Biosolids-derived Phosphorus
What We've Learned from the Upper St. Johns River Watershed

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Bureau of Environmental Sciences
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Division of Water Resources

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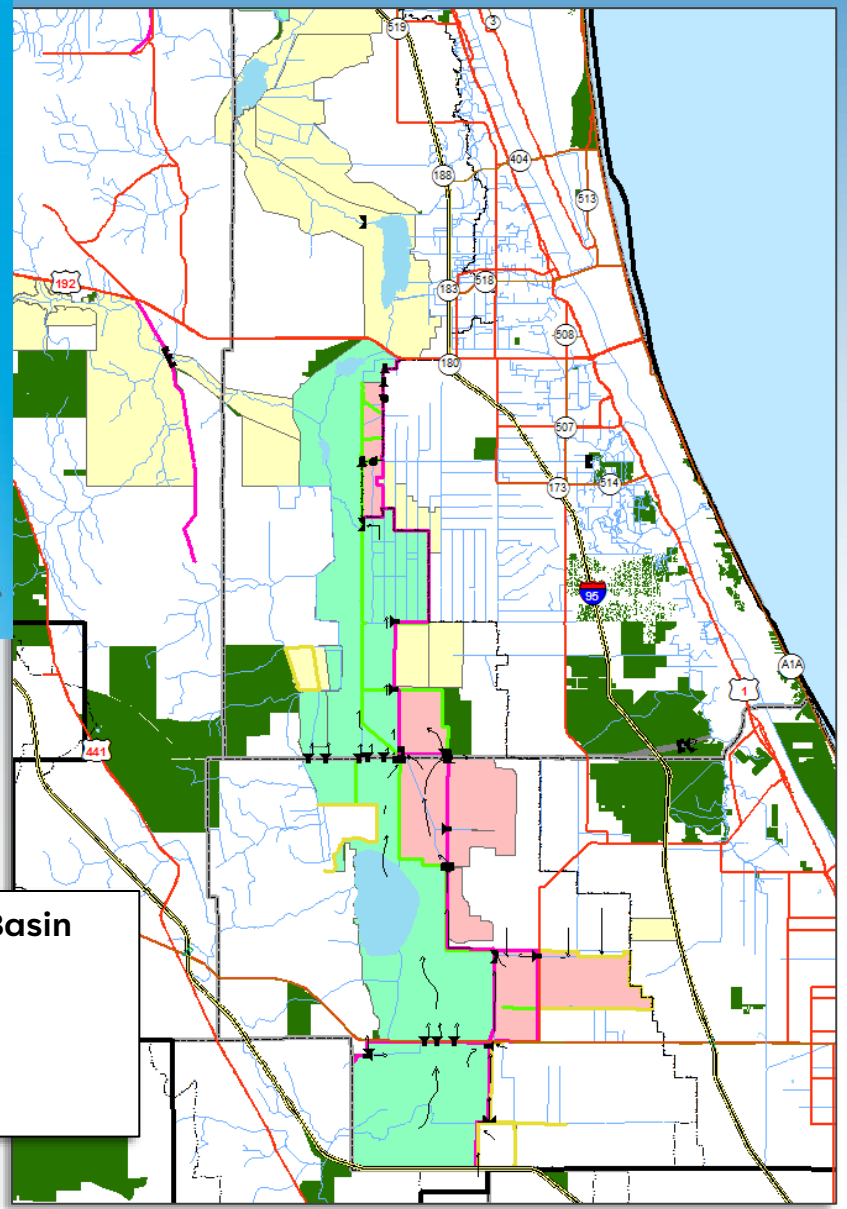
The Upper St. Johns River Basin

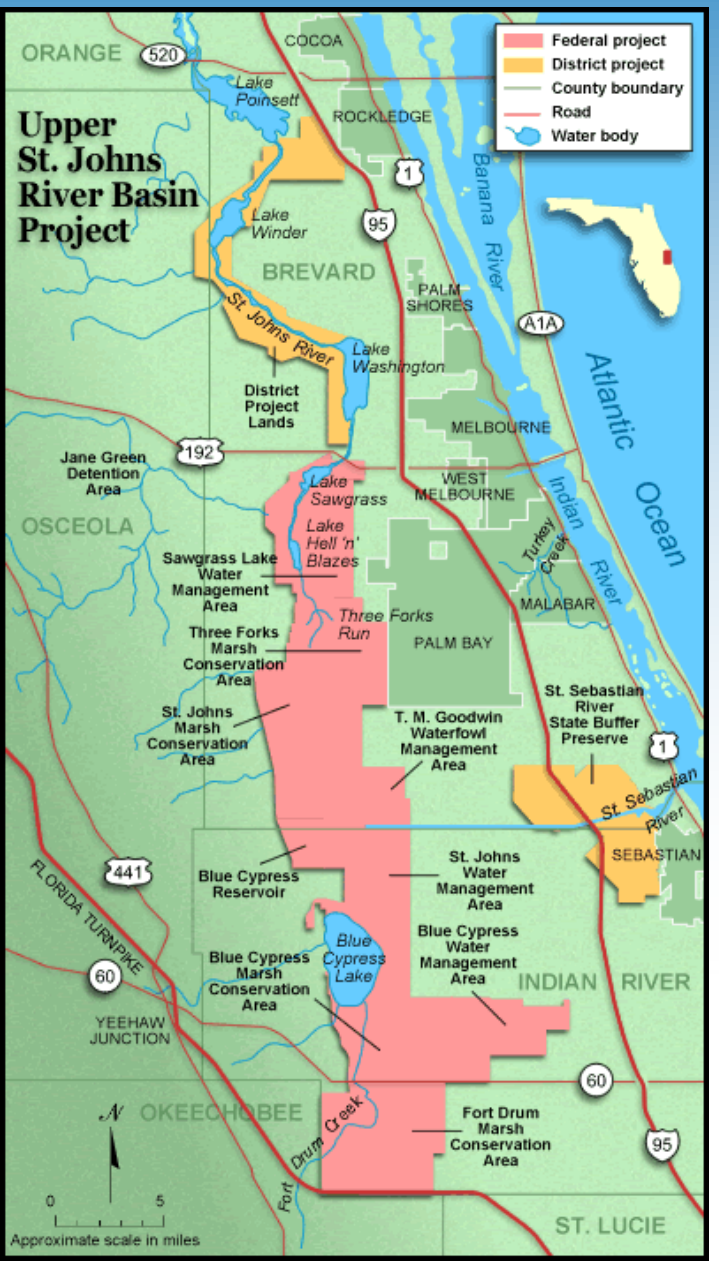


Upper St. Johns River Basin

- Conservation Areas
- Water Mgmt. Areas
- Floodplain
- Public Lands

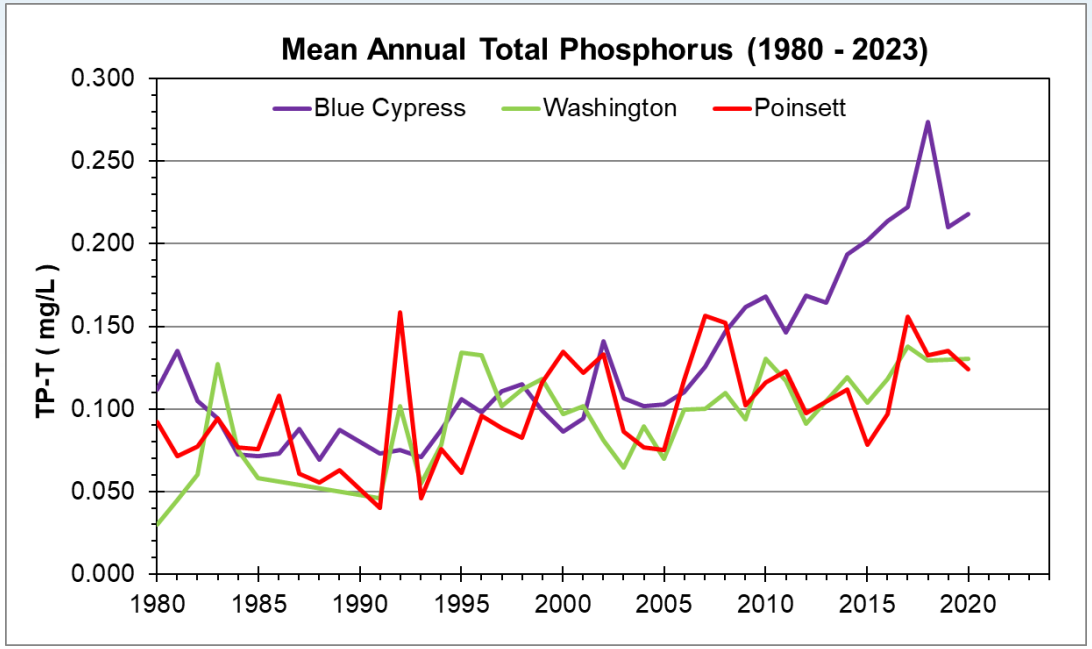
- Historically expansive herbaceous marsh and river-run lakes
- SJRWMD owns and manages over 166,000 acres for flood mitigation, water quality, natural systems enhancement and water supply
  - Thiess River Award for integrating environmental restoration and flood mitigation — 2008
  - Florida Engineering Society “Project of the Century” — 2016
- Designated use — Class I potable supply

Phosphorus Trends and HABs



2018 Water Quality Status and Trends Report

- 10 of 55 sites exhibit increasing TP trends
  - Blue Cypress Lake: Increasing chlorophyll *a*
- Management Concerns:
  - 31 segments impaired or “4d”
  - Downstream TMDL targets
  - Increased incidence of *Microcystis* and *Dolichospermum circinale* (formerly *Anabaena*) in potable water supply



Phosphorus Source Hypotheses

1. Land Use Changes
2. Increased fertilizer use
3. Hydrologic Management of the Upper Basin Project
4. Vegetation Management (P in herbicides i.e., glyphosate)
5. Erosion
6. Biosolids
7. Others?

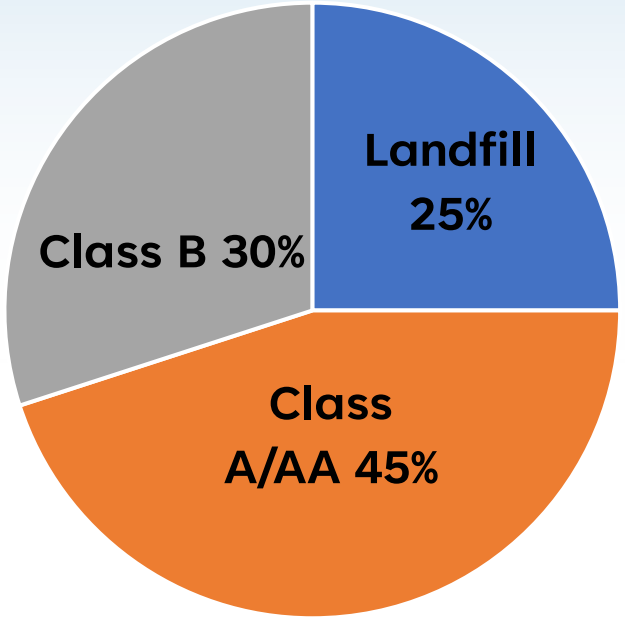
Hypotheses

1. Land Use Changes – minimal in these Agriculture-dominated basins
2. Increased fertilizer use – using Potassium as tracer, no evidence for wide-spread increase
3. Hydrologic Management
   a) Timing and Spatial patterns don't coincide
   b) Insufficient magnitude
   c) Other chemical indicators don't support
4. Herbicide-derived phosphorus – insufficient magnitude
5. Erosion – not supported by Total Suspended Solids (TSS) or Turbidity data or P as SRP
6. Biosolids – Compatible with:
   a) Timing
   b) Location
   c) Chemistry
   d) Magnitude

What are Biosolids?

- Nutrient-rich, solid / semisolid residue from domestic wastewater treatment
- Class B regulated by FDEP
- Class A/AA regulated by FDACS as fertilizer
- **Low N:P ratio**

Florida's Biosolids
350,000 dry tons/year



Class B Uses

- Cow/calf production on pasture or forage
- Required site permits, reporting of quantities generated and applied
- Nutrient Management Plans prepared by Certified Nutrient Planners or PE

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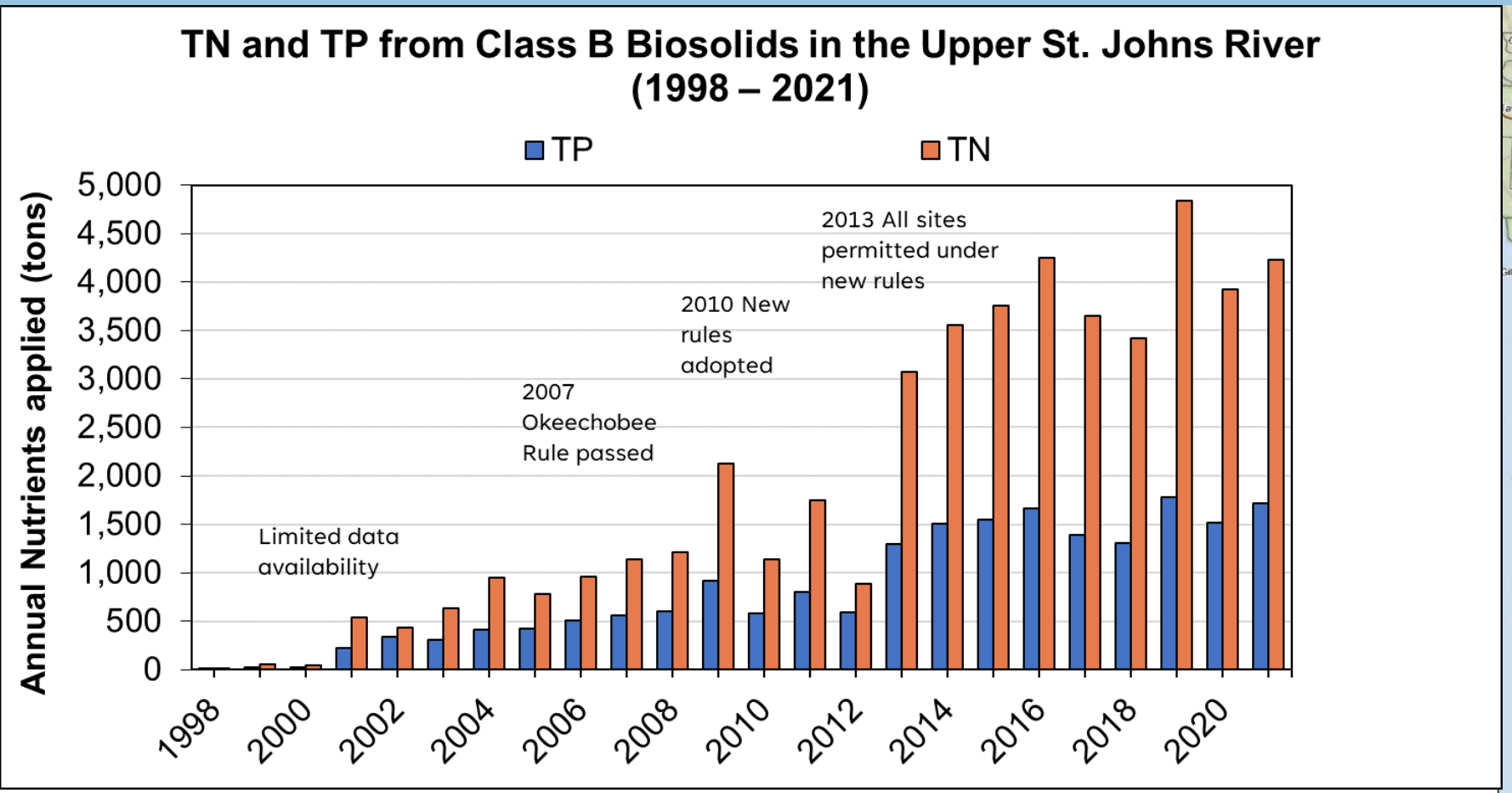
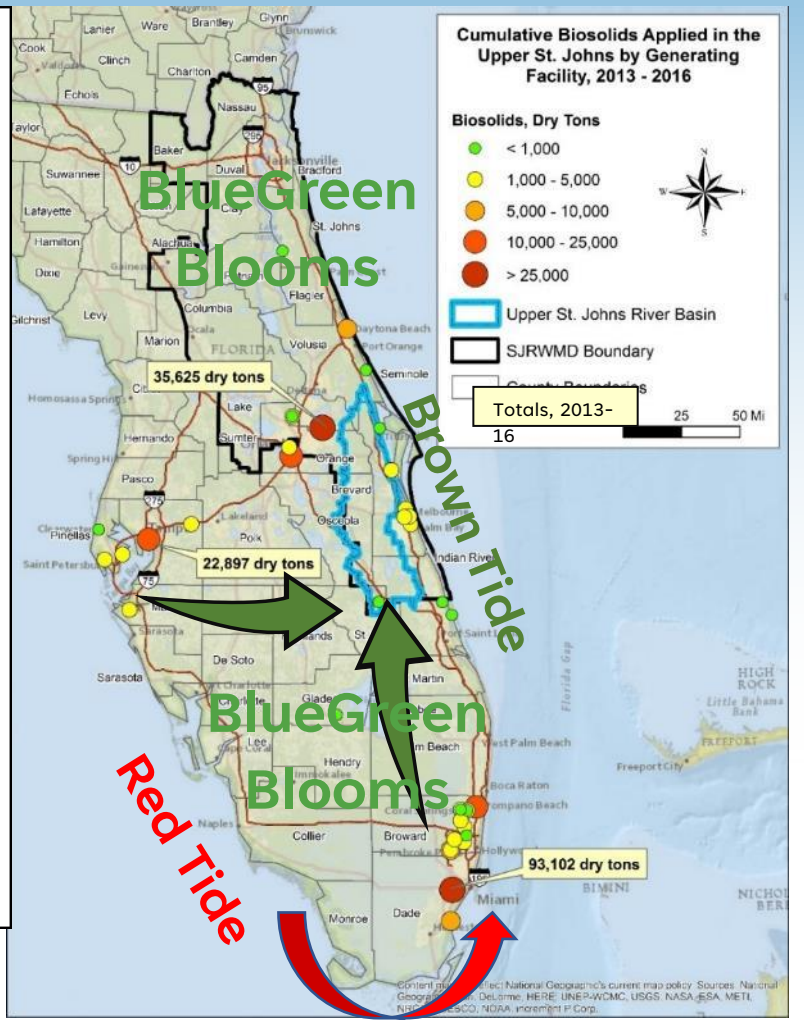
Upper SJR Basin
Class B Biosolids Applications





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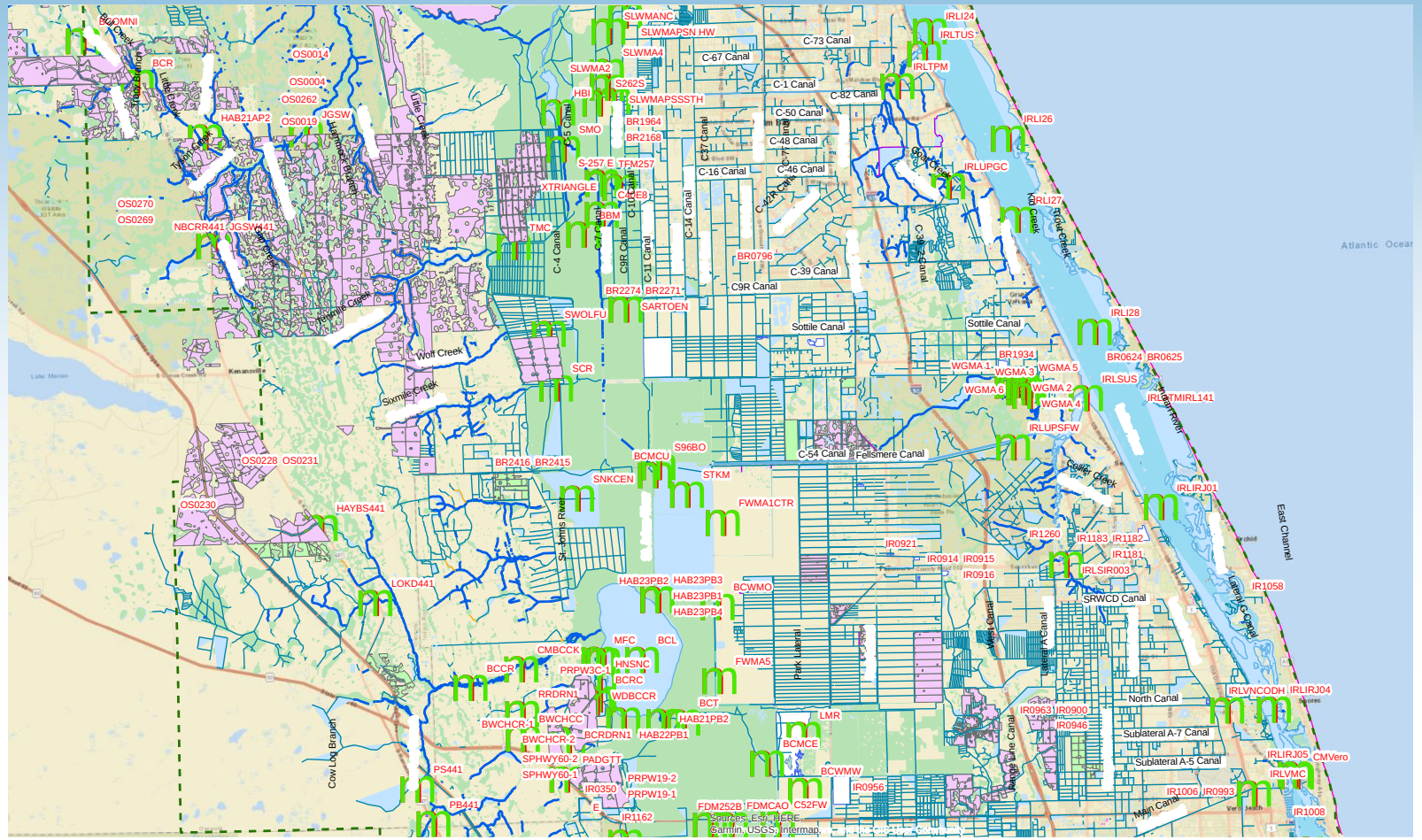
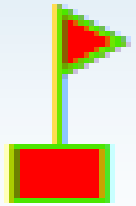
Data Evaluation
FDEP's Class B Land Application Permit Data and SJRWMD Water Quality Network

Purple fields with FDEP's detailed Class B land application permit data



SJRWMD's Water Quality Stations



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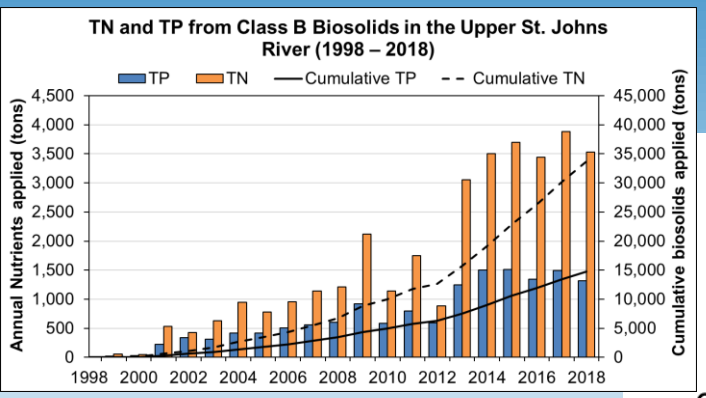
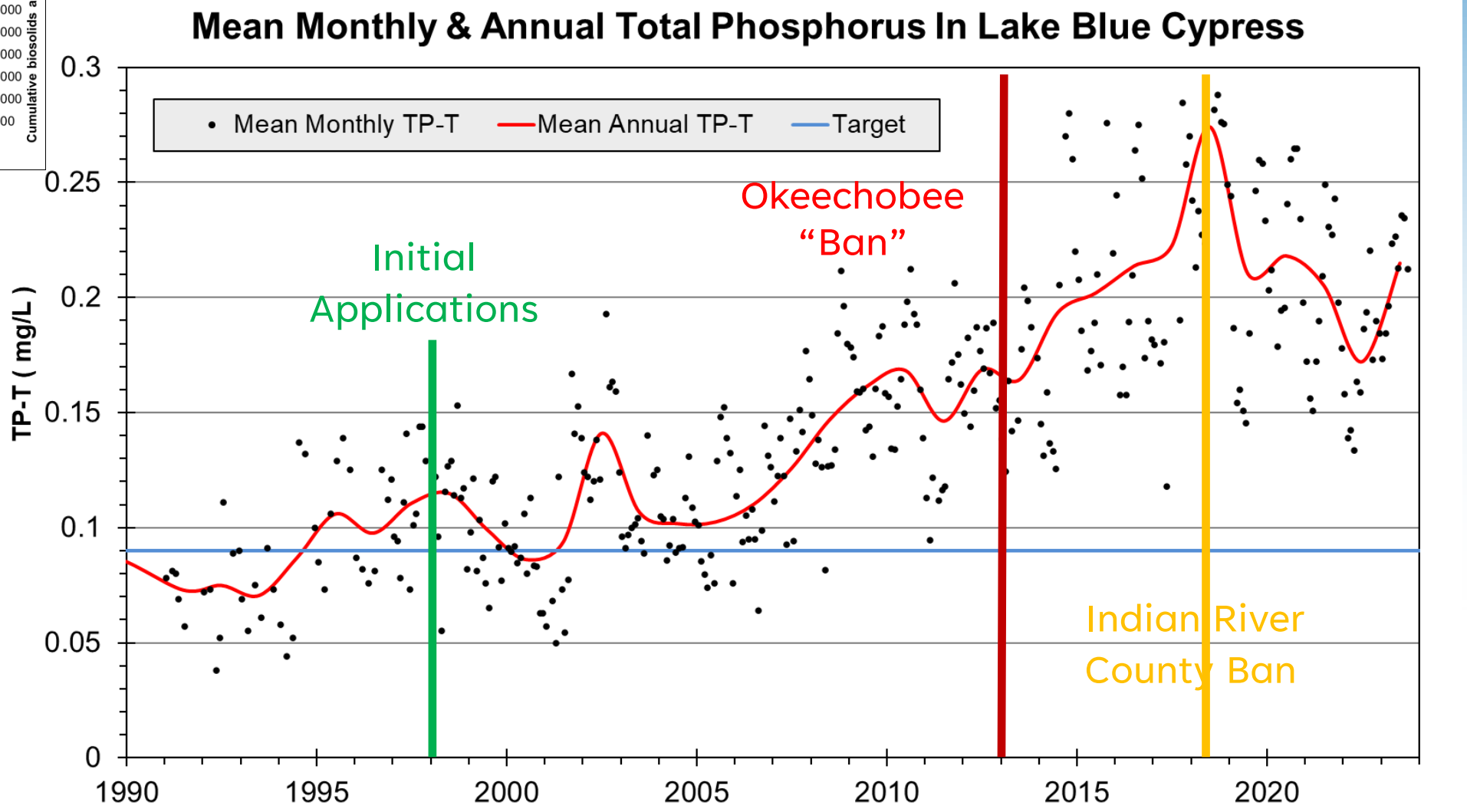
Lines of Evidence for Biosolids Contribution

1. Timing of Changes — Phosphorus concentration tracks changes in biosolids application rates

1. Timing



Blue Cypress Lake example



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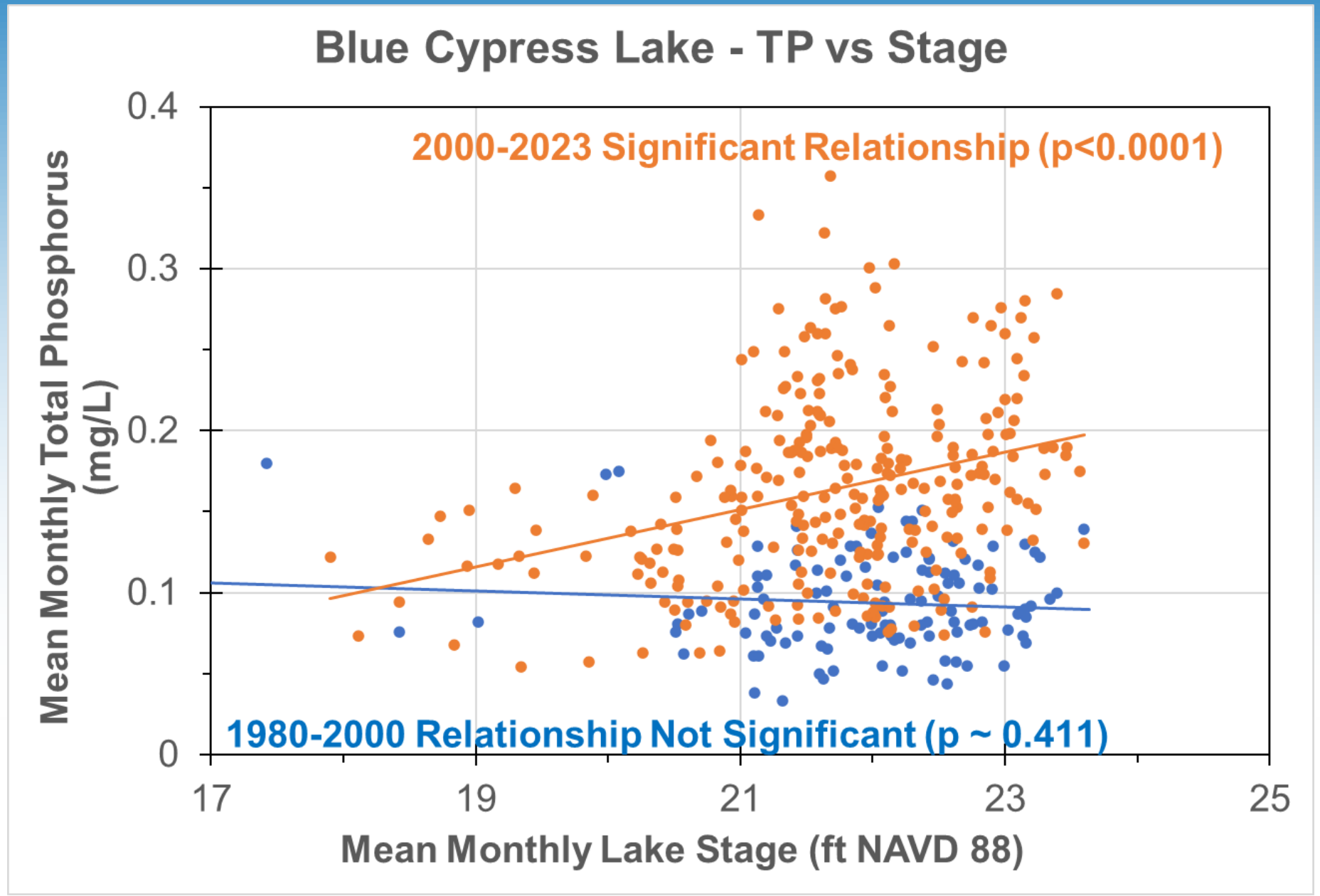
1. Timing of Phosphorus Increase



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Lines of Evidence for Biosolids Contribution

1. Timing of Changes — Phosphorus concentration tracks changes in biosolids application rates
2. Location of Changes — Increased phosphorus concentration in watersheds with biosolids but not other watersheds

2. Spatial Pattern of Phosphorus Increase

Upper St. Johns River Basin

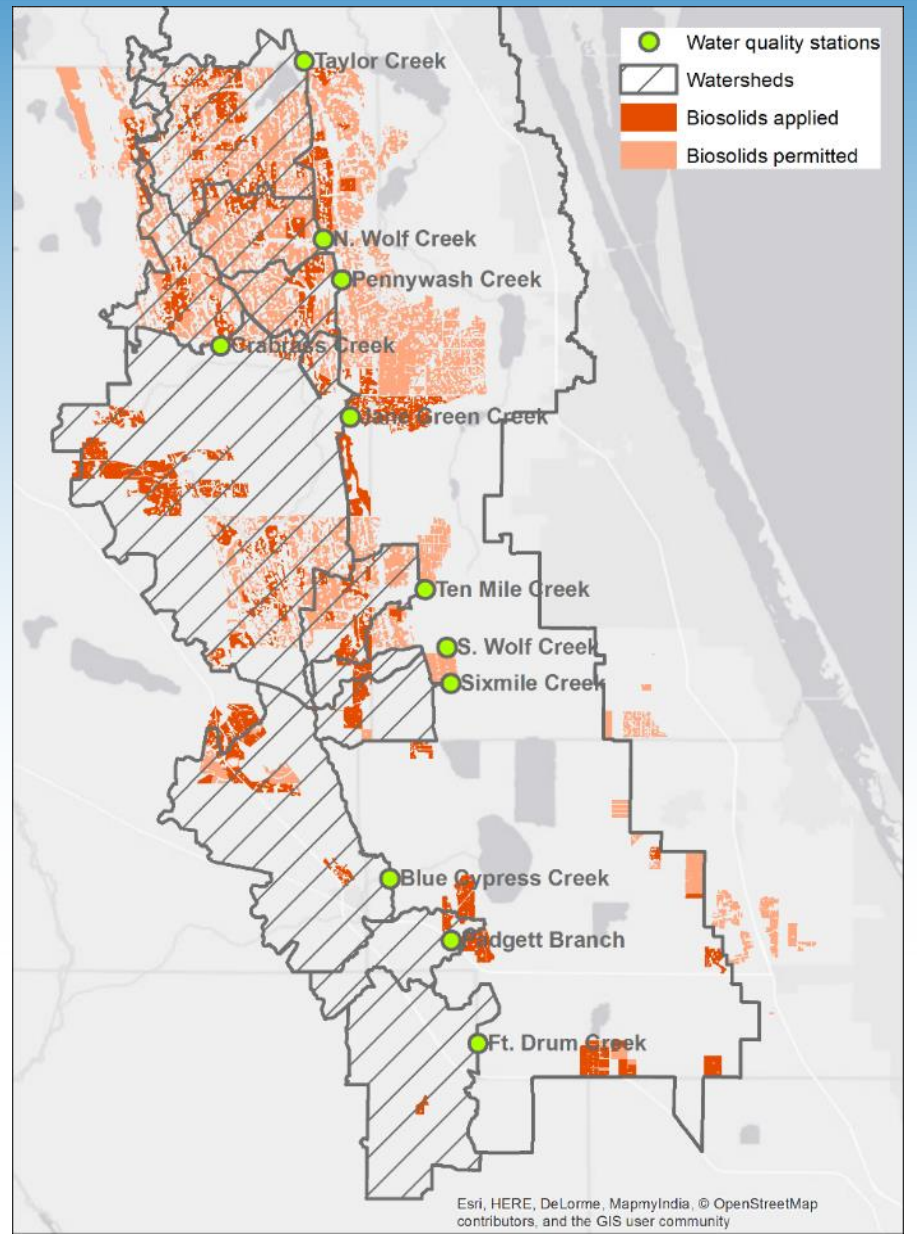
2018 Status and Trends Assessment

Trends over past 15 years

www.sjrwmd.com/data/water-quality

	Number of Sites		
	Decreasing	Stable	Increasing
Total Phosphorus	8	13	21
Dissolved Phosphate	2	13	24
Total Nitrogen	20	20	1
Total Organic Carbon	14	24	4
Total Suspended Solids	22	18	2
Turbidity	25	17	0

- Biosolids applied from 1998 – 2018 collated from permit records
- Field-scale detail allows application rate assessment



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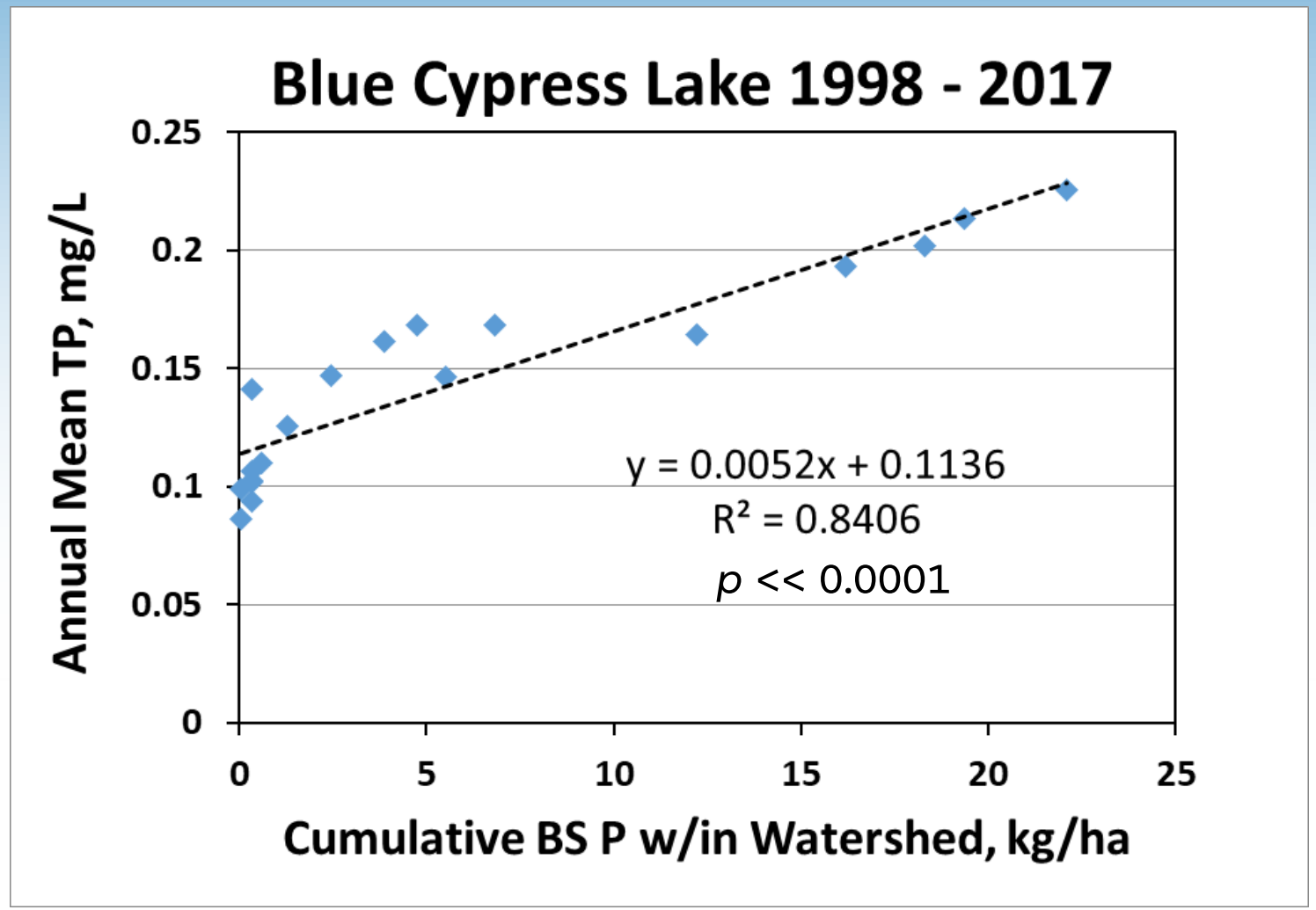
2. Spatial Patterns

Cumulative Biosolids Loading Strongly Correlated with Mean Annual TP for Blue Cypress Lake



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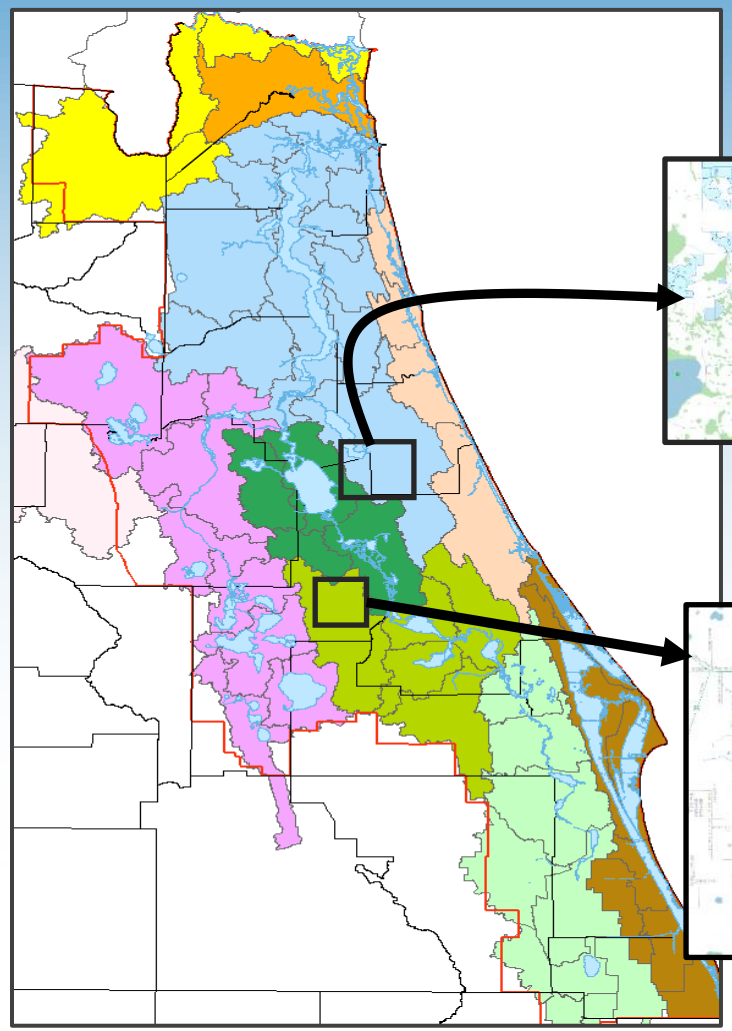
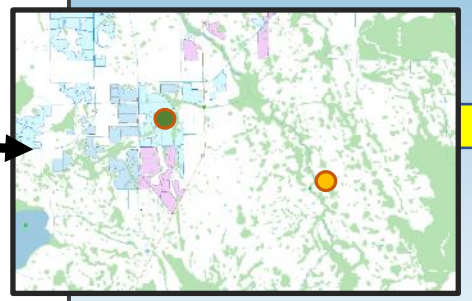
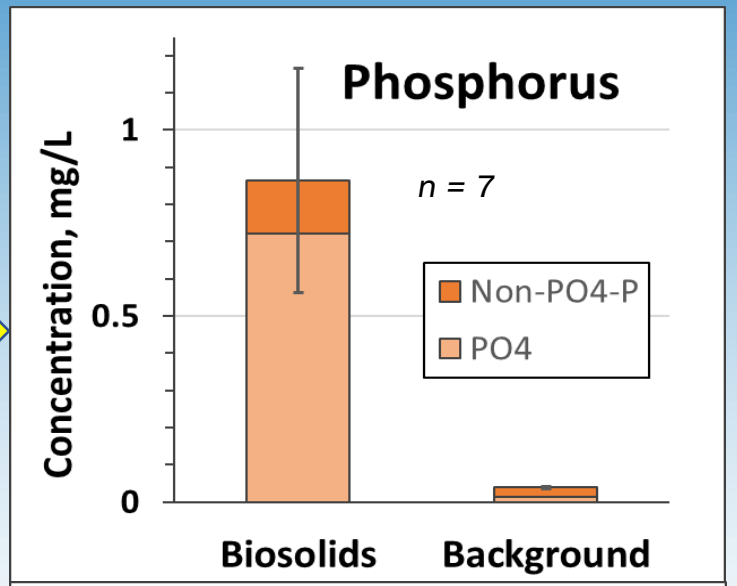
3. Spatial Patterns — Paired Watersheds

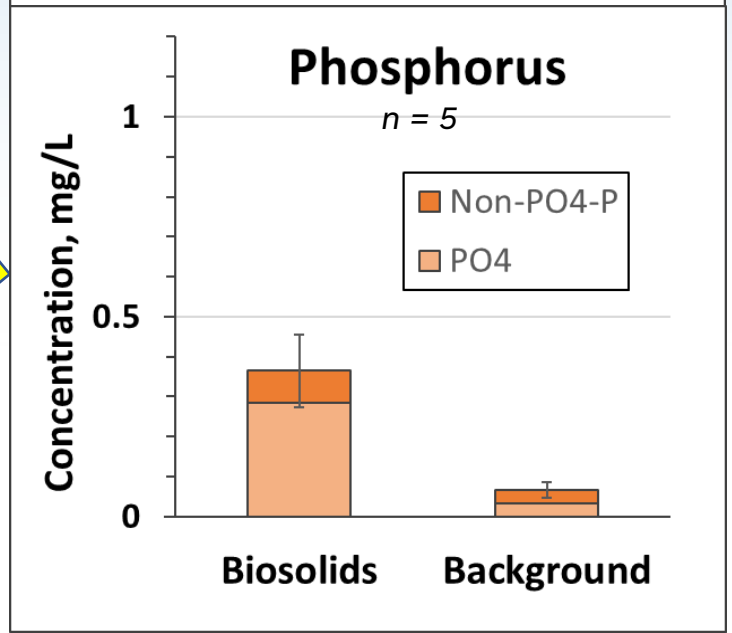


Crescent Lake



Umatilla





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Lines of Evidence for Biosolids Contribution

1. Timing of Changes — Phosphorus concentration tracks changes in biosolids application rates
2. Location of Changes — Increased phosphorus concentration in watersheds with biosolids but not other watersheds
3. Magnitude of Changes — increased phosphorus concentrations are large, requiring a large input change

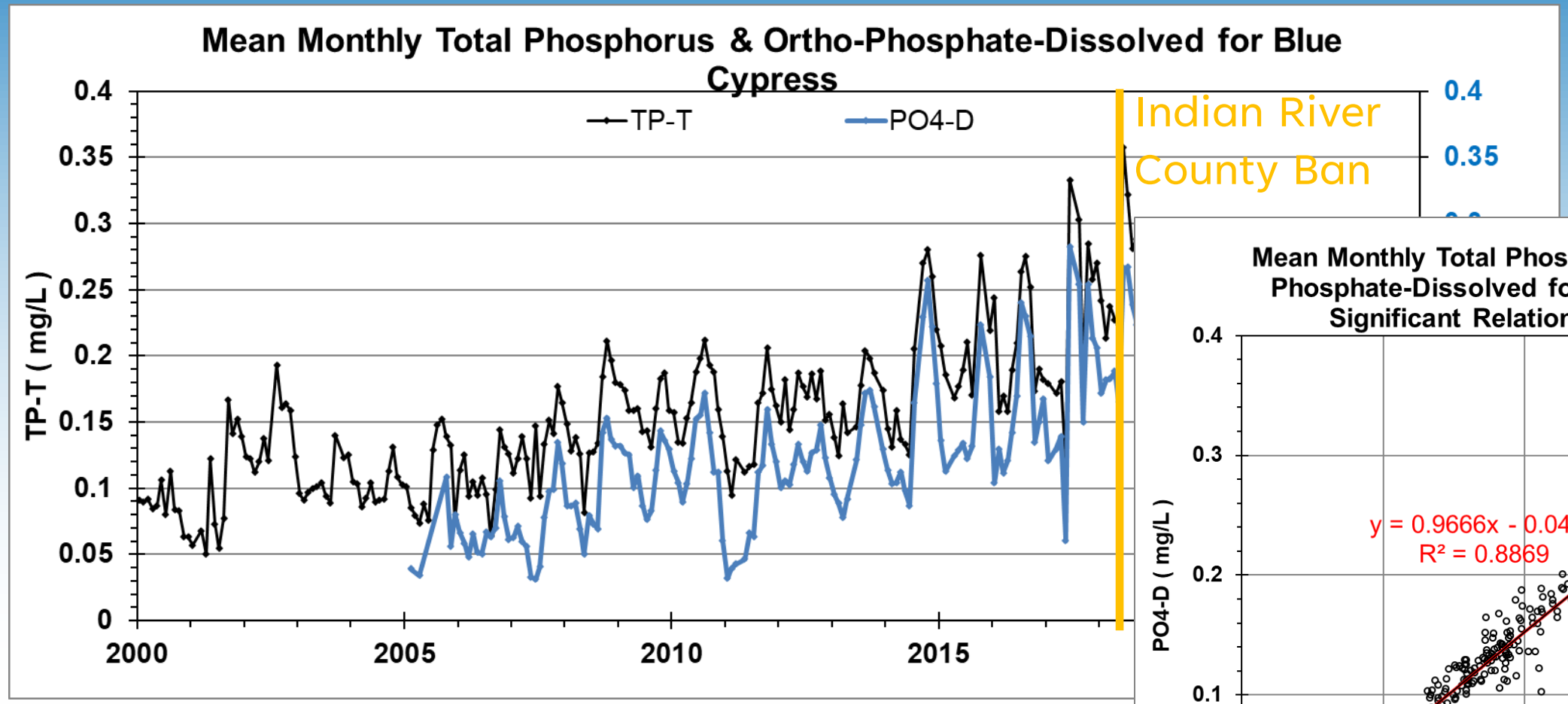
3. Magnitude of Phosphorus Increase

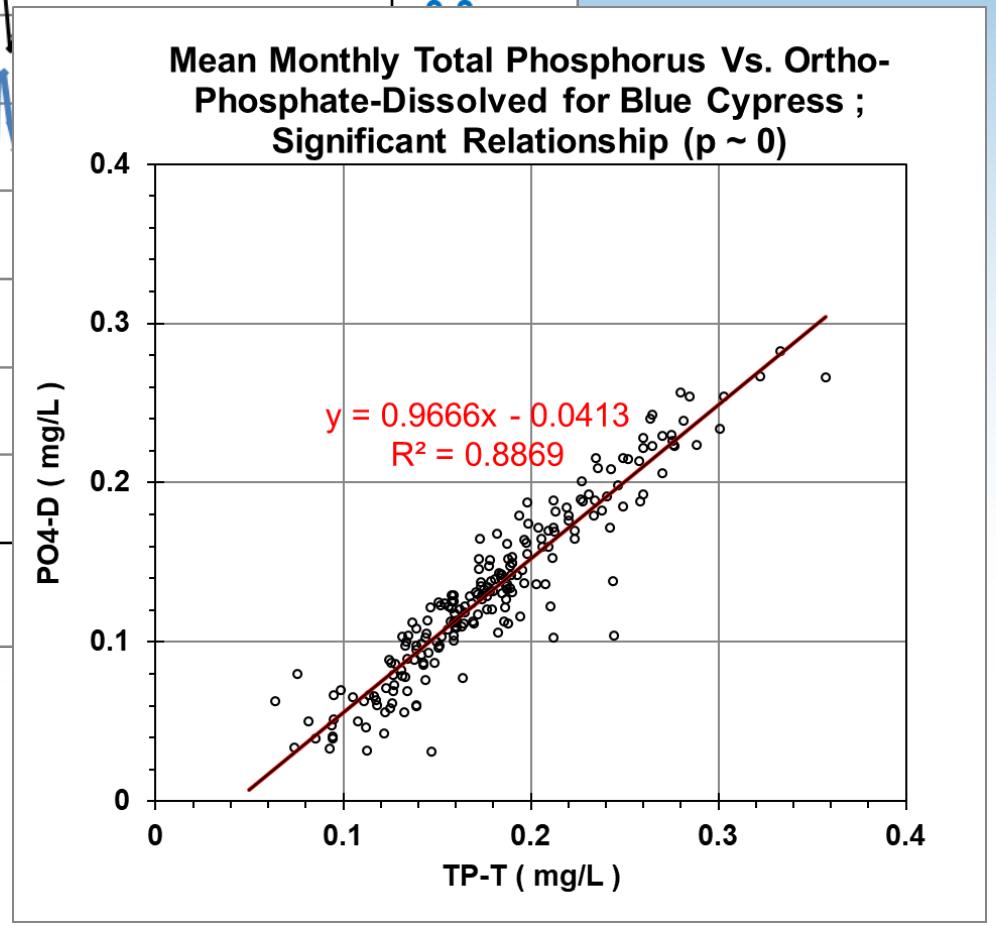
- Blue Cypress Lake P mass increase in water column at least 13 tons
  - 1,340 tons of P applied in Blue Cypress Lake's watershed as Class B
- 14,730 tons of P applied to USJRB since 1998 as Class B (as of 2018)
- Hydrologic management <4 tons of P annually, prior to regulation schedule change
- Fertilizer applied at agronomic rates and runoff detectable in potassium data

Lines of Evidence for Biosolids Contribution

1. Timing of Changes — Phosphorus concentration tracks changes in Class B biosolids application rates
2. Location of Changes — Increased phosphorus concentration in watersheds with Class B biosolids application but not other watersheds
3. Magnitude of Changes — increased phosphorus concentrations are large, requiring a large input change
4. Chemistry of Changes
   a) Elevated phosphorus is primarily soluble reactive phosphorus form
   b) Increasing phosphorus but not nitrogen

4. Chemistry of Phosphorus Changes





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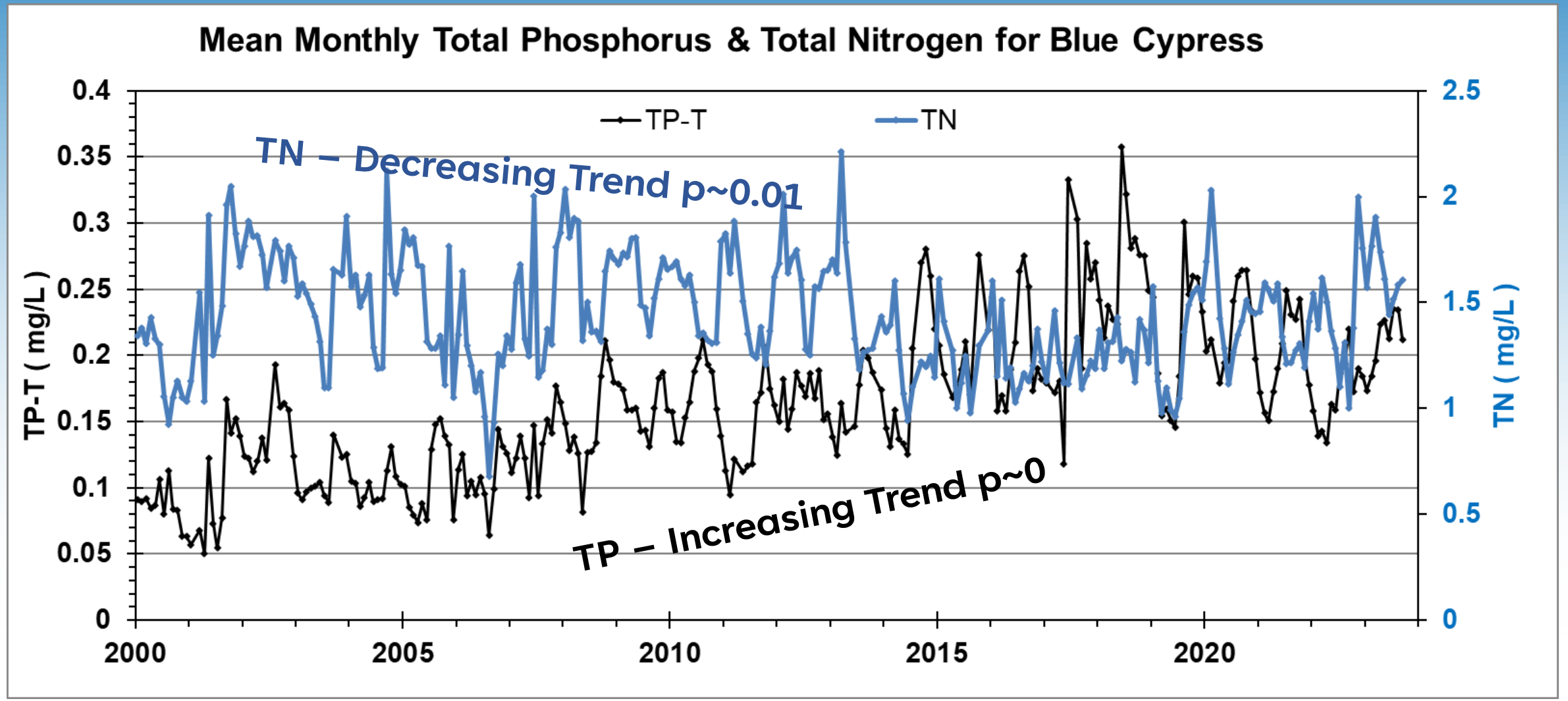
4. Chemistry of Change – N vs. P



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2022 SJRWMD Biosolids Publication

Research Article

Trends in phosphorus fluxes are driven by intensification of biosolids applications in the Upper St. Johns River Basin (Florida, United States)

Andy Canion, Victoria Hoge, John Hendrickson, Thomas Jobes & Dean Dobberfuhl

Published online: 24 Jun 2022

Download citation https://doi.org/10.1080/10402381.2022.2082345 Check for updates

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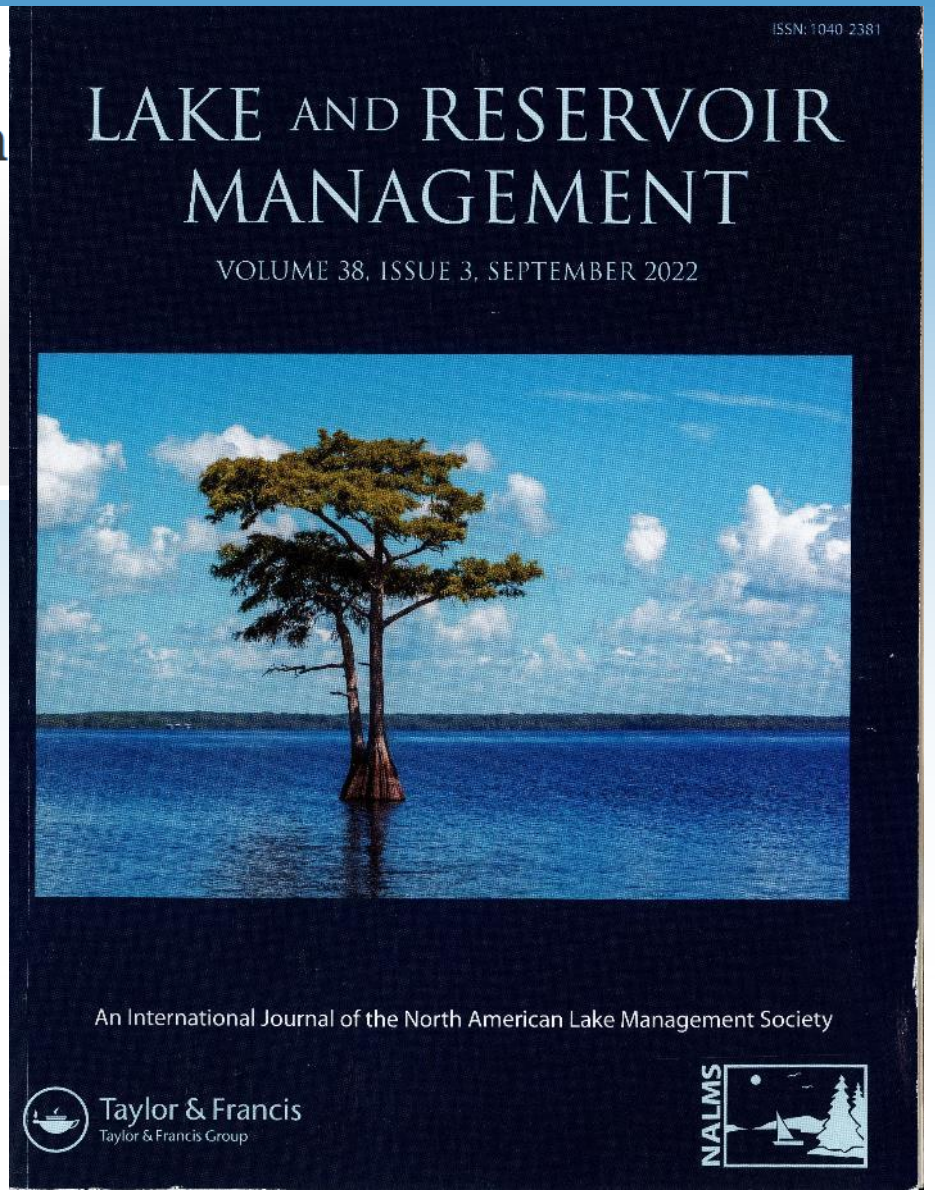

- Includes analyses with more sites and longer periods of record
- Includes more sophisticated statistical evaluations

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2020 Legislative Changes
Summary of Key Provisions

- Meet a minimum unsaturated soil depth of two feet from the depth of biosolids placement when biosolids are applied
- Not allow application on soils with a seasonal high-water table (SHWT) within six inches of the soil surface unless the permittee provides reasonable assurance through the site nutrient management plan and water quality monitoring plan that land application will not cause or contribute to surface water quality violations or groundwater violations

2020 Legislative Changes
Summary of Key Provisions

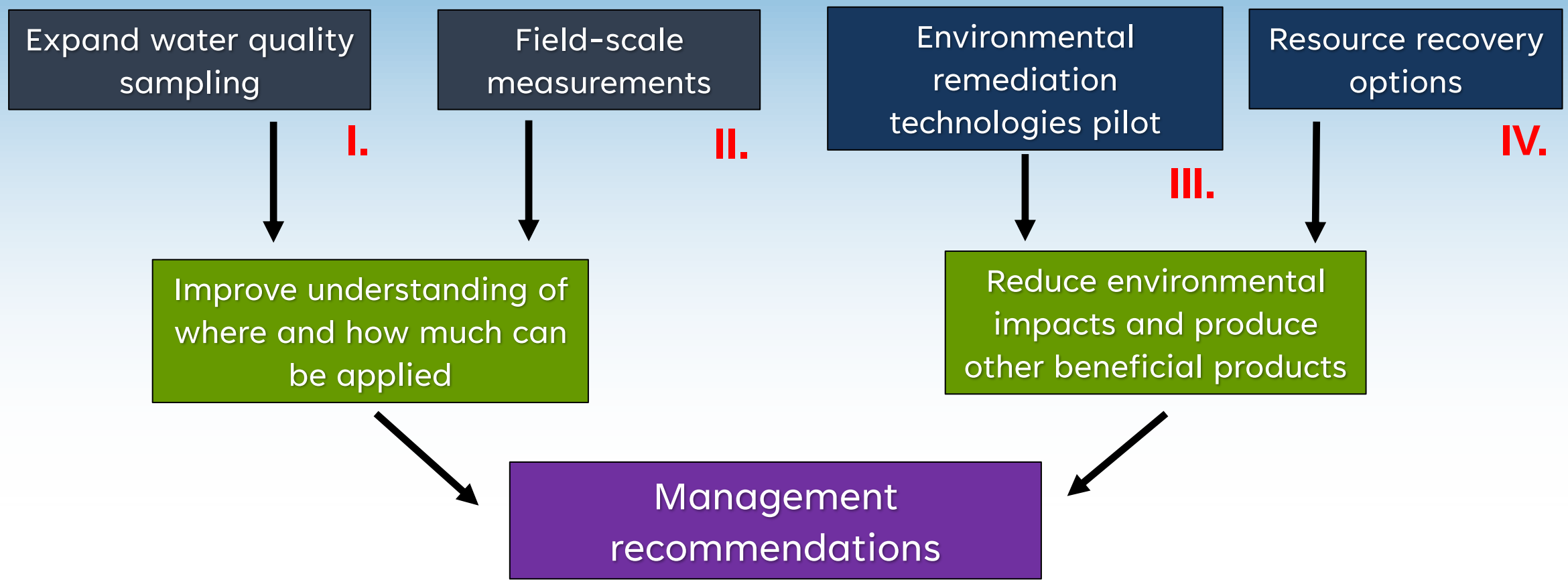
- Require enrollment in a Florida Department of Agriculture and Consumer Services' (DACS) Best Management Practices (BMP) program for applicable commodity type
- Revising the provisions for determining biosolids land application rates (rates based on Nitrogen [N] or Phosphorus [P])
- Groundwater and surface water monitoring requirements for land application sites

2020 Legislative Changes
Summary of Key Provisions

- New and renewed permits after July 1, 2020, must include a permit reopener condition to add a compliance date of no later than one year after the effective date of new biosolids rules
- All permits must comply with the new rules no later than two years after the effective date of the new biosolids rule
- Biosolids permit applications shall be considered projects of heightened public interest

FDEP Grant

Projects to Monitor and Improve Water Quality: Biosolids Assessment ($1.9 M)



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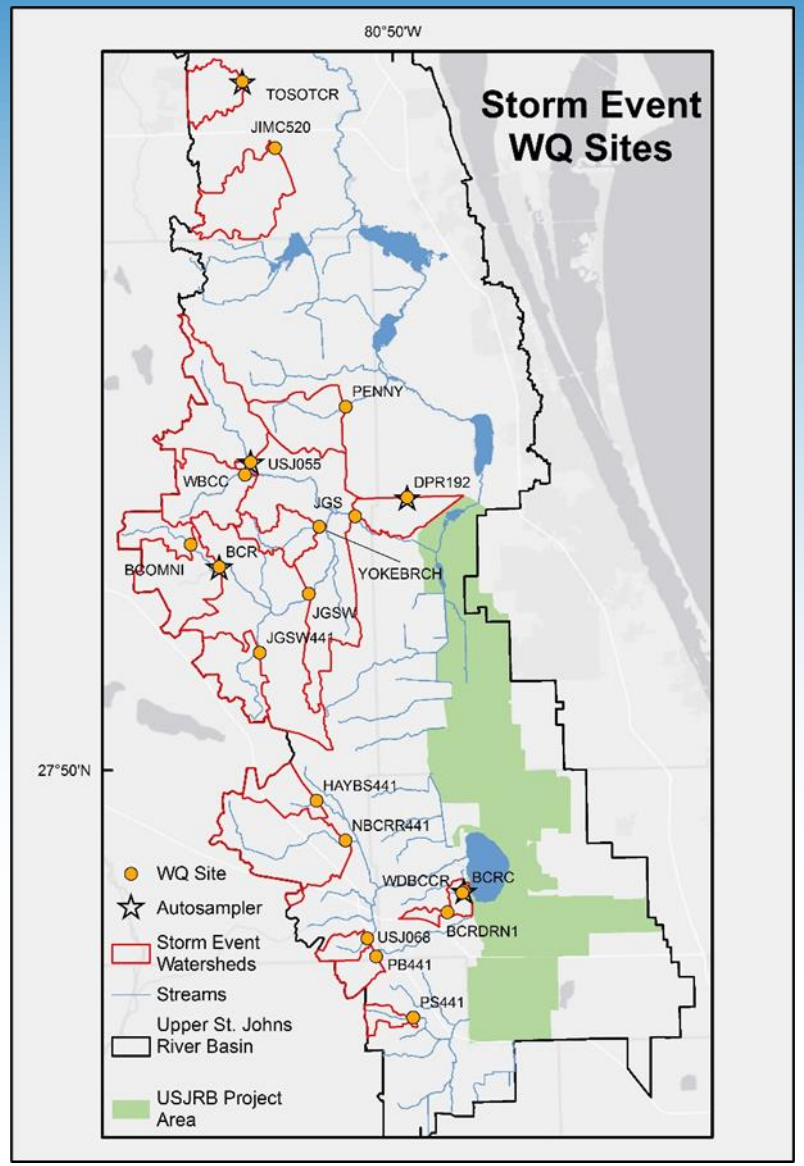
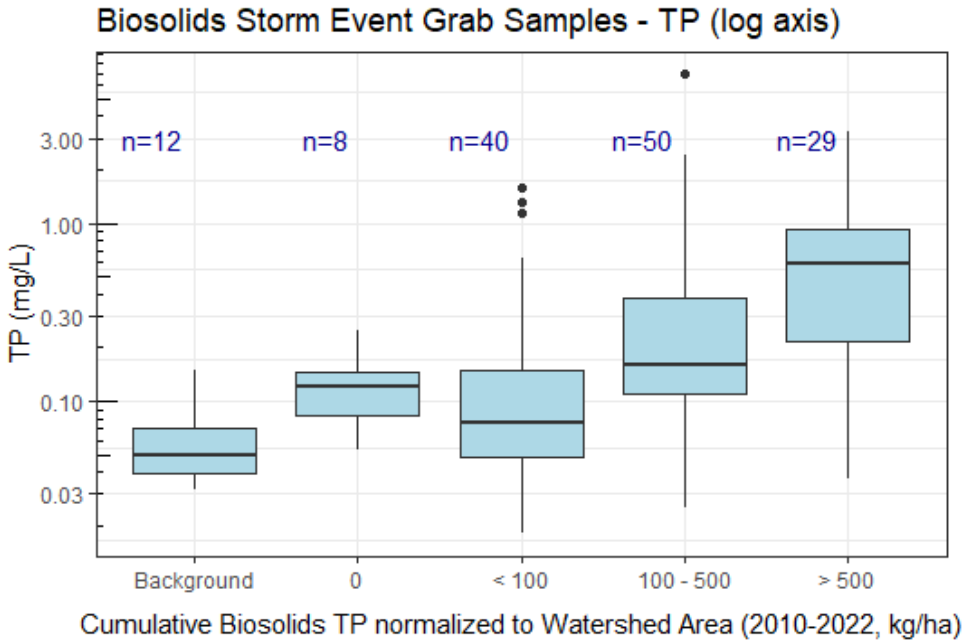
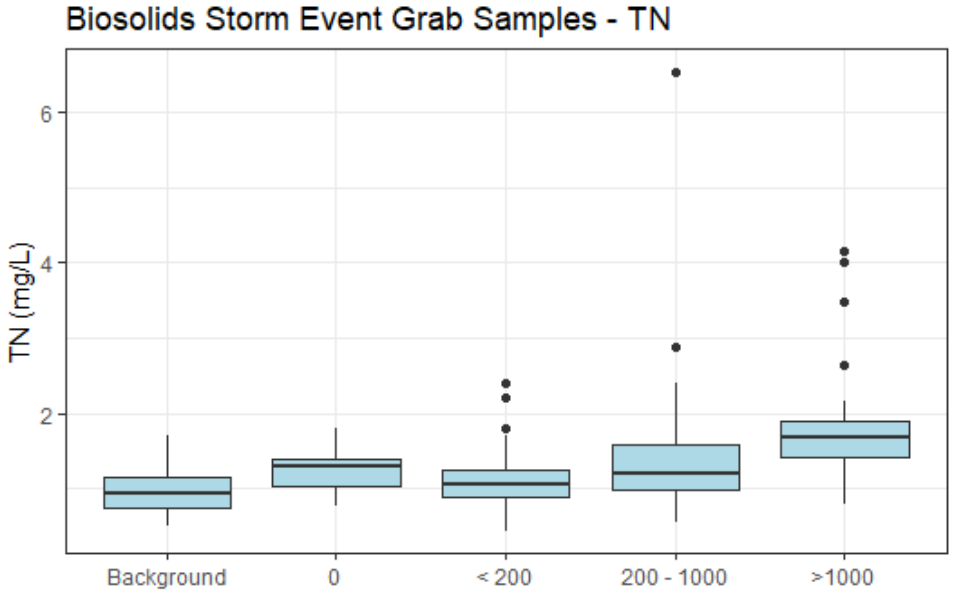
I. Storm Sample P Data





Cumulative Biosolids TP normalized to Watershed Area (2010-2022, kg/ha)



Cumulative Biosolids TN normalized to Watershed Area (2010-2022, kg/ha)

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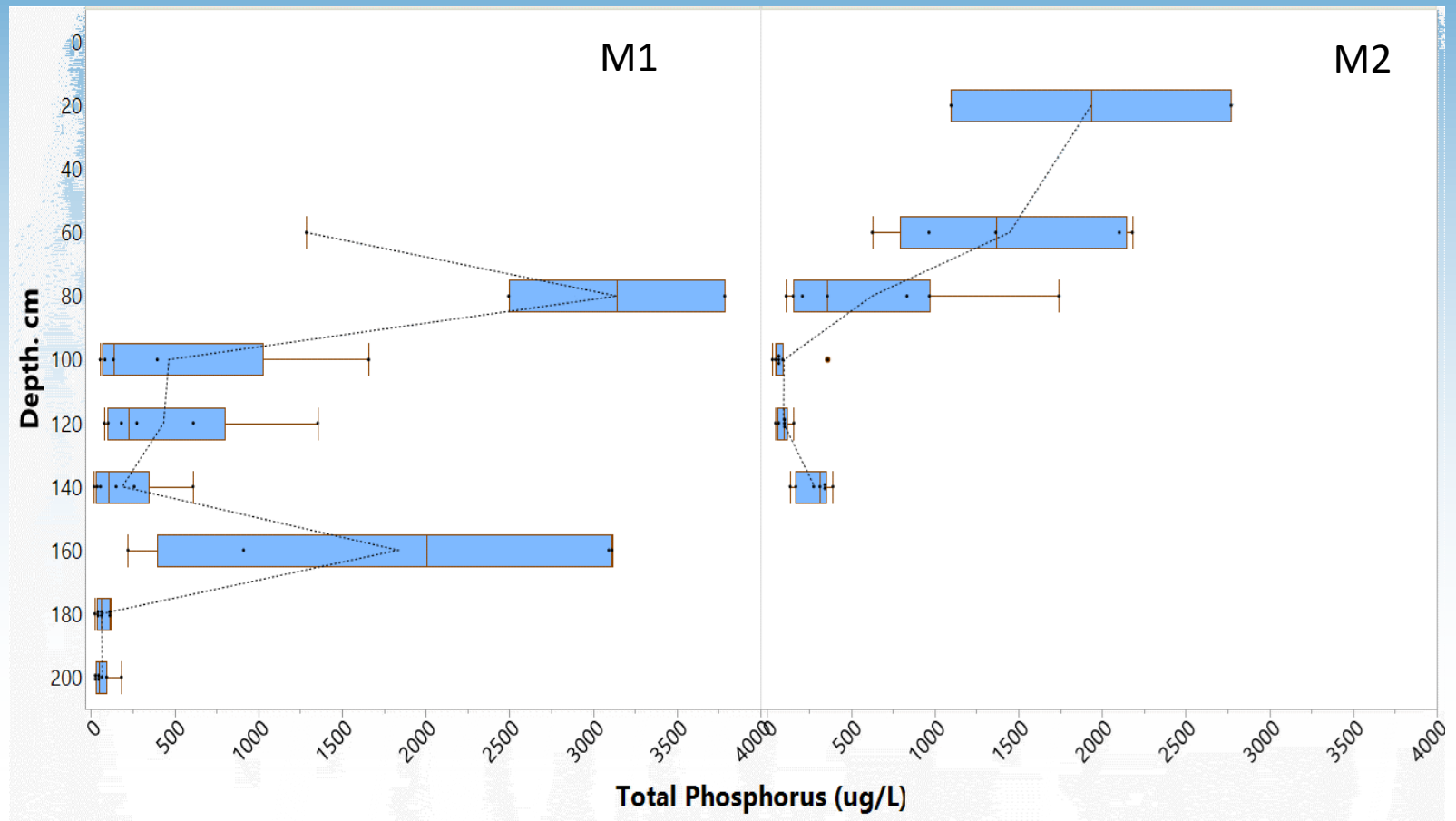
II. Groundwater TP concentrations at Field C10



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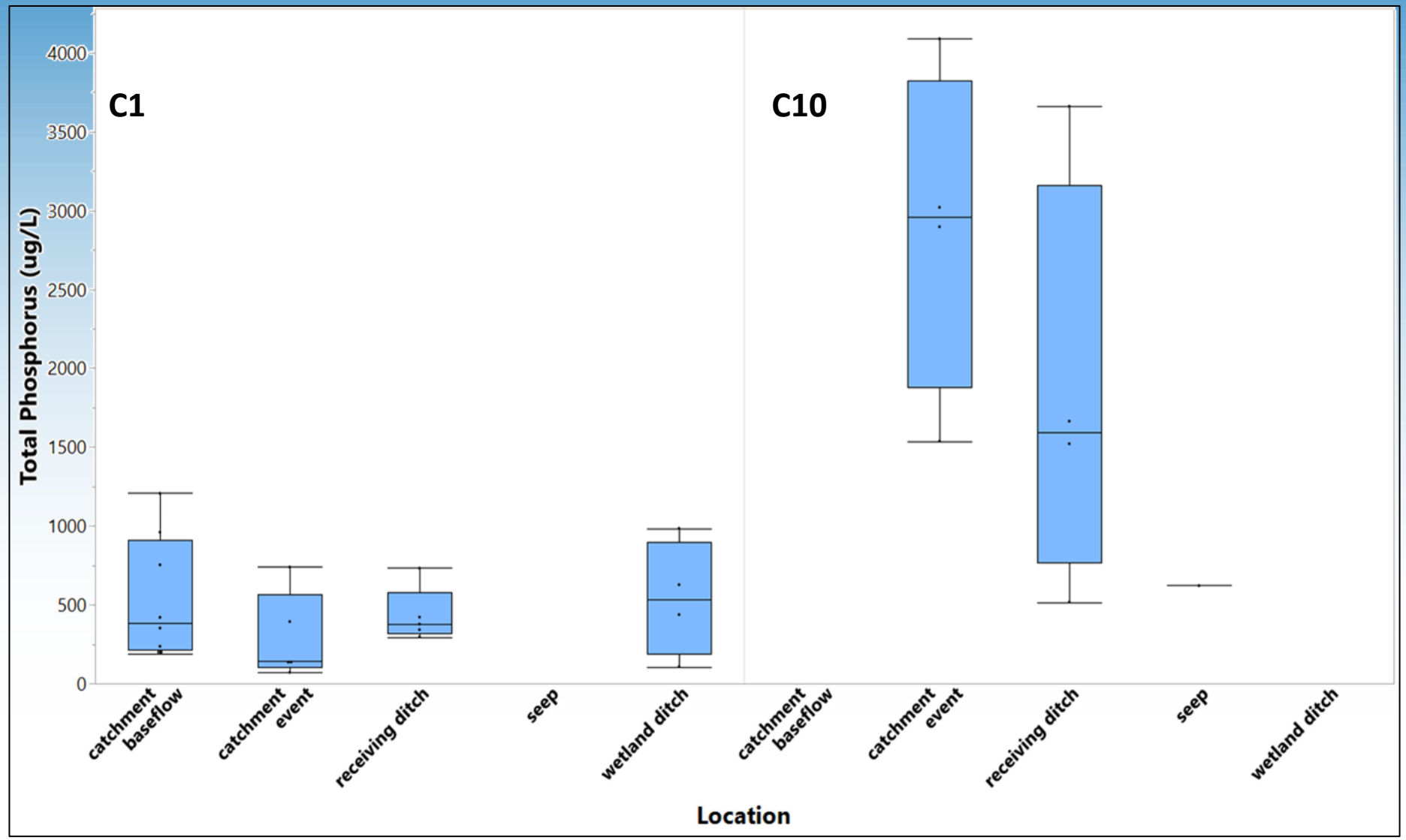
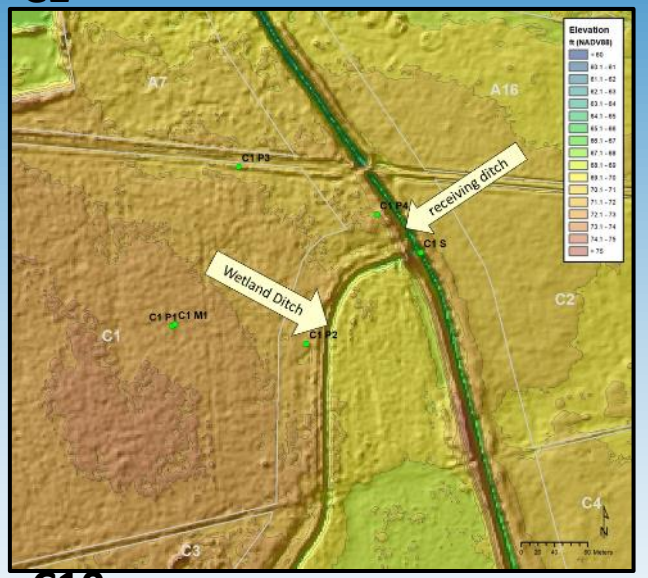
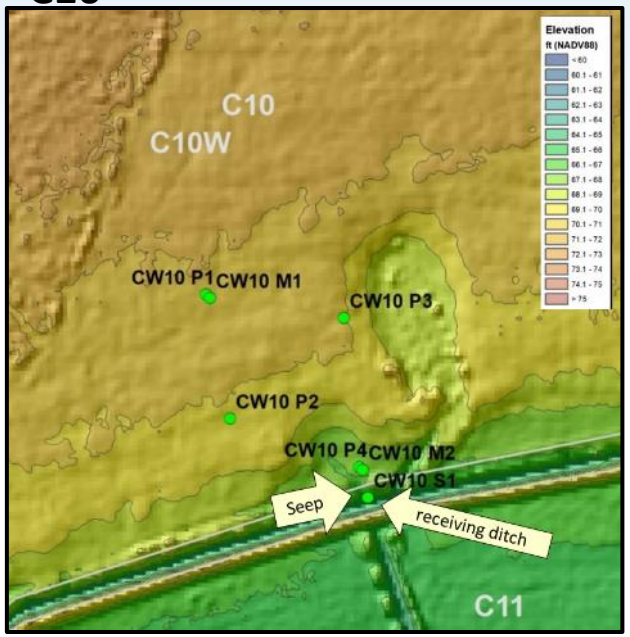
II. Surface water P concentrations at C1 and C10



C1



C10



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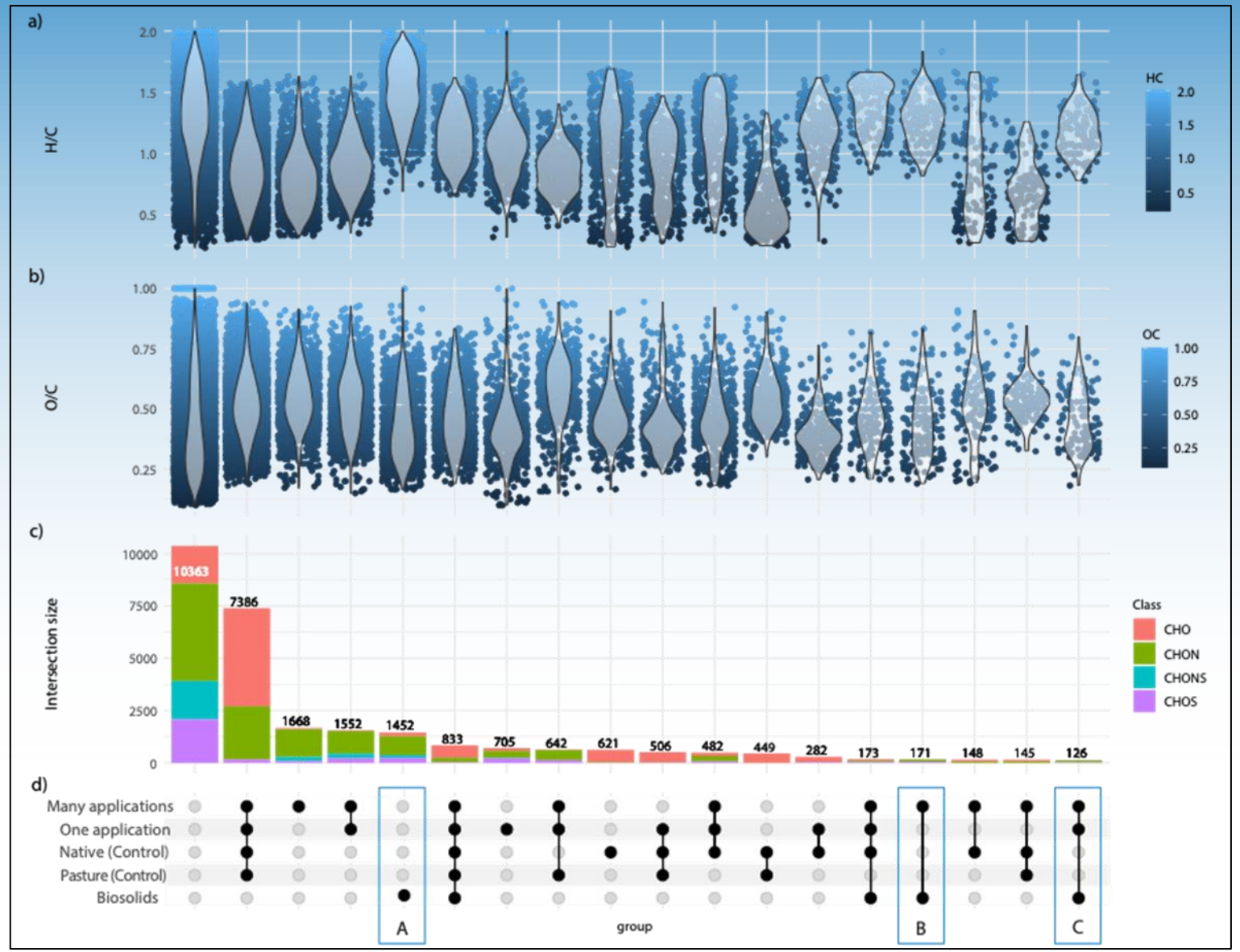
II. FT-ICR-MS (FSU)

- Watershed sample analyses forthcoming
- Checking unique biosolids formulae for possible single compound tracer



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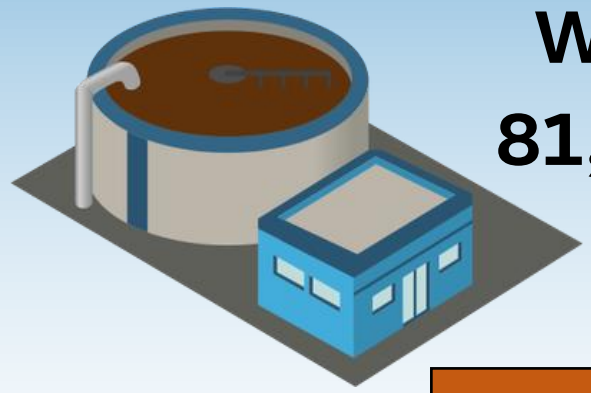
IV. Biosolids Management — Utilities in SJRWMD



WRF
81,000

45,000

20,00

17,000

Class B

Dry Tons (DT)

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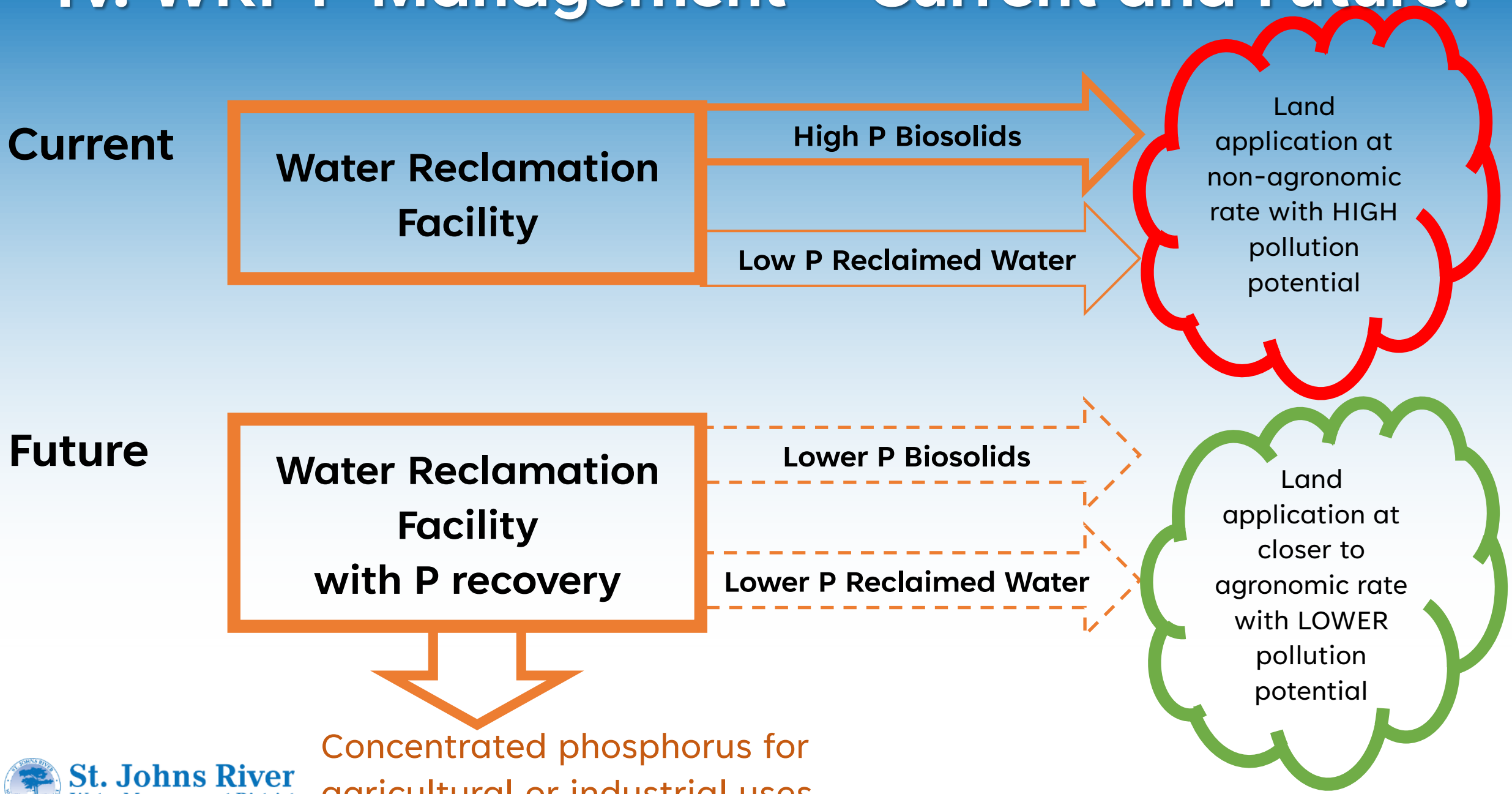
IV. WRF P Management – Current and Future?



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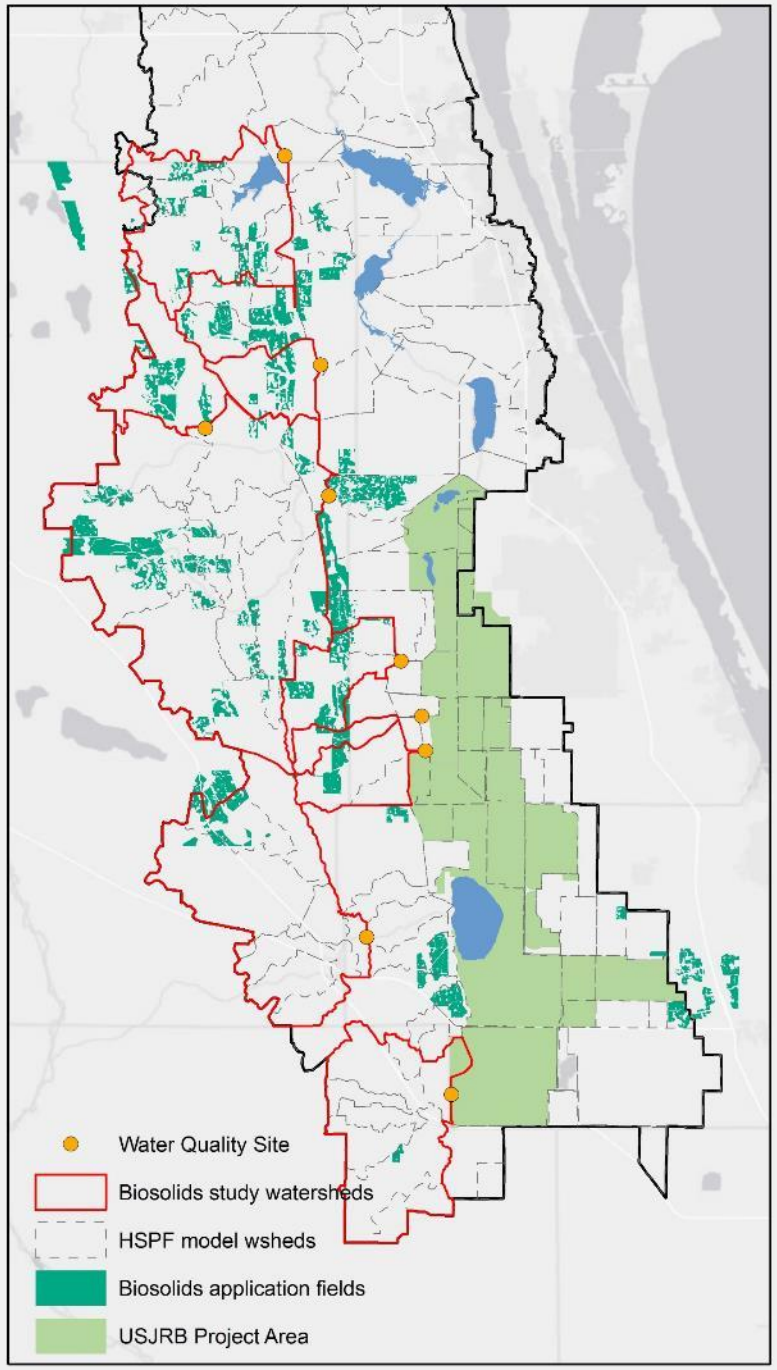
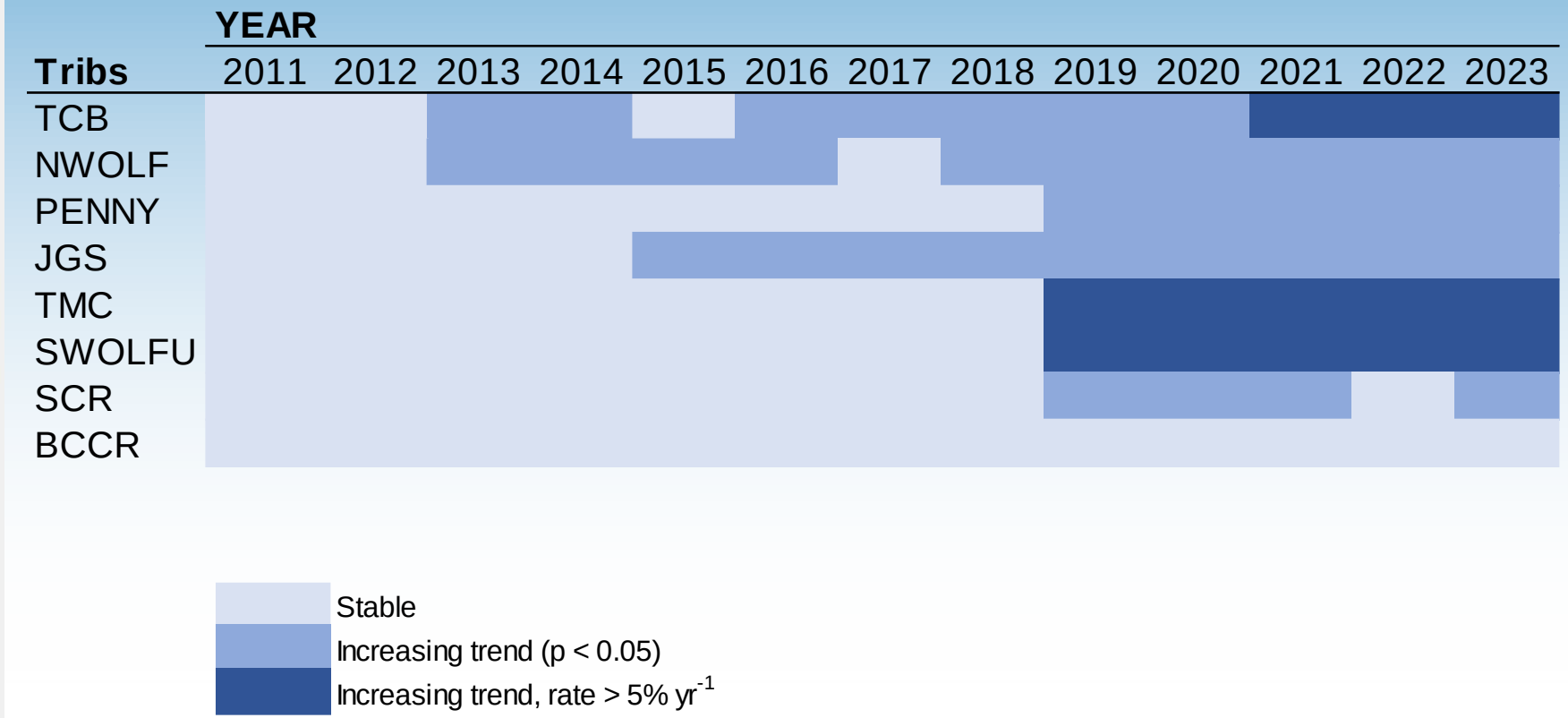
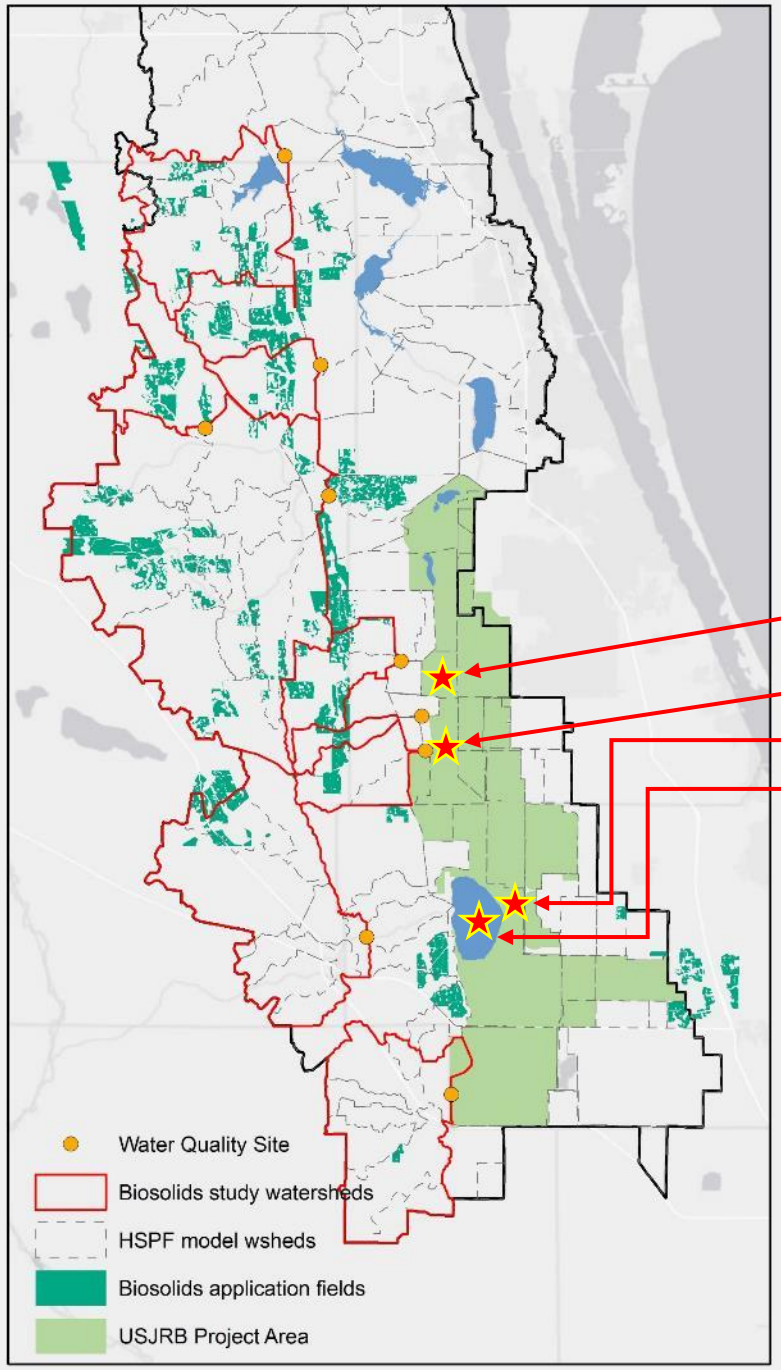
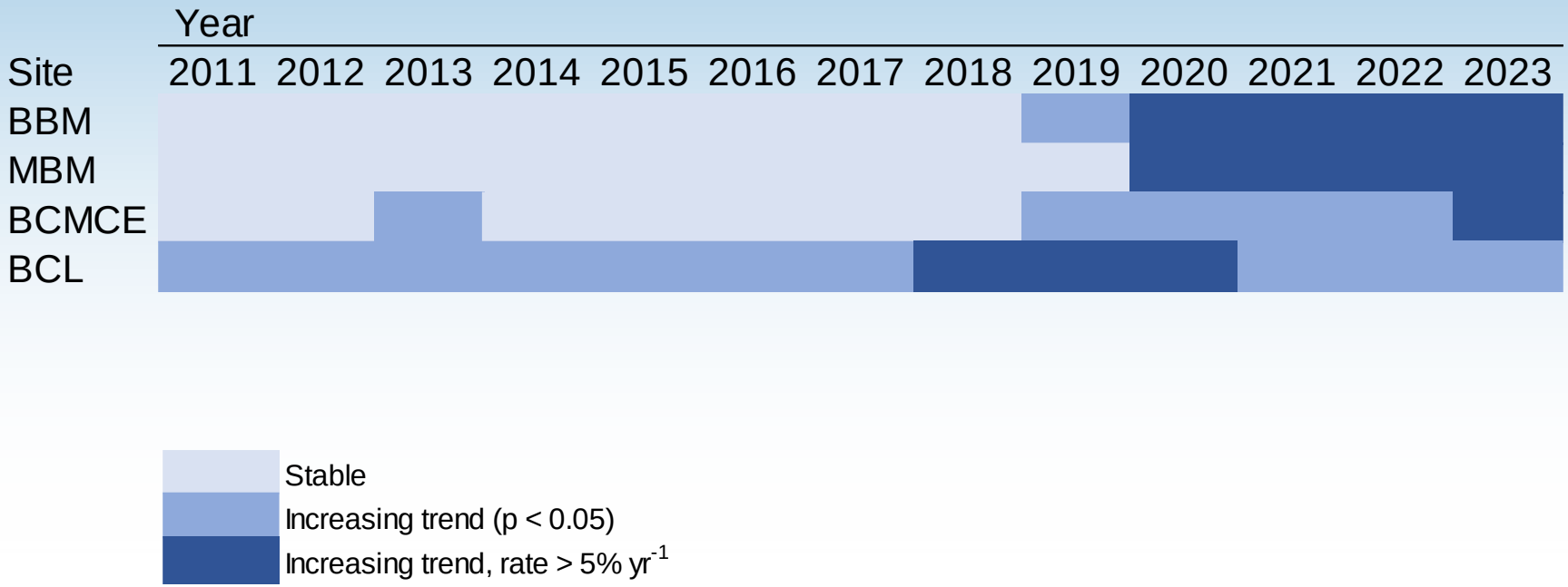
Tributary Trends



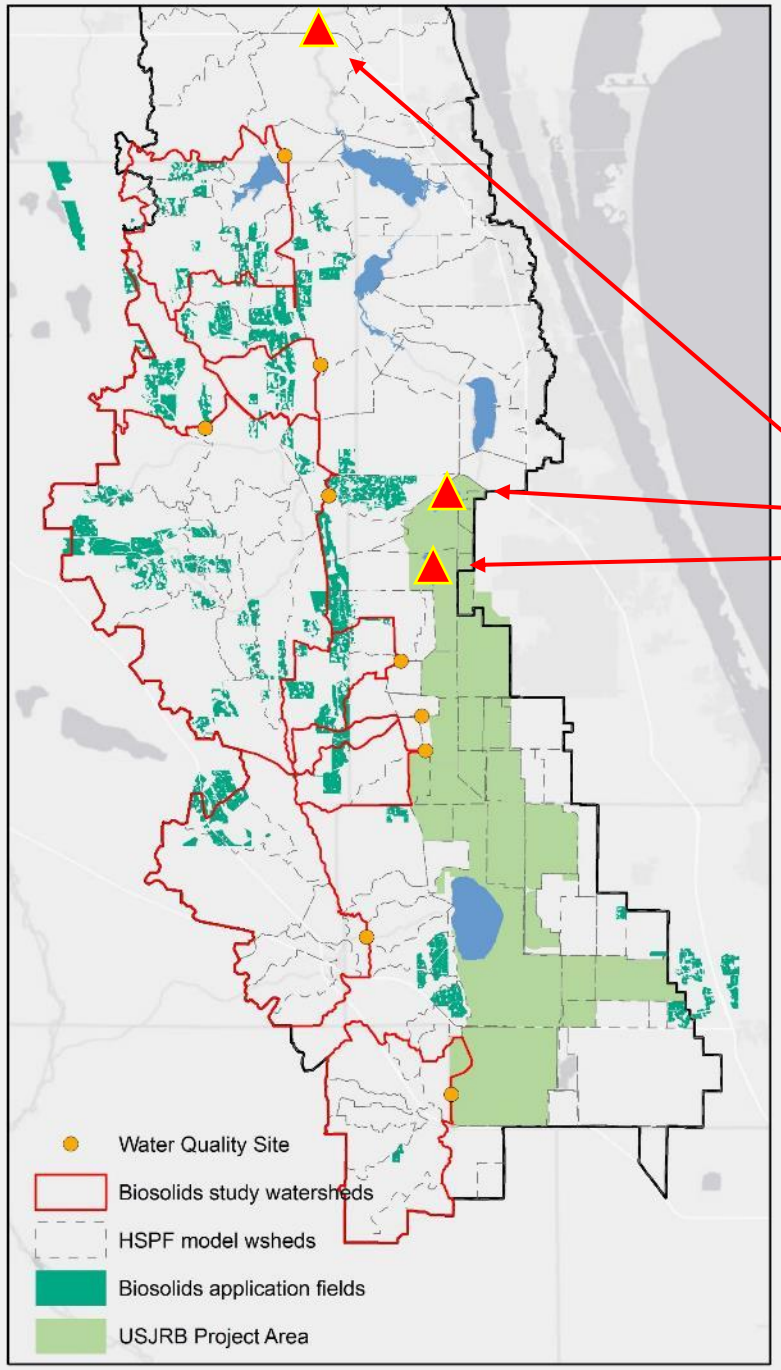


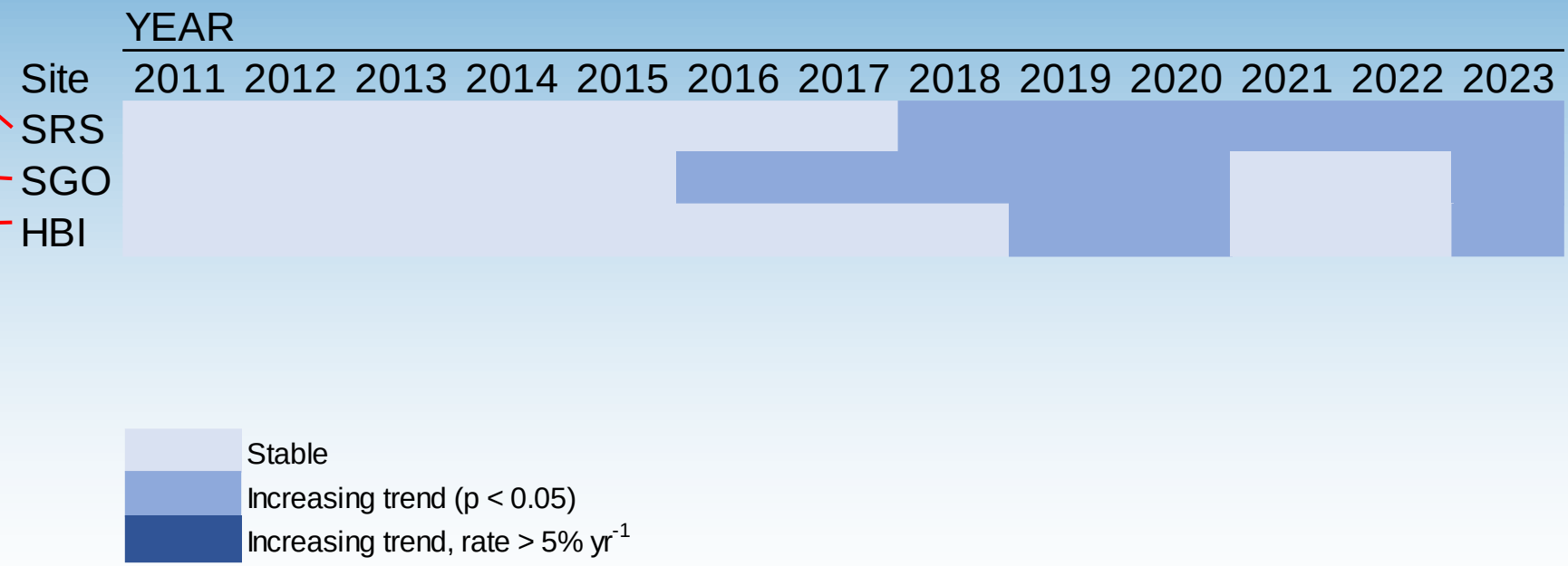
Wetland Trends
"Moving Front"





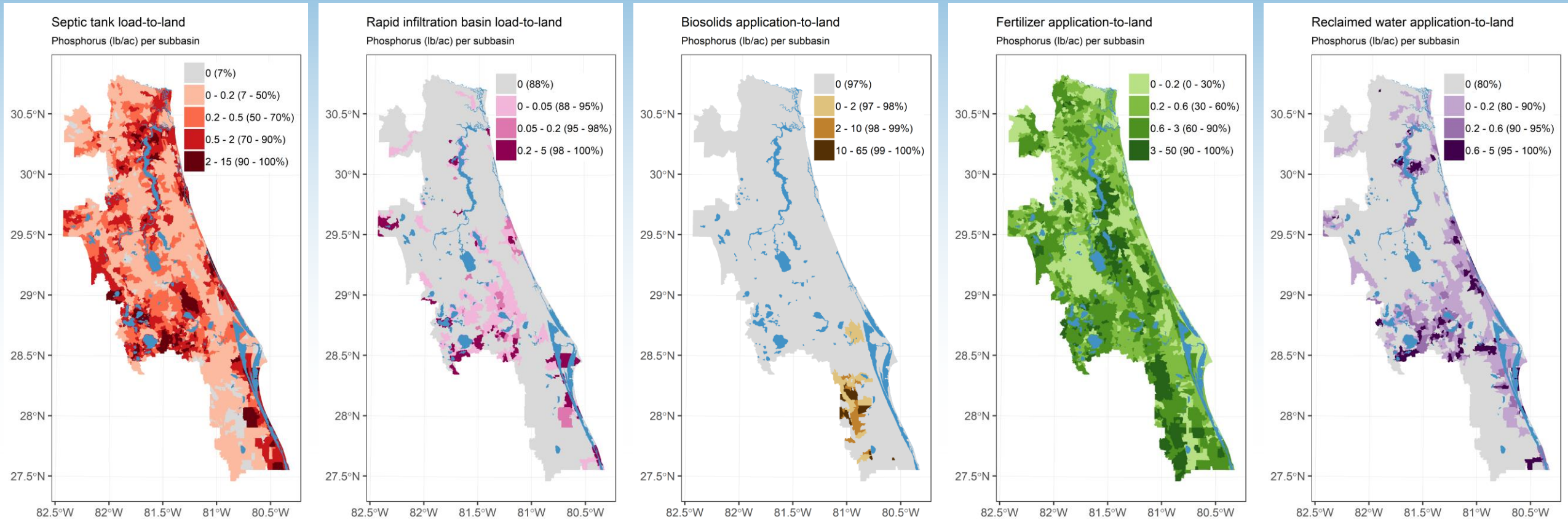
Water Body Trends
"Moving Front"





Phosphorus Inventory

Septic + RIB + Biosolids + Fertilizer + Reclaimed



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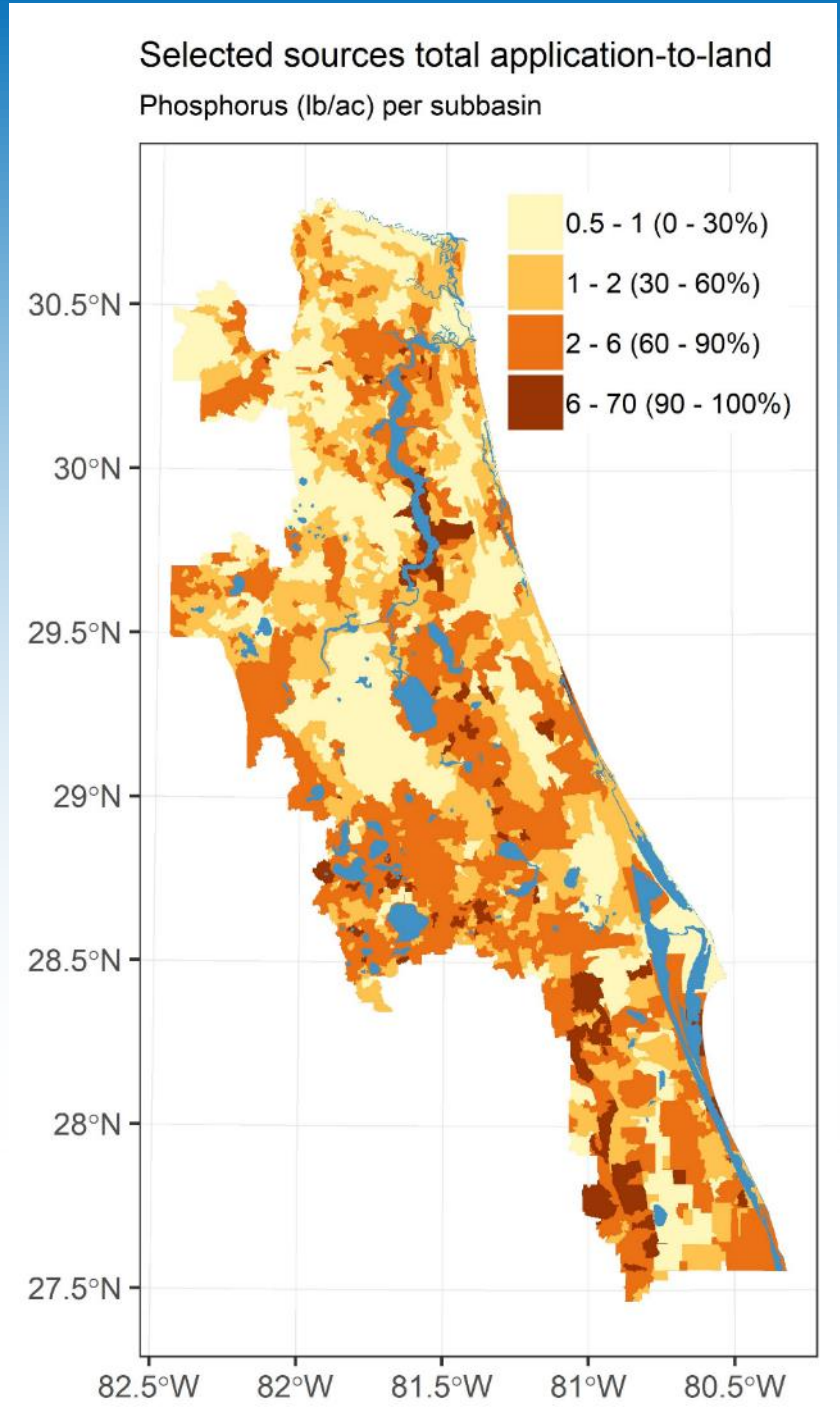
Phosphorus Inventory

- “Banking” P
- Explain water quality patterns
- Prioritize remediation and restoration efforts



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Thank you!