

# Inflow to Outflow Water Quality Patterns in STA-2 Flow-way 3

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# Overall Study Goal

To improve our understanding of the mechanisms and factors that affect P treatment performance of the STAs, particularly those that are key drivers to performance at the lower reaches of the treatment flow-ways.

## Key Questions

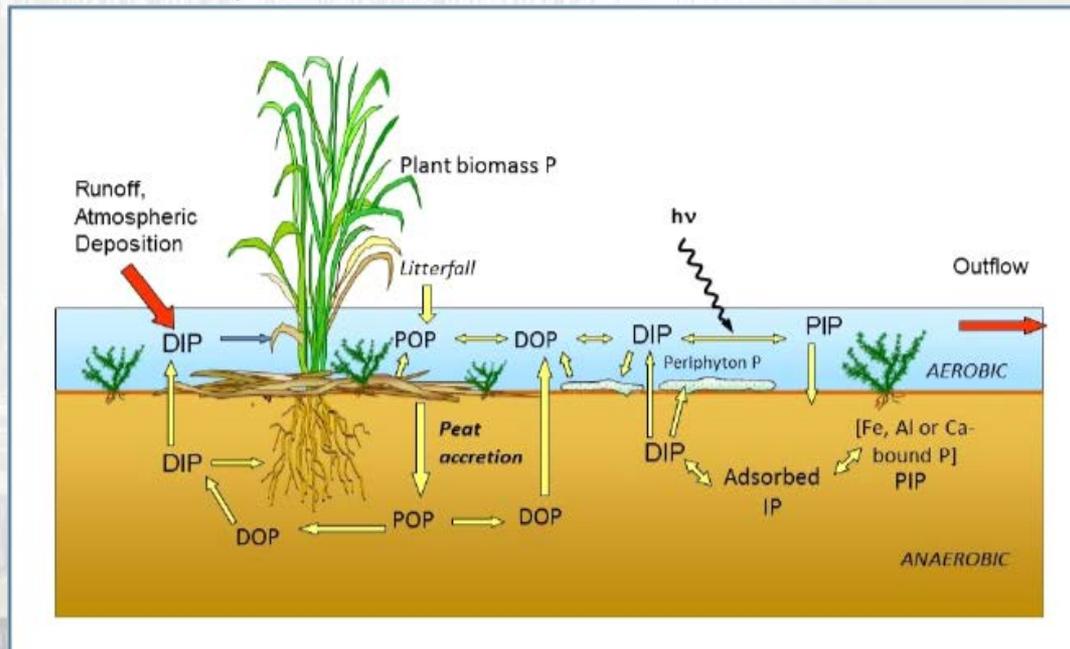
- Can internal loading of P to the water column be reduced or controlled, especially at the lower reaches of the treatment trains?
- Can the biogeochemical or physical mechanisms be managed to further reduce soluble reactive (SRP), particulate (PP) and dissolved organic P (DOP) concentrations at the outflow of the STAs?

# Study Objectives

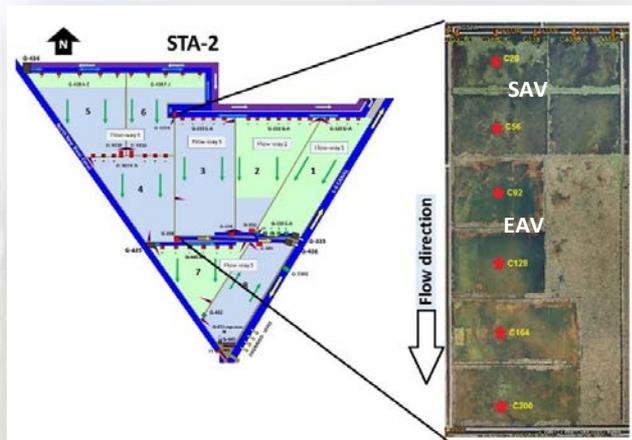
- Evaluate biogeochemical responses of the different regions along selected STA flow-ways to three different flow scenarios; stagnant, low flow and high flow events.
- To determine what the influencing factors are and the relative magnitude of influence of each of those factors, particularly those related to P sources, P flux, and P species transformations.

# Hypothesis

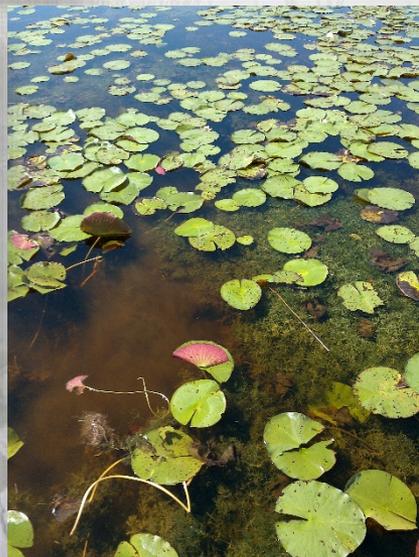
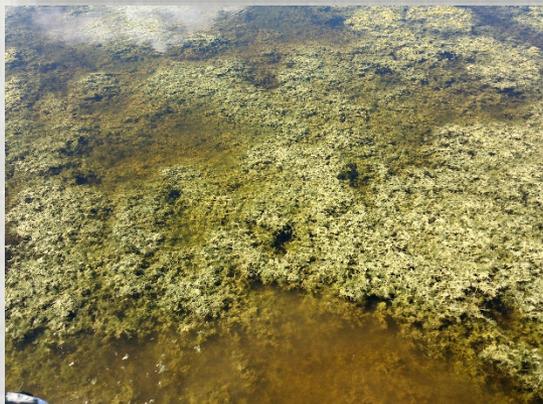
The ability of an STA flow-way to remove soluble reactive P (SRP), convert dissolved organic P (DOP) to SRP, and retain particulate P (PP) early in the flow-way will reduce total P concentrations at the lower reaches of the flow-way and at the outflow.



# Study Site – STA-2 Cell 3



- Single cell flow-way
- Treatment area - 2,296 acres
- Predominantly SAV
- Came online Feb. 2001
- POR outflow TP - 17  $\mu\text{g}/\text{L}$



# Water Quality Monitoring Platforms



# Controlled Flow Events

## 1<sup>st</sup> Flow Event – (Feb 22 – Apr 11, 2016) 50 days

Phase	Phase Period	Water Depth, ft	Flow, cfs	HLR, cm/d	PLR, mg/m <sup>2</sup> /d
High Flow	2/22 - 3/7	1.96 ± 0.04	325 ± 60	8.55 ± 1.58	3.7 ± 1.3
Stagnant	3/8 - 3/29	1.91 ± 0.06	0	0	0
Normal	3/30 - 4/11	1.60 ± 0.21	55 ± 111	1.45 ± 2.91	1.0 ± 2

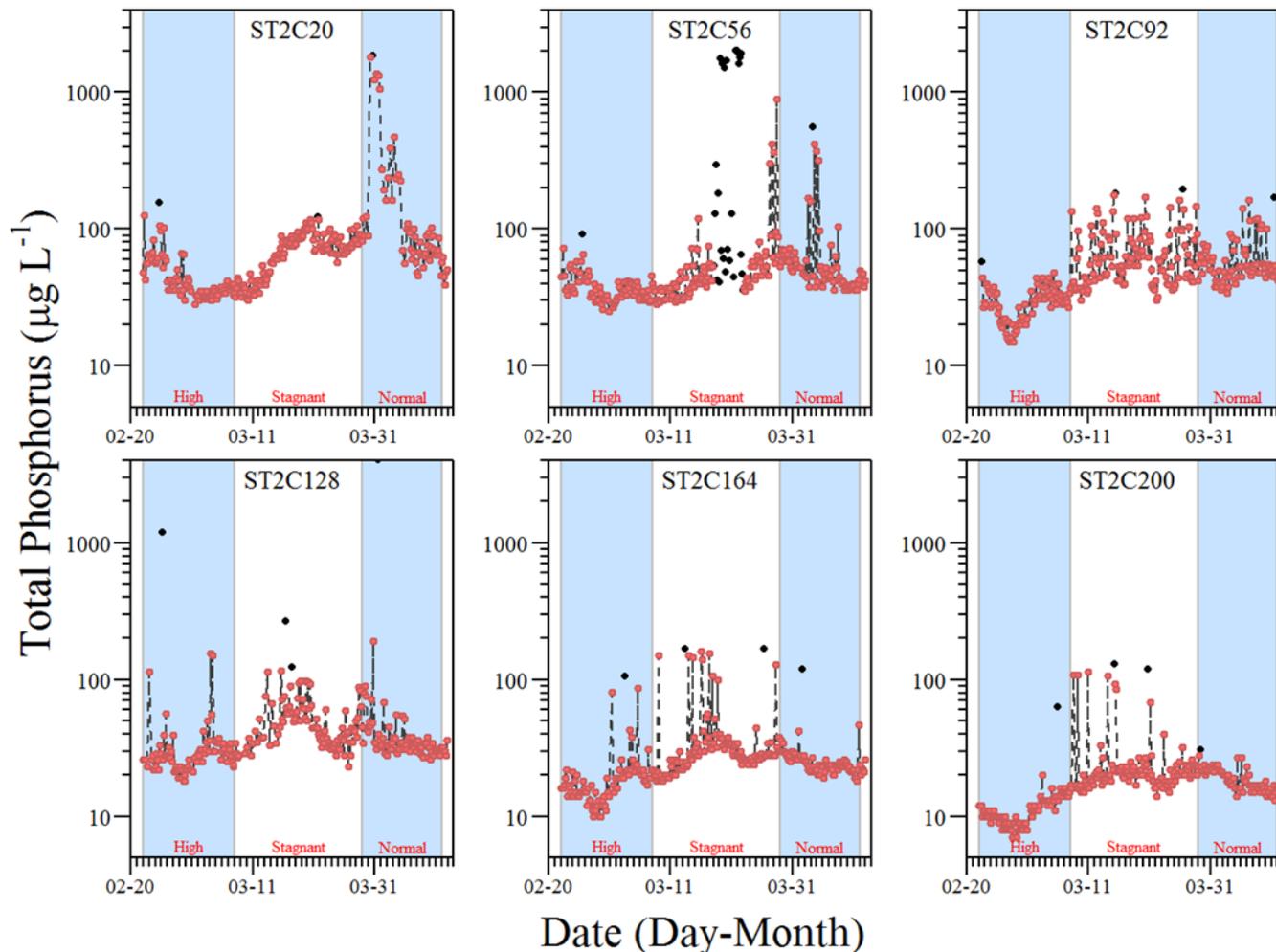
## 2<sup>nd</sup> Flow Event – (Jun 27 – Aug 29, 2016) 64 days

Phase	Phase Period	Water Depth, ft	Flow, cfs	HLR, cm/d	PLR, mg/m <sup>2</sup> /d
Stagnant	6/27 – 7/2	1.46 ± 0.05	0	0	0
Low Flow	7/3 - 7/24	2.03 ± 0.18	132 ± 33	3.48 ± 0.87	1.6 ± 0.7
Stagnant	7/25 - 8/8	1.93 ± 0.07	0	0	0
Low Flow	8/9 - 8/29	2.00 ± 0.07	120 ± 86	3.15 ± 2.26	2.3 ± 1.6

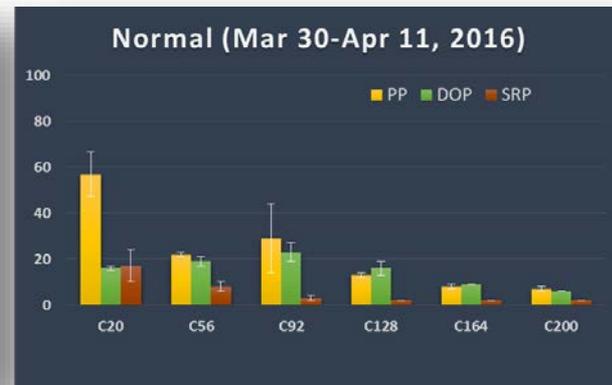
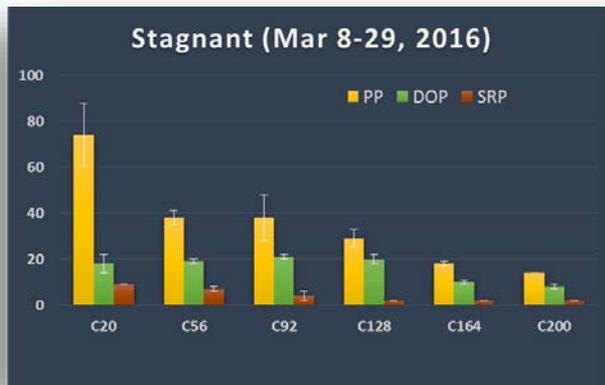
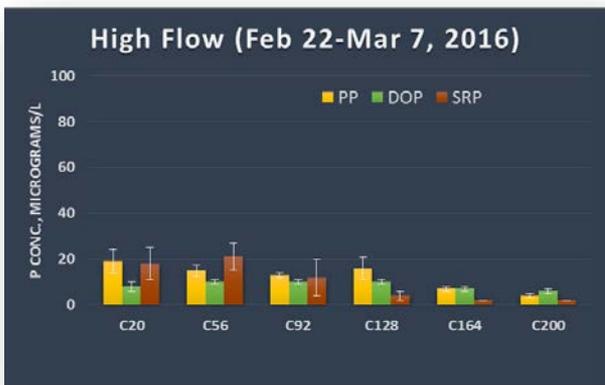
# Monitored Parameters

METHOD	PARAMETERS	FREQUENCY
Autosampler	TP	Every 4 hours
	TN, TOC	Daily composite
Grab	TP, SRP, TDP, DOC, TN, Ca, Mg, K, Na, NH <sub>4</sub> , NO <sub>x</sub> , Fe, SO <sub>4</sub> , Cl, Alkal, Color, TSS, Hardness, Chlorophyll	Weekly
Field	pH, DO, Specific conductance, Temperature	Every 15 minutes

# Autosampler TP- 1<sup>st</sup> Flow Event



# P Forms along the Flow-way



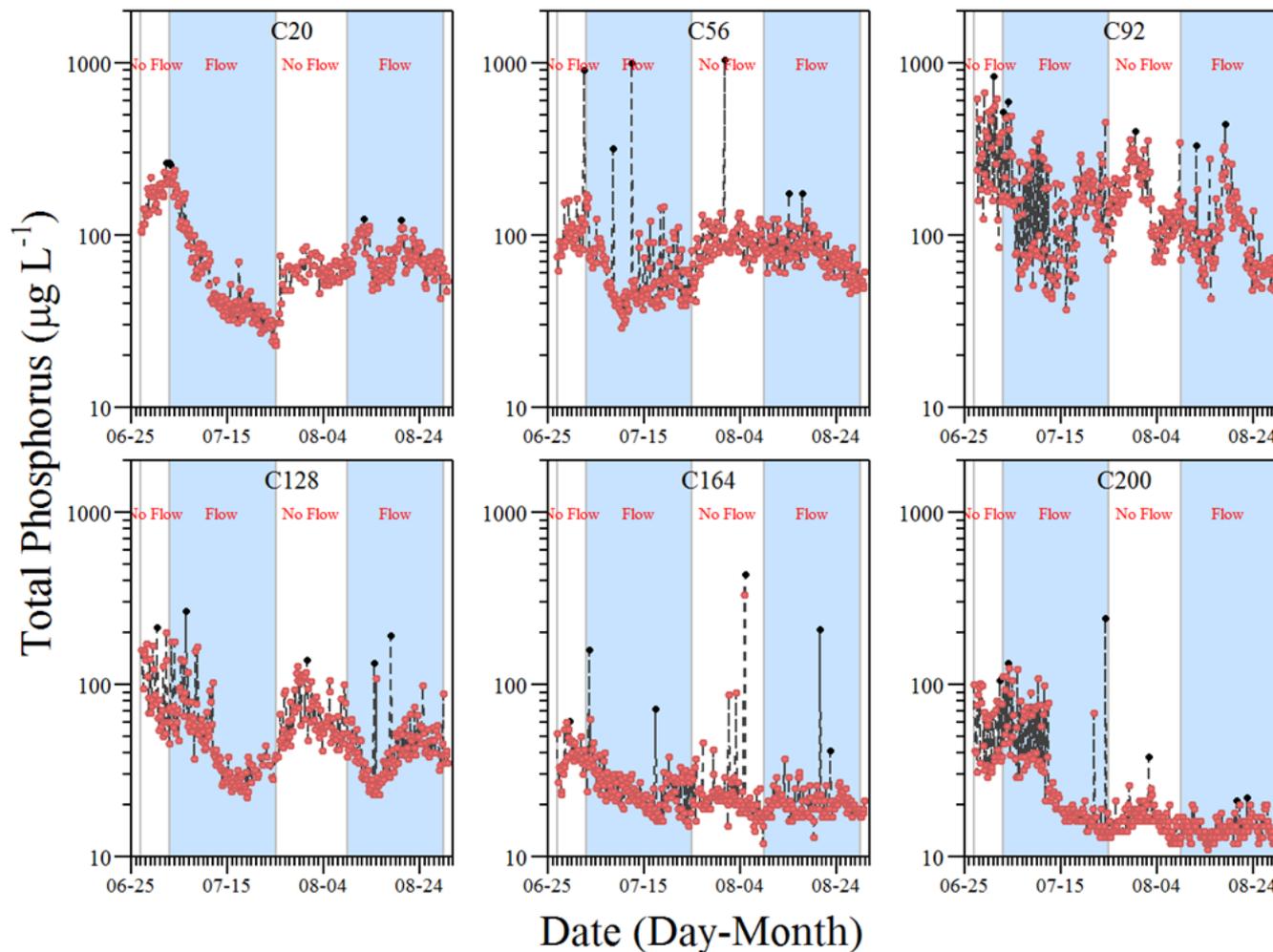
Station	TP µg/L	P Form, µg/L		
		PP	DOP	SRP
C20	45	19	8	18
C56	46	15	10	21
C92	36	13	10	12
C128	30	16	10	4
C164	15	7	7	2
C200	12	4	6	2

Station	TP µg/L	P Form, µg/L		
		PP	DOP	SRP
C20	101	74	18	9
C56	65	38	19	7
C92	63	38	21	4
C128	51	29	20	2
C164	30	18	10	2
C200	24	14	8	2

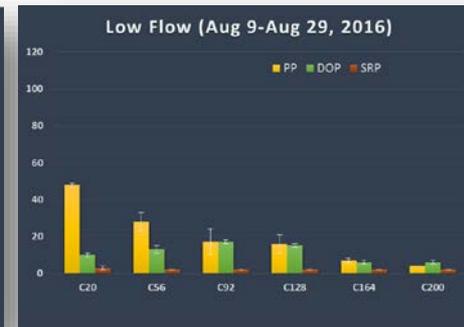
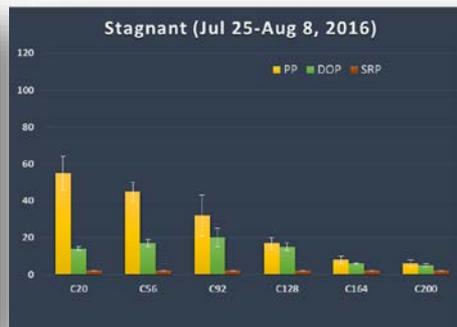
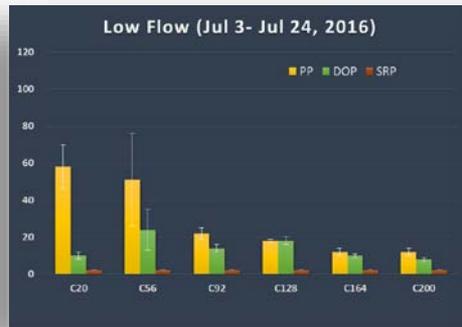
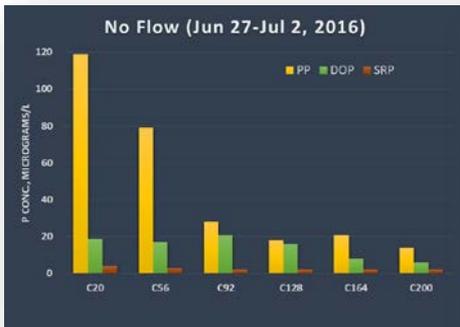
Station	TP µg/L	P Form, µg/L		
		PP	DOP	SRP
C20	89	57	16	17
C56	48	22	19	8
C92	54	29	23	3
C128	31	13	16	2
C164	19	8	9	2
C200	15	7	6	2

SRP – Soluble reactive P; DOP – Dissolved organic P; PP – Particulate P

# Autosampler TP- 2<sup>nd</sup> Flow Event



# P Forms along the Flow-way



Station	TP µg/L	P Form, µg/L		
		PP	DOP	SRP
C20	142	119	19	4
C56	99	79	17	3
C92	51	28	21	2
C128	36	18	16	2
C164	31	21	8	2
C200	22	14	6	2

Station	TP µg/L	P Form, µg/L		
		PP	DOP	SRP
C20	70	58	10	2
C56	77	51	24	2
C92	38	22	14	2
C128	37	18	18	2
C164	24	12	10	2
C200	21	12	8	2

Station	TP µg/L	P Form, µg/L		
		PP	DOP	SRP
C20	71	55	14	2
C56	63	45	17	2
C92	54	32	20	2
C128	33	17	15	2
C164	16	8	6	2
C200	13	6	5	2

Station	TP µg/L	P Form, µg/L		
		PP	DOP	SRP
C20	61	48	10	3
C56	43	28	13	2
C92	36	17	17	2
C128	32	16	15	2
C164	14	7	6	2
C200	12	4	6	2

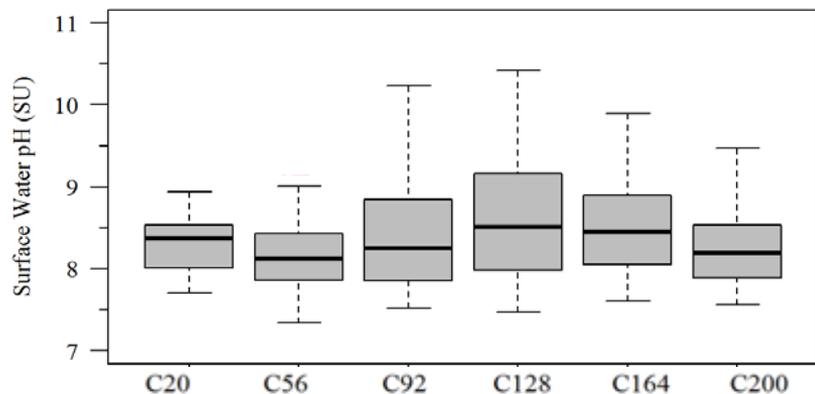
SRP – Soluble reactive P; DOP – Dissolved organic P; PP – Particulate P

# WQ Parameters Influencing TP

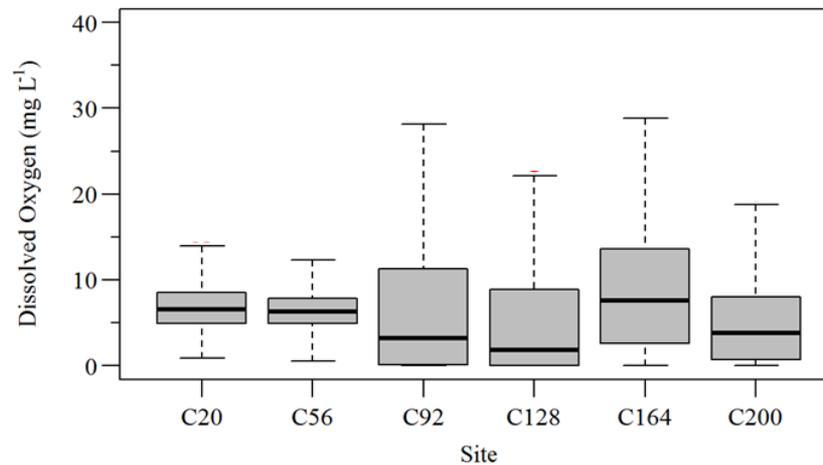
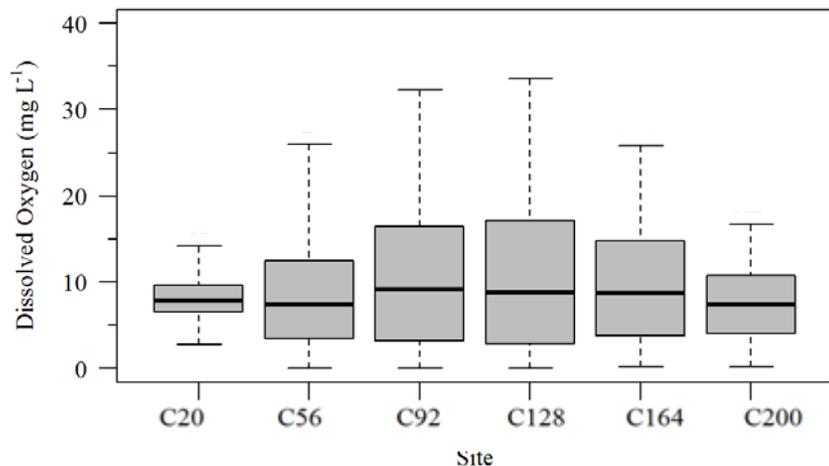
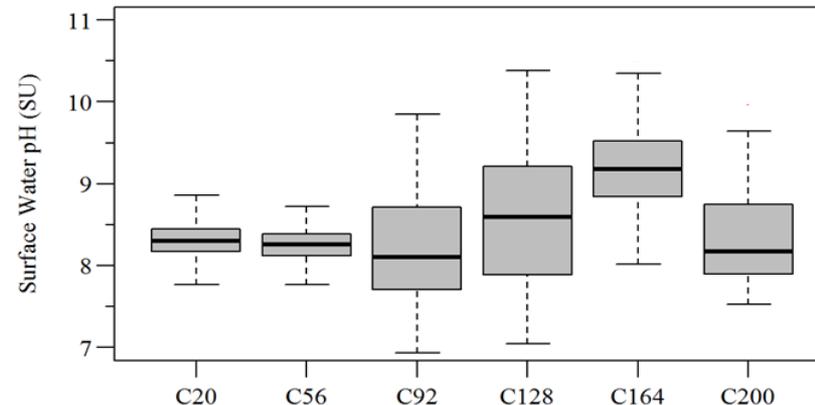
WQ Parameter	Correlation	Significance
Calcium	Strong	Significant
Magnesium	Weak	Not significant
Iron	Strong	Significant
Dissolved organic C	Weak	Not significant
Total nitrogen	Strong	Significant
Total dissolved solids	Weak	Not significant

# pH and Dissolved Oxygen

1<sup>st</sup> Flow Event



2<sup>nd</sup> Flow Event



# SAV Biomass



**Inflow**

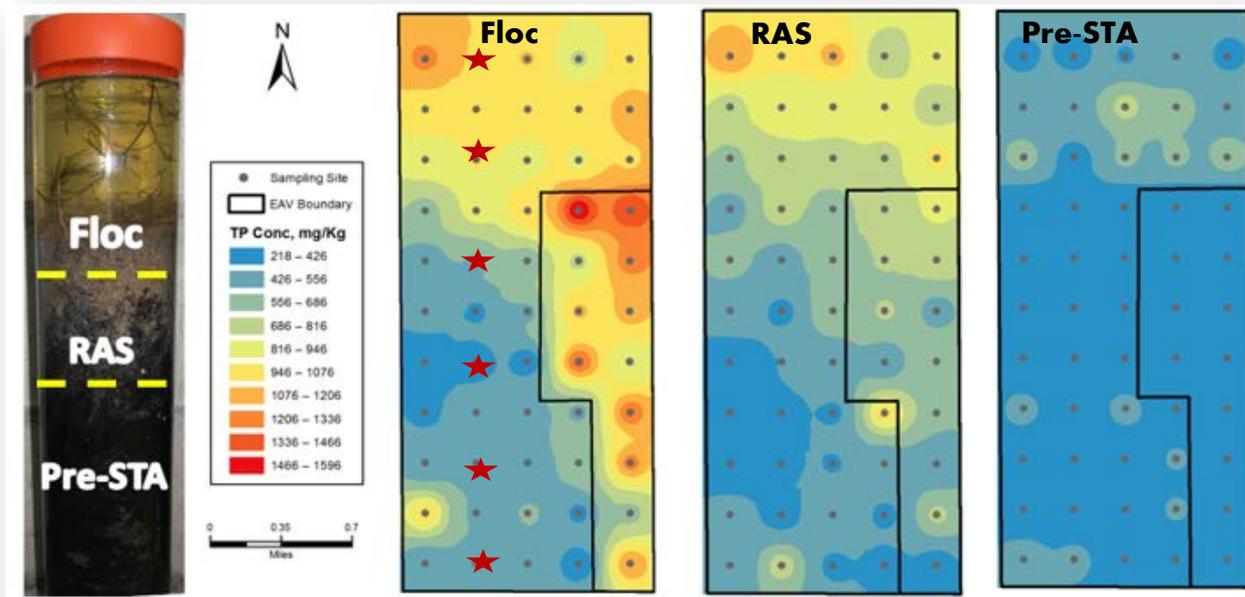


**Midregion**



**Outflow**

# Spatial Distribution of TP



Core section	Thickness, cm	Total Phosphorus, mg/Kg			
		Min	Max	Mean	Std Dev
Floc	10.7	296	1,596	802	334
RAS	3.1	282	1,206	623	226
Pre-STA	16.9	218	769	380	119

# Summary of Initial Findings

- Distinct TP concentration gradient from inflow to outflow at all phases of both flow events; reduction in all P forms.
- TP concentrations along the flow-way were elevated under stagnant condition following a period of high P loading.
- No consistent pattern of P release was seen under stagnant condition following a period of low P loading.
- The different P forms were higher under stagnant condition following high P loading than post low P loading.
- The mid region of the cell (C92) consistently showed elevated TP concentrations during both flow events.

# Summary of Findings (cont'd)

- SRP was effectively reduced to detection limits at the lower regions of the flow-way during all phases of the flow events; residual P is comprised mainly of PP and DOP.
- TP was correlated with Ca and Fe suggesting important role in P co-precipitation.
- Wide swings in pH and dissolved oxygen at the mid to outflow regions of the cell indicate high primary productivity.
- Baseline soils data show P enrichment at the front end of cell. Vertical profile of soil P: floc>RAS>pre-STA.

# QUESTIONS?