

Soil Accrual and Phosphorus Retention in an Everglades Stormwater Treatment Area: A Longitudinal Study in Space and Time

Forrest Dierberg, Janelle Potts, Michelle Kharbanda, Nichole Larson, Kevin Grace, Dawn Sierer Finn, Mike Jerauld, Scott Jackson, and Tom DeBusk

DB Environmental, Inc.



Delia Ivanoff

South Florida Water Management District



Greater Everglades Ecosystem Restoration Conference

Coral Springs, Florida

April 18, 2017

Goal: Quantify Sustainability of Effective STA P Removal



Approach: Focus on a well-performing flow-way (Cell 3) in STA-2 to evaluate its P removal performance by examining P gradients periodically throughout 17 years of operation

Cell 3 of STA-2

Area = 919 ha

Mean water depth = 0.55 m

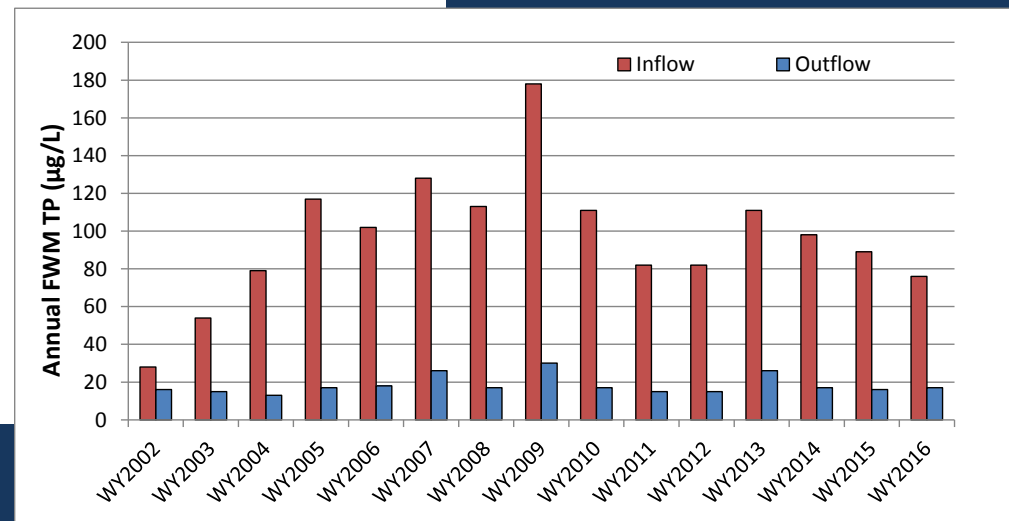
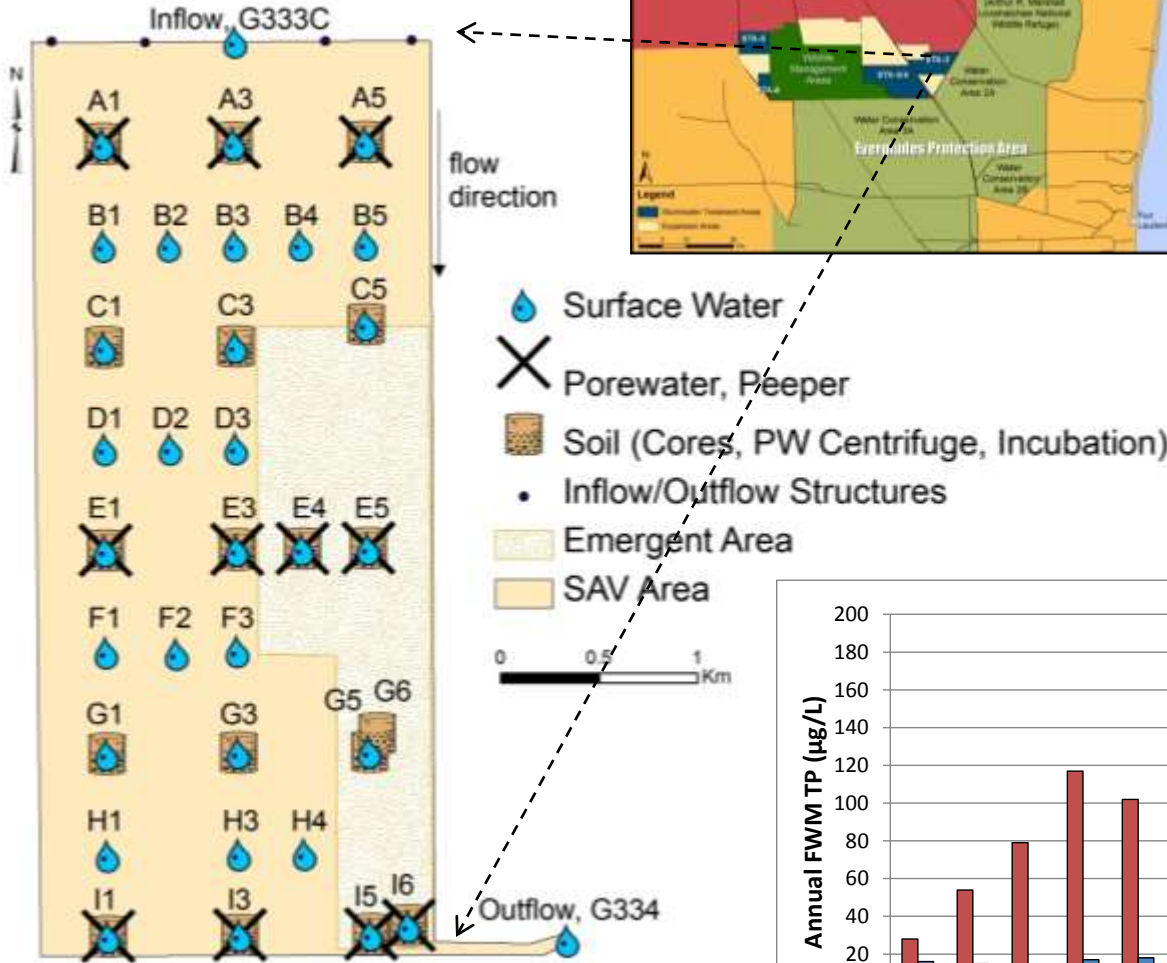
Mean HRT = 14.2 days

Mean Annual P Load:

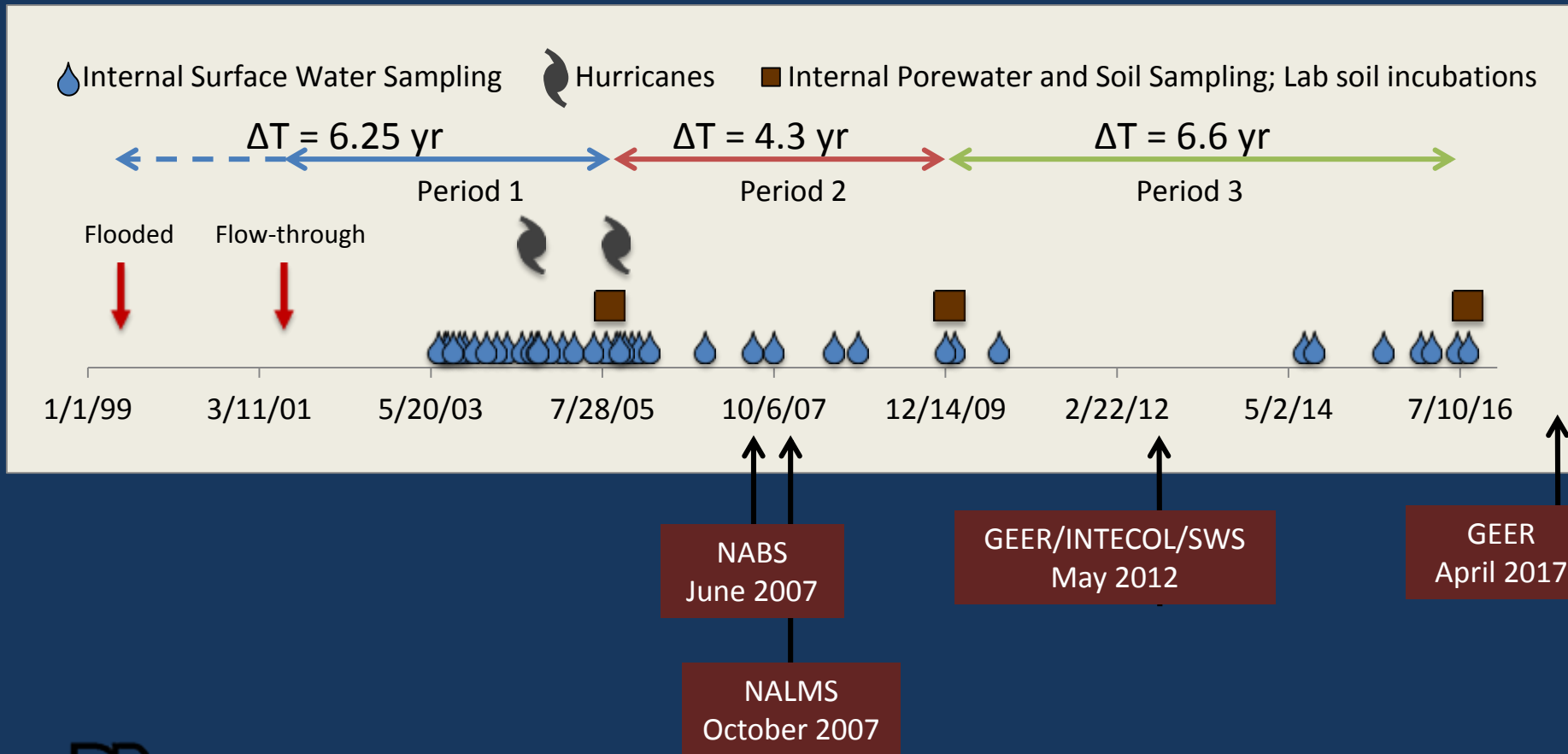
1.30 g P/m²·yr

Mean Annual P Retention

Rate: 1.04 g P/m²·yr






Timeline of Sampling Events and Presentations on Cell 3 of STA-2

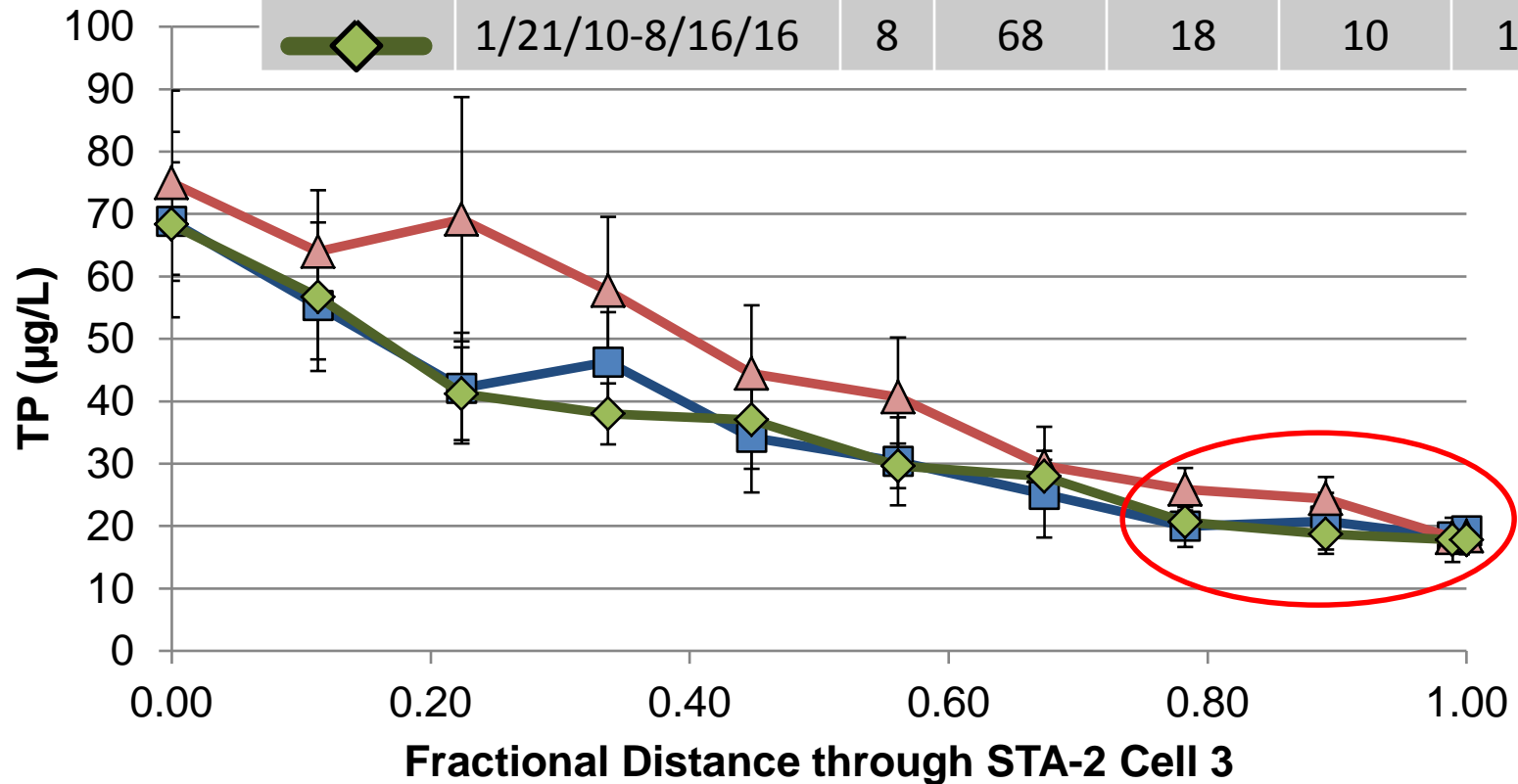


Finding #1: Wetland treatment effectiveness not declining over time

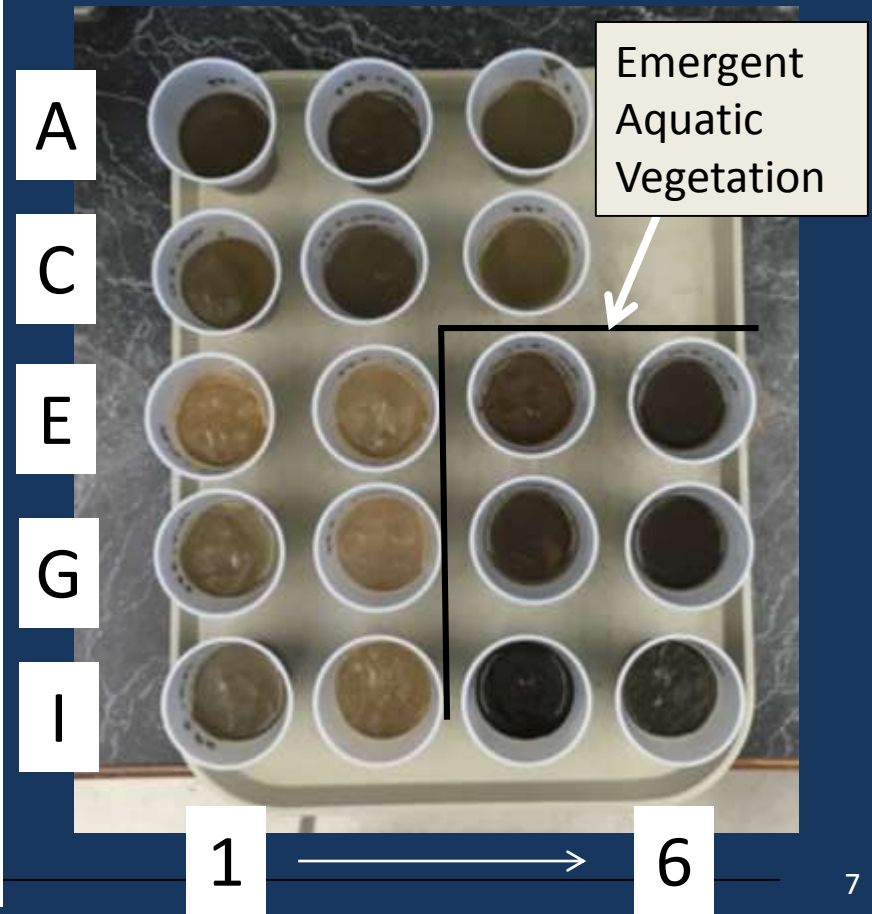
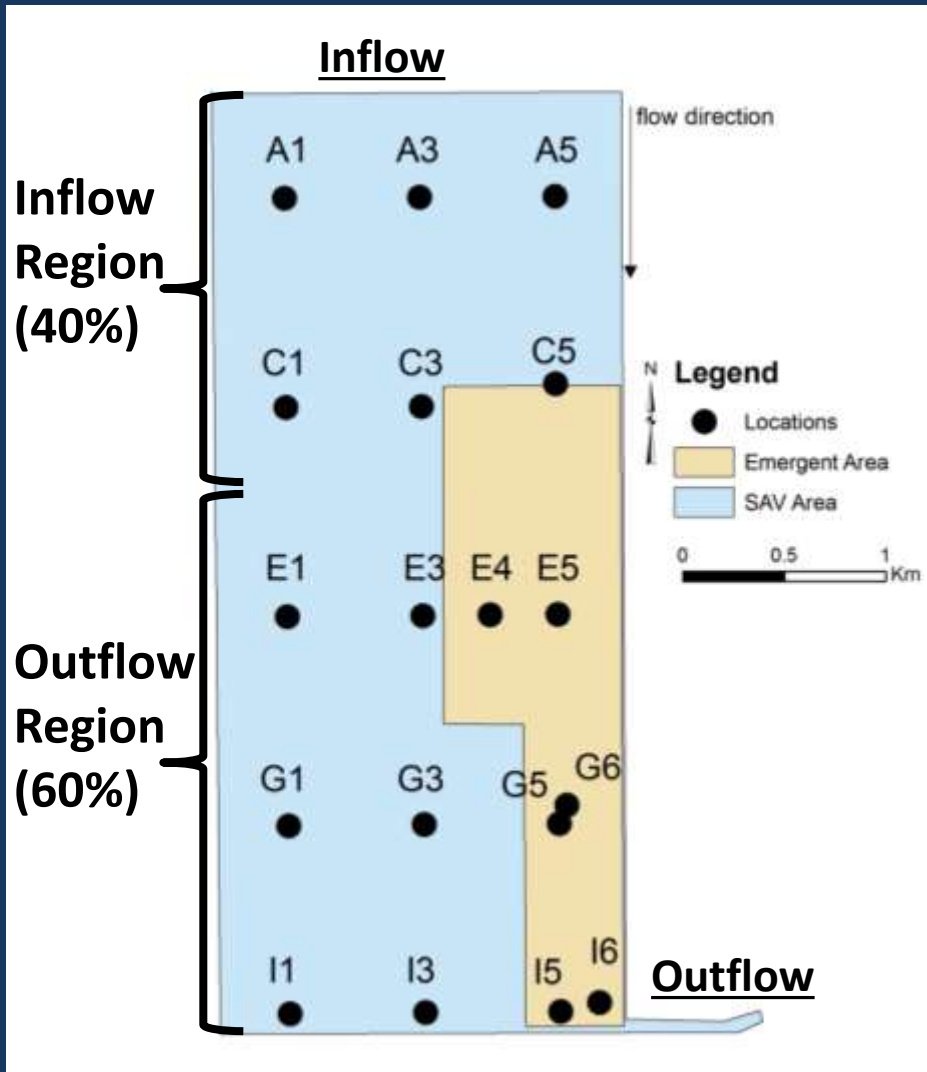


Surface Water Total Phosphorus Concentrations

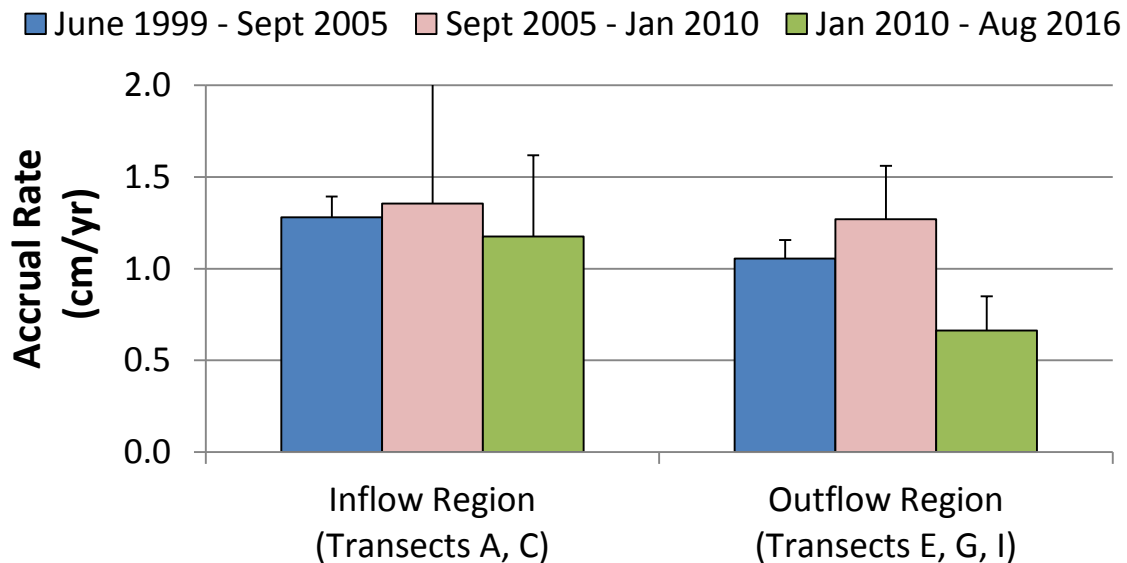
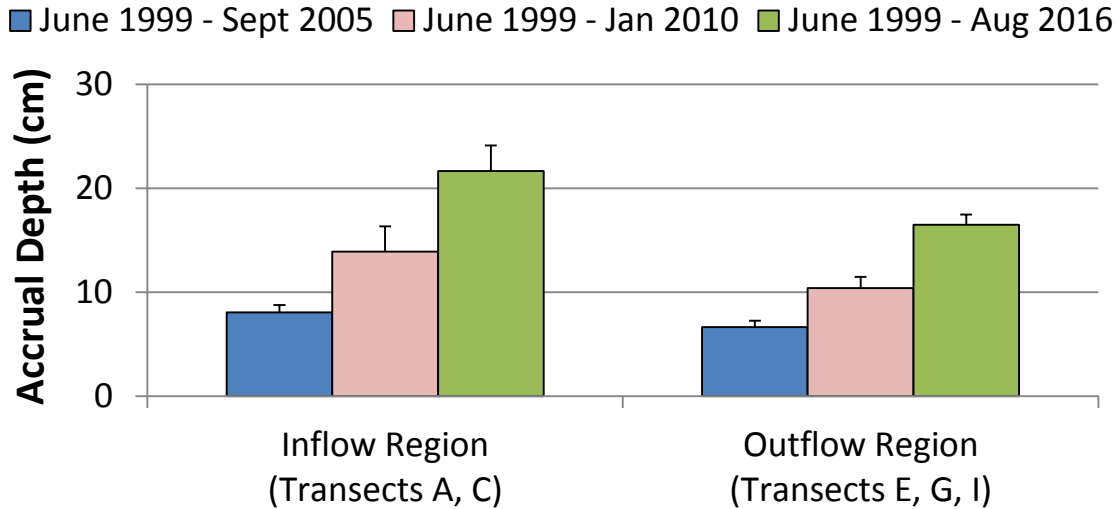
	Period	N	C_{in} ($\mu\text{g/L}$)	C_{out} ($\mu\text{g/L}$)	HLR (m/yr)	k (m/yr)
	6/20/03-6/27/05	20	69	19	23	34.6
	9/27/05-1/21/10	13	75	18	15	29.5
	1/21/10-8/16/16	8	68	18	10	15.8



Finding #2: New soil accumulation is evenly distributed throughout the cell and soil P concentration distribution remains the same over time within a region



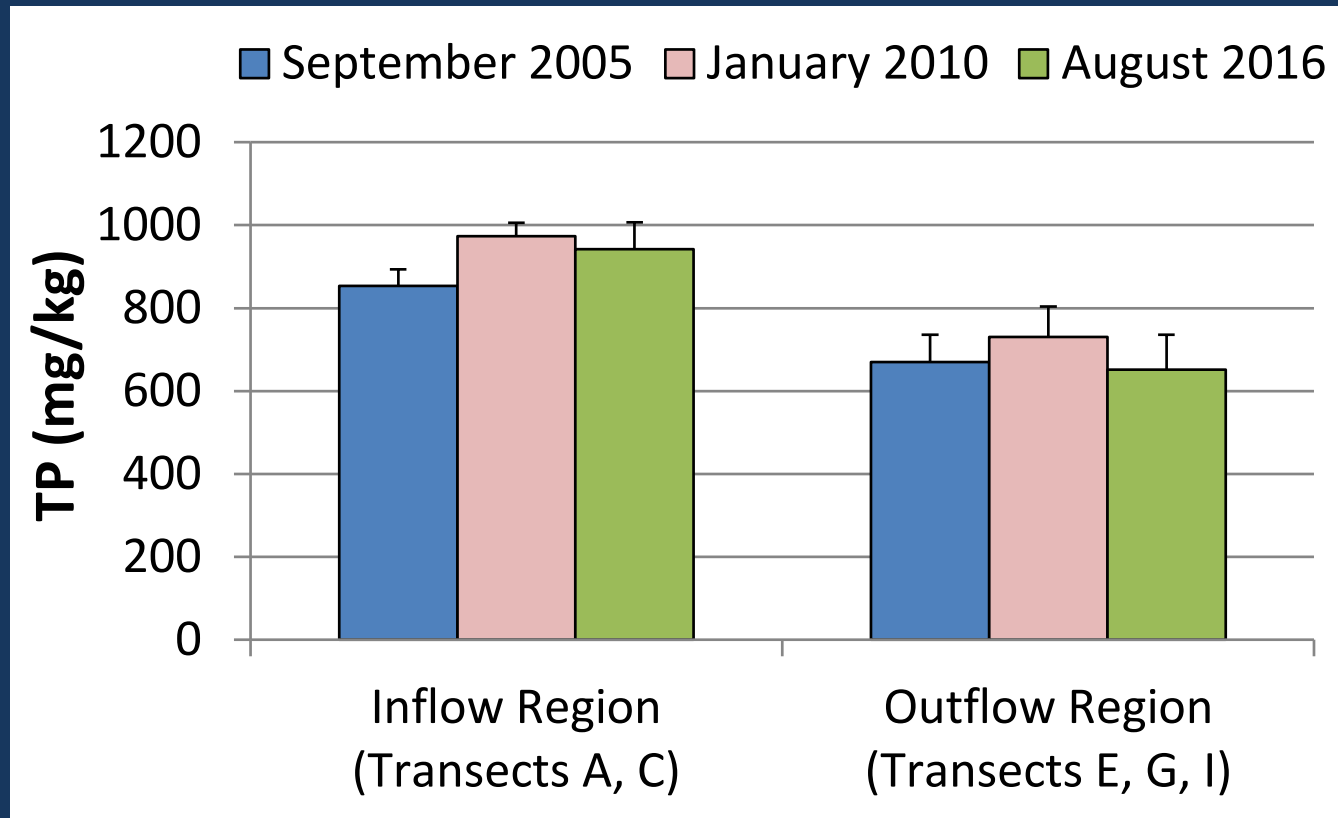
Cumulative Accrual Depth



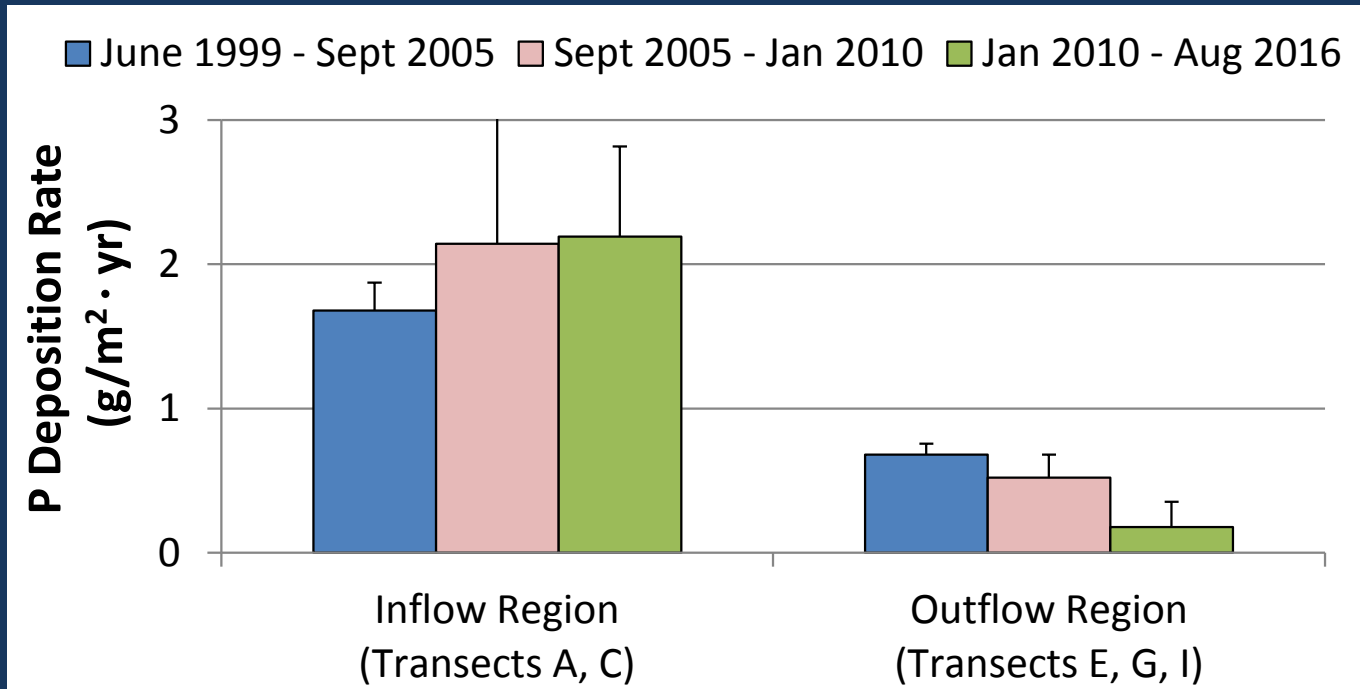
Accrual Rate within Three Time Intervals



Total P Concentrations in Accrued Layer



P Deposition Rates



Mean (± 1 S.E.) Soil Accrual and P Deposition and Loading Rates for Entire Cell

	1999-2005 $\Delta T=6.25$ yrs	2005-2010 $\Delta T=4.3$ yrs	2010-2016 $\Delta T=6.6$ yrs
Soil Accrual Rate (cm/yr)	1.1 \pm 0.07	1.3 \pm 0.45	0.9 \pm 0.19
P Deposition Rate (g P/m ² ·yr)	1.1 \pm 0.26	1.2 \pm 0.58	1.0 \pm 0.54
P Loading Rate (g P/m ² ·yr)	1.42	1.55	1.13
P Load Retention (%)	77	77	88



Finding #3: Accreted soil P is stable at the Outflow Region and does not contribute to an increase in internal loading over time

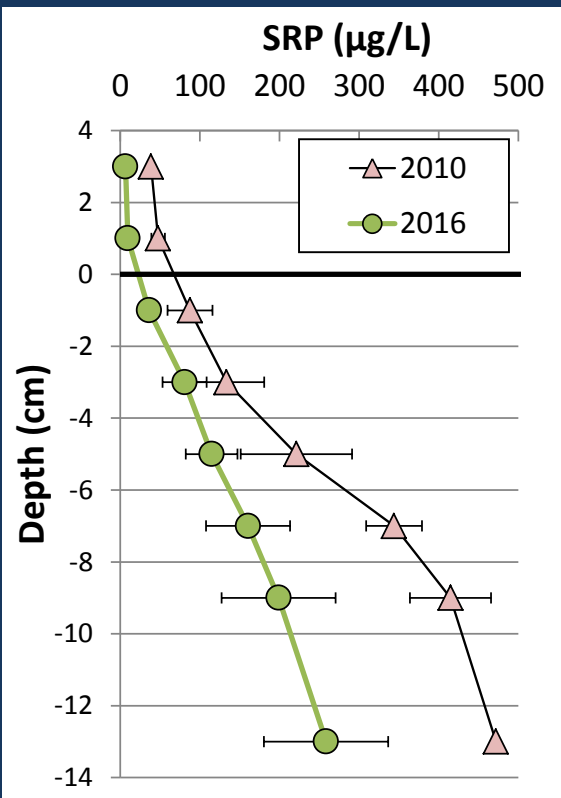
14-day anoxic lab incubations (0-4 cm soil depth)

Peepers

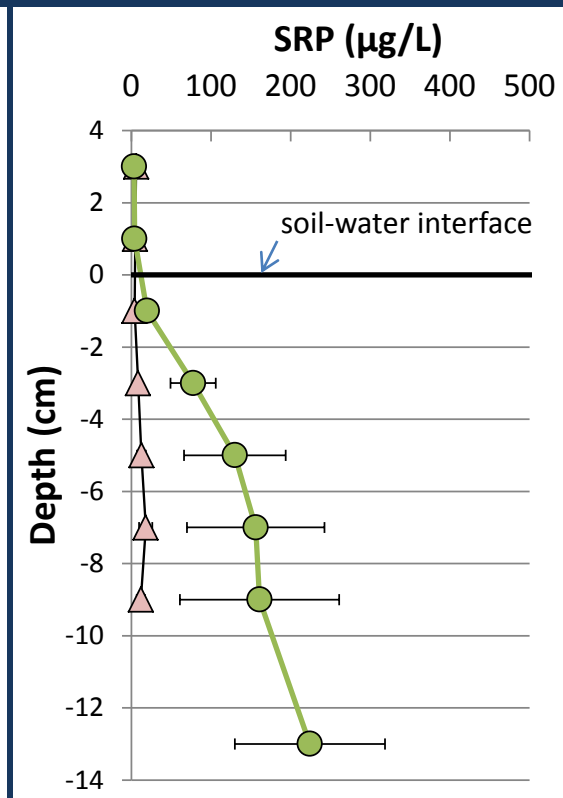


Porewater SRP Concentrations Along Three Transects in 2010 and 2016

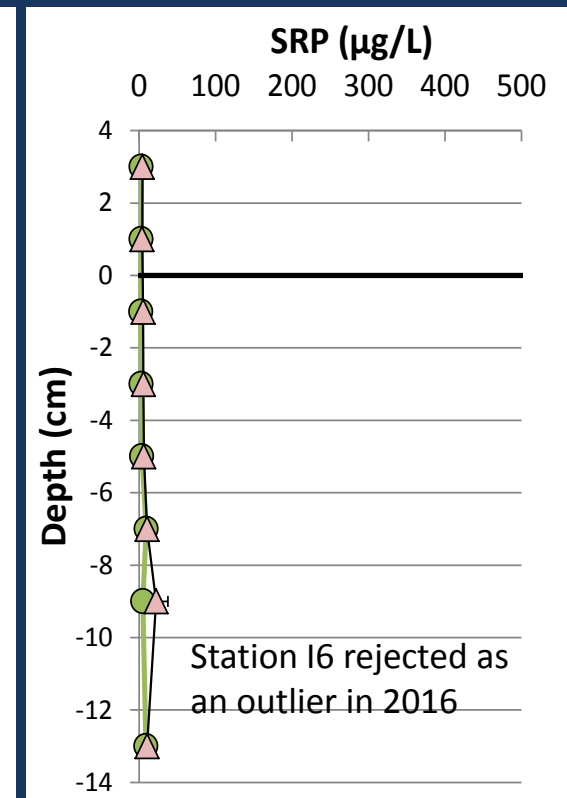
Inflow



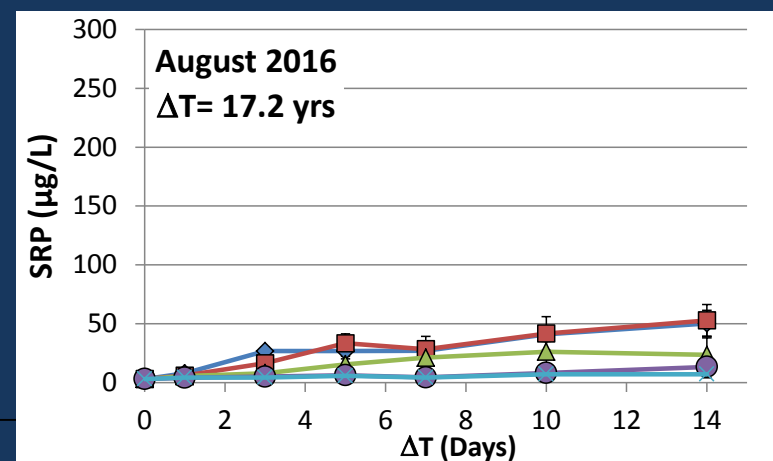
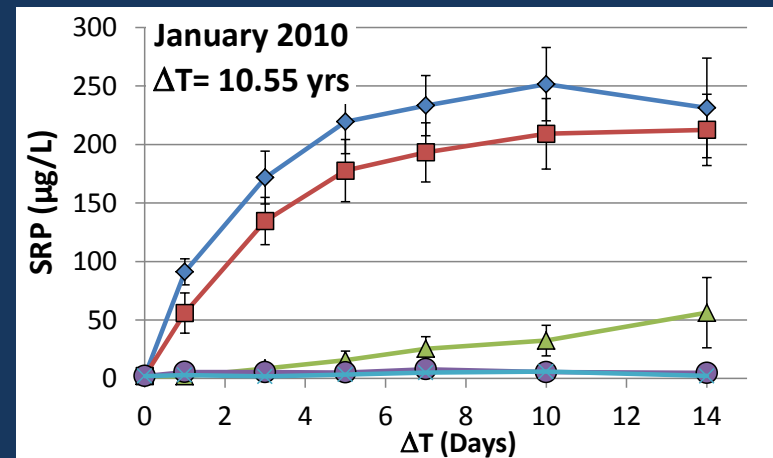
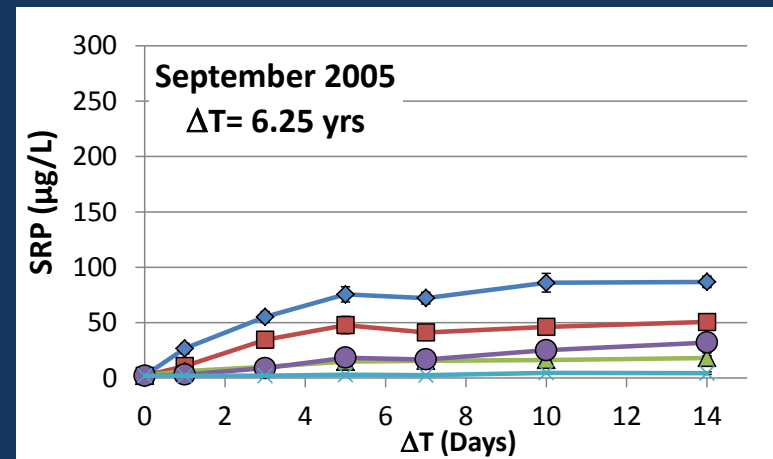
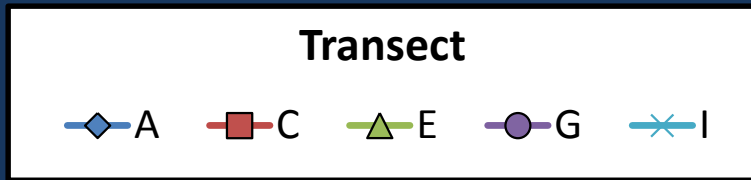
Mid



Outflow



SRP Release from 0-4 cm Soil Depths During 14-Day Anoxic Incubations



Conclusions

- Overall P removal capacity has not been diminished after 17 years of operation, indicating a steady-state condition in P removal
- Efficient P removal at present loading rates is likely to continue since soil at the outflow region of the cell has not become P-saturated



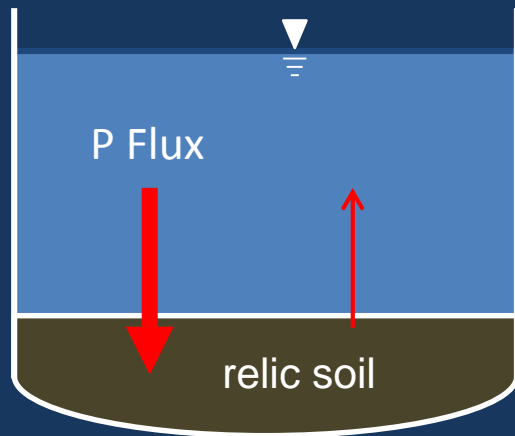
Acknowledgments

This long-term study was supported by the Everglades Agricultural Area Environmental Protection District and the South Florida Water Management District

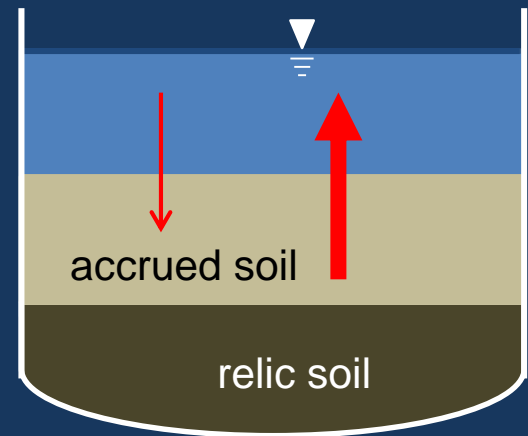


Back-up slides

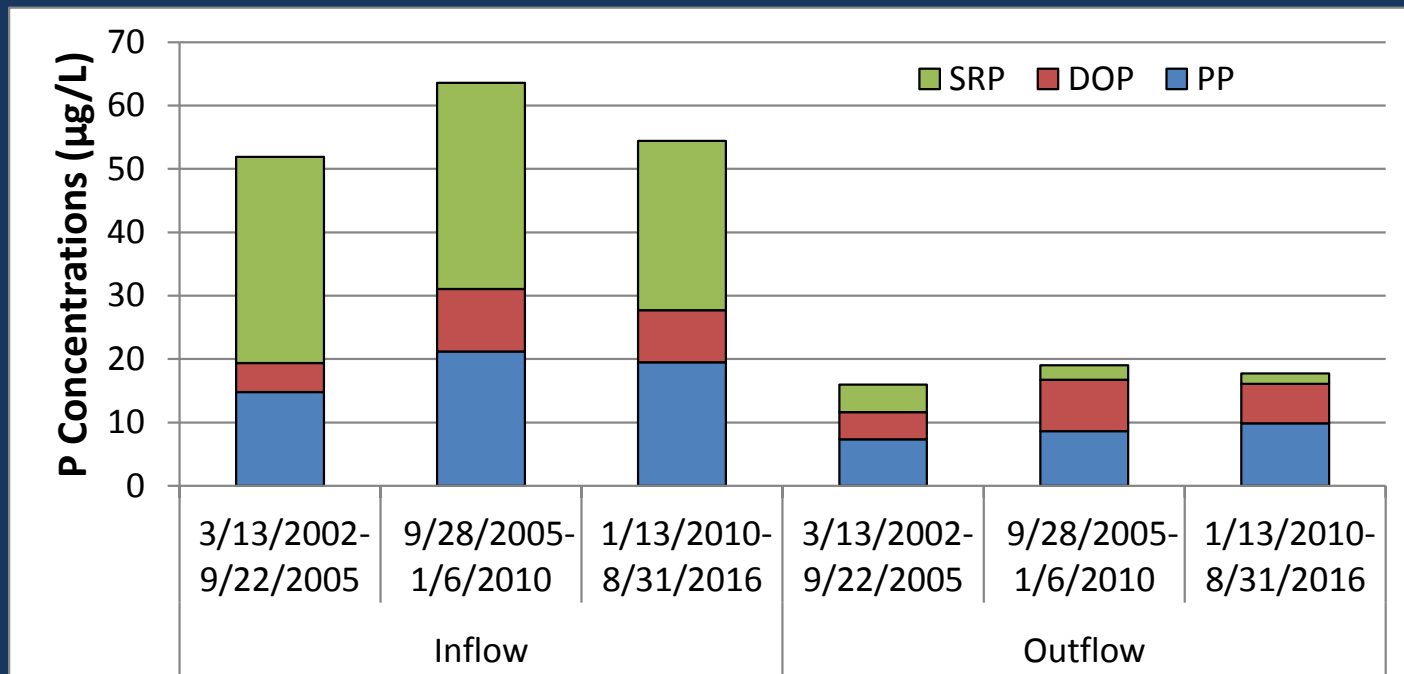
Cross-section



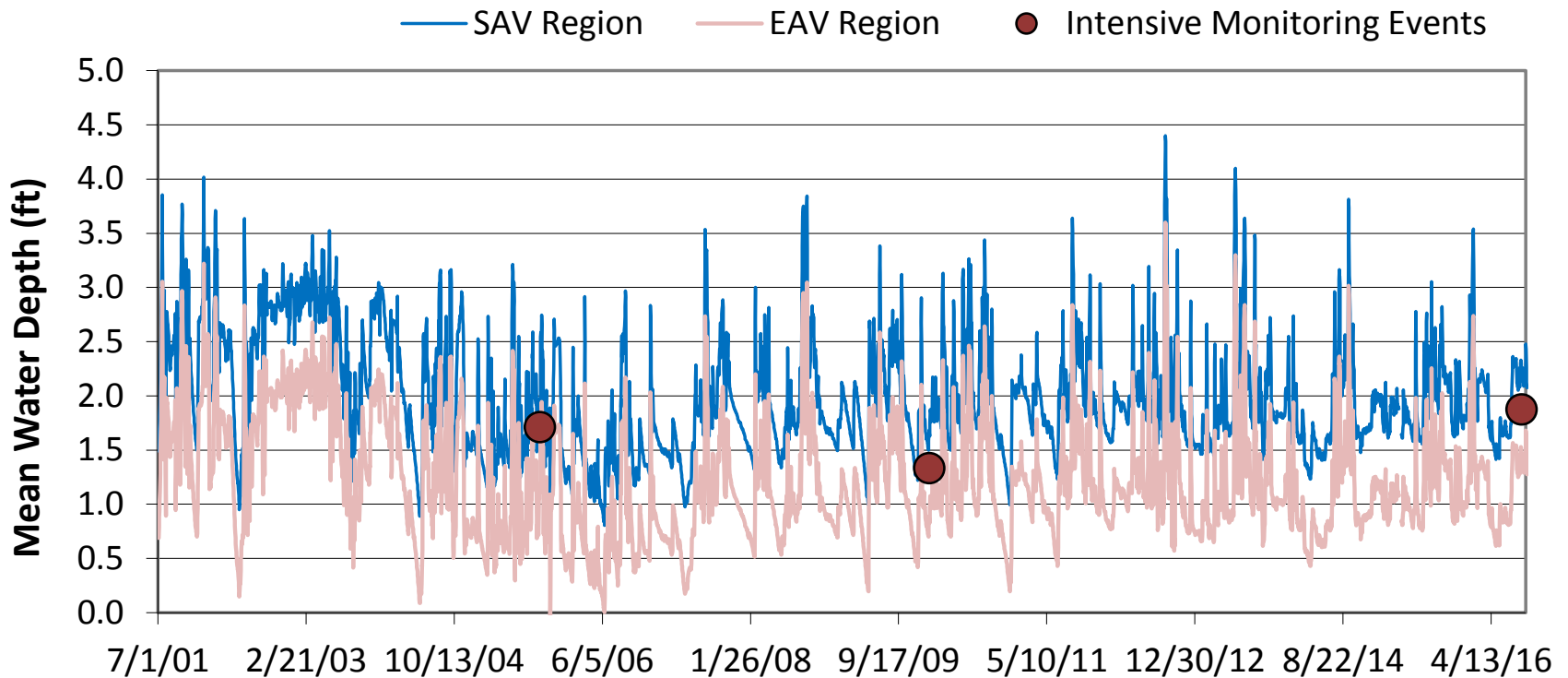
time



Mean surface water P concentrations at the inflow and outflow of STA-2 Cell 3



Water Depths in Cell 3 of STA-2



STA-2 Cell 3

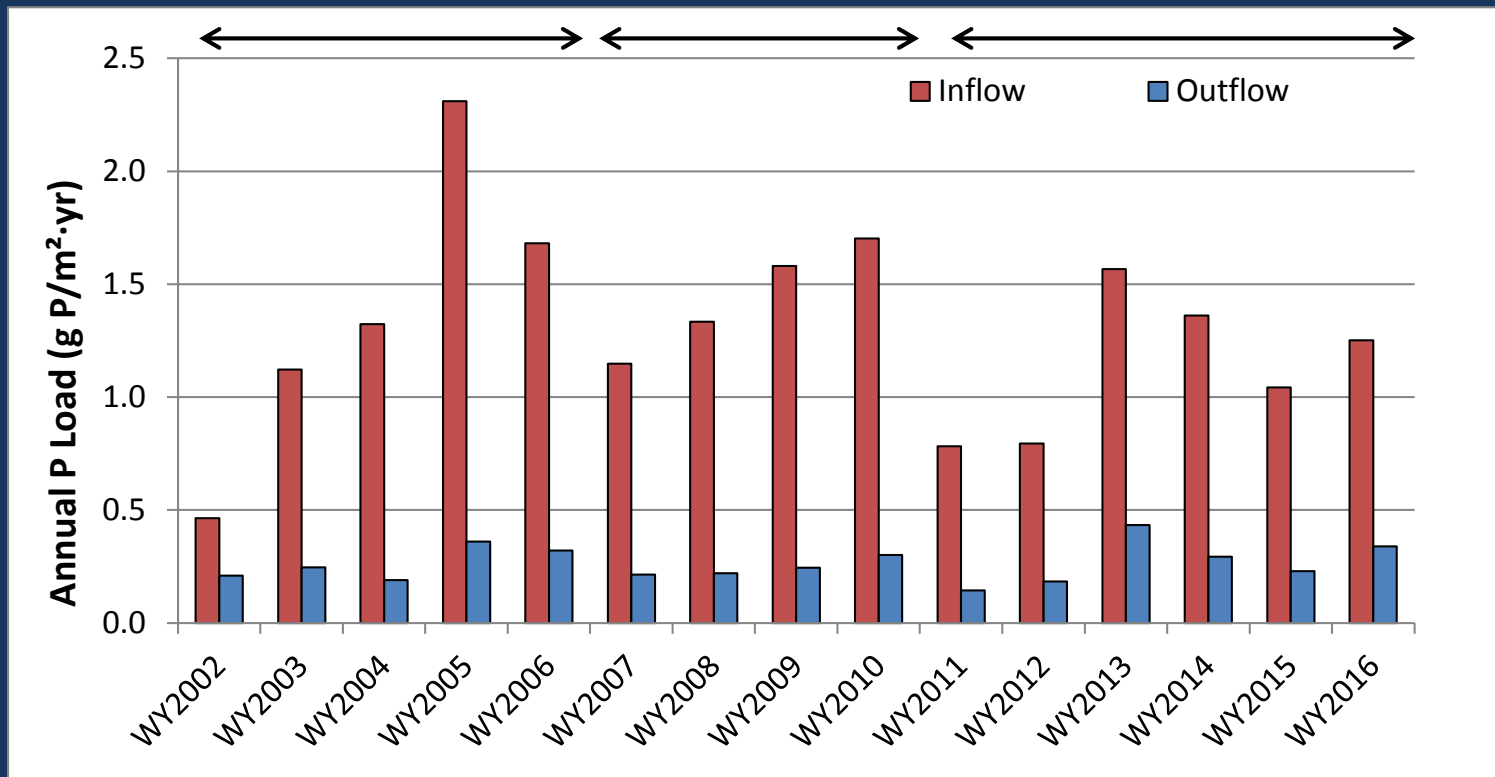
Cumulative P Load

for each period

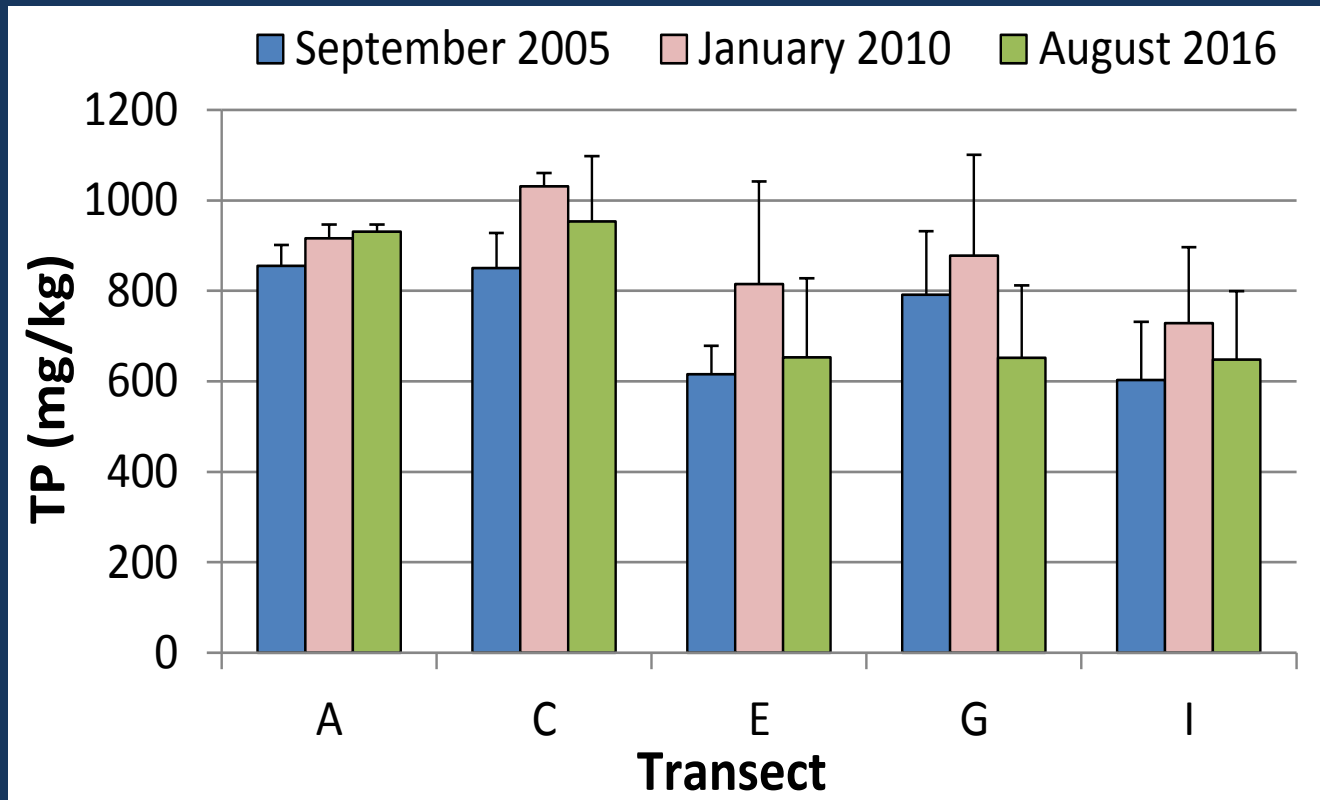
6.90 g P/m²

5.76 g P/m²

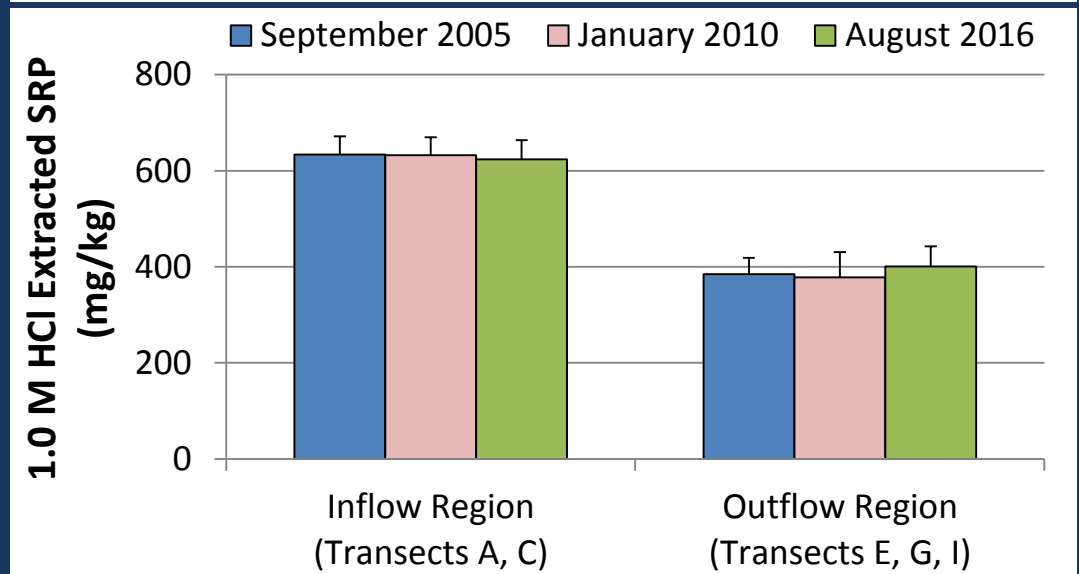
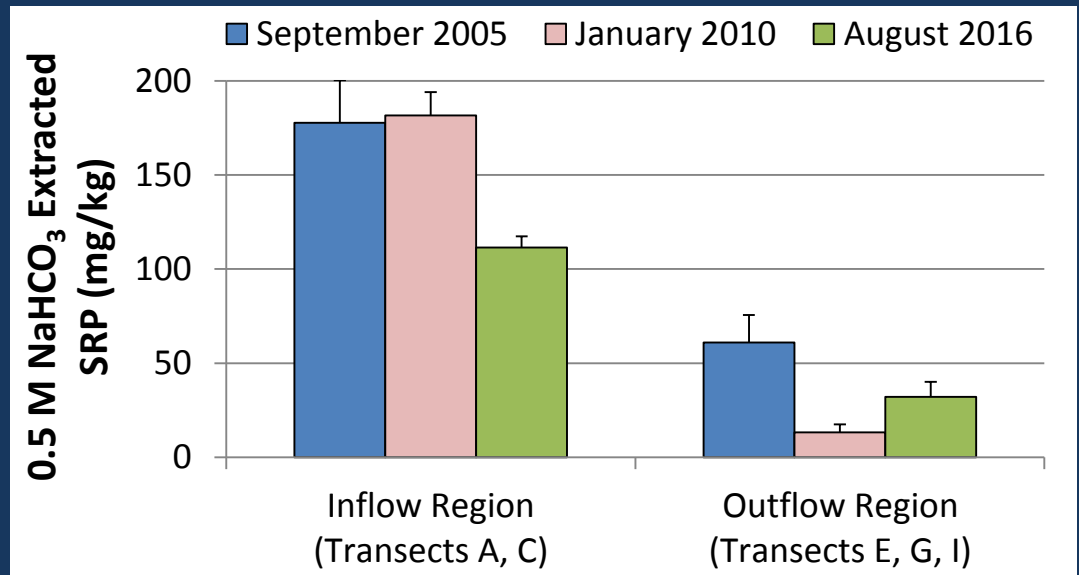
6.80 g P/m²



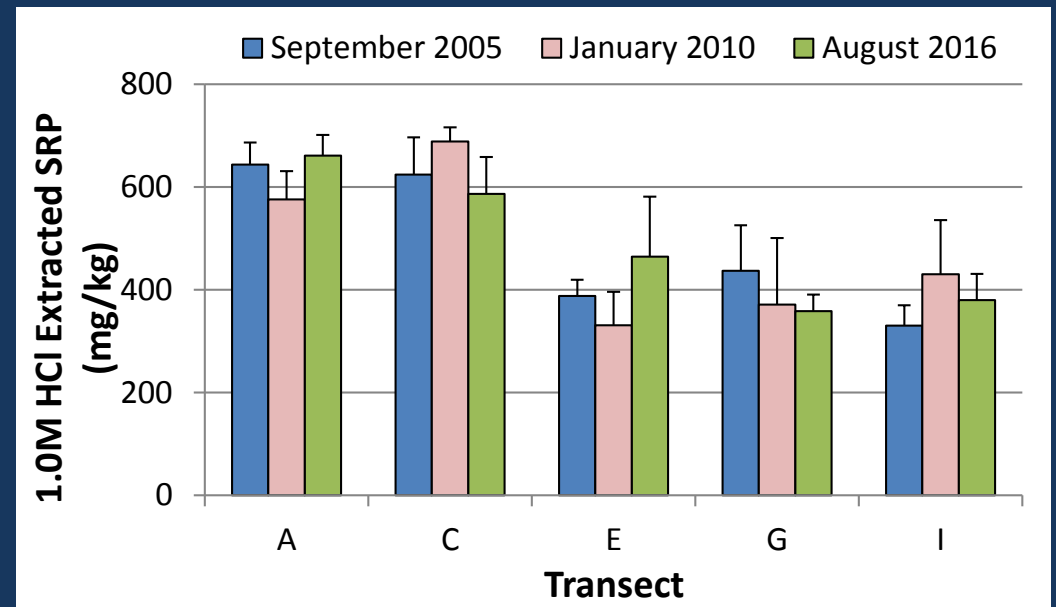
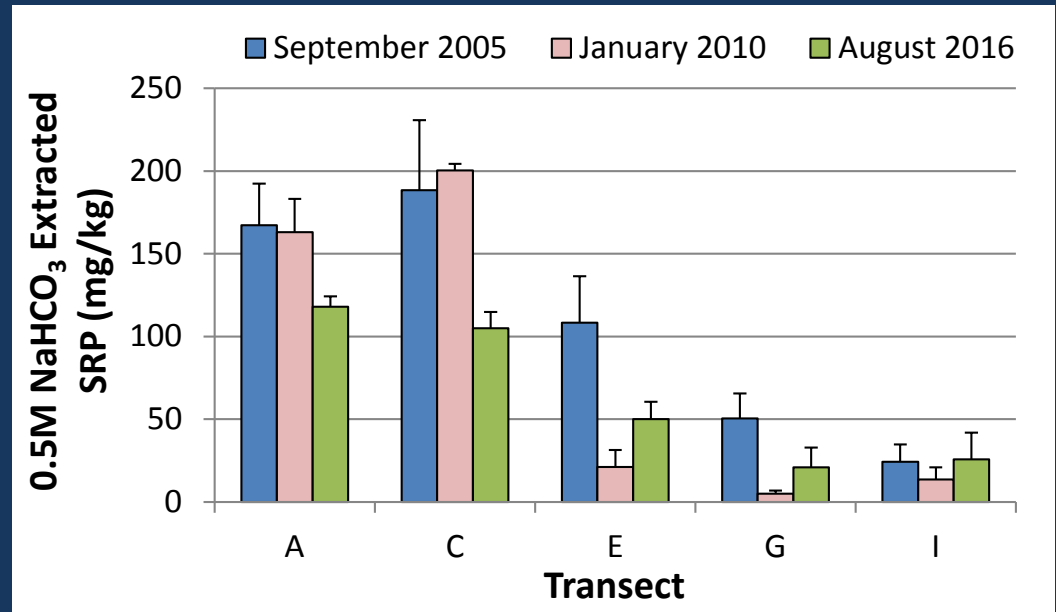
Total P Concentrations in Accrued Layer



Inorganic P Fractions from 0.5 M NaHCO₃ and 1.0 M HCl Single Extractions of the 0-4 cm Soil Depth



Inorganic P
Fractions from
0.5 M NaHCO₃
and 1.0 M HCl
Single Extractions
of the 0-4 cm Soil
Depth



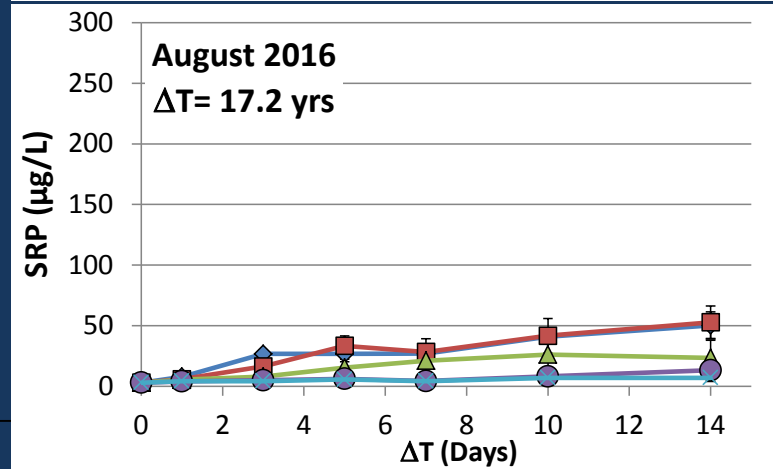
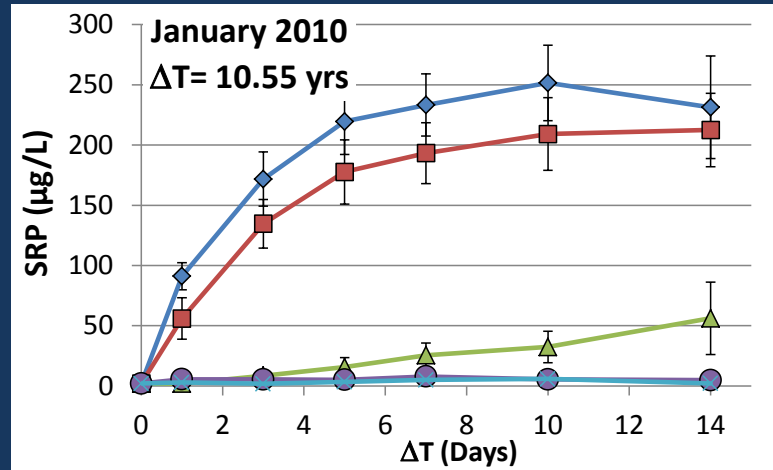
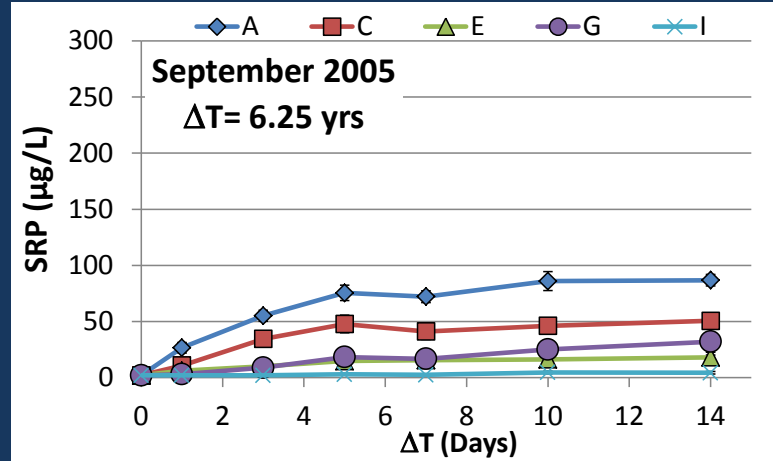
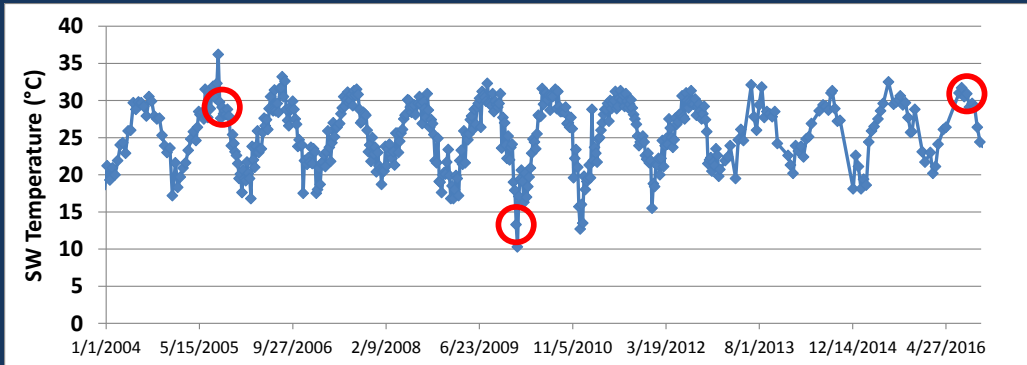
SRP Flux Rates (mg SRP/m²-day) After 10.5 and 17.2 Years of Operation

Year	ΔT	Transect		
		A: Inflow	E: Mid	I: Outflow
2010	10.5 yr	0.050±0.028	-0.001±0.002	0.002±0.001
2016	17.2 yr	0.044±0.020	0.029±0.017	0.001±0.002



SRP Release from 0-4 cm Soil Depths During 14-Day Anoxic Incubations

Surface Water Temperature (°C)



14-day Anoxic Lab Incubations

