

Periphyton Stormwater Treatment Area (PSTA) and Phosphorus Mesocosm Research Studies

10th Annual Public Meeting on the Long-Term Plan for Achieving Water Quality Goals for Everglades Protection Area Tributary Basins

Delia Ivanoff
Sr. Supervising Environmental Scientist
Water Quality Treatment Technologies Section

Presentation Outline

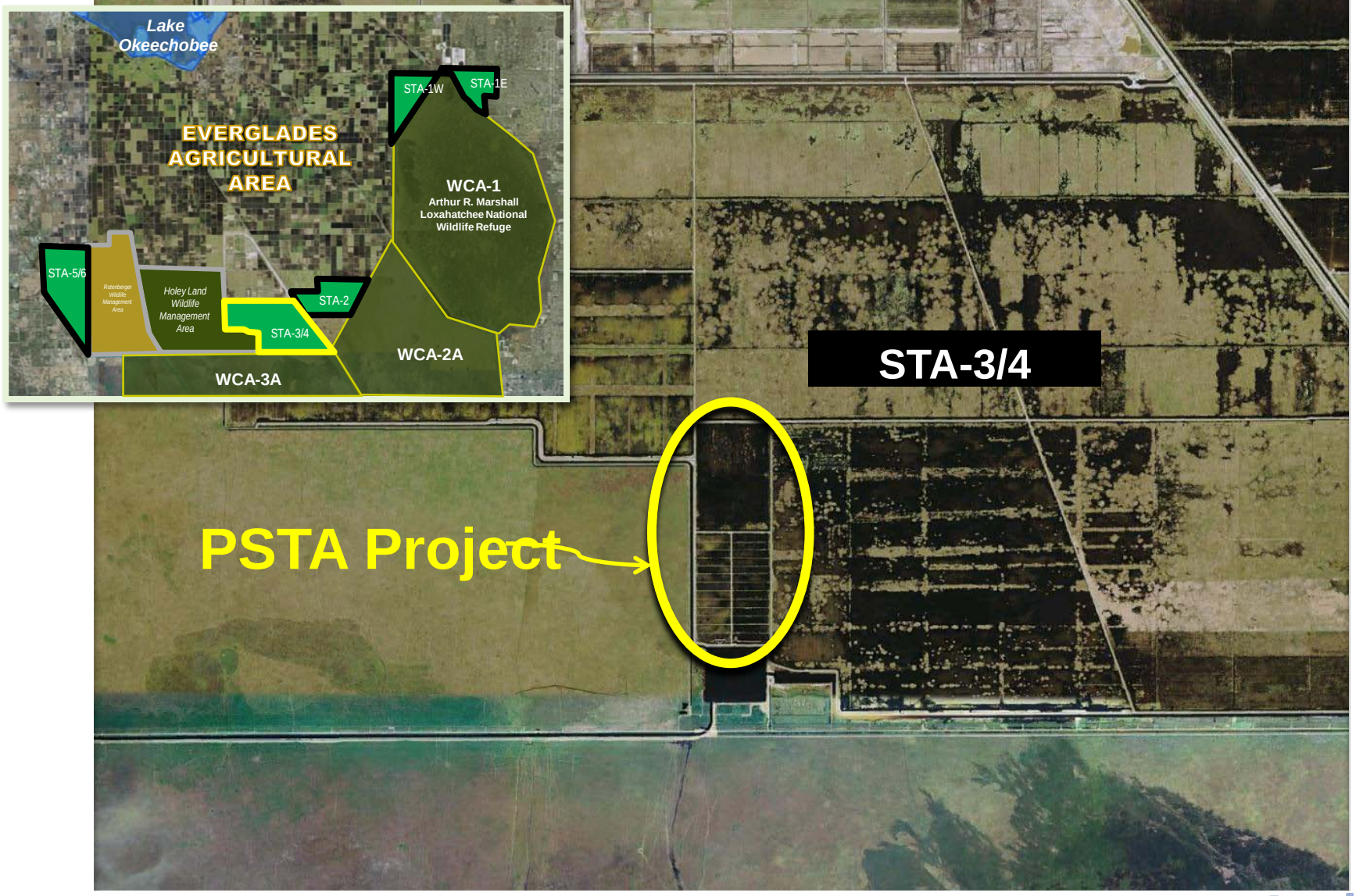
STA-3/4 PSTA Project

- Brief introduction about the PSTA project and its long-term performance
- Overview of the PSTA research plan
- Improvement in PSTA water budget
- Preliminary assessment of PSTA P mass balance
- Short-term trend in P concentration
- Role of enzymes, UV radiation, macrophytes, and calcareous periphyton in PSTA treatment

Phosphorus Mesocosm Study

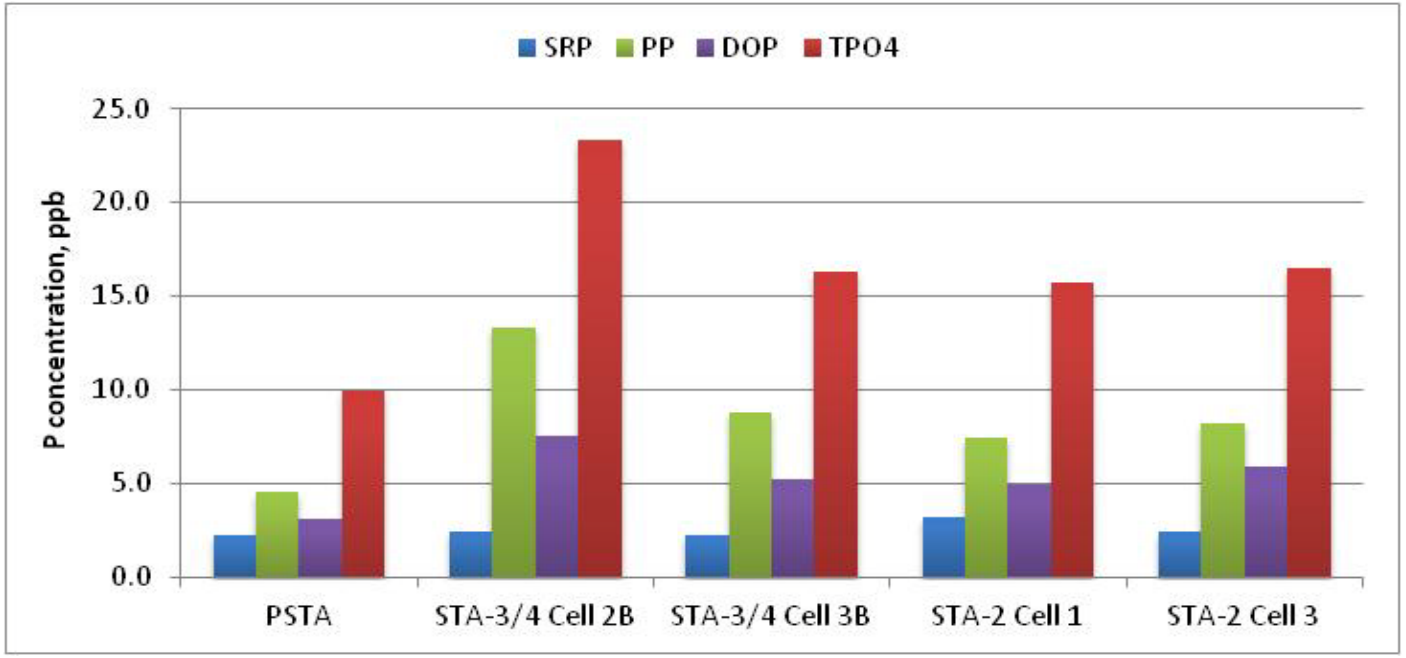
- Objectives
- Description
- Initial findings

PSTA Project Location

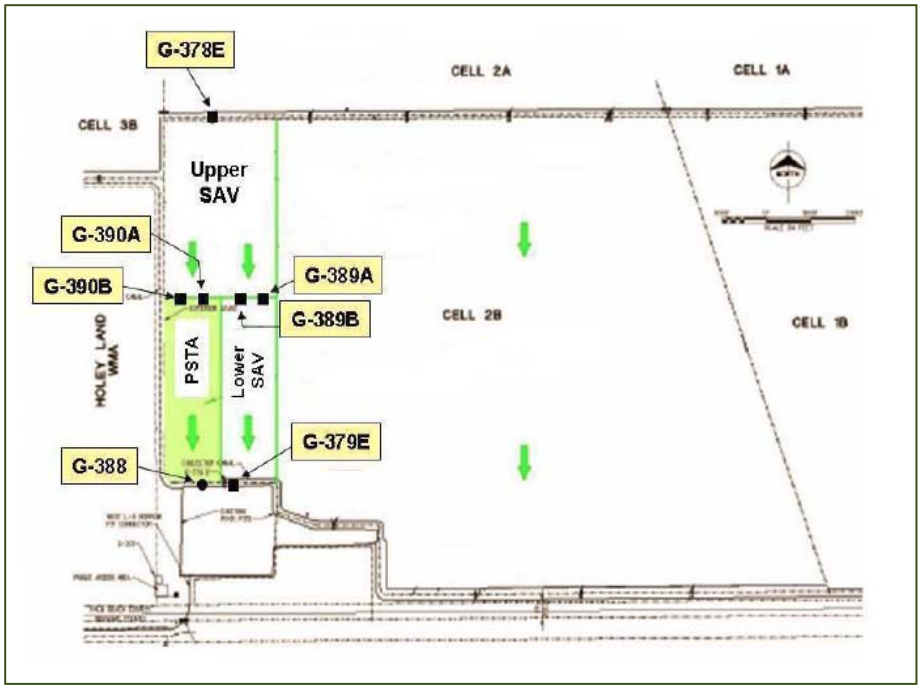


Outflow Phosphorus Concentrations:
PSTA vs. Well-performing STA Cells*

While SRP removal is comparable among cells, PSTA outperforms other well-performing cells in terms of dissolved organic P (DOP) and particulate P (PP) removal



*Period of record results from grab samples where SRP, TDP, and TP were analyzed (PSTA: 10/2006 – 1/2013; STA-2: 10/2006-1/2013; STA-3/4: 9/2006-1/2013)


G-378E
CELL 2A
CELL 1A
CELL 3B
Upper SAV
G-390A
G-390B
G-389A
G-389B
CELL 2B
CELL 1B
HOLEY LAND WMA
PSTA
Lower SAV
G-379E
G-388


G390B
G390A
G389B
G389A-C
G390B-C
G390A-C
G389B-C
G388-P
G388
G379E-C

PSTA Research Plan

Research Plan Objective:
Provide more accurate assessment of PSTA technology performance; determine factors that contribute to the performance and replication options.

What are the important design elements and biogeochemical characteristics that enable the PSTA Cell to achieve ultra-low outflow TP levels?

- **Characteristics of major ecosystem components of the PSTA Cell**
- **Substrate conditions**
- **Vegetation (SAV/periphyton conditions/role of vegetation strips)**

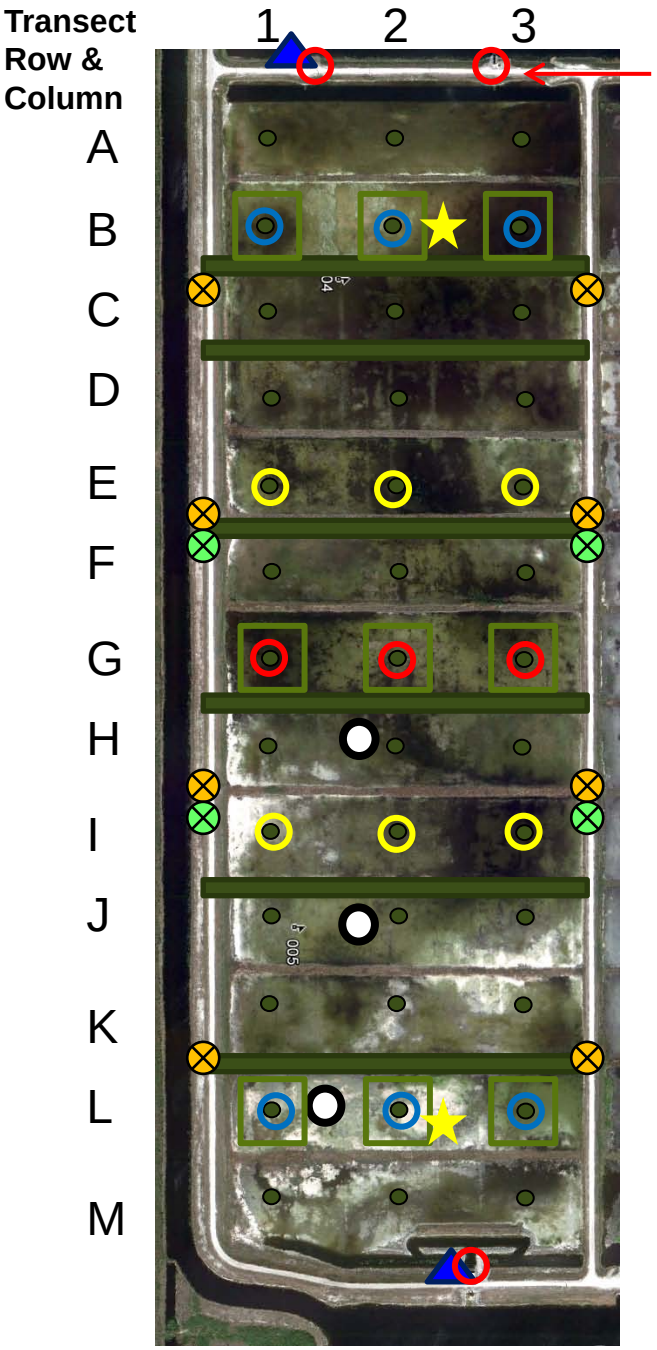
What are the key operational ranges that enable the PSTA Cell to achieve ultra-low TP levels?

- **Hydraulic loading rate (HLR), pulsing, extreme events (dry-out and re-flood)**
- **P loading rate (PLR) and concentrations**
- **Water depths/UV radiation**

What management practices are required to sustain the PSTA Cell's good performance?

- **Sediment stability, dry-out/re-flood, optimal flow condition**

PSTA Sampling Locations



Surface Water

- TP, TSP, SRP, DOC, UV absorbance, alkaline phosphatase activity, calcium, sulfate, NH_4, NOx, TKN,
- TP, TSP, SRP, DOC, UV absorbance
- Total P only
- Remote P analyzer

Vegetation and Sediment

- Semi-quantitative SAV cover & floc depth
- Sediment, SAV and periphyton chemistry, SAV biomass, periphyton APA
- Periphytometer deployment

Hydraulic and hydrology

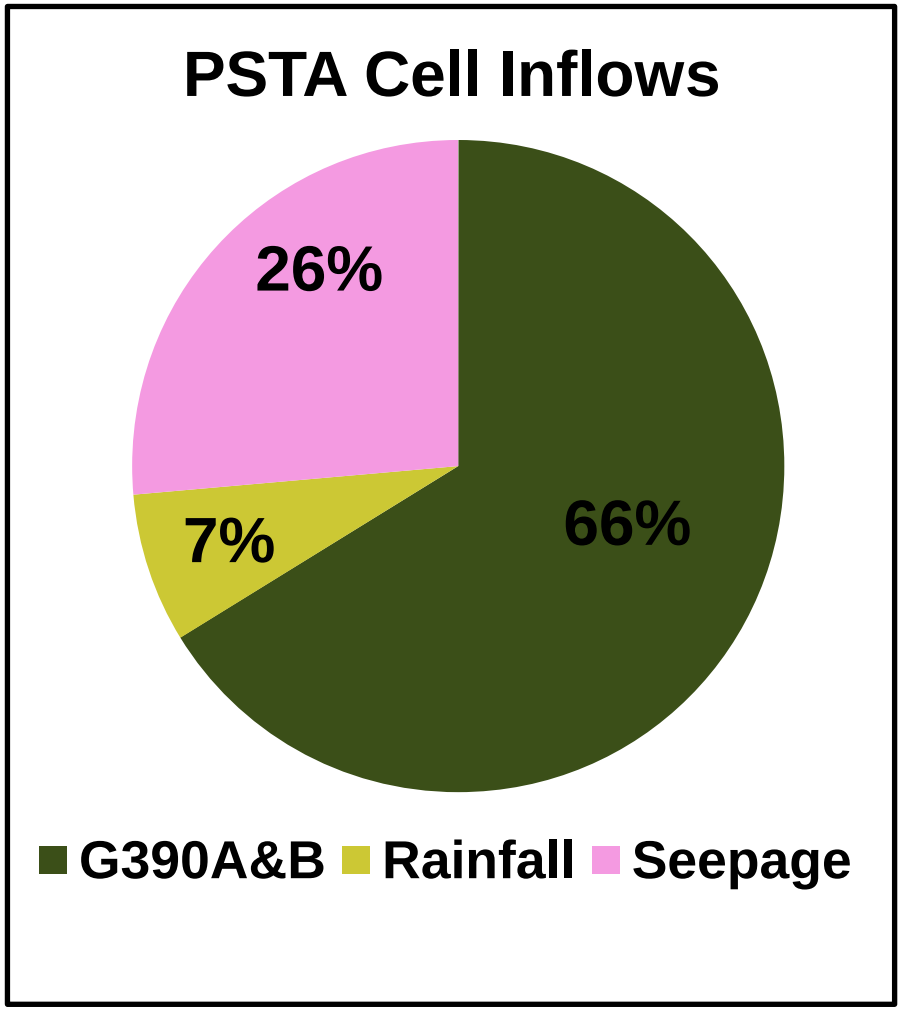
- Internal stage recorder
- Seepage water level
- Seepage water quality

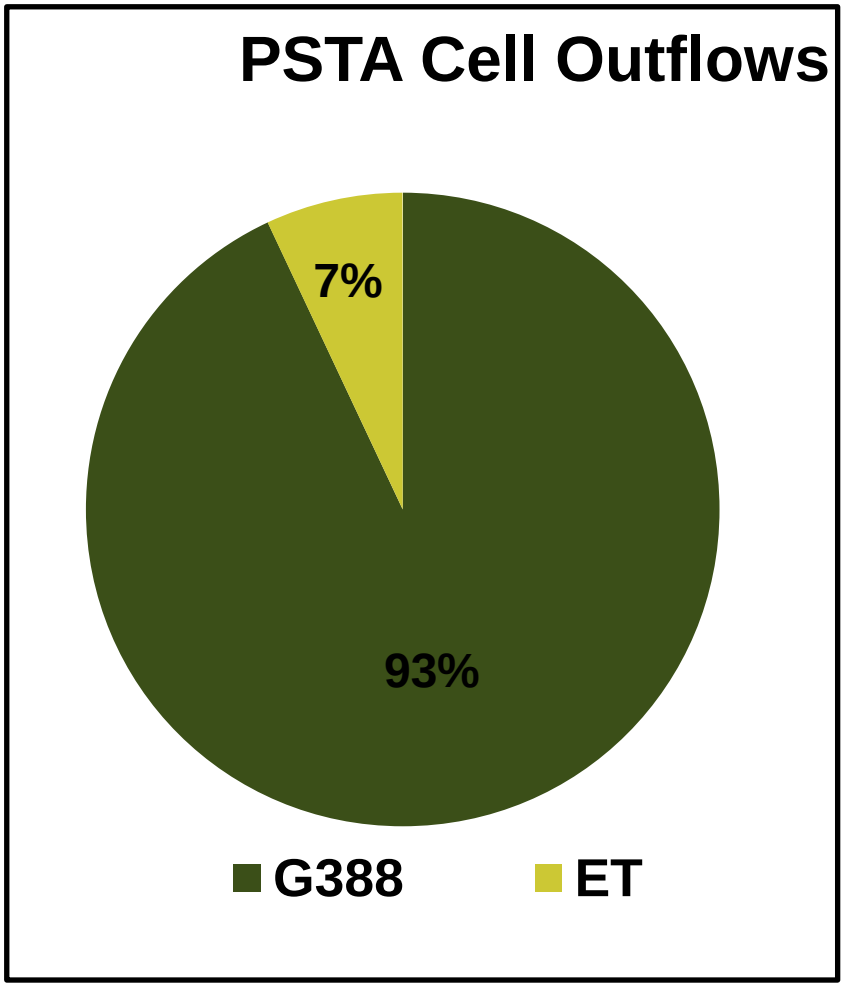
PSTA Cell Water Budget (POR)

With structural improvements, the water budget uncertainty was reduced.

Water Year	Inflow G390A&B (ac-ft)	Net Seepage (ac-ft)	Rain (ac-ft)	G388 Outflow (ac-ft)	ET (ac-ft)	Change in Storage (ac-ft)	Remainder (ac-ft)	Remainder %
2008	2,922	1,840	562	5,200	491	131	498	9
2009	3,298	2,229	452	6,587	504	-73	1,038	15.9
2010	7,020	2,395	627	10,076	494	-8	521	5.1
2011	3,289	785	409	3,973	511	-9	-8	-0.1
2012	7,462	2,181	536	9,826	500	-8	139	1.4

PSTA Cell Water Budget





Well Sampling

Inflow

B A

Cluster 5
Well 1 = 8’
Well 2 = 36’

PSTA

Cluster 6 (WQ)
Well 1 = 8’
Well 2 = 20’
Well 3 = 36’

Cluster 7 (WQ)
Well 1 = 8’
Well 2 = 36’

Cluster 8
Well 1 = 8’
Well 2 = 36’

G-388

Cluster 1
Well 1 = 8’
Well 2 = 36’

Cluster 2 (WQ)
Well 1 = 8’
Well 2 = 20’
Well 3 = 36’

Cluster 3 (WQ)
Well 1 = 8’
Well 2 = 36’

Cluster 4
Well 1 = 8’
Well 2 = 20’
Well 3 = 36’

Outflow

- Quarterly sampling was initiated in February 2012
- Four 8-foot wells and four 36-foot wells from 4 clusters (2, 3, 6 and 8) were sampled
- Tested for TP (for seepage P values) and major ions (seepage source estimation)

Performance Analysis*

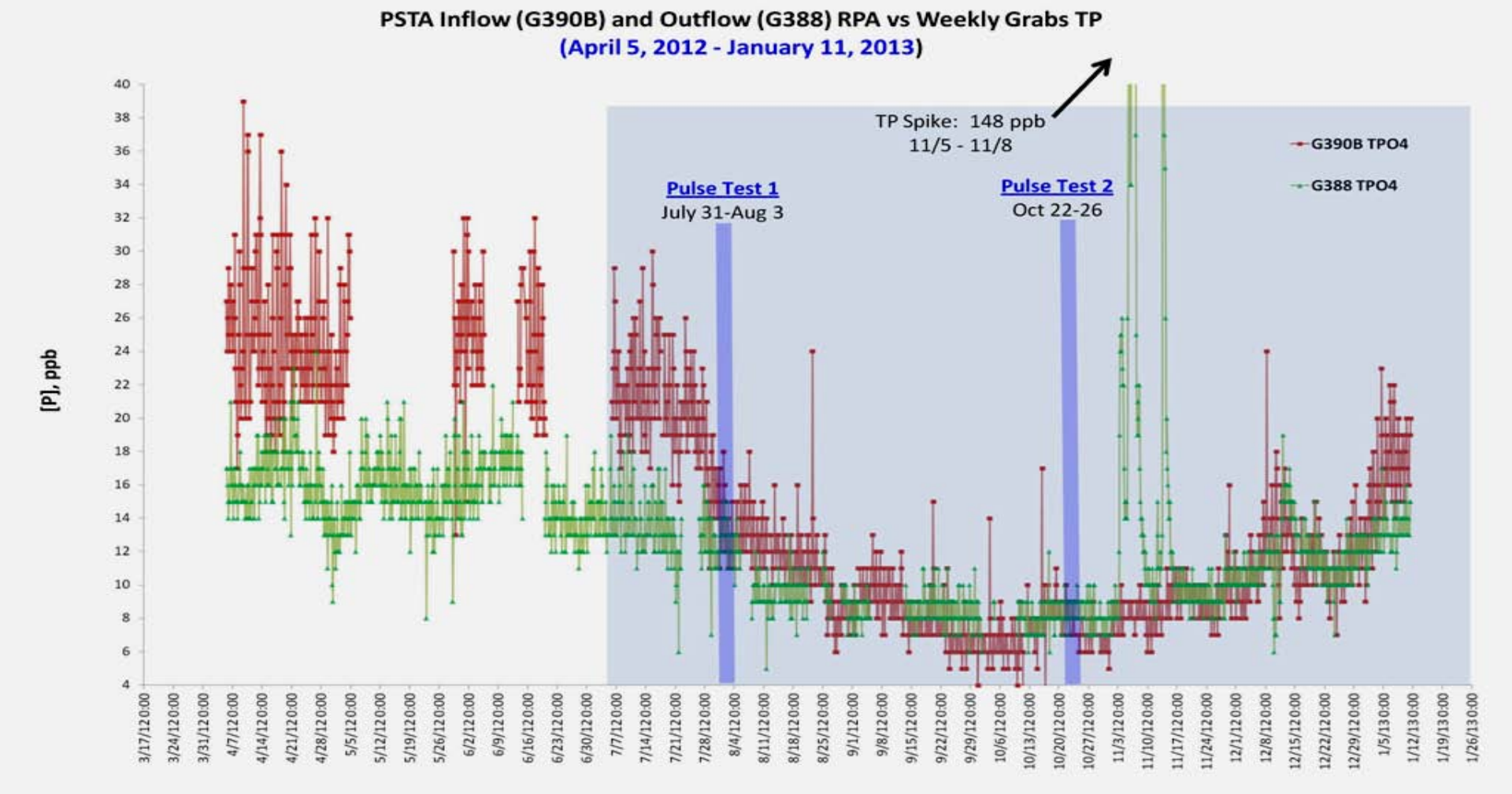
Based on a median seepage TP value of 17 ppb, the estimated TP load reduction and TP concentration reduction are ~40%.

Water Year	Total Inflow (G390A+G390B + Rainfall + Seepage) (ac-ft)	Structural			Based on **Median** Seepage TP Concentration of 17 ppb		
		Inflow TP FWMC (G390A + G390B) (ppb)	Outflow (G388) (ac-ft)	Outflow FWMC (G388) (ppb)	Total Inflow FWMC (ppb)	TP Load Reduction	Concentration Reduction
2008	5,324	27	5,200	12	22	56%	44%
2009	5,979	14	6,587	8	15	57%	45%
2010	10,042	20	10,076	10	18	53%	45%
2011	4,483	18	3,973	11	17	47%	33%
2012	10,179	17	9,826	12	17	35%	27%
5-WY Summary	36,007	19	35,662	11	17	40%	39%

*This is a preliminary analysis. Performance updates will continue as new data becomes available.

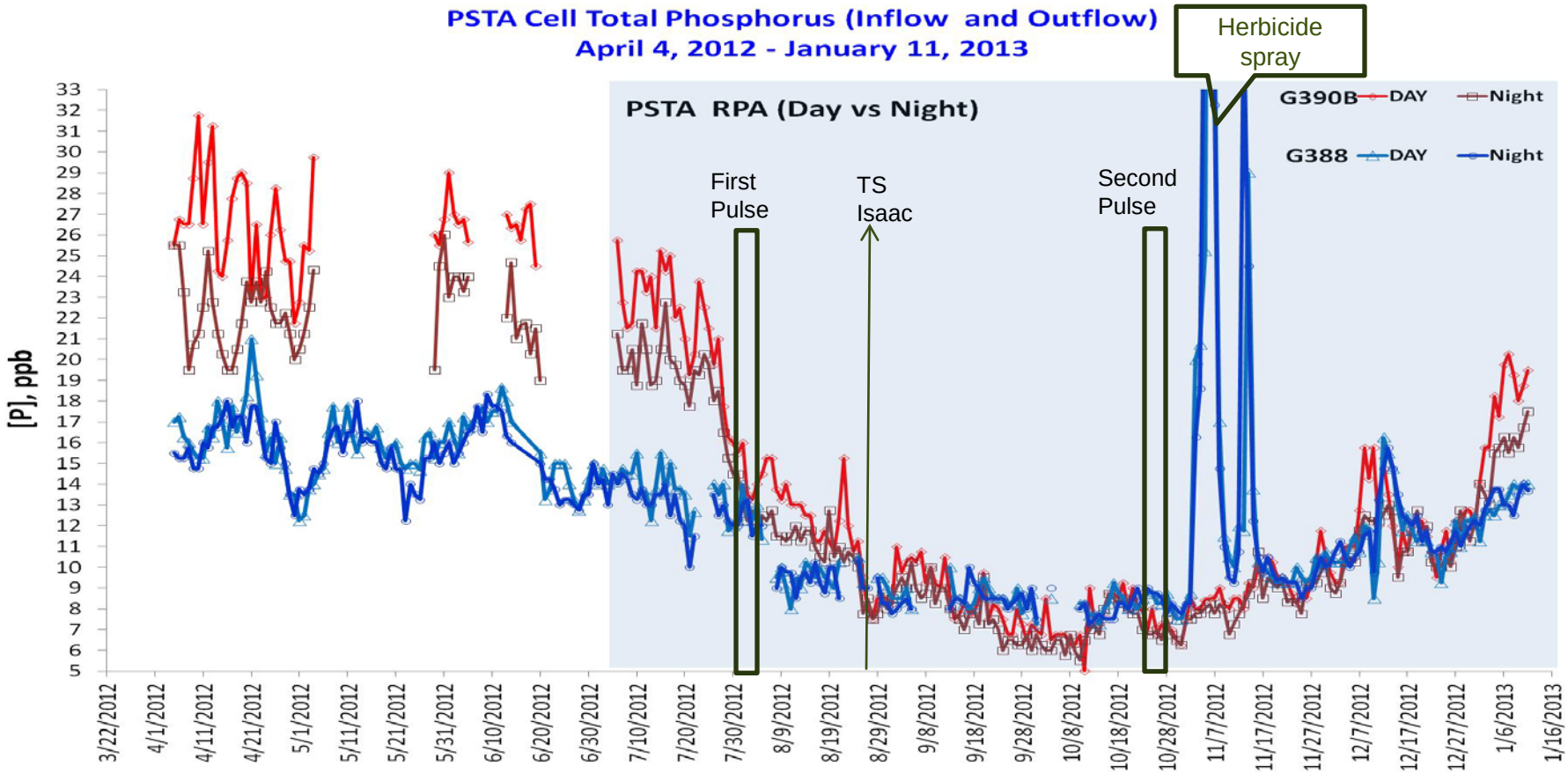
Short-term Phosphorus Trend

- P concentration fluctuates during a 24-hr period
- Trend did not seem impacted by the flow pulsing events.
- Spikes occurred during vegetation maintenance activities within the cell



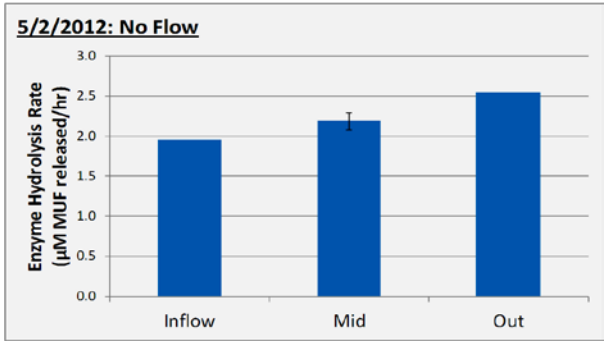
PSTA Cell Total Phosphorus Trend

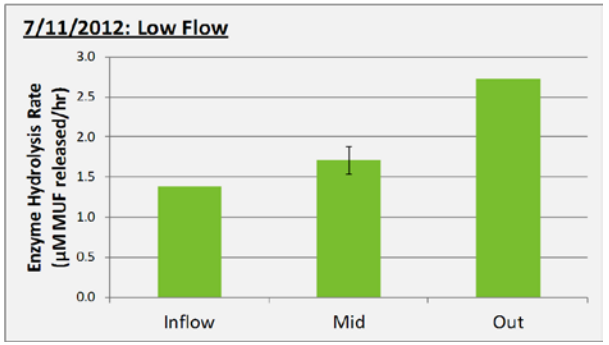
- P concentration fluctuates slightly with time of day; fluctuation is more prominent at the inflow
- P concentration decreased once the system began flows in July 2012

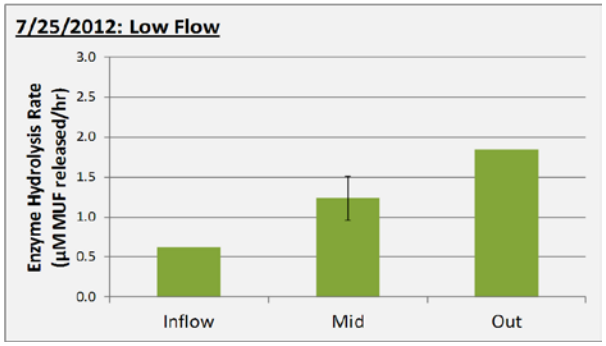


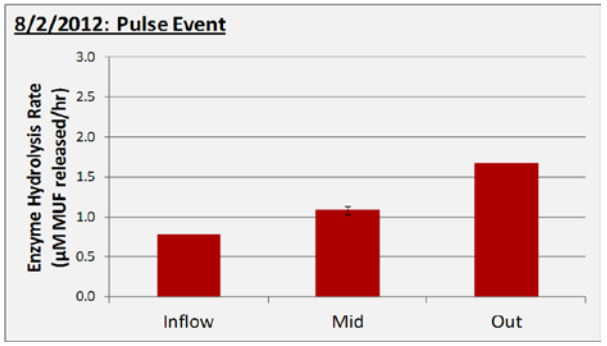
Water Column Enzyme Activities

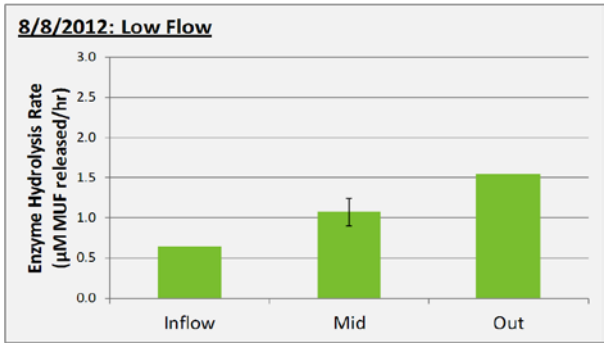
Enzyme activities increase along the downstream gradient.

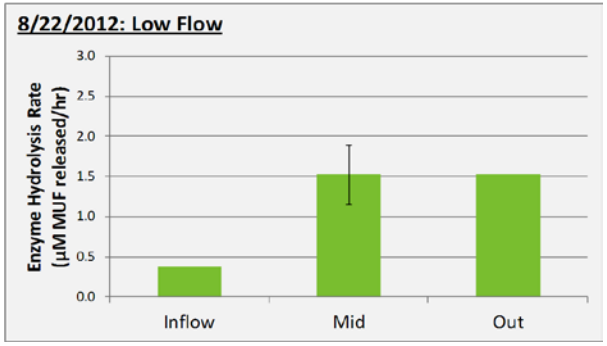




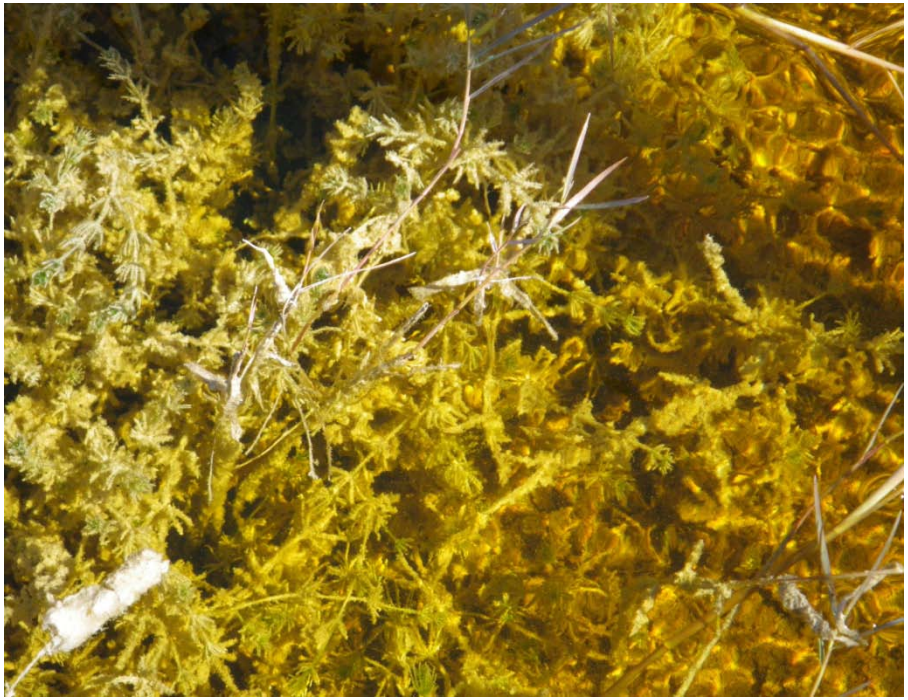


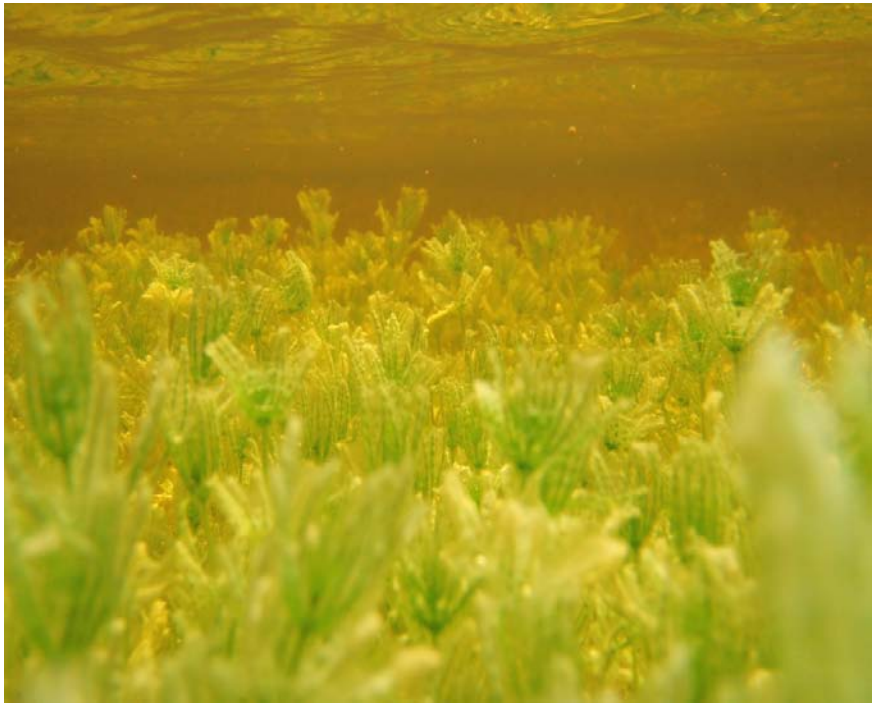






Enzymatic and Ultraviolet Radiation Organic P Breakdown

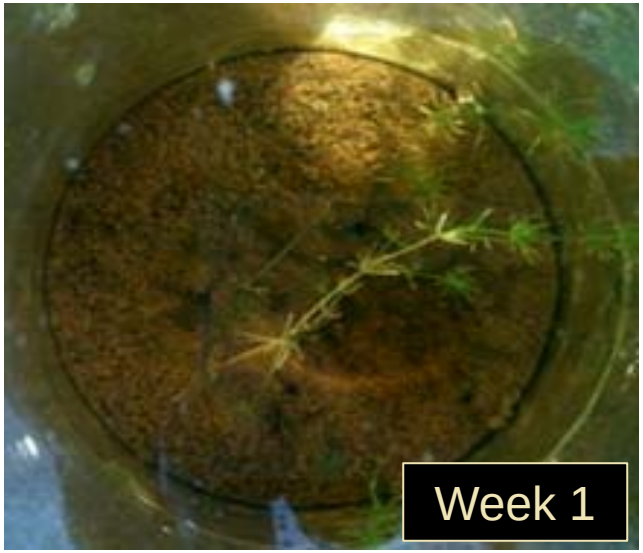


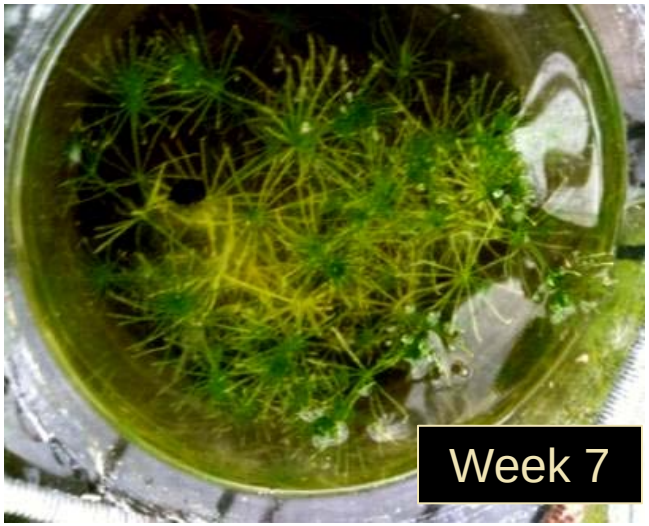


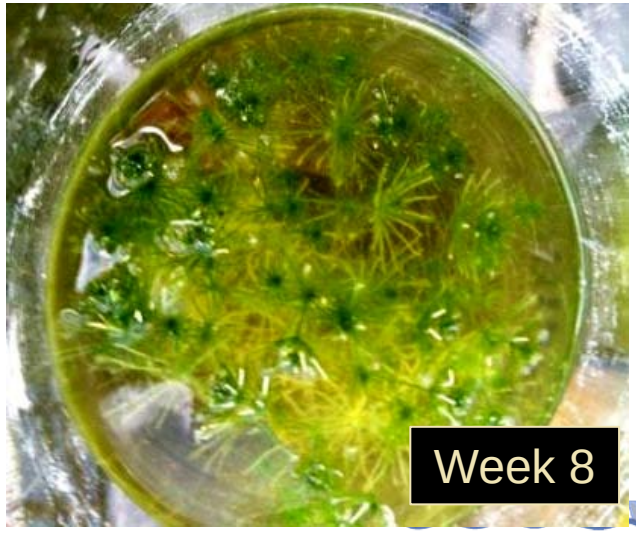
Phosphatase enzymes and/or UV radiation may play a role in DOP (and PP) breakdown. The UV process may be enhanced in regions of shallow, sparse vegetation, or in areas where SAV is not “topped out”.

Core Incubations

Evaluate SAV and periphyton growth rates, and the influence of these components on enzyme activity.







Core Incubations

SAV growing on PSTA sediment core

Results to date demonstrate greater enzyme activity due to presence of calcareous periphyton than in treatment with SAV.

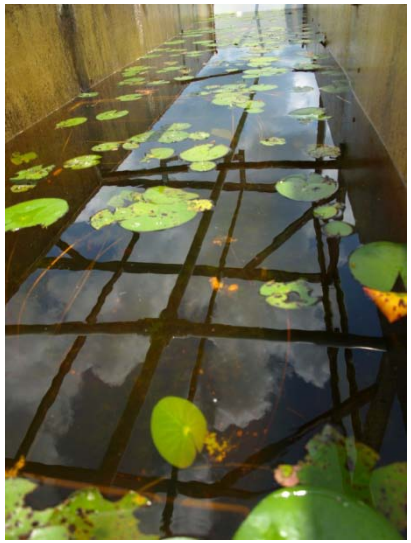
Phosphorus Mesocosm Study:

Assessing nutrient removal efficacy and uptake mechanisms of native wetland vegetation

Objectives & Hypothesis

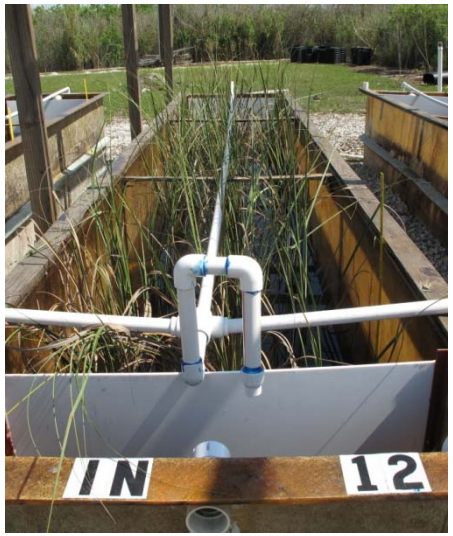
- Assess nutrient removal efficacy of six vegetation types under a very low P environment
- Examine major P removal mechanisms
- Test the hypothesis that the native vegetation treatments, including water lily and sawgrass, will reduce water-column P concentrations to levels below what SAV and cattail treatments can achieve

6 vegetation types X 3 replicates



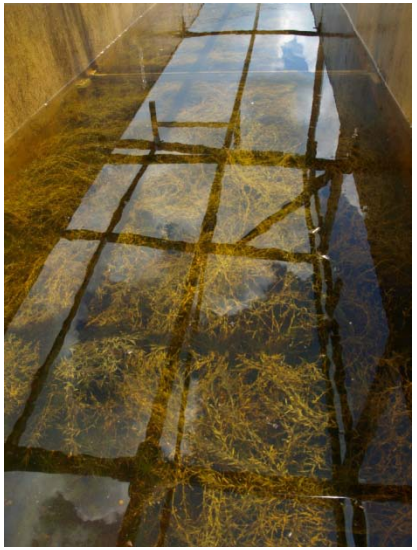
Waterlily monoculture

Waterlily –Spikerush mix

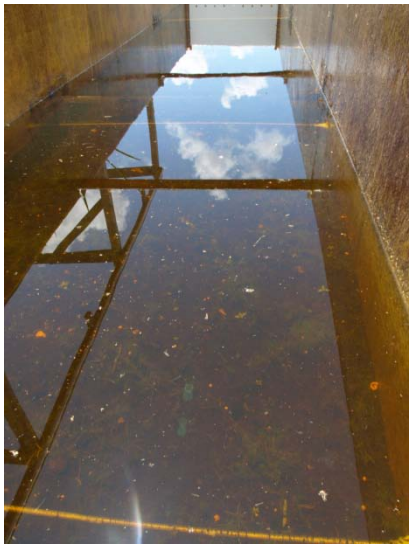


Sawgrass

Cattail



SAV



Control (no vegetation)

May 2010

Water lily

Dec. 2012

Sawgrass

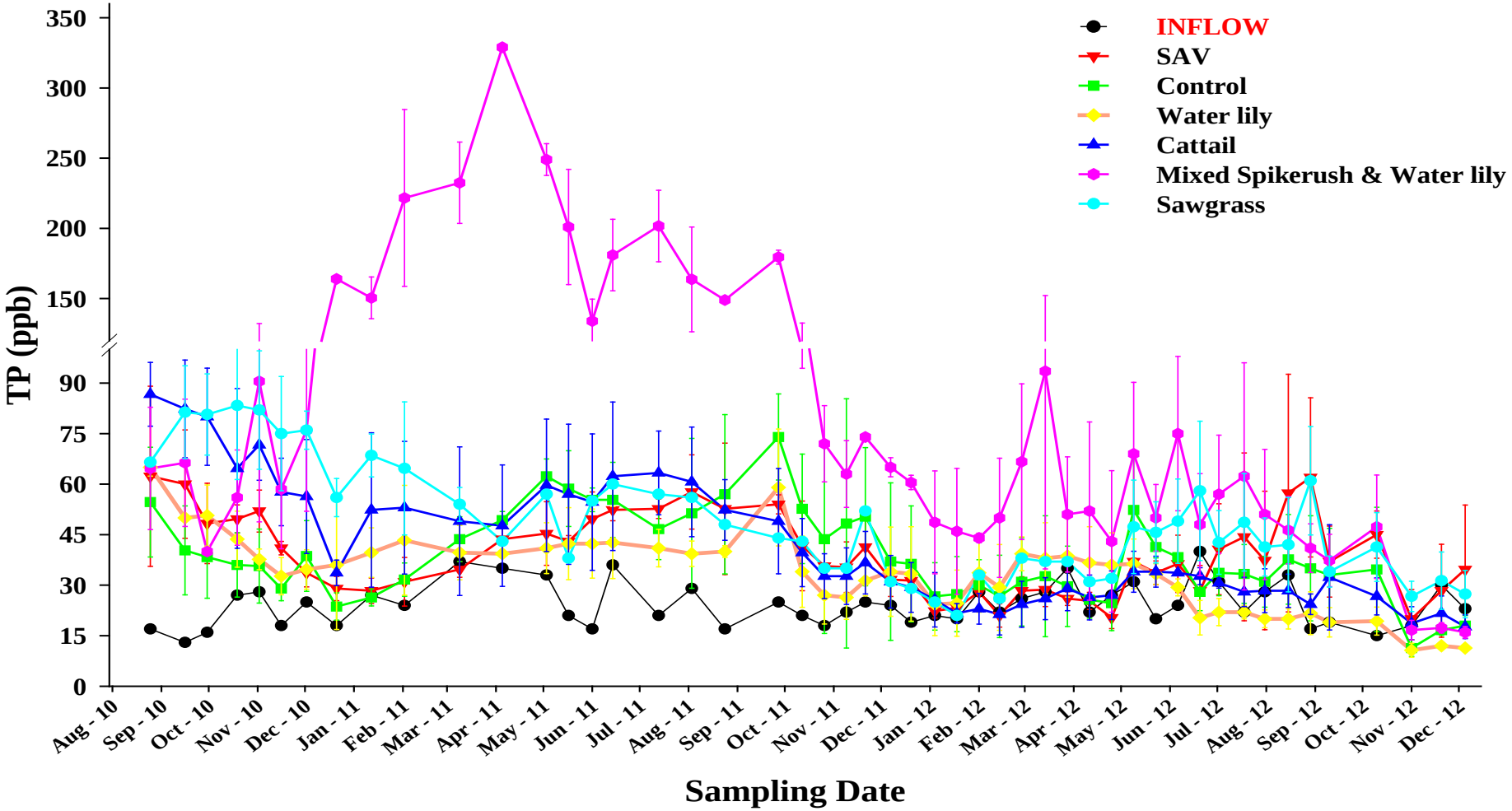
Mixed/Spikerush

SAV

Cattail

Outflow TP Concentrations

- P flux observed during the first ~2 yrs of study (stabilization period)
- Poorest performance in Spikerush/water lily mix
- Best performance in water lily treatment



Outflow TP Concentrations (11/1, 11/20, & 12/5 sampling)

- Best performance observed to date was in water lily treatment

	Inflow TP (ppb)	Outflow TP Concentration (ppb)					
		Water lily	Soil-SAV	Mixed	Cattail	SAV	Sawgrass
Mean	23.7	11.3	15.3	16.7	19.3	27.7	28.4
SD	6.0	1.2	2.3	2.0	4.5	13.9	6.7

Questions?

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