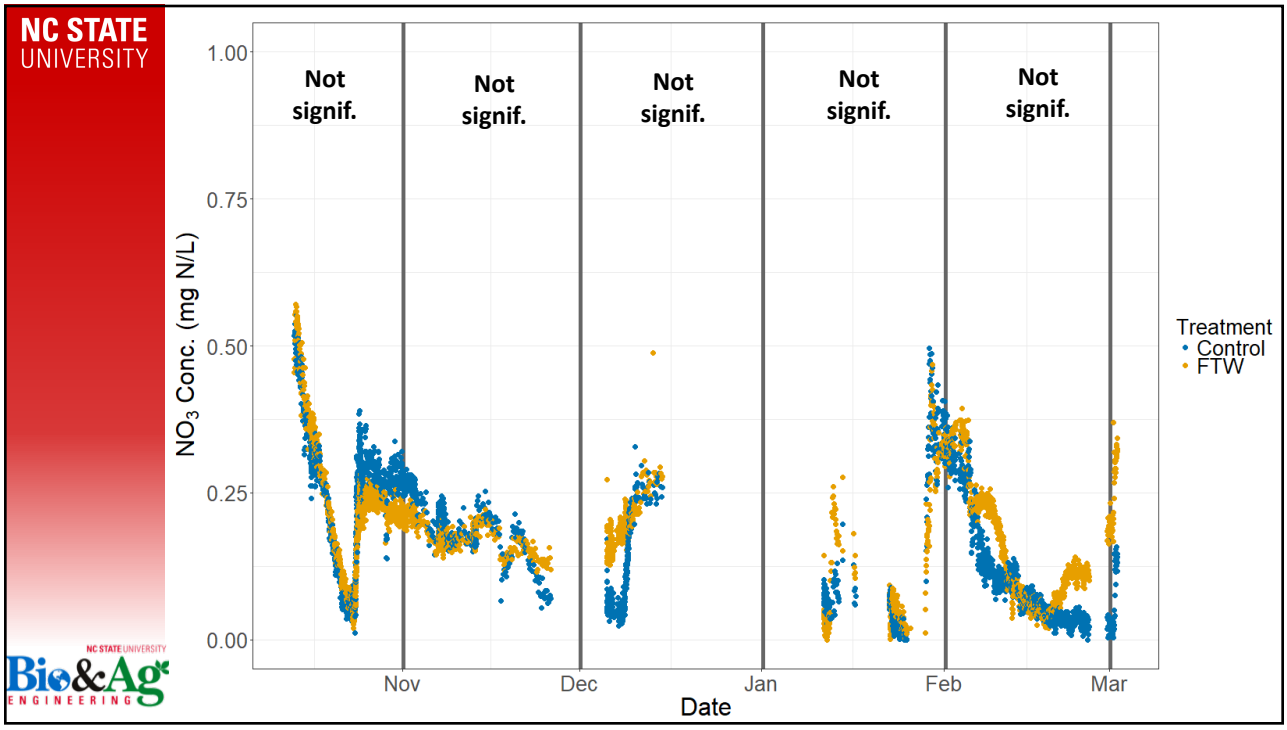
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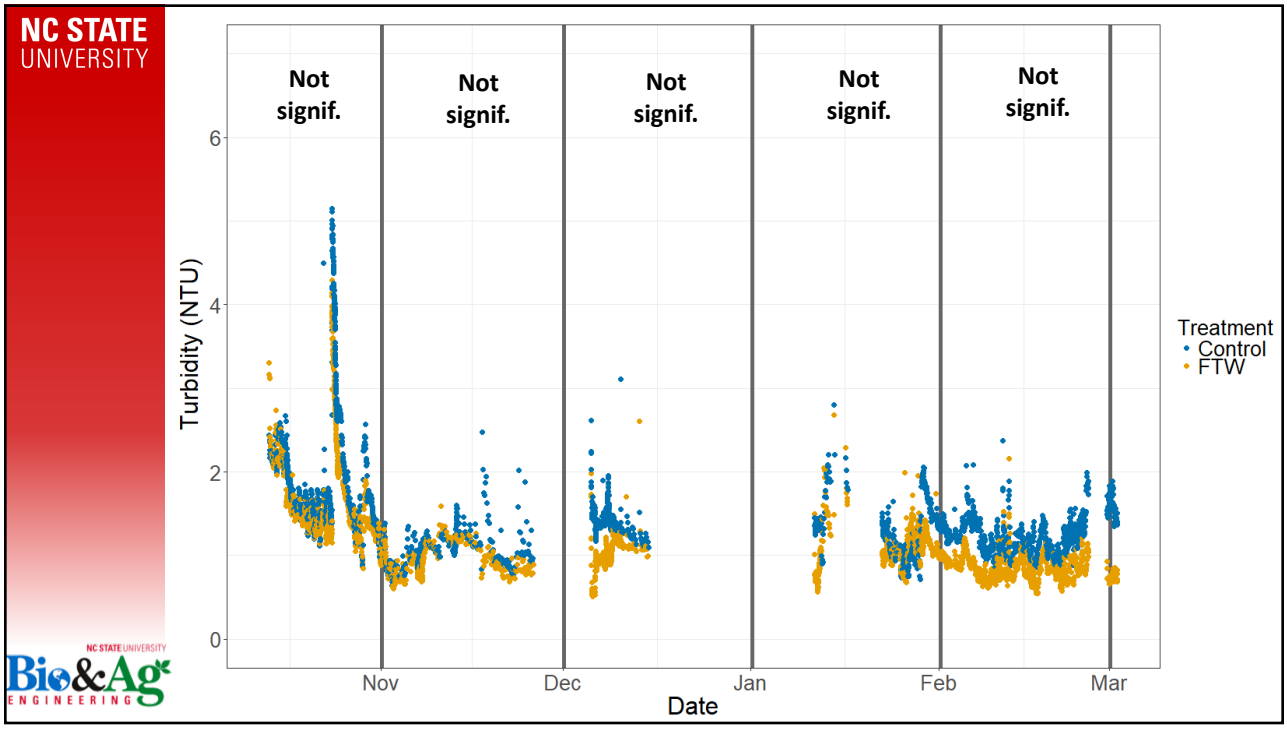
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