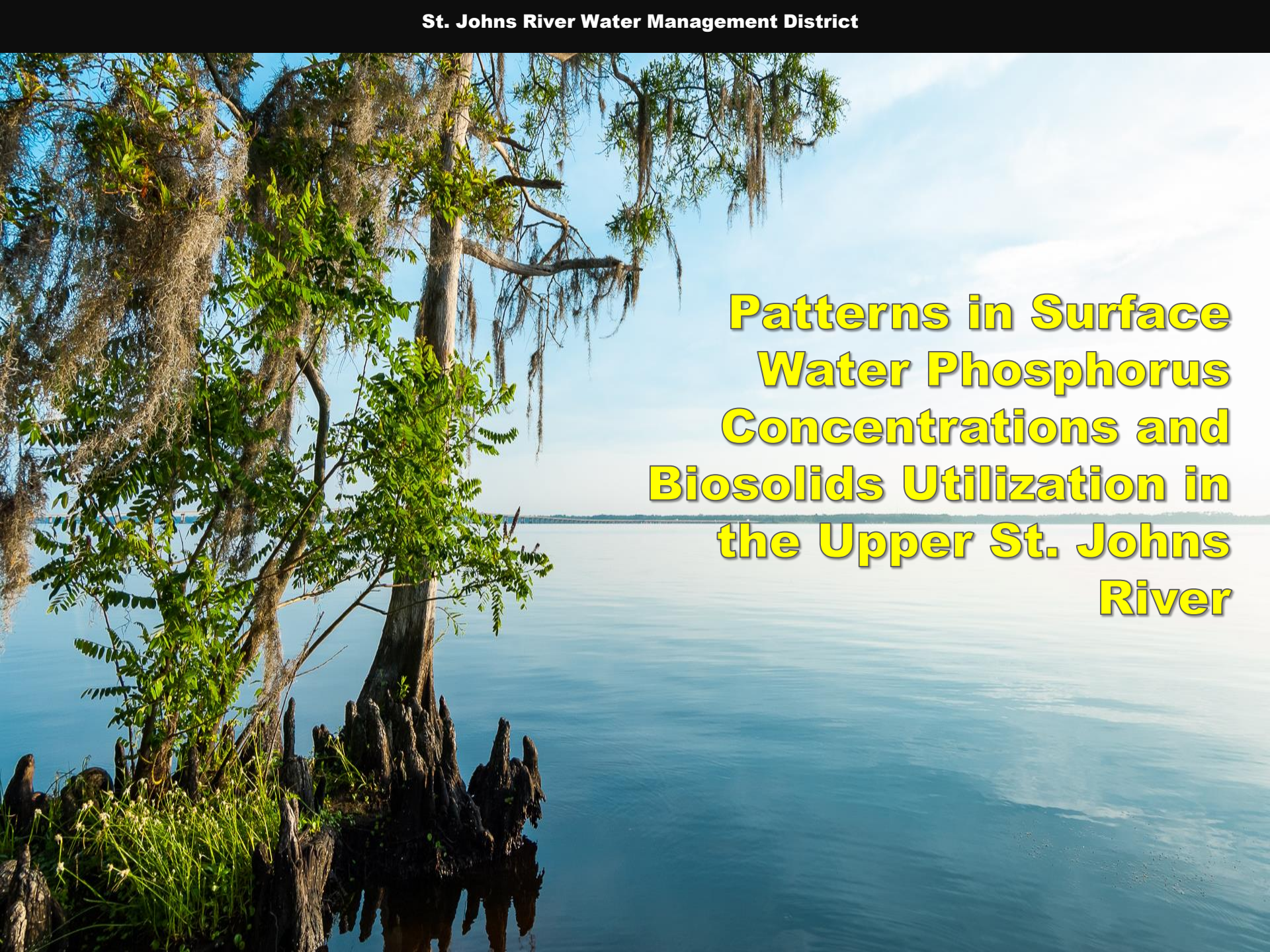
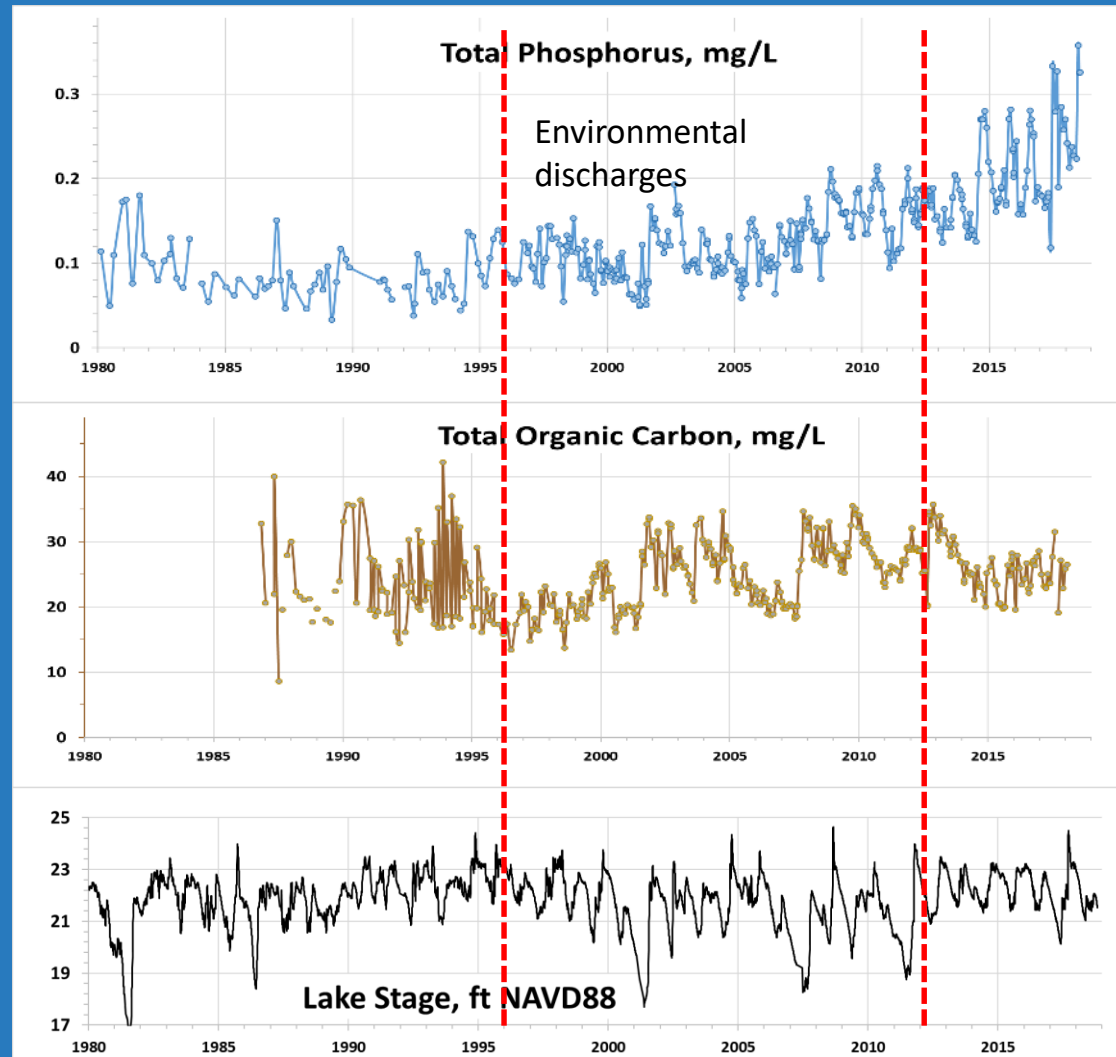


A scenic view of the St. Johns River. In the foreground on the left, a large, gnarled tree trunk with green foliage and Spanish moss hangs over the water. The river is calm and blue, reflecting the sky. In the distance, a bridge is visible across the river under a clear blue sky with some light clouds.

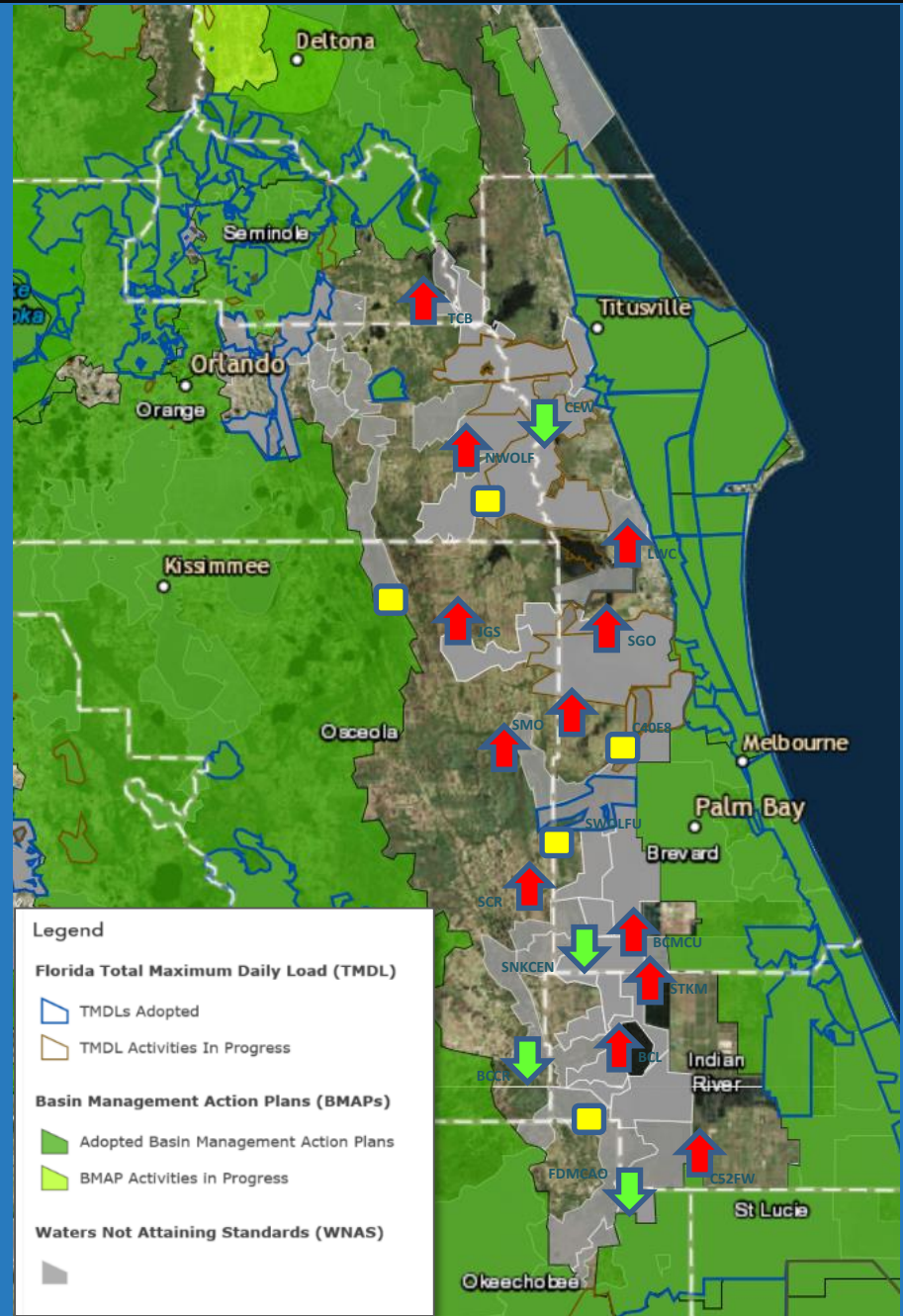
Patterns in Surface Water Phosphorus Concentrations and Biosolids Utilization in the Upper St. Johns River

Blue Cypress Lake

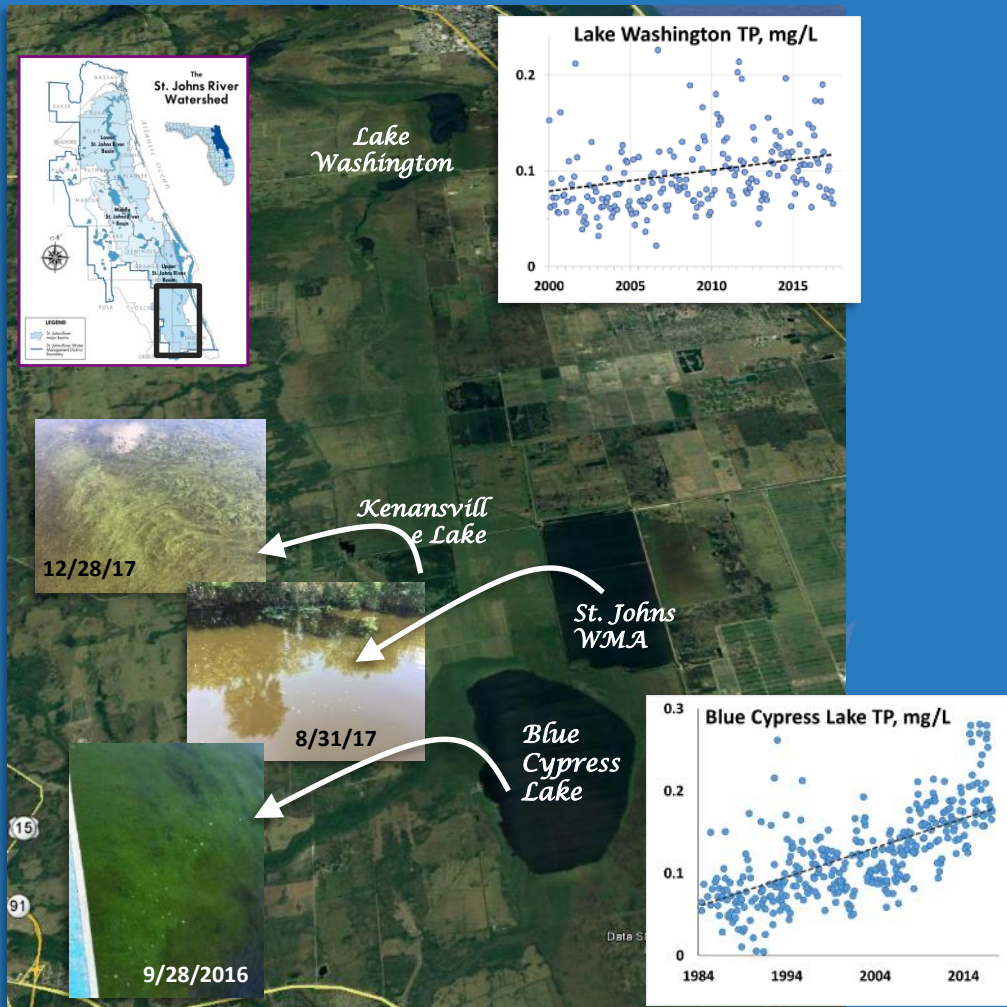


WQ Status

Upper St. Johns River Basin

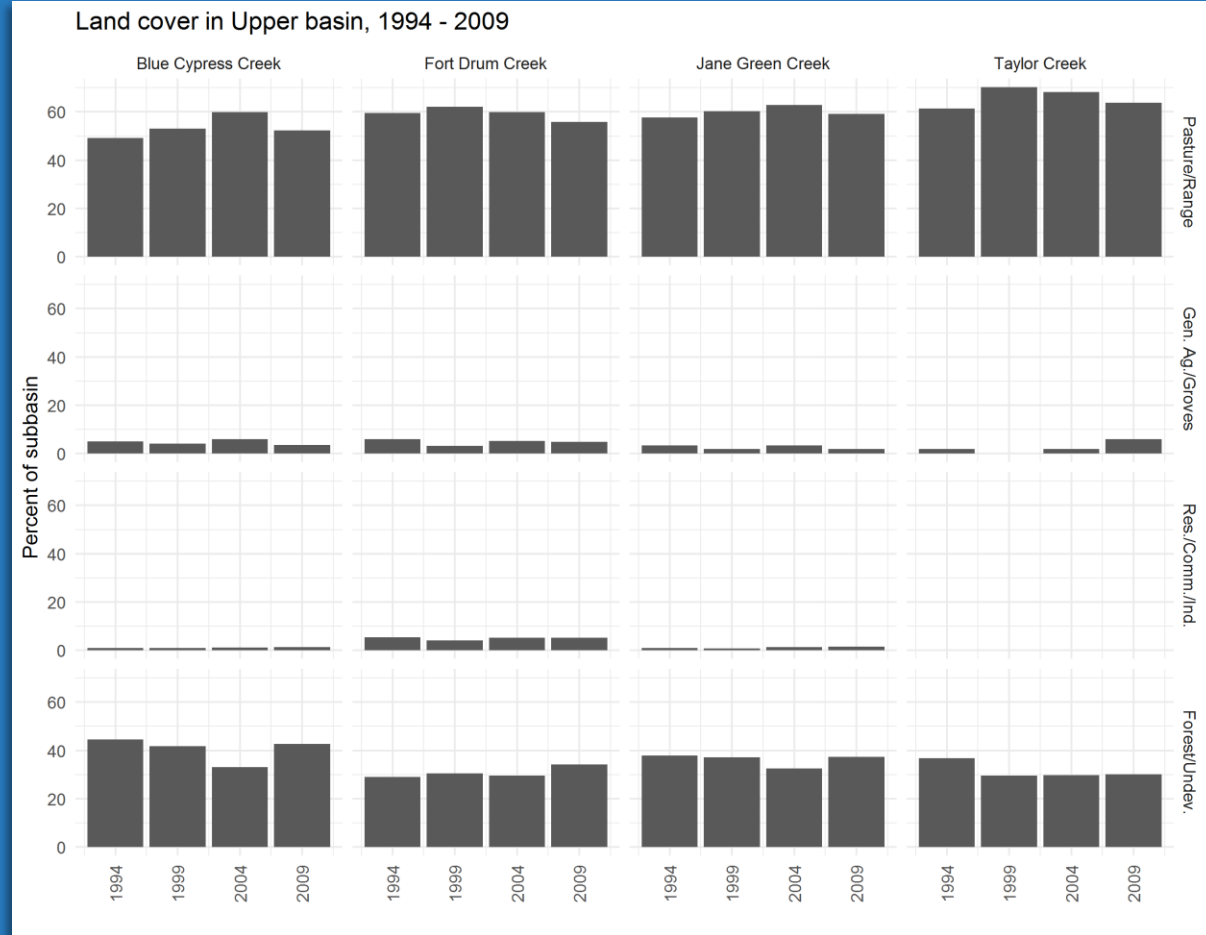
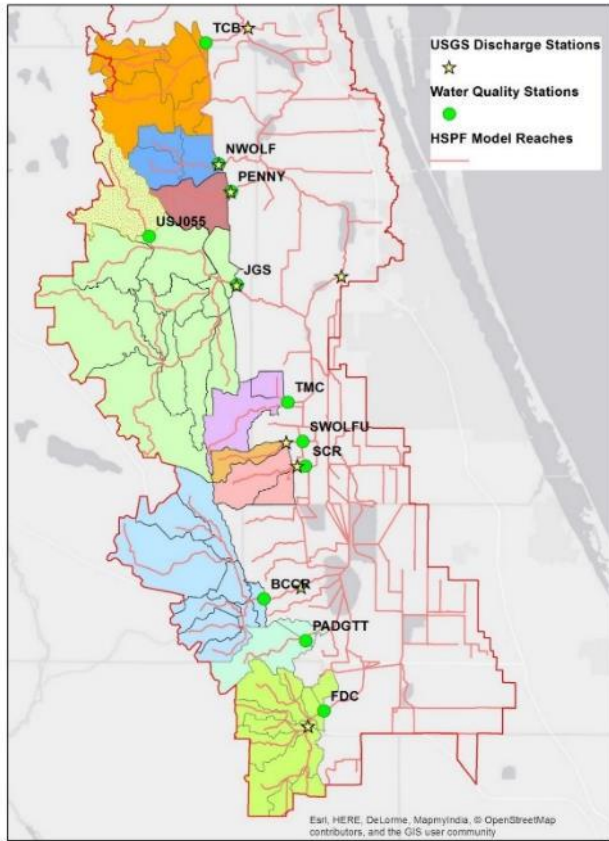


Phosphorus Trends

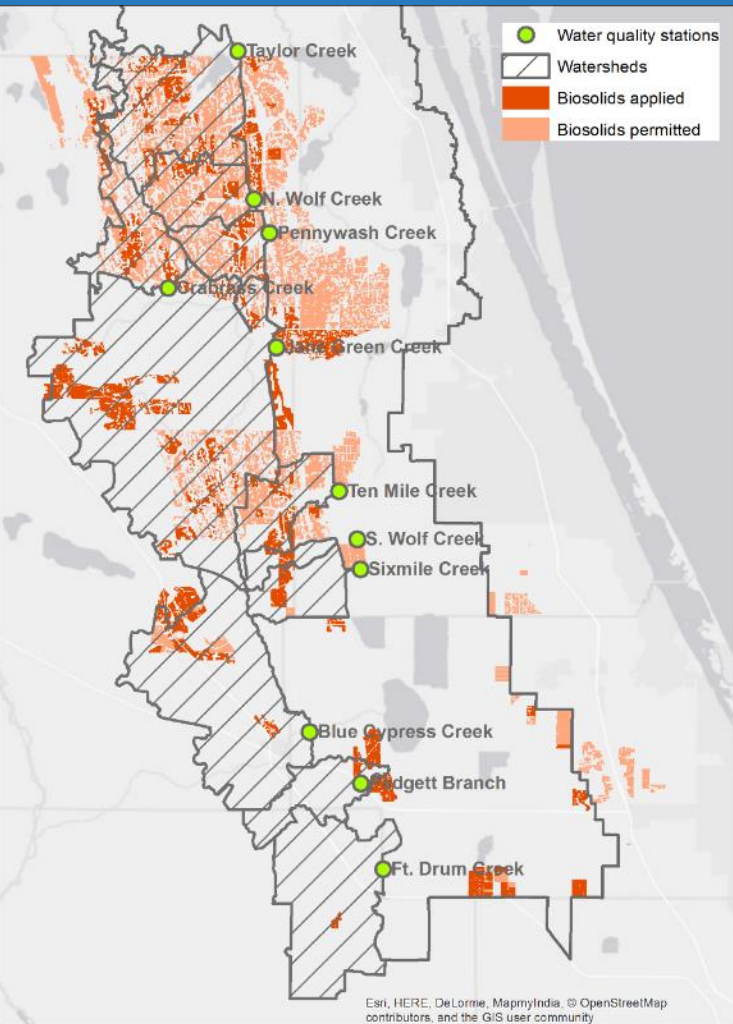


- 11 of 36 WQ sites exhibit increasing TP trends
 - Blue Cypress Lake: Increasing chlorophyll *a*
- Increased incidence of *Microcystis* in Class 1 waters
- Downstream TMDL targets
 - 31 segments impaired or “4d”

Major Western Watersheds of the USJ – Land Use



Biosolids Applications & Water Quality Status



Waterbody	Watershed Area, ac	Years of Biosolids Applications	Cumulative Biosolids TP Applied, lbs.	Cumulative Biosolids TP Applied, kg/ha	SJRWMD 2018 Status & Trends
Tributaries					
Fort Drum	44011	14 (1999-2017)	59383	1.5	Stable
Padgett Branch	14990	5 (2013-17)	121095	9.1	Stable
Sixmile	13529	4 (2014-17)	239866	19.9	Increasing
Blue Cypress	63588	11 (2006-17)	1465697	25.8	Decreasing
Crabgrass	19779	9 (2007-17)	576024	32.6	Stable
South Wolf	5156	5 (2013-17)	167979	36.5	Stable
North Wolf	16697	11 (2007-17)	707638	47.5	Increasing
Pennywash	12434	8 (2007-17)	675129	60.8	Stable
Jane Green	154534	20 (1998-2017)	9201551	66.7	Increasing
Ten Mile	16175	9 (2007-17)	1855277	83.5	Increasing
Lakes					
Blue Cypress	195900	16 (1999-2017)	2686896	15.4	Increasing
Taylor Cr. Res.	42842	7 (2007-16)	1043797	27.3	Increasing

Database Development

Part III. Nutrient Management - Application Zone Summary

Complete a separate sheet for each application zone, and use additional sheets for each zone if needed.

Information about application zone

Application Zone ID	10	Application Zone Acres	67.45
Crops Grown	Floralta		
☒ Yes ☐ No	The management, harvesting, and resulting crop yield on this zone was consistent with the NMP.		
☒ Yes ☐ No	The application of all sources of nutrients on this zone has been consistent with the NMP and the total nutrient loadings did not exceed the loadings set by the NMP for this zone.		

Allowed Biosolids Nutrient Loading Information for this Zone for the Reporting Period (from the NMP)

Basis for Application Zone Nutrient Budget (check one)	Maximum Allowed Plant Available Nitrogen (PAN) from Biosolids (lbs/acr)	Maximum allowed P2O5 from Biosolids (lbs/acre)	Maximum allowed TN from Biosolids (lbs/acre)	Maximum allowed TP from Biosolids (lbs/acre)
☒ Nitrogen (N)	N/A	N/A	354.2	N/A
or ☐ Phosphorus (P)	N/A	N/A	354.2	N/A

Generator information

Summary of Annual Facility Loadings to the Application Zone for the Reporting Period

Facility ID(s)	Dry Tons of Biosolids Applied	Dry Tons of Biosolids Applied Per Acre	Plant Available Nitrogen (PAN) from Biosolids (lbs/acre)	P2O5 from Biosolids (lbs/acre)	TN from Biosolids (lbs/acre)	TP from Biosolids (lbs/acre)
FL0031771	174.81	2.59			223.93	131.14
FLA024805	5.49	0.08			10.58	4.07
Totals:	180.30	2.67			234.50	135.21

Annual total TN and TP applied (lbs/ac)

Database Development

Permitting files and water quality sampling reports from generating facilities provide additional information on TN and TP concentration in biosolids applied on site

3. Residuals Characteristics (annual arithmetic average):

Parameter	Units*	Ceiling Limits for Class A and B	Concentration	Parameter (continued)	Units*	Ceiling Limits for Class A and B	Concentration
Total Nitrogen	%	N/A	4.10	Copper	mg/kg	4300	340
Total Phosphorus	%	N/A	1.30	Lead	mg/kg	840	13.0
Total Potassium	%	N/A	0.29	Mercury	mg/kg	57	0.85
Total Solids	%	N/A	28.2	Molybdenum	mg/kg	75	7.80
pH	std. units	N/A	12.4	Nickel	mg/kg	420	6.20
Arsenic	mg/kg	75	1.19	Selenium	mg/kg	100	1.50
Cadmium	mg/kg	85	1.40	Zinc	mg/kg	7500	320

*All units are in a dry weight basis except for total solids and pH. All sampling and analysis shall be conducted pursuant to Title 40 Code of Federal Regulations, Section 503.8, and the POTW Sludge Sampling and Analysis Guidance Document.
N/A = not applicable

4. Pathogen Reduction Class Provided:

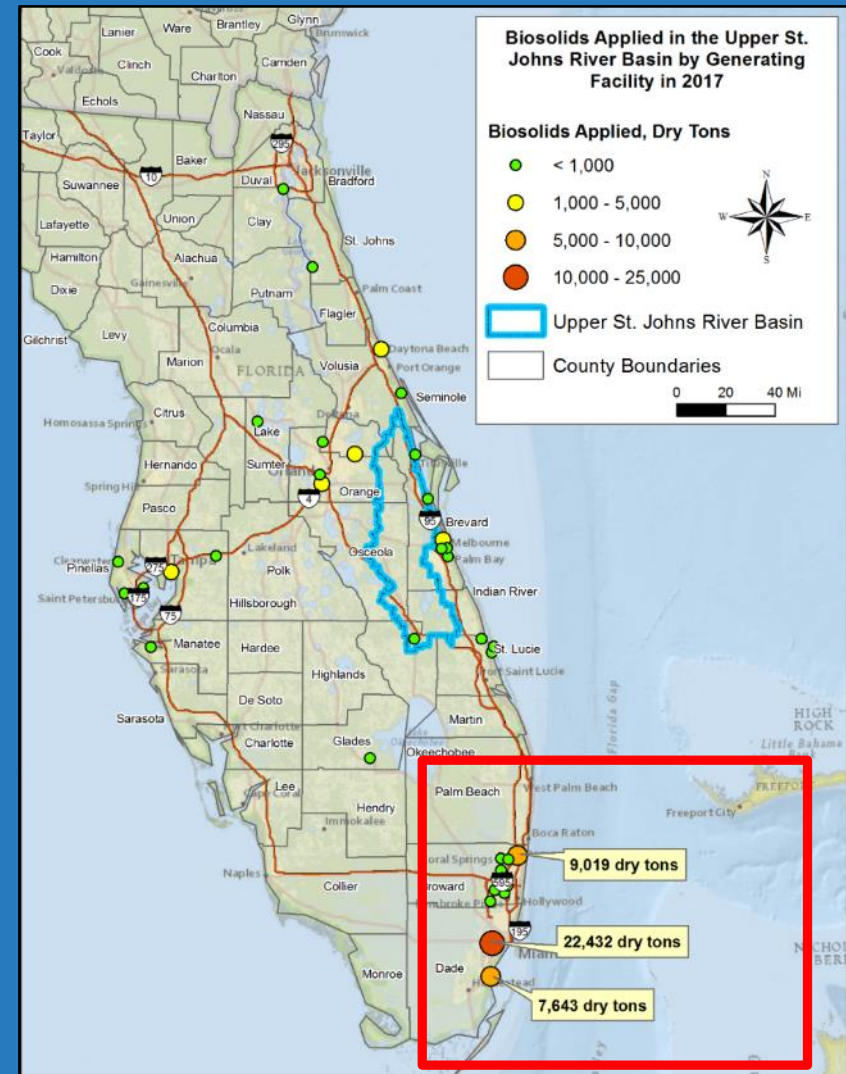
☐ A

☒ B

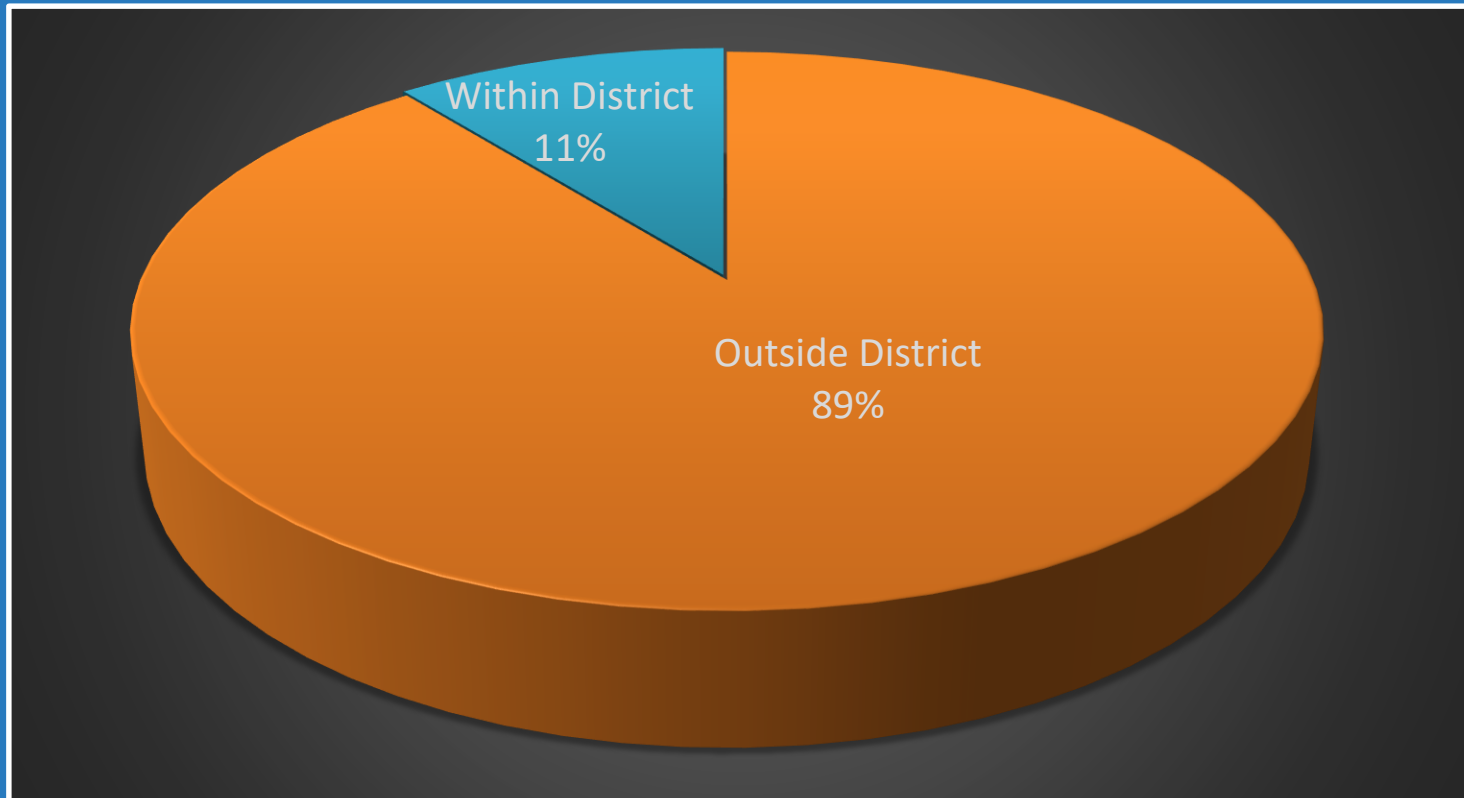
(Rule 62-640.600(1), F.A.C)

2017 USJRB Generators

- Class B biosolids produced at 42 generating facilities were land applied in the USJRB in 2017
- Three facilities land applied > 5000 dry tons of biosolids in the USJRB in 2017
- Most utilities contract with haulers that land apply biosolids



2017 Sources of Biosolids Applied in the Upper St. Johns River Basin



Biosolids Application Sites

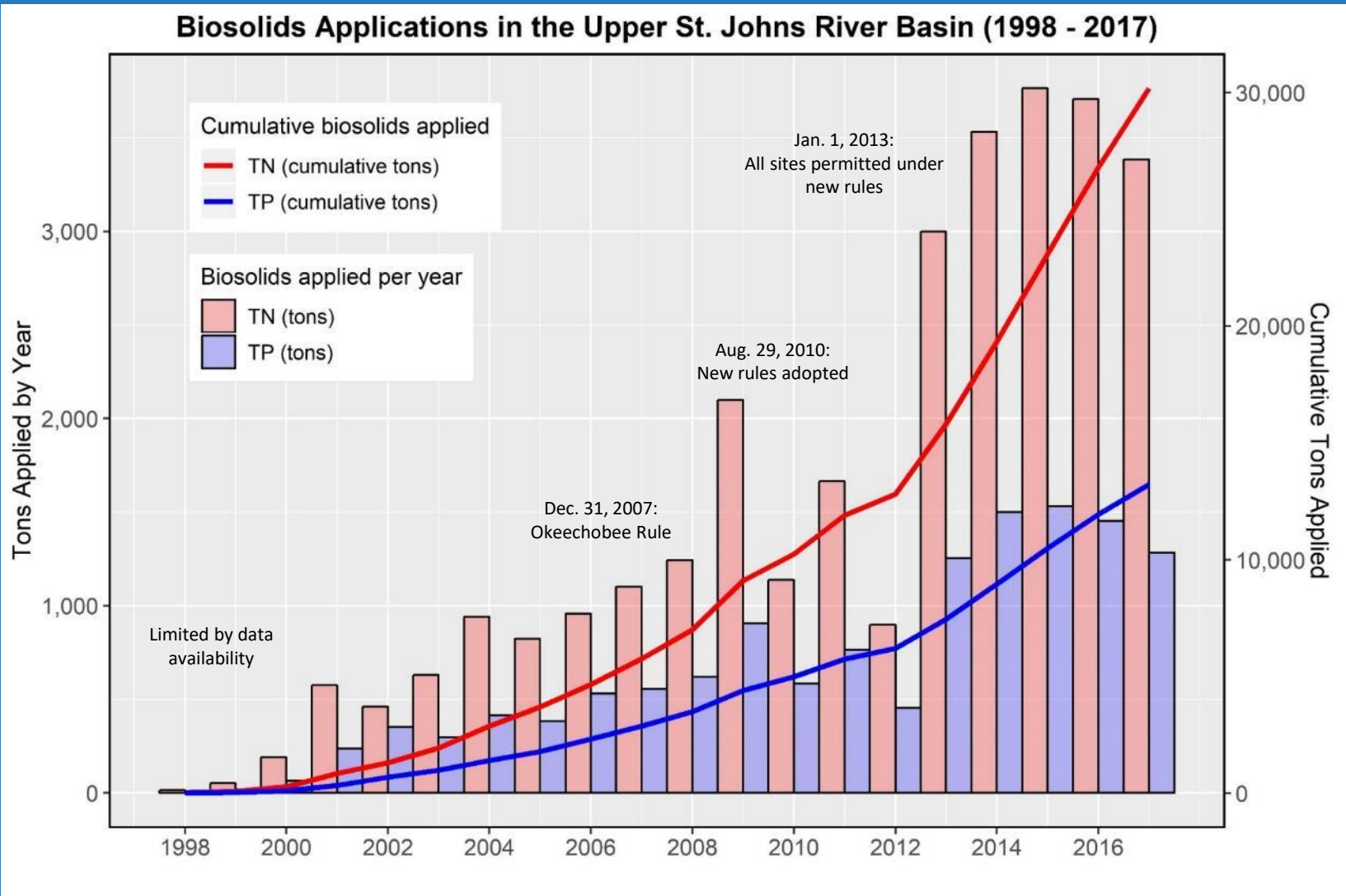
as of July 2018

SJRWMD Major Basin	Total Number of Sites (POR)	Active Permits	Applied in 2017
Lower St. Johns	39	6	1
Upper Ocklawaha	36	2	1
Upper St. Johns	30	17	14
Middle St. Johns	21	1	1
Indian River Lagoon	16	2	1
Northern Coastal	12	2	2
Florida Ridge	7	0	0
St. Marys	7	3	3
Nassau River	6	0	0
Lake George	4	0	0

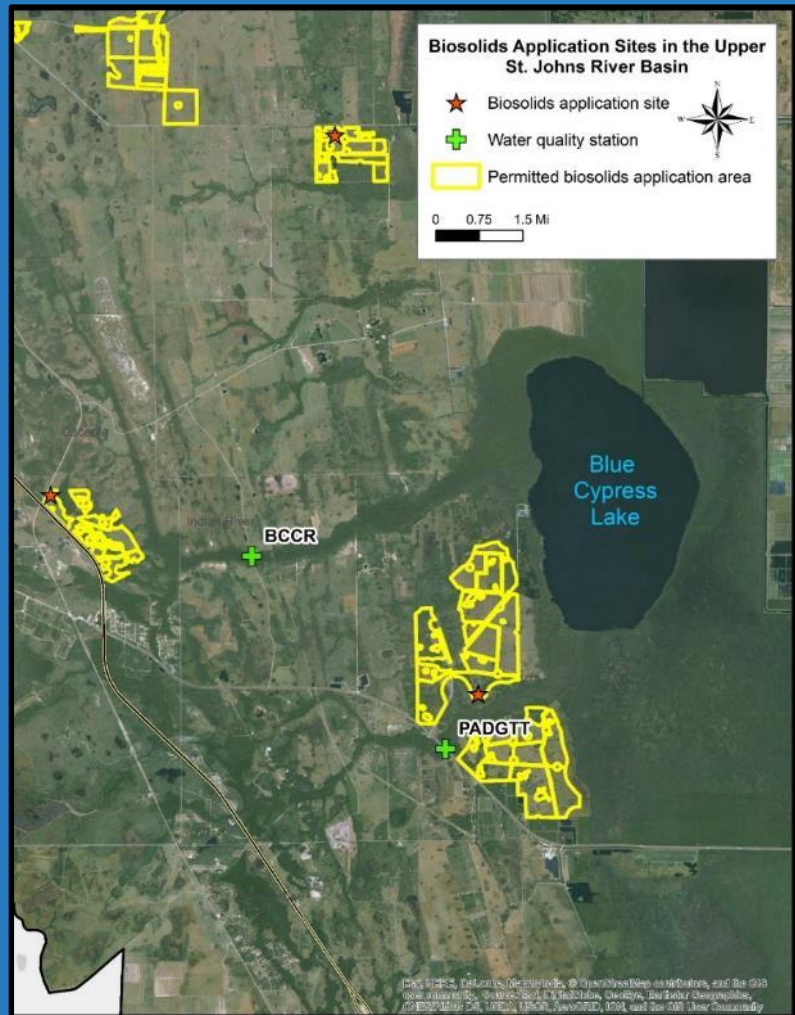
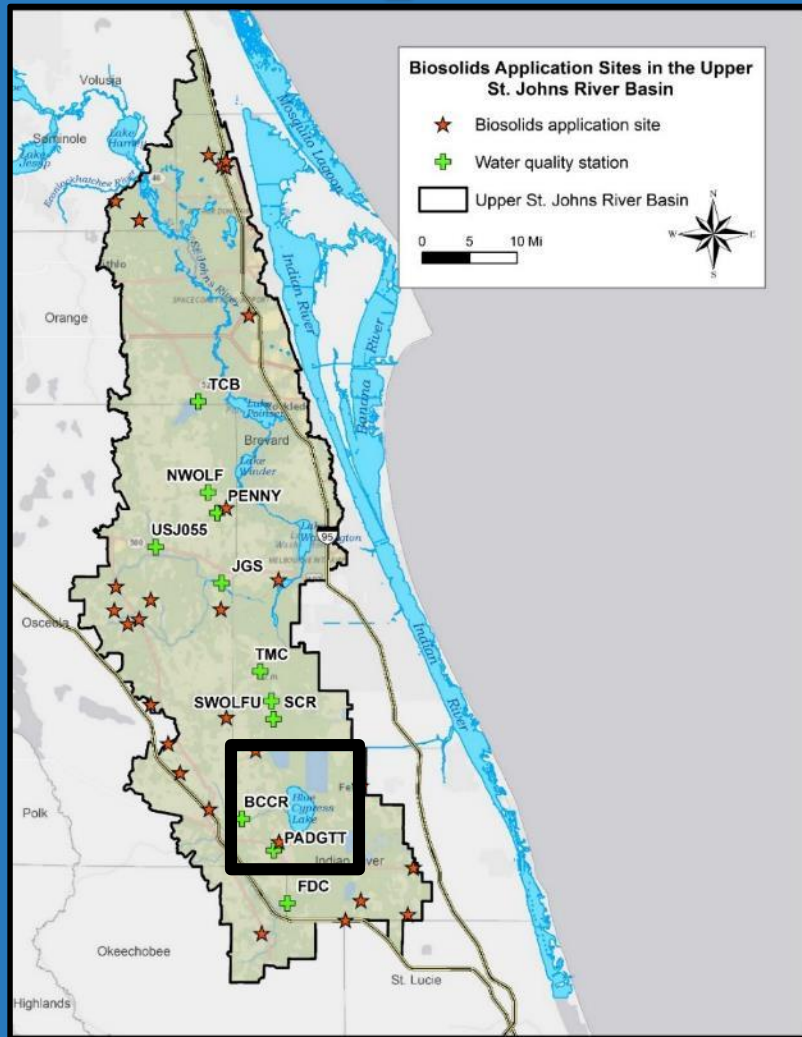
Cumulative Biosolids Applications within SJRWMD

SJRWMD Major Basin	TN Applied (tons)	TP Applied (tons)	Years in database (POR)
Upper St. Johns	30,183	13,219	1998—2017
Lower St. Johns	3,339	1,658	1993—2017
Florida Ridge	3,215	2,945	1995—2016
Upper Ocklawaha	2,316	1,006	1992—2017
Middle St. Johns	2,011	958	1993—2017
Indian River Lagoon	1,638	818	2000—2017
St. Marys River	253	174	1999—2017
Northern Coastal	234	58	1993—2017
Lake George	3	1	2002—2011

Cumulative Biosolids Applications



Spatial Layer Coverage

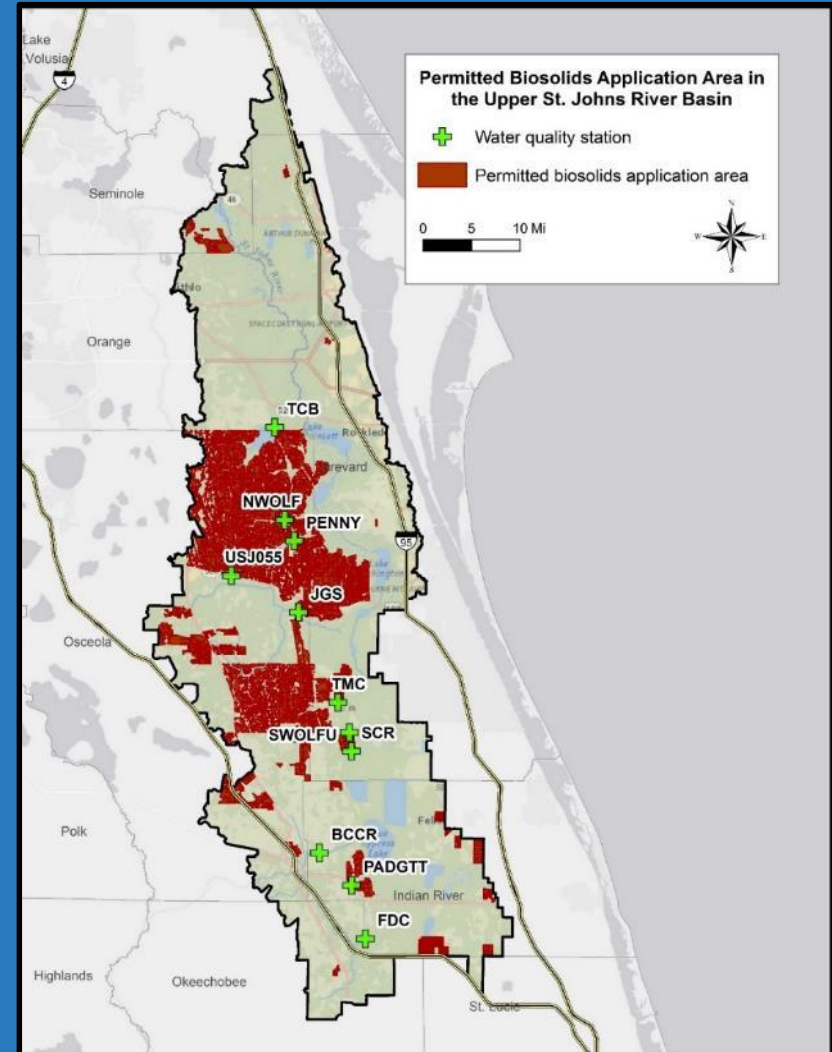


- Development of point and polygon ArcGIS shapefiles for geospatial analyses using site maps

Spatial Layer Coverage

Historical and active permitted biosolids application areas in the Upper St. Johns make up ~12% of the entire Upper St. Johns area

Major Basin	Biosolids area (acres)	% total area
Upper St. Johns	136,155	12%
Lower St. Johns	12,623	1%
Middle St. Johns	12,088	2%



Source of Nutrients - Phosphorus

Fertilizer Label

N – P₂O₅ – K₂O
4 – 1 – 2

N – P – K
4 – **0.436** – 1.66

Biosolids

N – P – K
4 – **2** – ?

IFAS fertilization recommendation
for grazed beef cattle:

11-17 lb P/ac/year

If soil and or tissue tests are low

2017 USJRB Calculated Application

Rate: **106 lb P/ac/year**

20,165 ac spread/58,859 permitted

Applying 5-10 times the
crop TP need

Biosolids Soil Phosphorus

2012

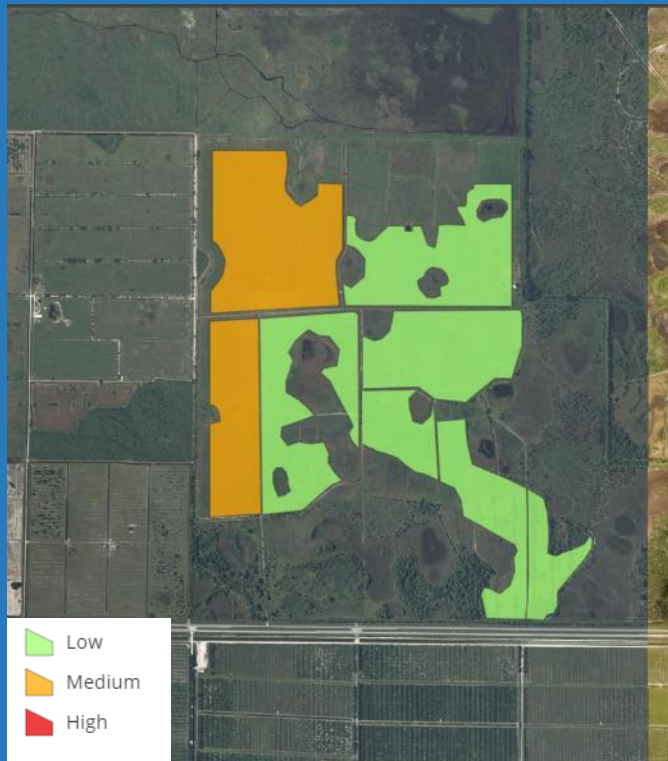


2017

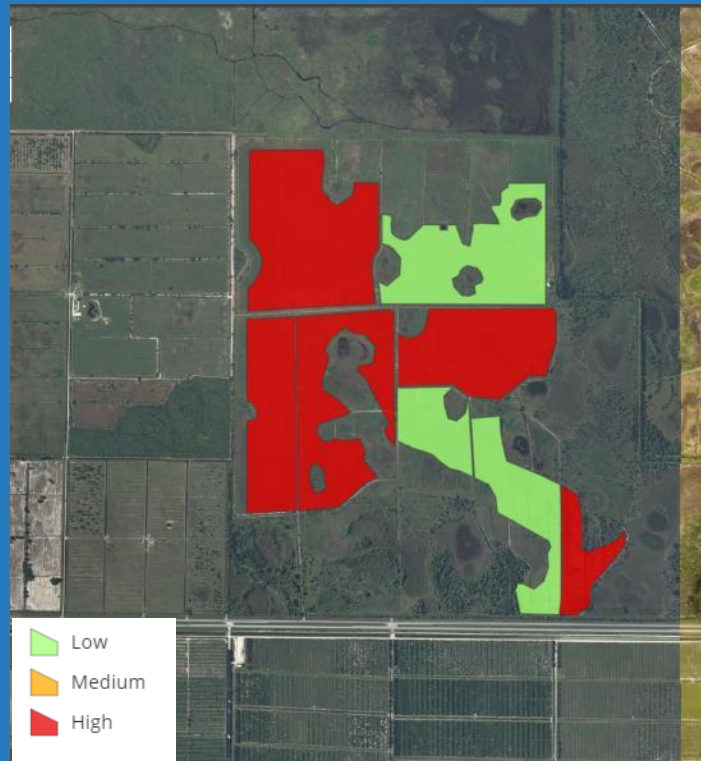


Biosolids Soil Phosphorus

2012

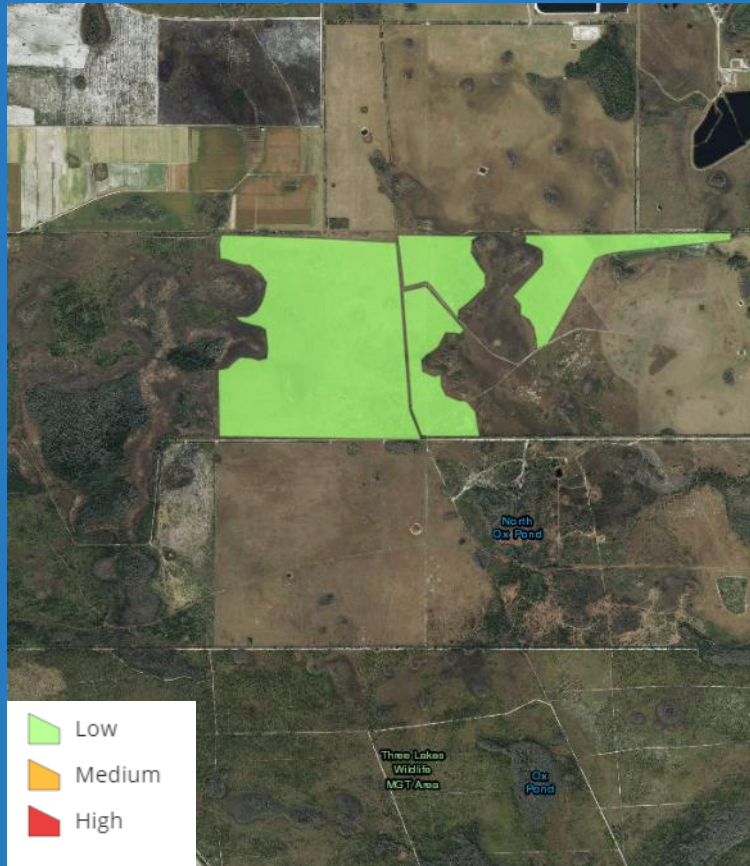


2017

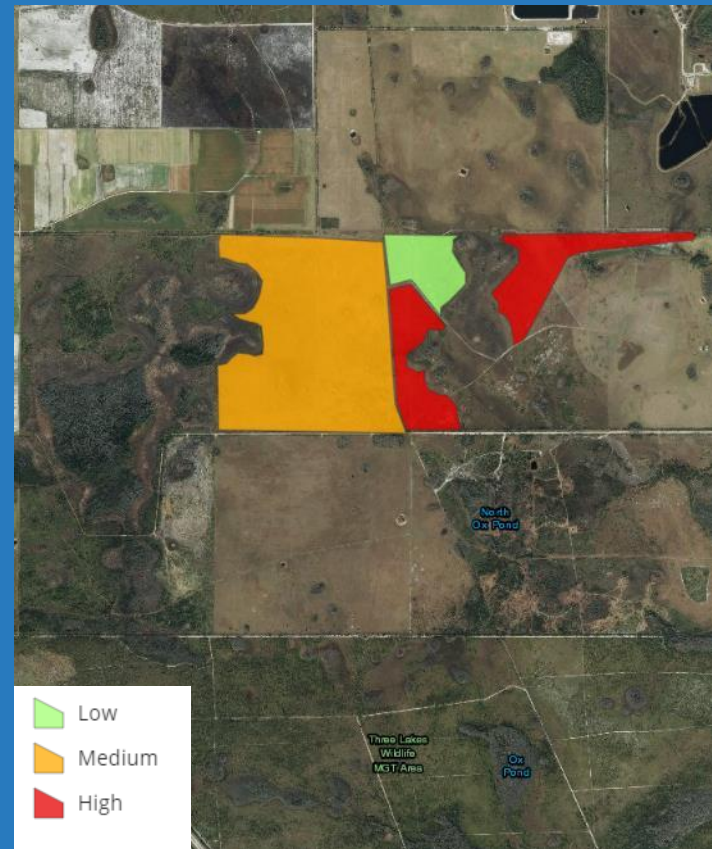


Biosolids Soil Phosphorus

2012

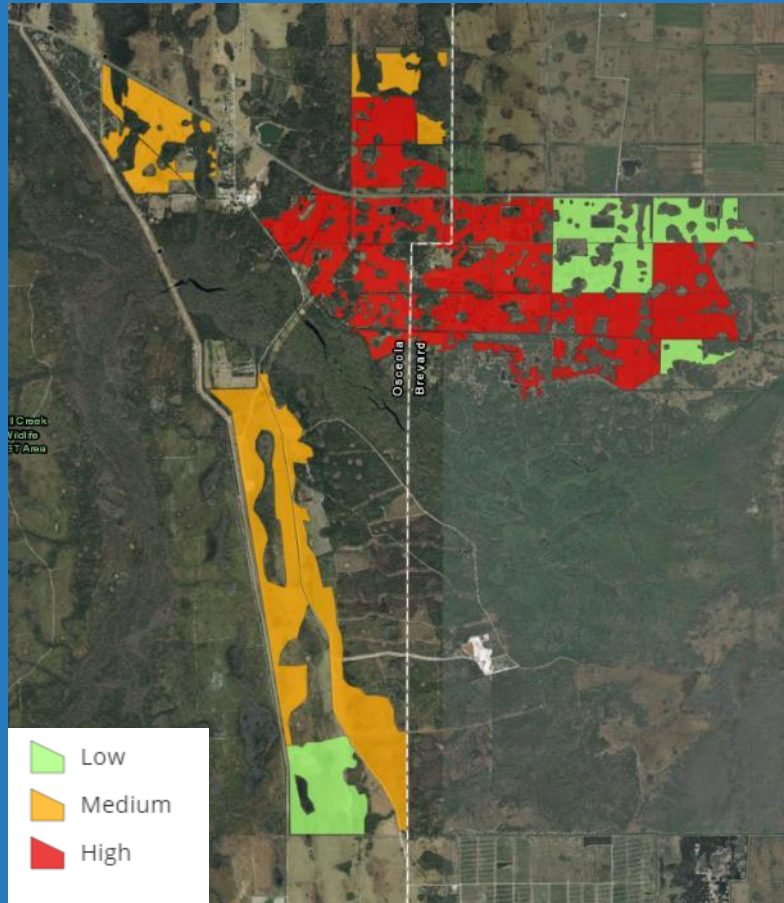


2017

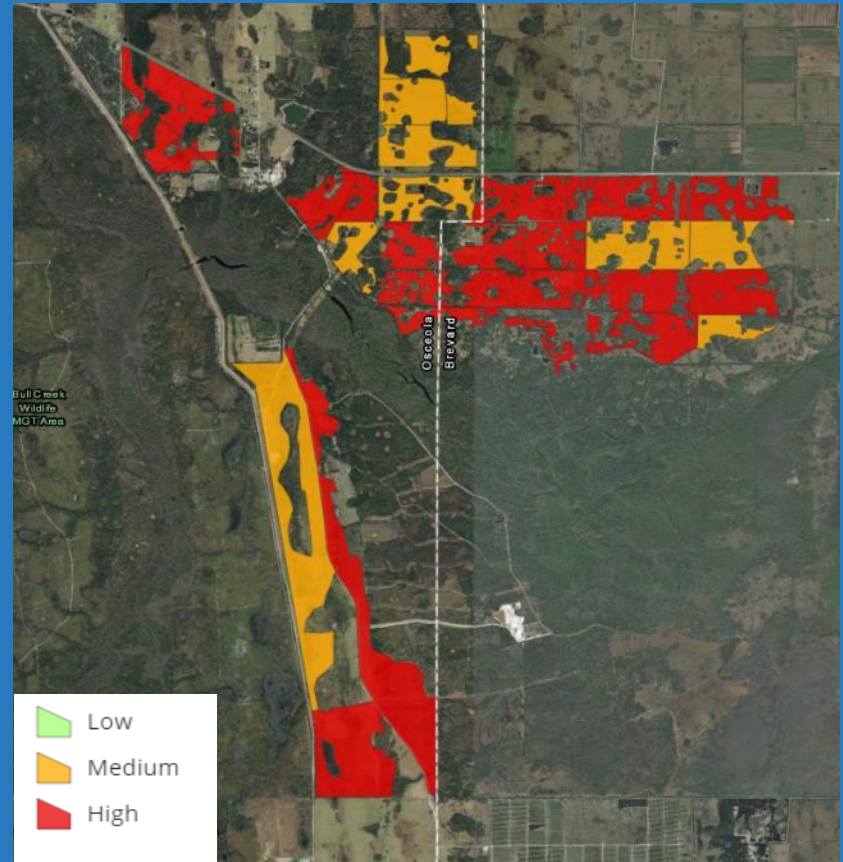


Biosolids Soil Phosphorus

2012

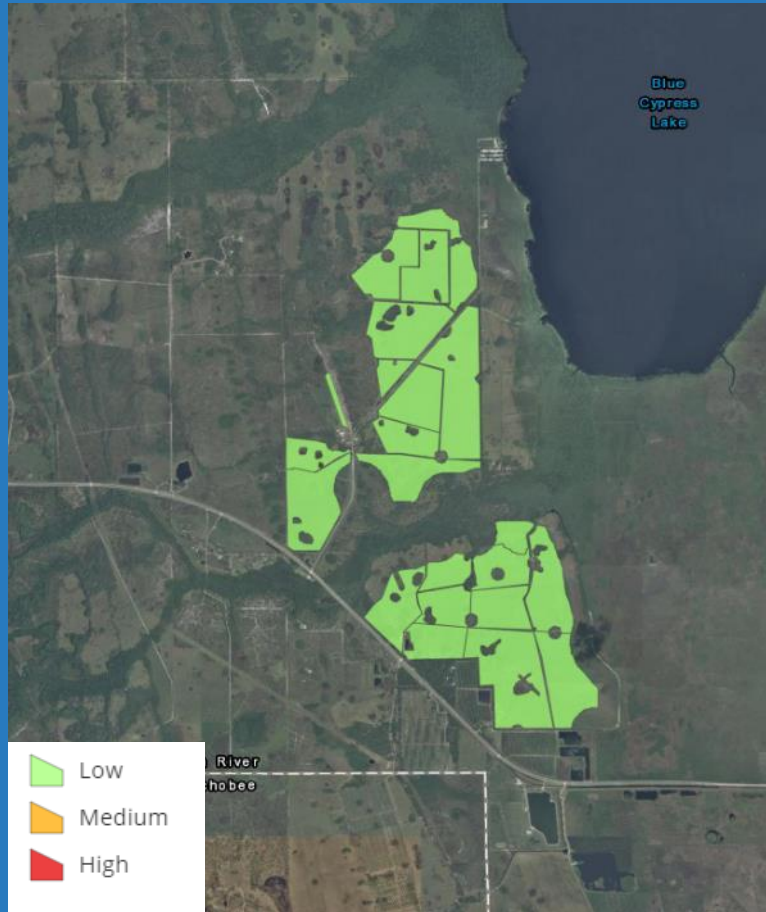


2017

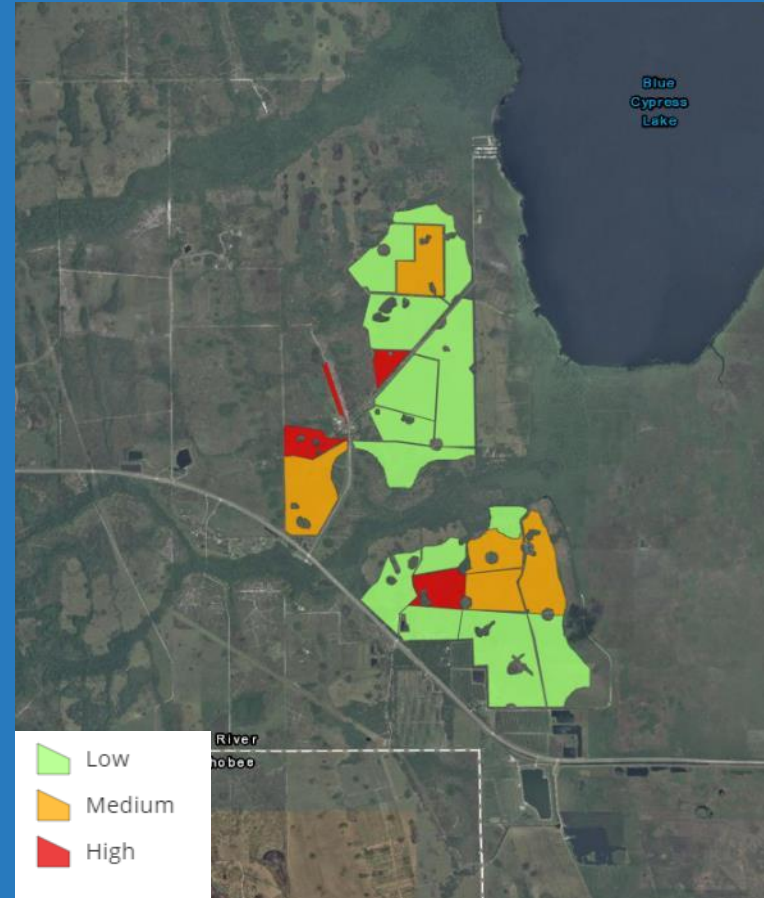


Biosolids Soil Phosphorus

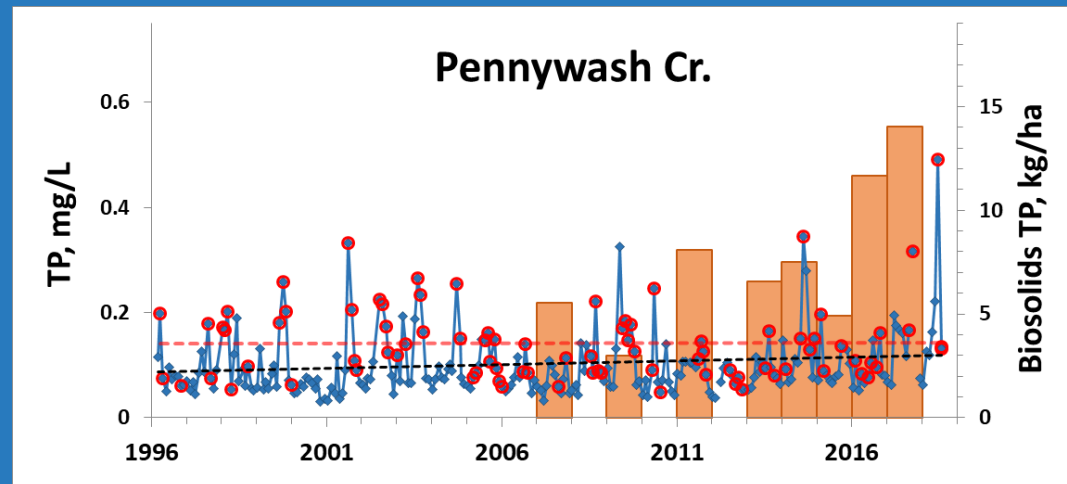
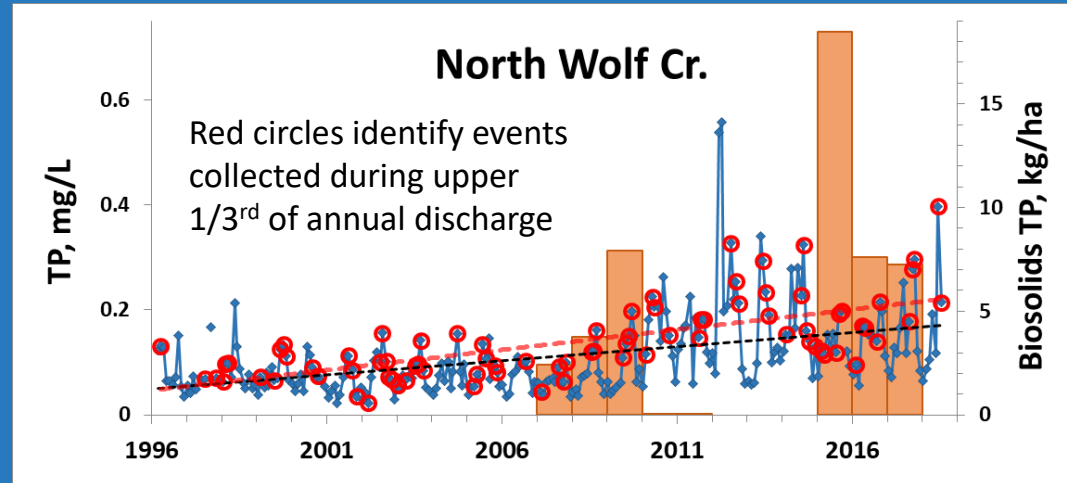
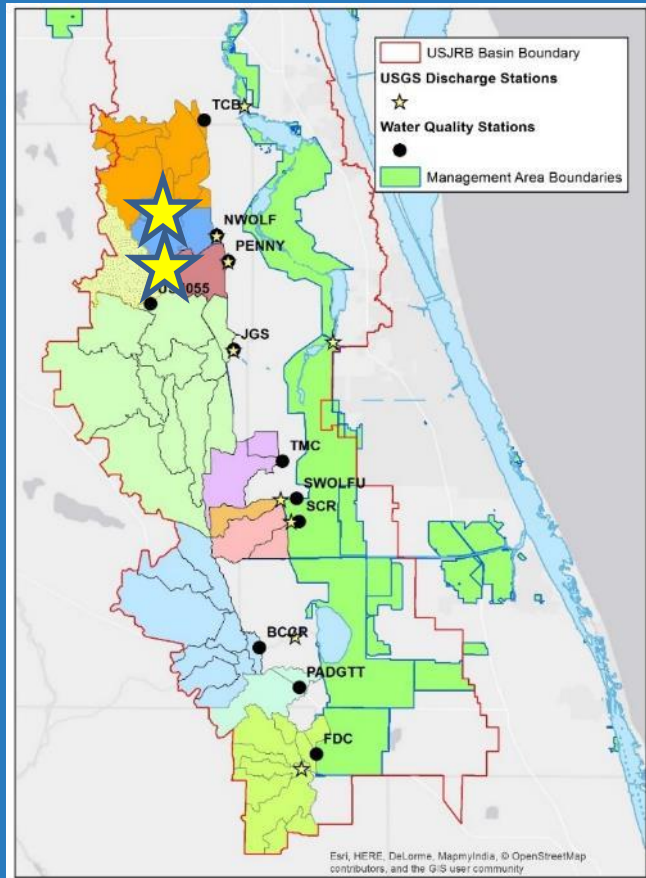
2012



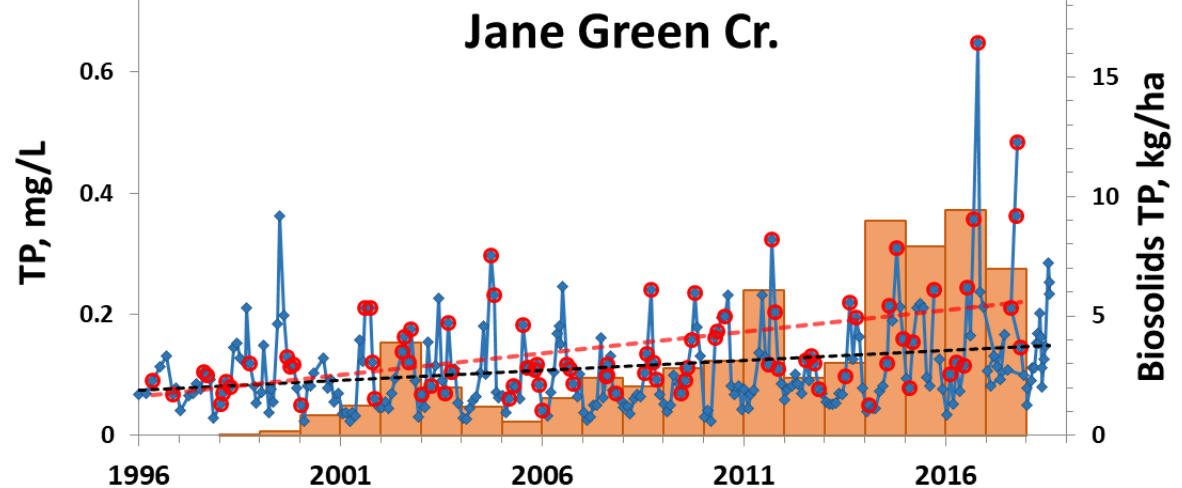
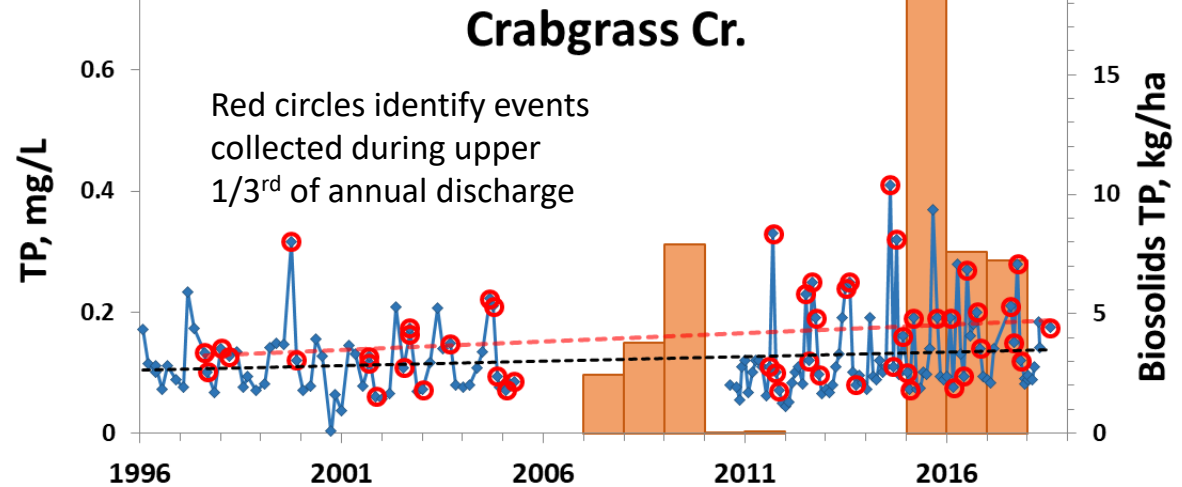
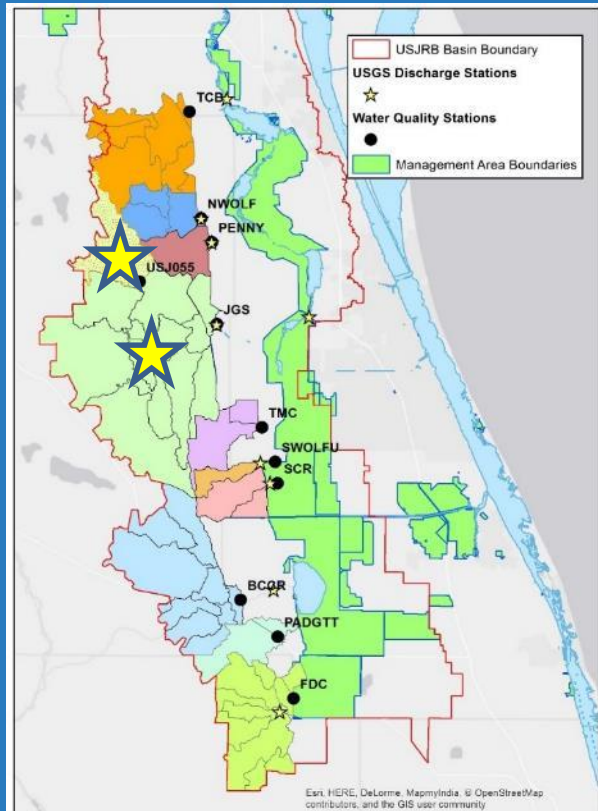
2017



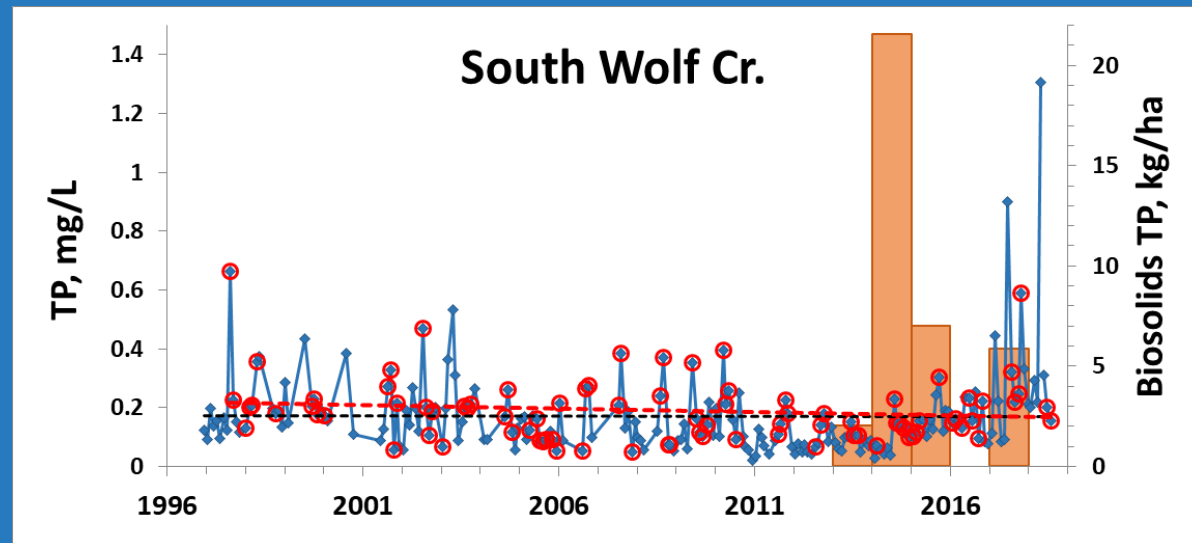
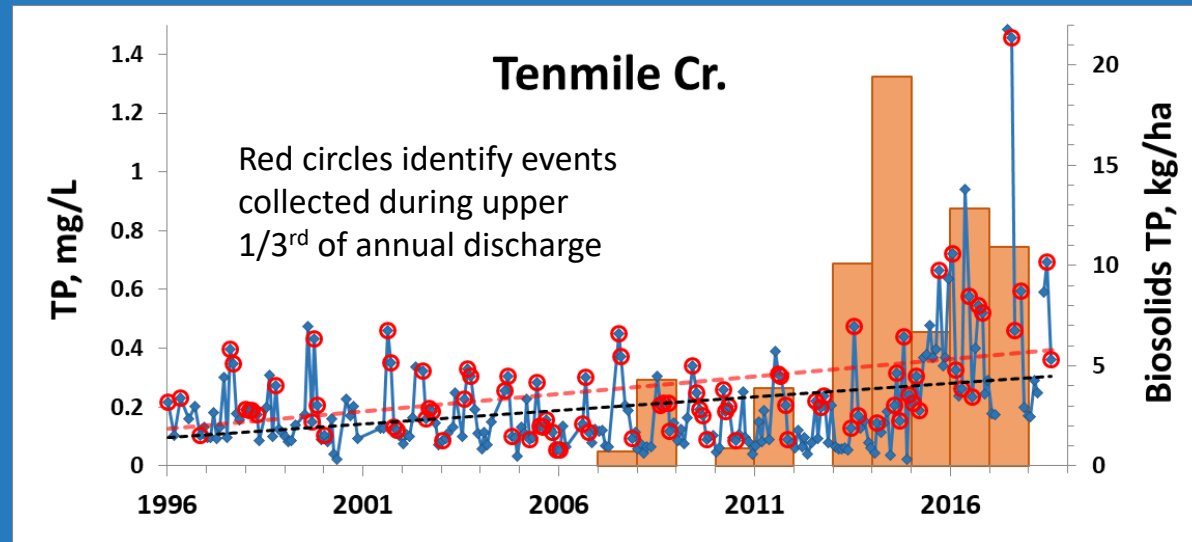
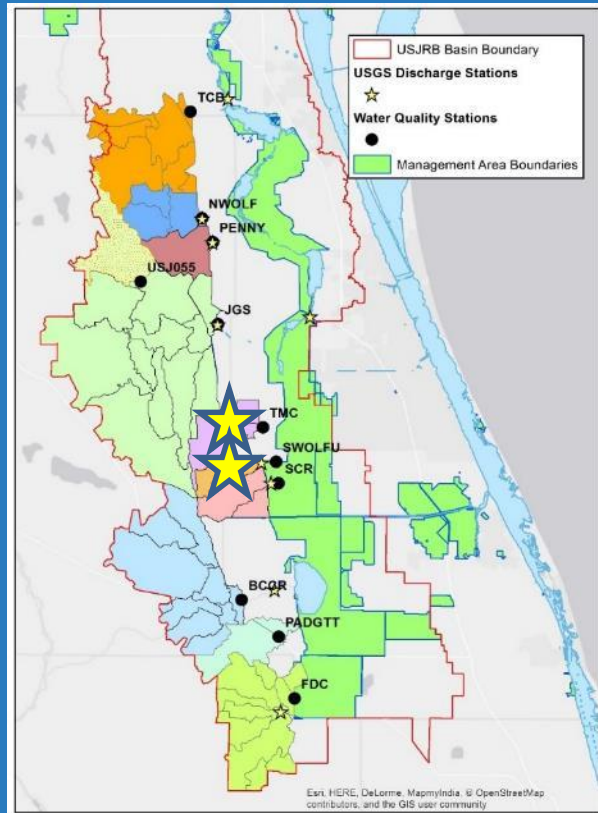
Biosolids Applications in USJ Western Basins



Biosolids Applications in USJ Western Basins

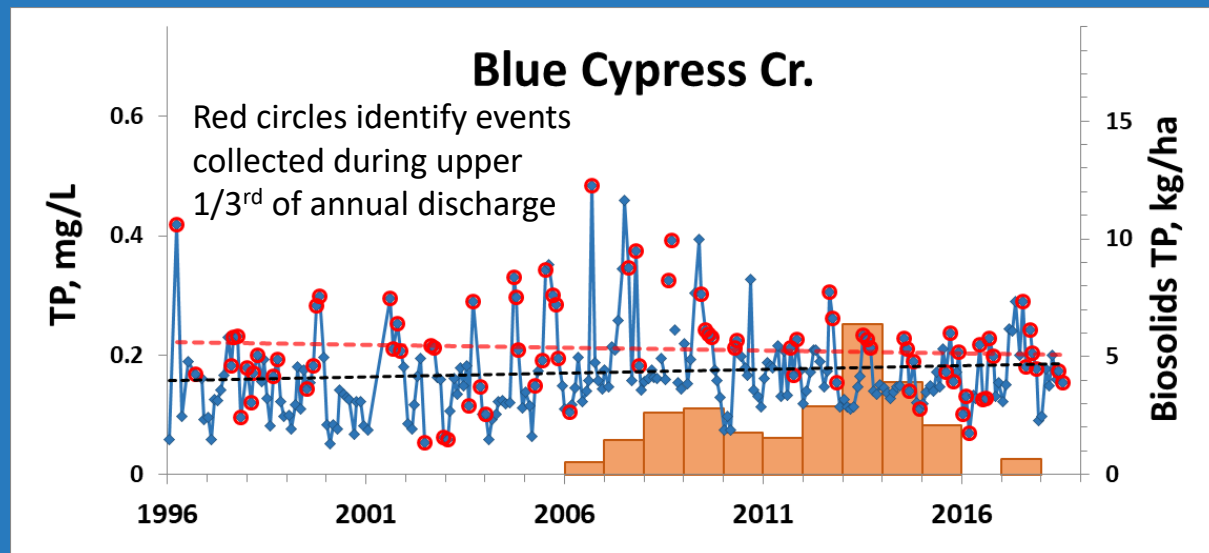
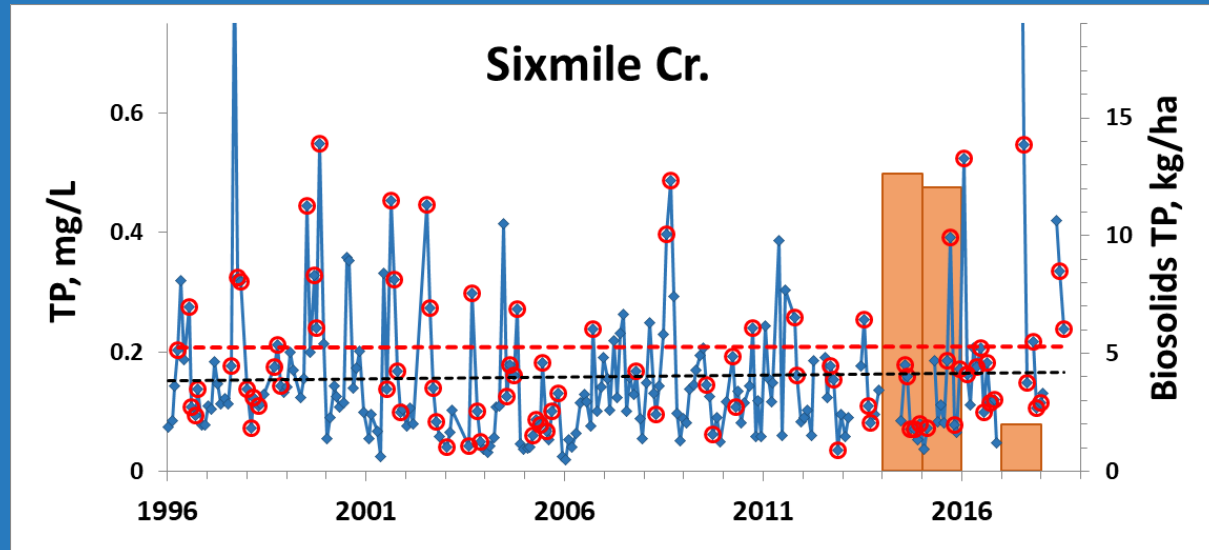
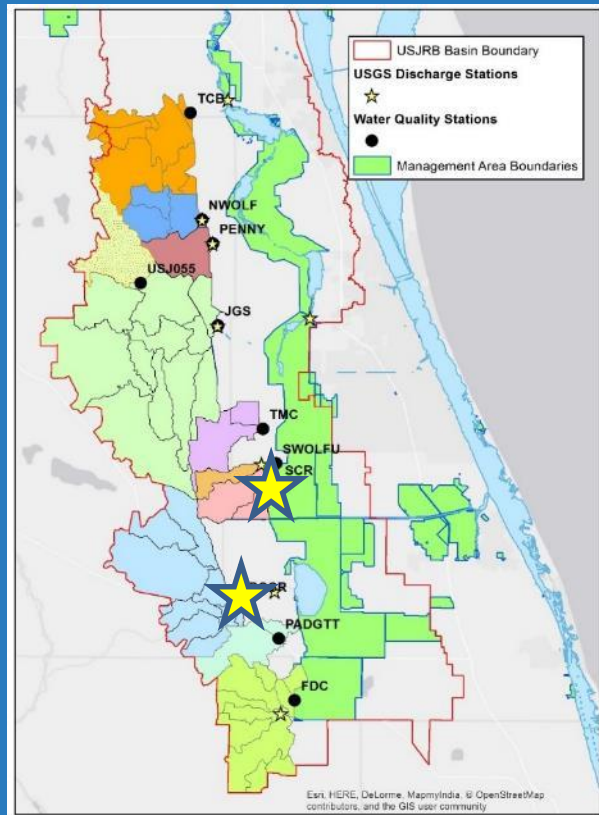


Biosolids Applications in USJ Western Basins



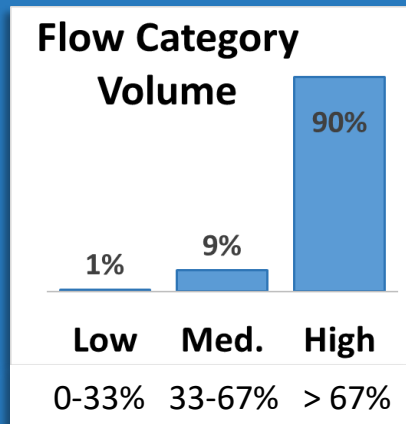
Note: Axes increased

Biosolids Applications in USJ Western Basins

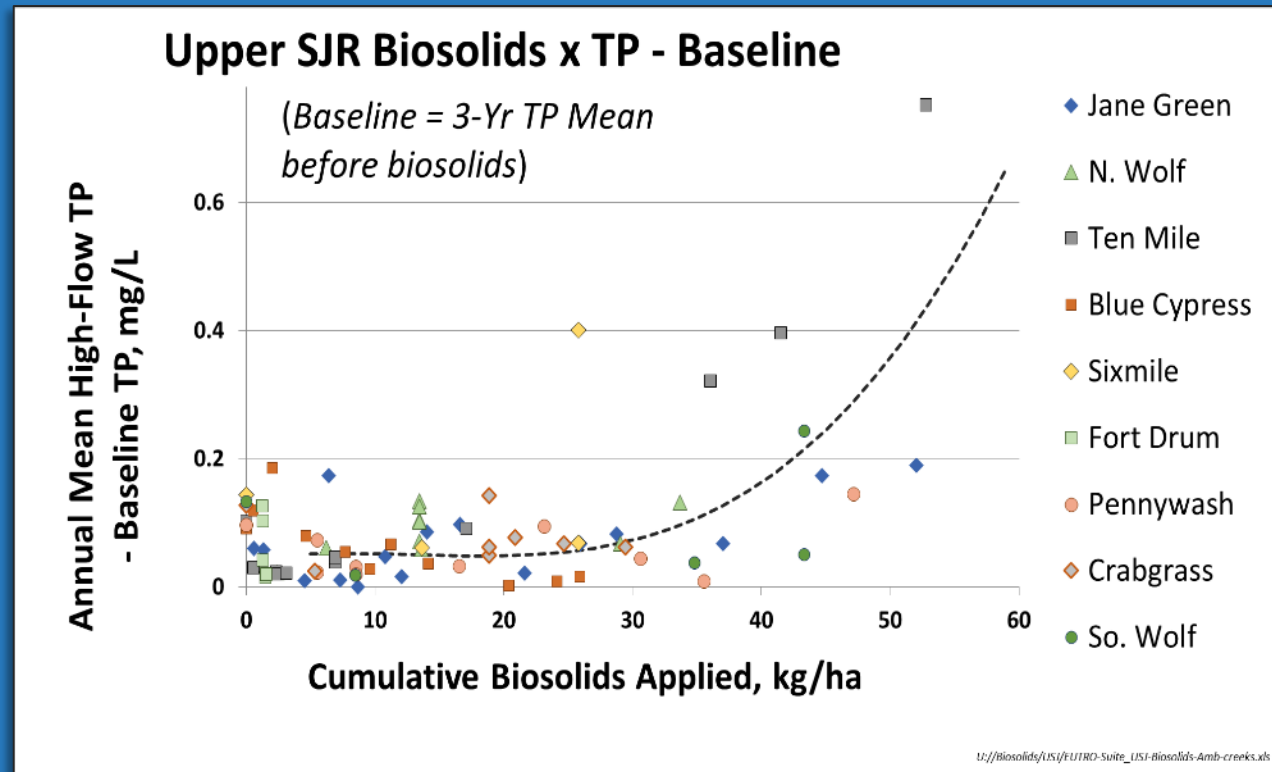


Ambient WQ Data –

High-Flow Total Phosphorus Relationship to Biosolids P



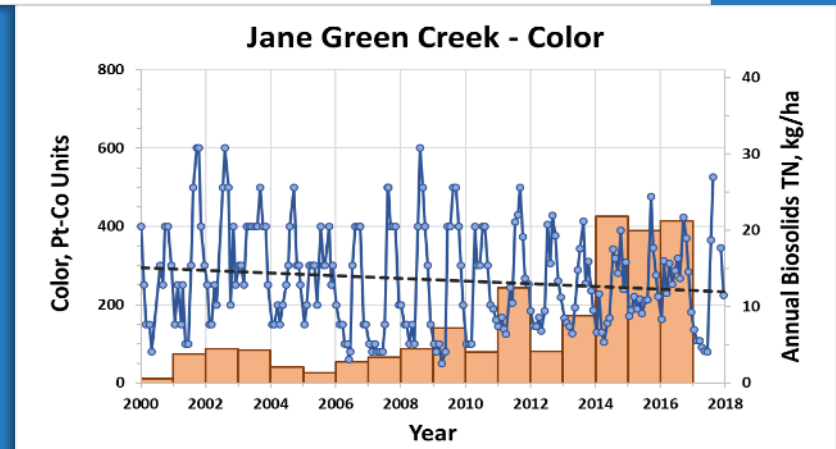
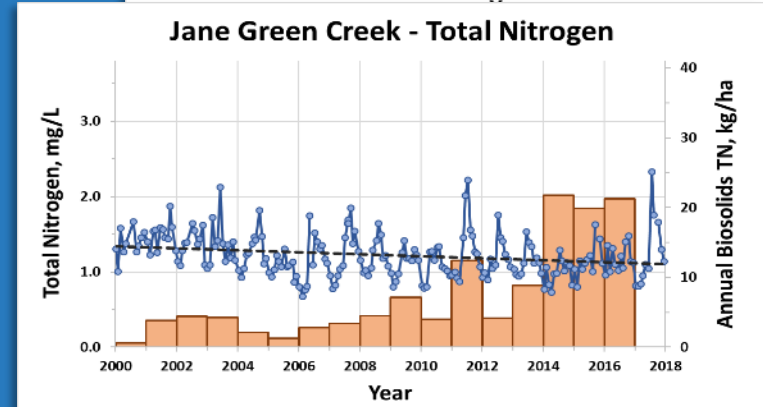
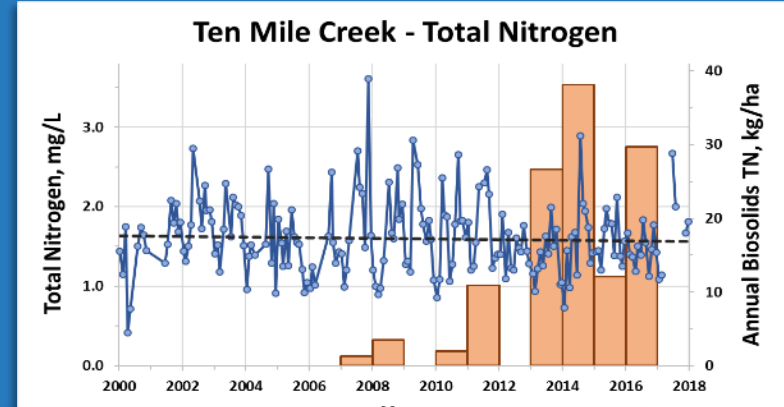
- **Biosolids P x TP correlation increases with increasing flow**
- **Highest 1/3rd of flow occurrence accounts for majority of water volume**



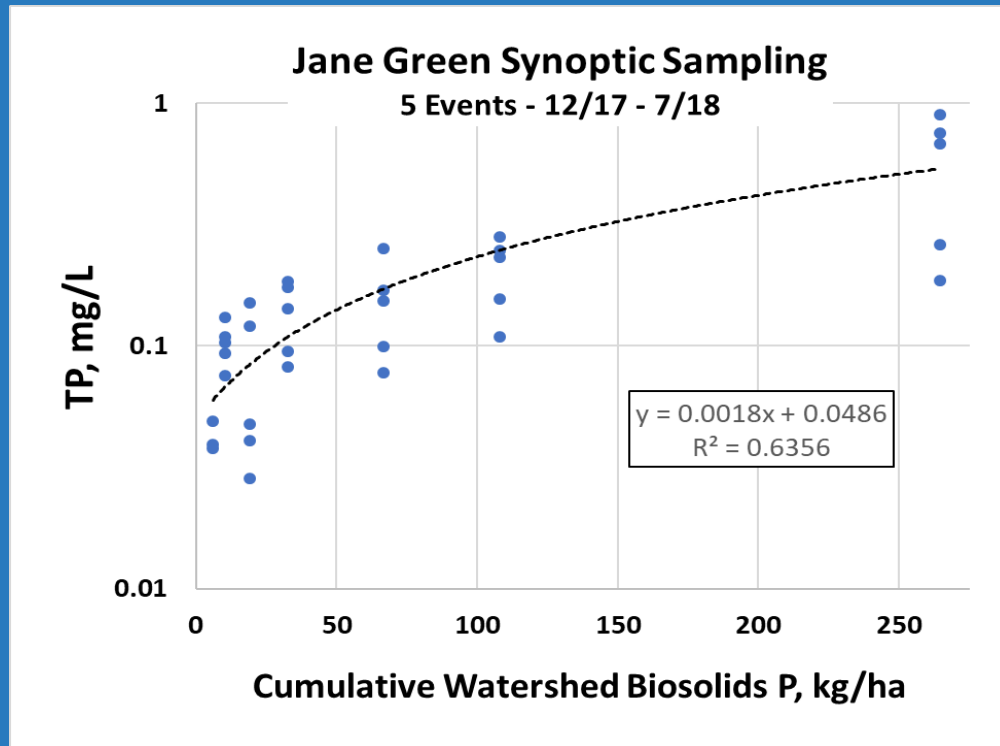
Ambient WQ Data Patterns

Total Nitrogen and Color

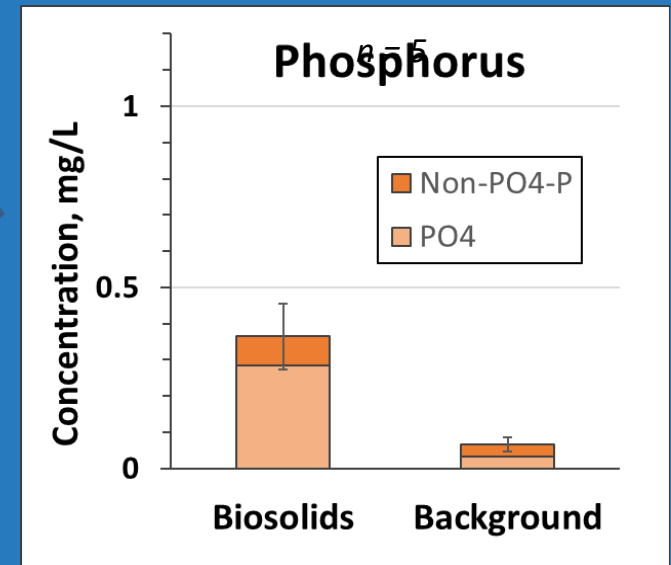
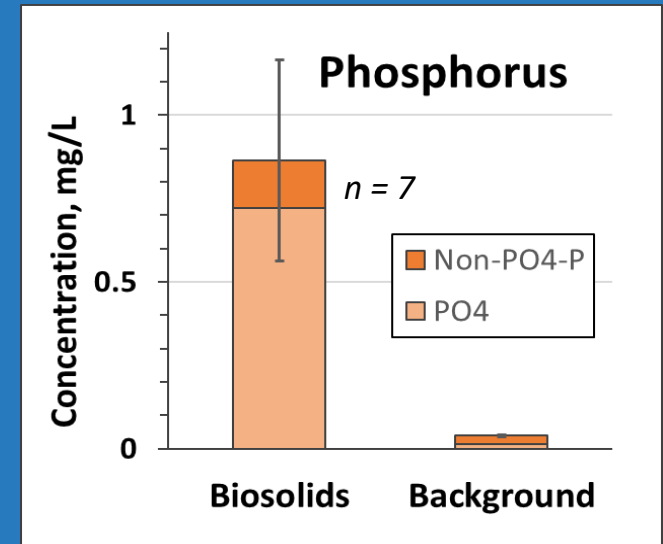
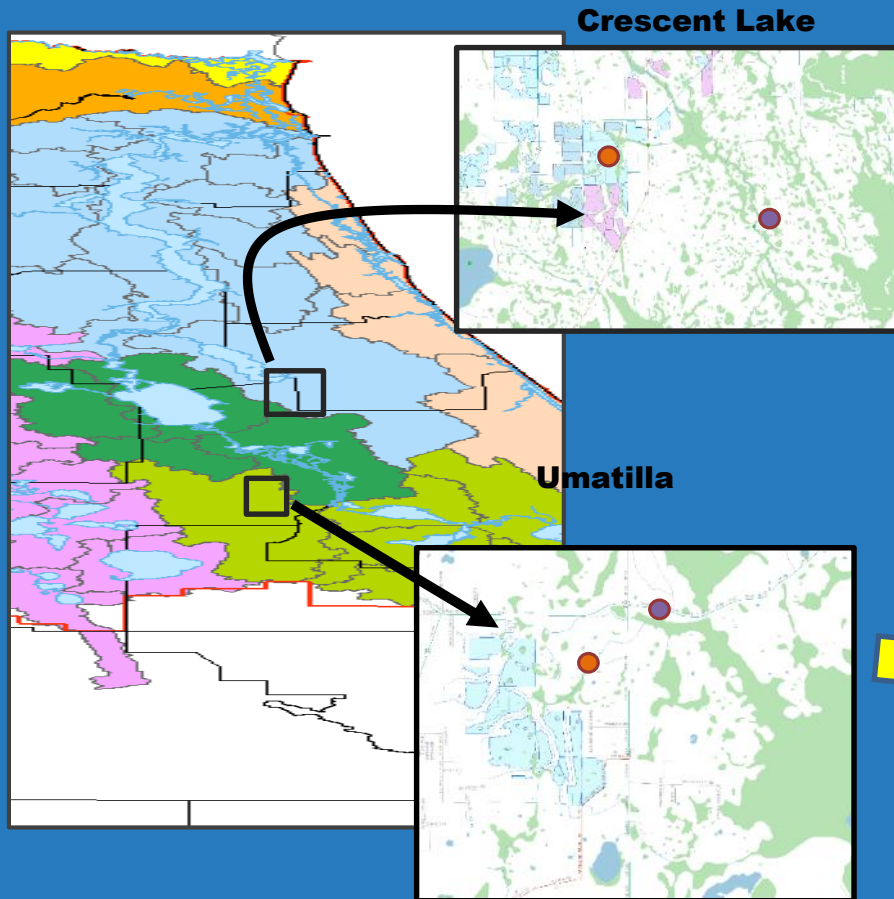
- As areal rate increases:
 - TN concentration unchanged or decreasing
 - Most significant for organic N; NO_x not significant
 - For Jane Green Cr., water color (CDOM) decreasing
 - Effect of watershed additions of labile OC?
 - No trace metal trends



Intensified Water Quality Sampling Jane Green Creek



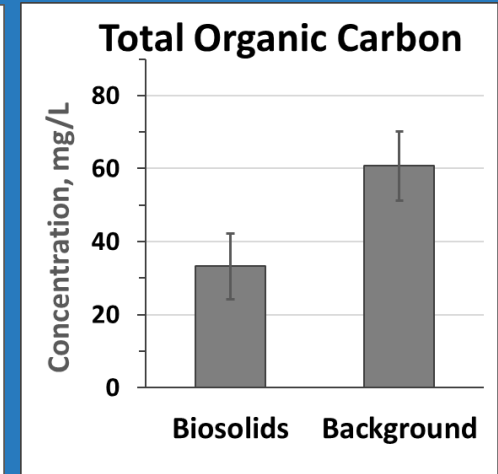
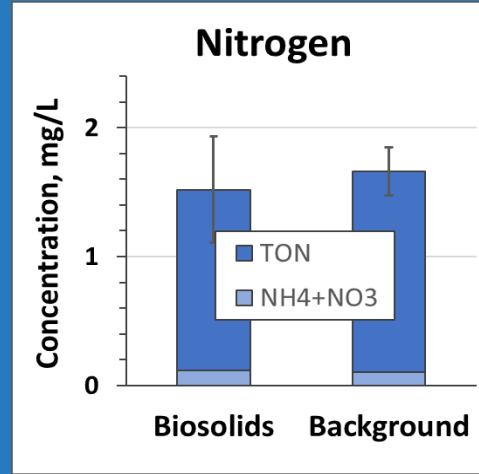
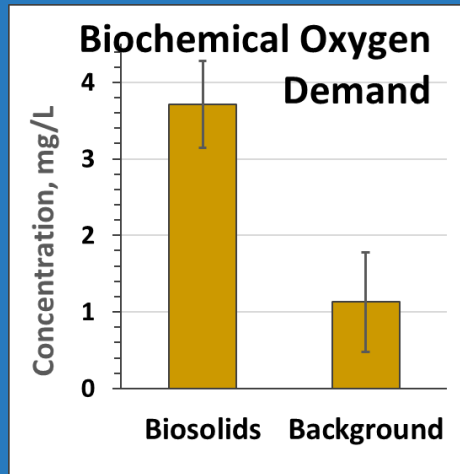
Other Paired Watershed Assessments



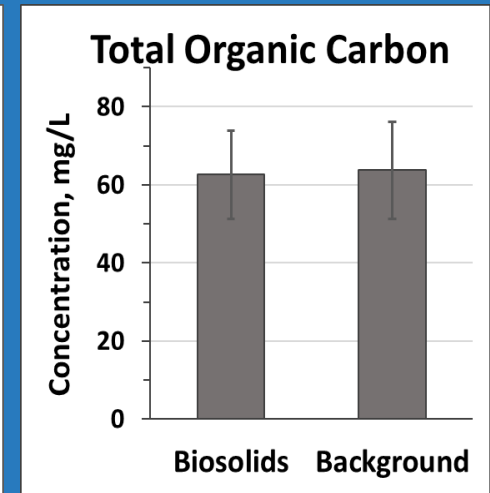
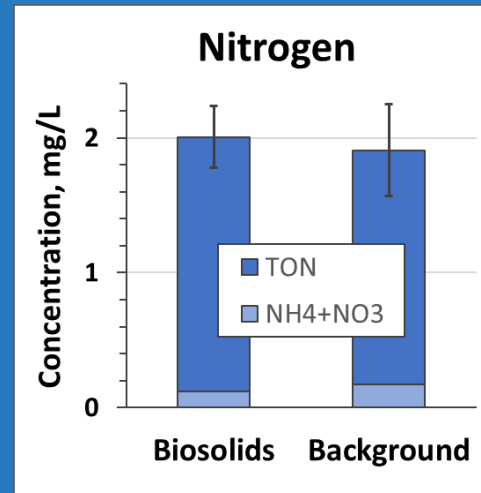
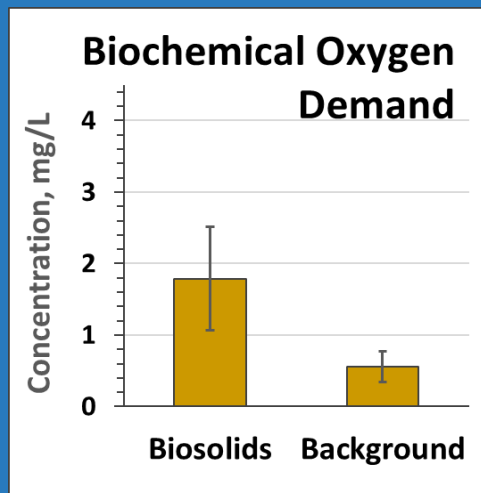
Other Paired Watersheds

BOD, Organic Carbon and Nitrogen

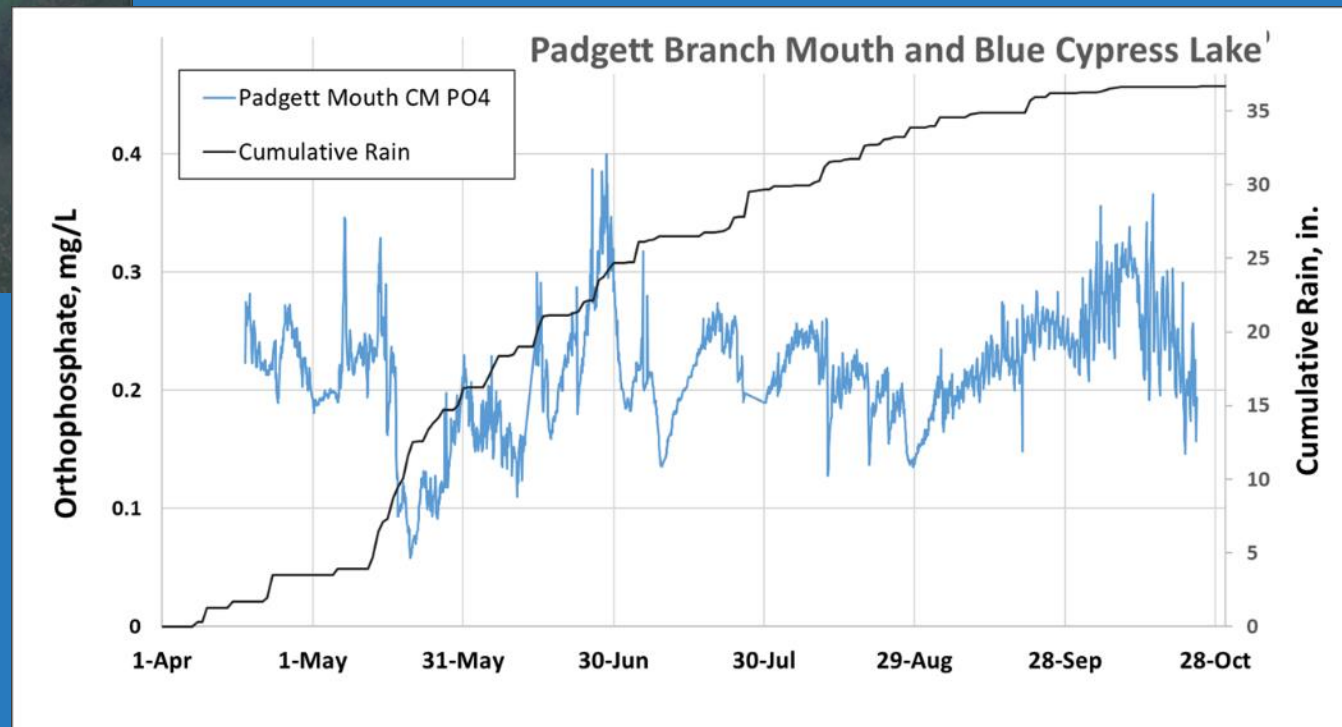
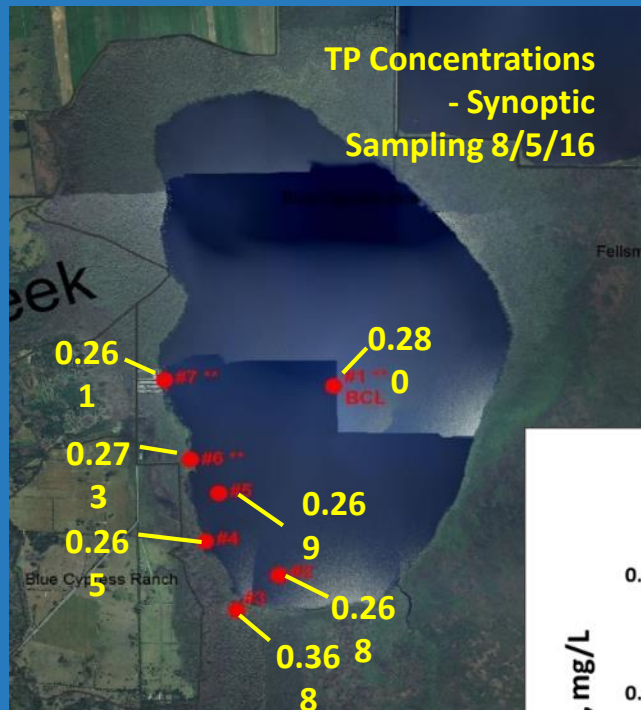
Crescent Lake



Umatilla

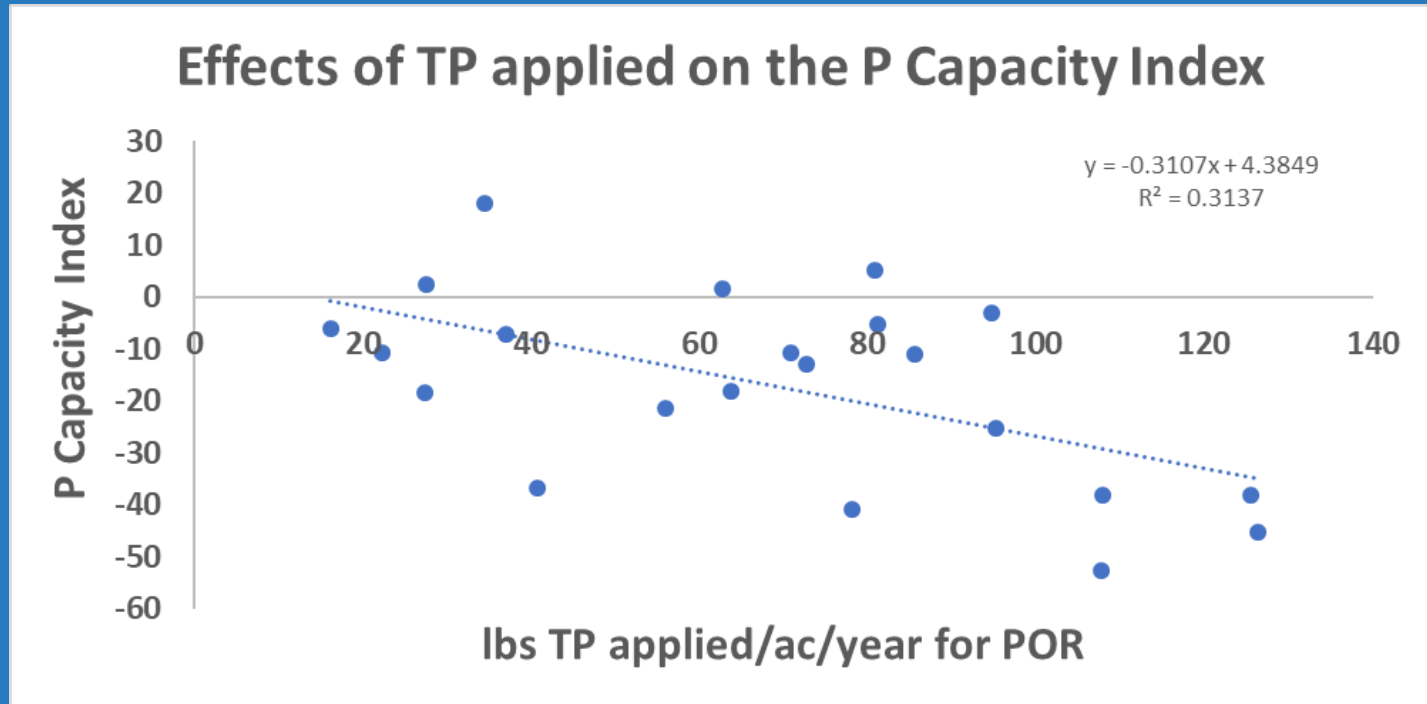


Padgett Branch Mouth PO4 Provisional data



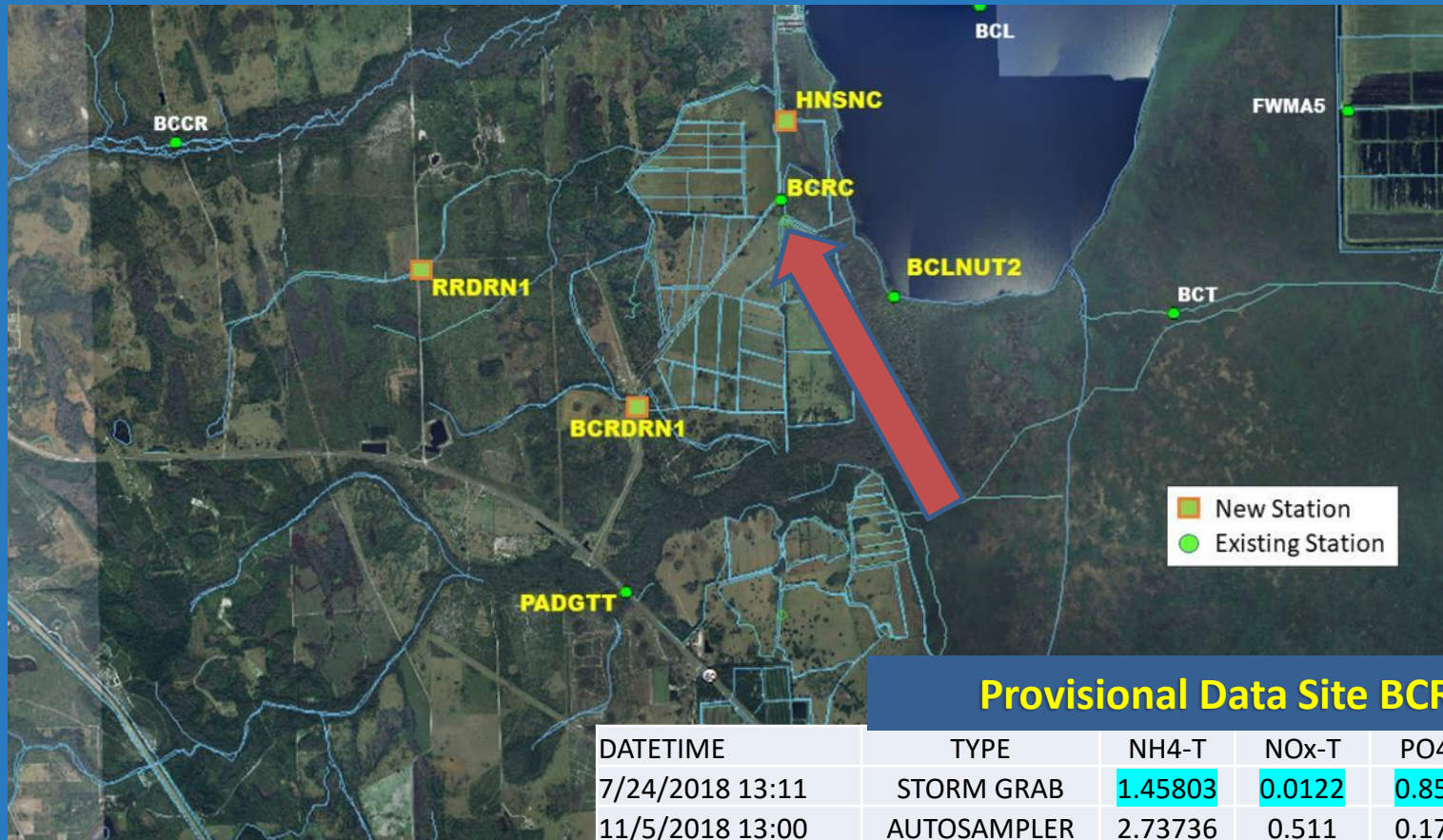
Pressley Ranch Soil P Results

Sampling of 23 Fields 11/6/18



Pounds of TP applied in biosolids per acre annually for the period of record (2013-2018) plotted versus the P Capacity Index of the top 6 inches of the soil profile. The period of record includes years that the field did not have any biosolids applied. The lower the value the greater the potential of offsite P export. Values above zero indicate additional capacity of the soil to retain P.

Surface Storm Water Locations of Blue Cypress Lake P Source Sampling. Monitoring request sites in yellow.



Provisional Data Site BCRC

DATETIME	TYPE	NH4-T	NOx-T	PO4-T	TKN-T	TP-T
7/24/2018 13:11	STORM GRAB	1.45803	0.0122	0.8595	4.6664	1.3312
11/5/2018 13:00	AUTOSAMPLER	2.73736	0.511	0.1758	5.4256	0.3782
11/5/2018 12:45	AUTOSAMPLER	2.51135	0.3724	0.3409	8.9874	1.1995
11/5/2018 12:50	AUTOSAMPLER	1.269	0.682	0.3411	4.5753	0.7506
11/5/2018 12:55	AUTOSAMPLER	2.08825	0.6625	0.2344	5.7562	0.638

Highlighted values dissolved, not total.

Proposed Soil Pore Water Sampling Sites

Arrows indicate digital elevation model
estimated soil pore water flow direction



Tracers Analyses

- Sucralose 6/26/17 – None detected
- Synoptic Event 7/24/18:

	Padgett Br. Hwy. 60	Blue Cypress Lake Middle	Blue Cypress Lake SW Shore	Blue Cypress L. Road Culvert
TP	0.14	0.29	0.27	0.95
1,4-Dioxane	0.020 U	0.020 U	0.020 U	0.16
Primidone	0.0040 U	0.0040 U	0.0040 U	0.0040 U
Acetaminophen	0.0080 U	0.0080 U	0.0080 U	0.0080 U
Carbamazepine	4.0E-04 U	4.0E-04 U	4.0E-04 U	4.0E-04 U
Hydrocodone	8.0E-04 U	8.0E-04 U	8.0E-04 U	8.0E-04 U
Naproxen	0.0080 U	0.0080 U	0.0080 U	0.0080 U
Ibuprofen	0.020 U	0.020 U	0.020 U	0.020 U

Lines of Evidence Between Biosolids and Increased TP Concentrations

- Temporal congruence of biosolids applications and changes in ambient TP
 - No evidence of land use driven changes
- No other known sources of P loading
- Strong relationship between cumulative biosolids application and TP concentrations
- TP and TOC concentrations become decoupled
- Paired watershed changes in water quality, especially TP
- N:P responses in ambient WQ and biosolids N:P

Upper SJR Basin Implications of Increased TP

- Upper Basin is Class I waters, currently used as a potable water source
 - Additional future withdrawals planned
 - Potential for algal blooms, especially toxin producing taxa, such as Microcystis
- Downstream TMDL/BMAPs anticipate TP load reductions from Upper Basin
- Impacts to Upper Basin water quality impact habitat conditions, recreation and aesthetics to a \$250M USACOE and District restoration project