Phosphorus Removal Performance and Sustainability of a Submerged Aquatic Vegetation-Dominated Constructed Wetland for Everglades (USA) Restoration

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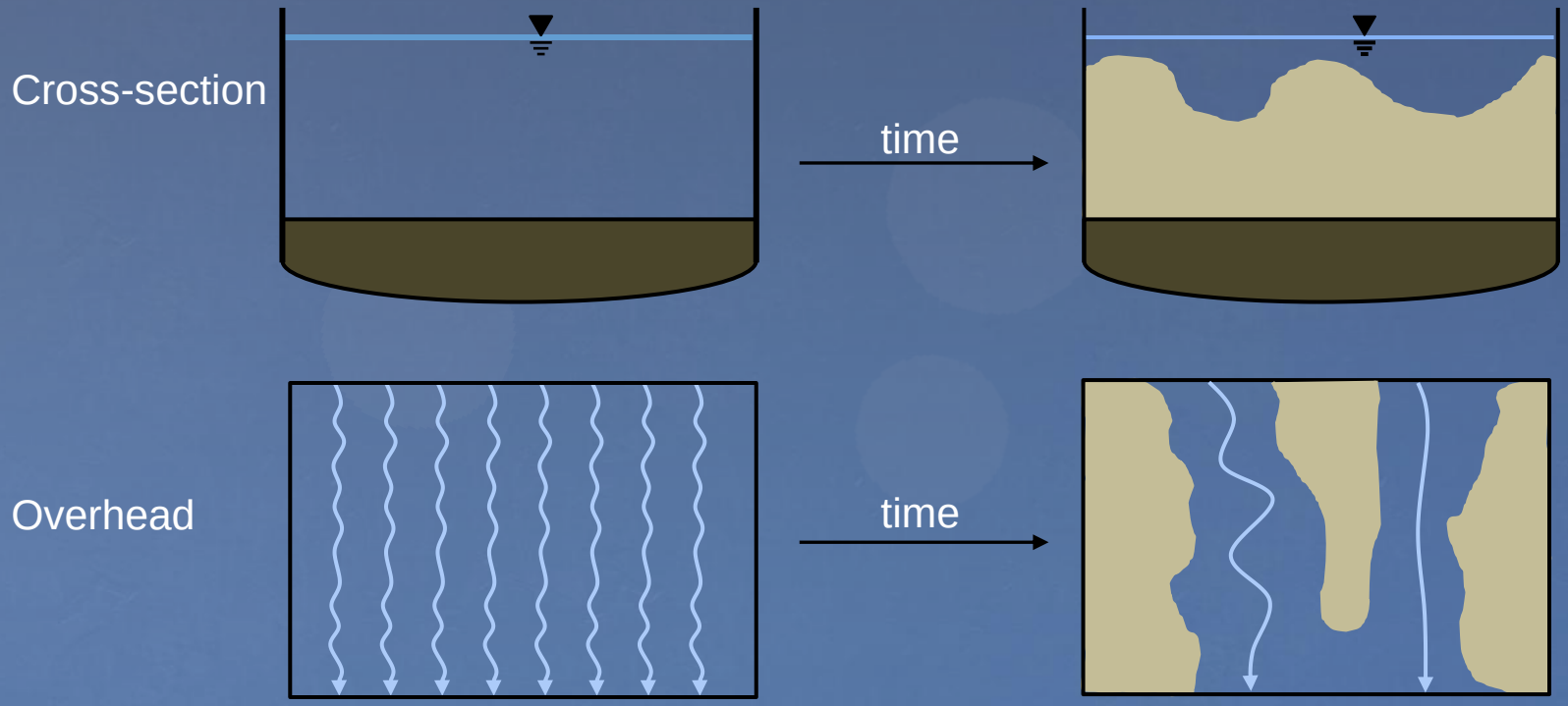
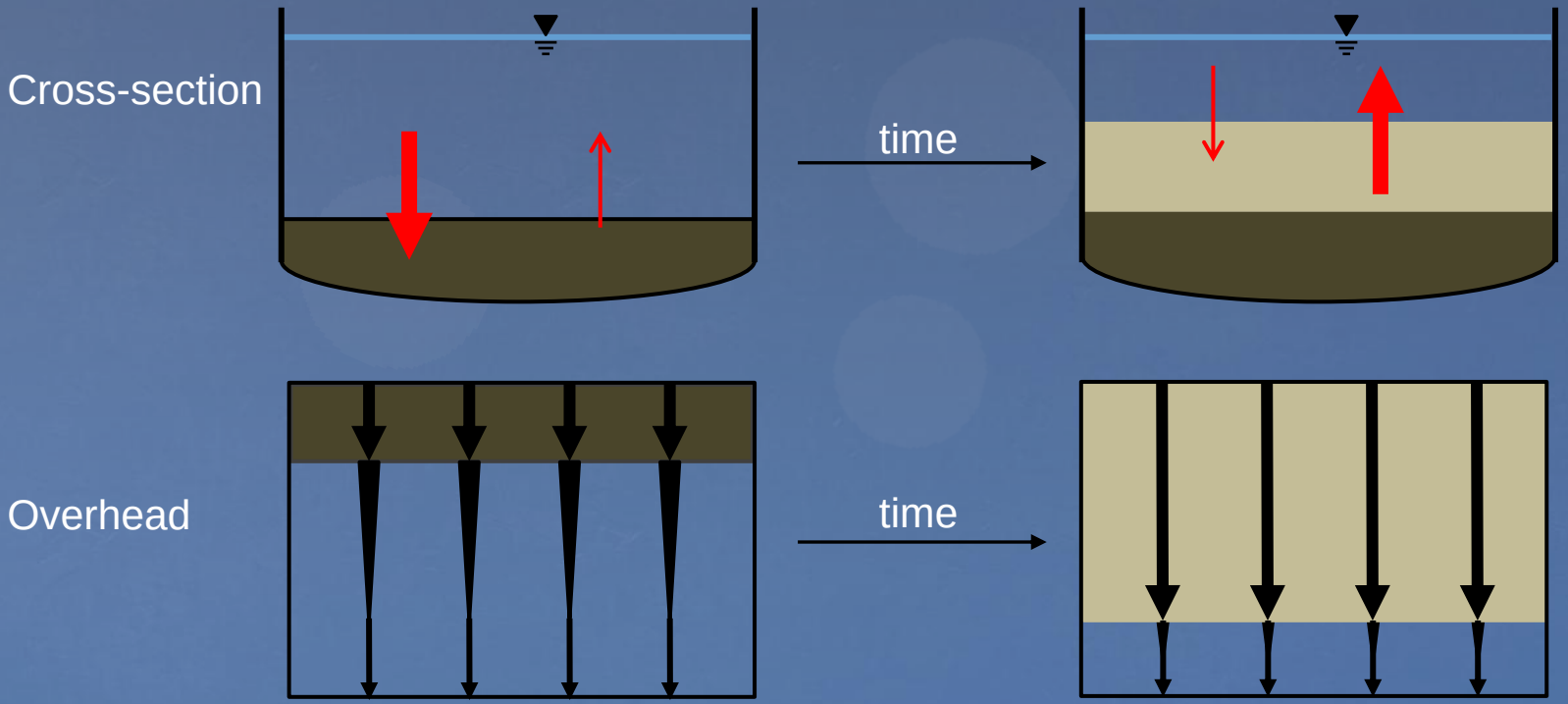
Presentation Outline

- Two major mechanisms by which a wetland can become less efficient in removing P
- Site description
- Soils
  - Accretion
  - P accumulation
  - Inorganic P fractions
  - Laboratory P release
- Porewater
- Surface water
- Settling coefficients
- Mass balances
- Conclusions

#1: Longevity of P removal affected by decrease hydraulic efficiency from “filling up” with solids



#2: Longevity of P removal affected by substrate P saturation

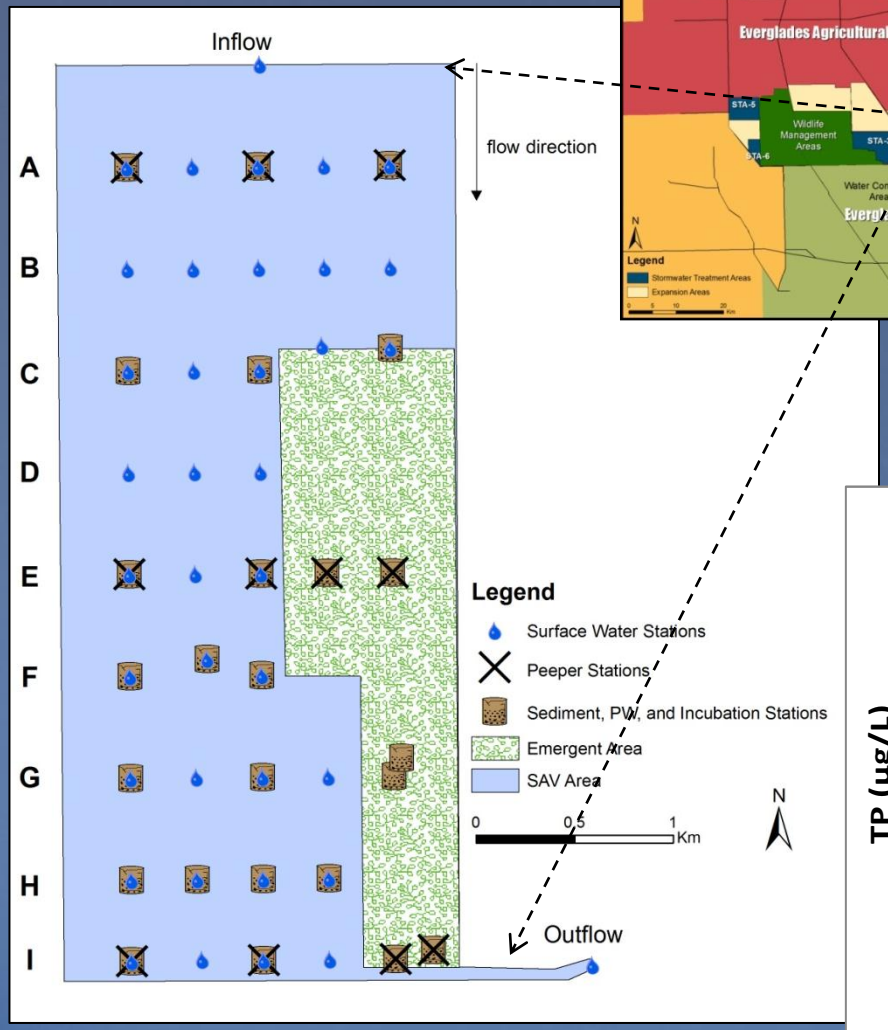


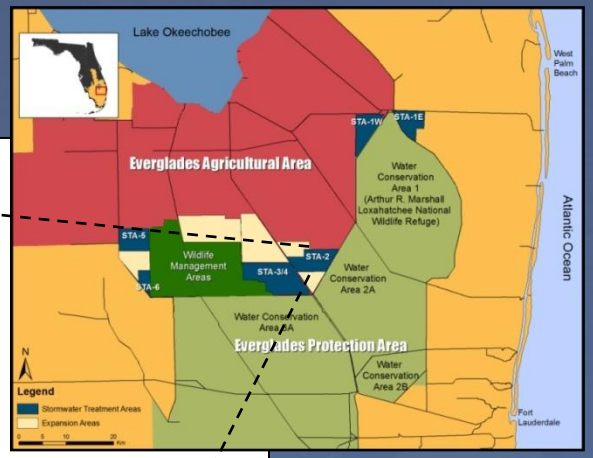
Cell 3 of STA-2

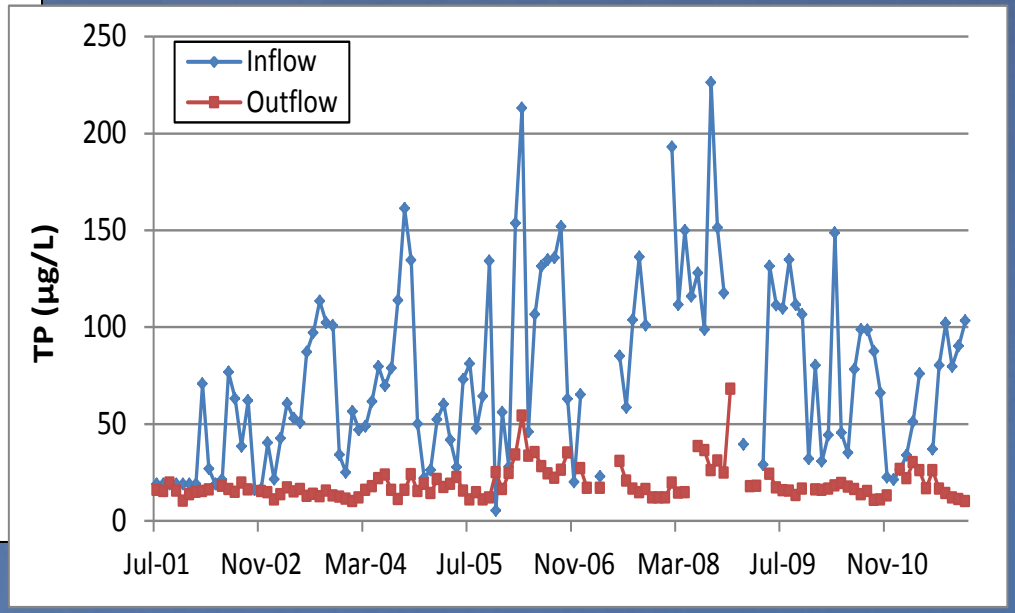
Area = 919 ha

Mean water depth = 0.51 m

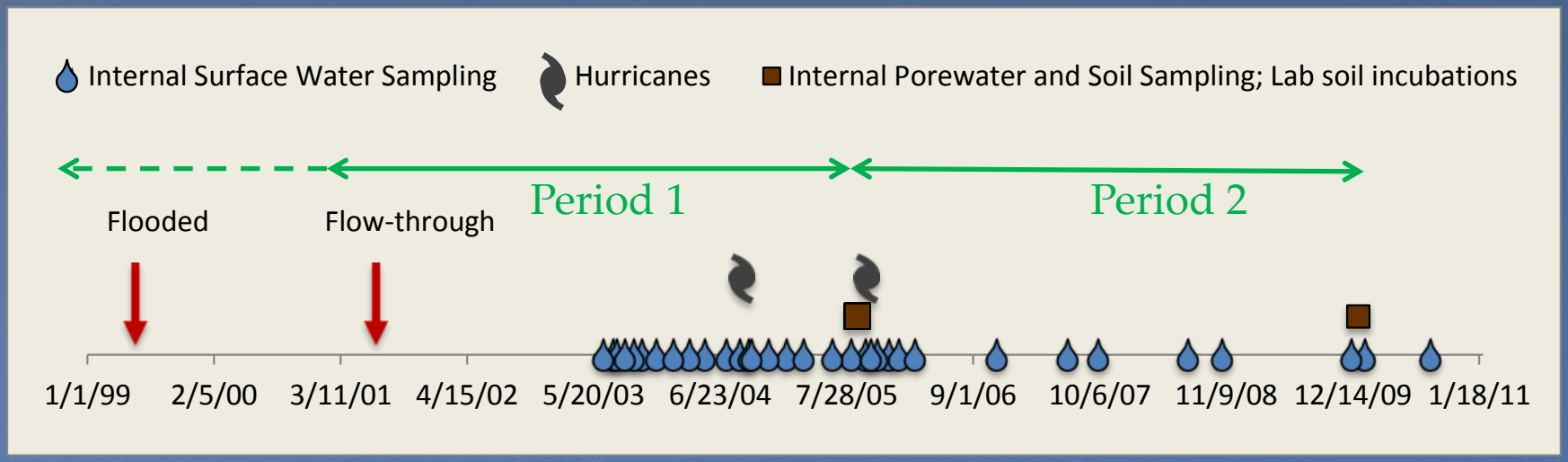
Mean HRT = 13.3 days



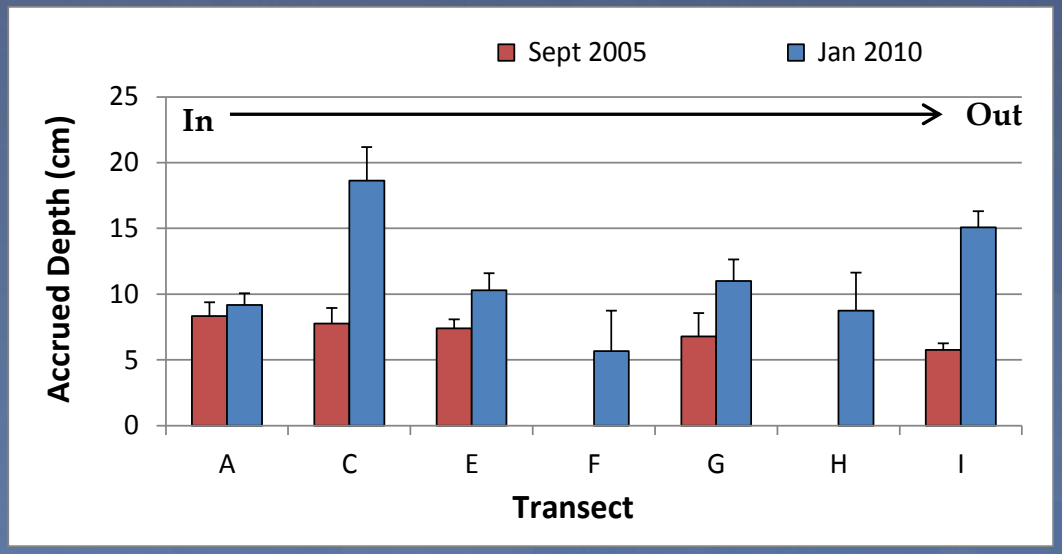


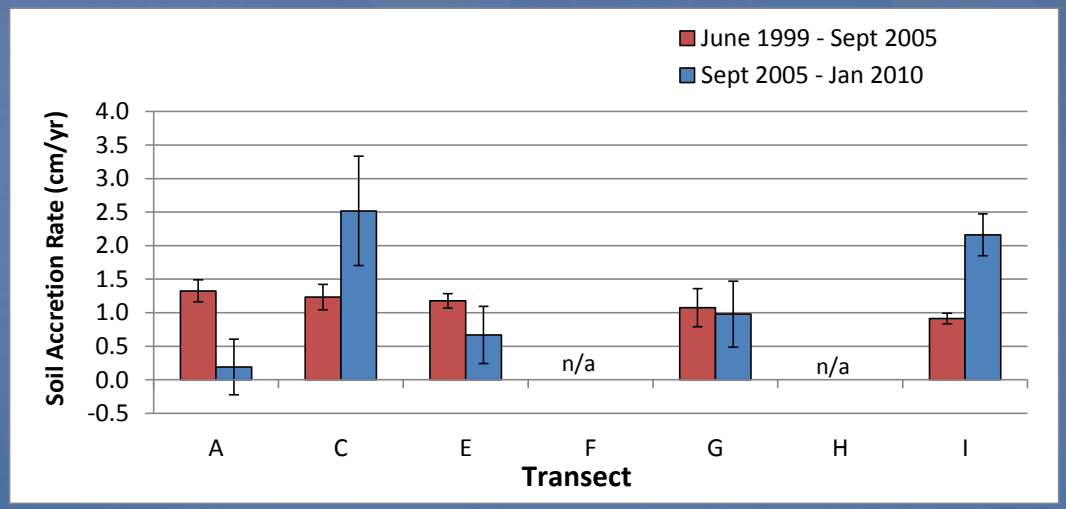


Changes in P gradients over time were utilized to characterize progression of P enrichment and potential impairment of P removal capacity

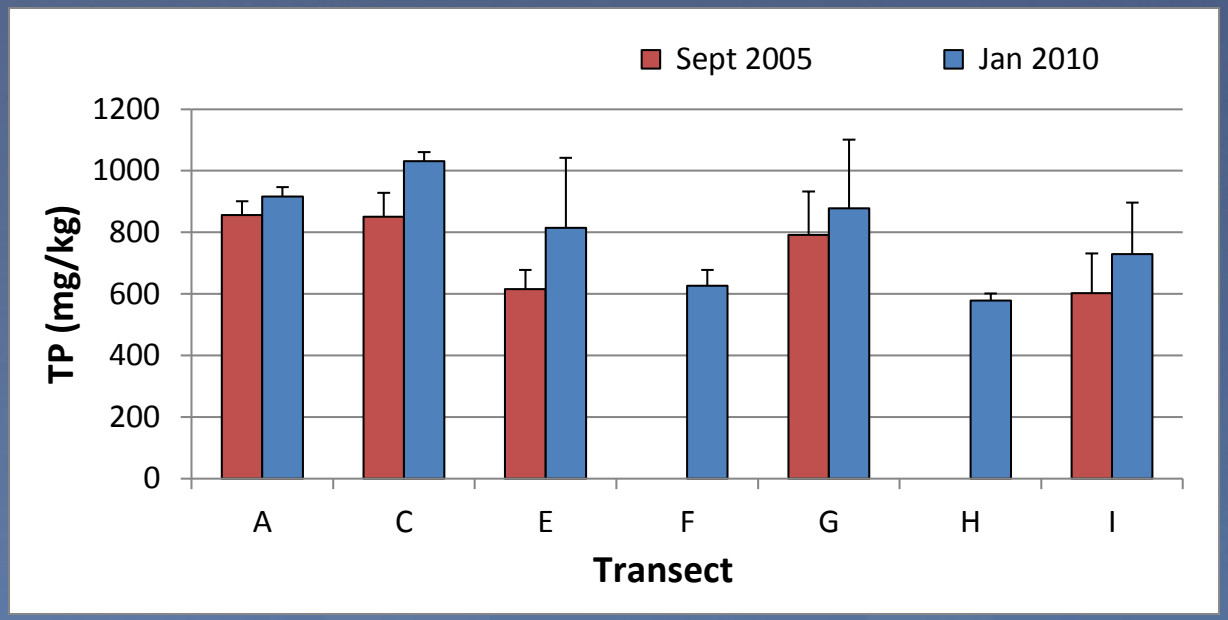


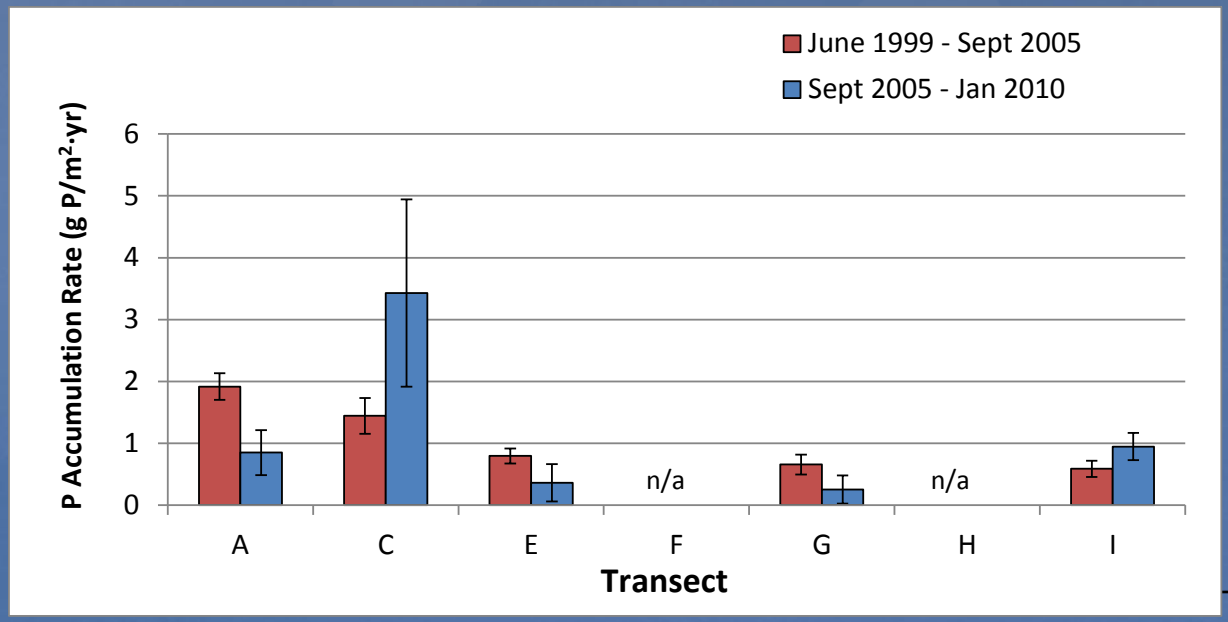
Accrued Soil Depth





Soil P Accumulation

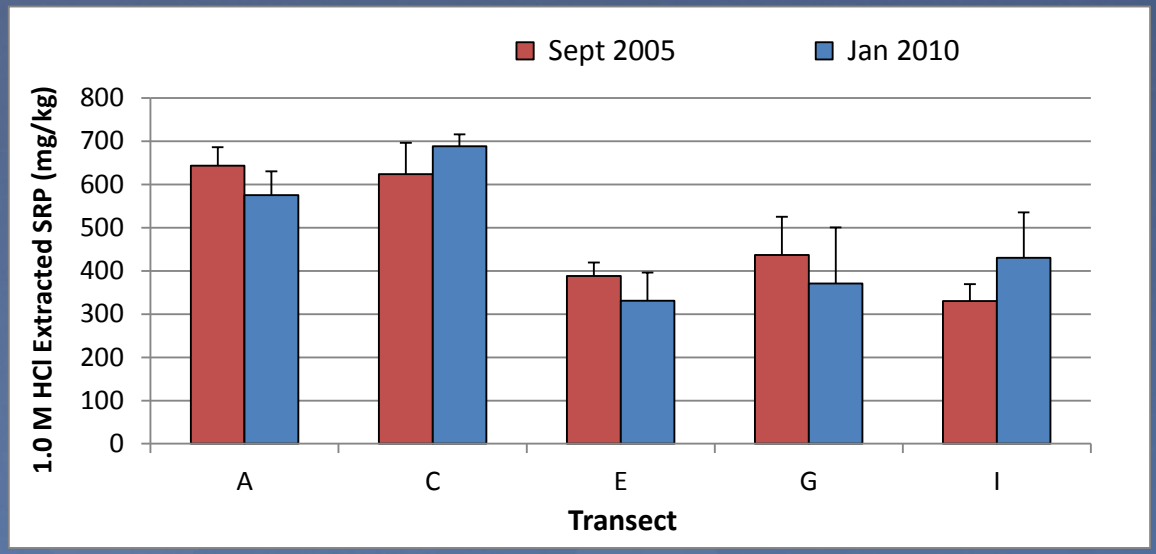


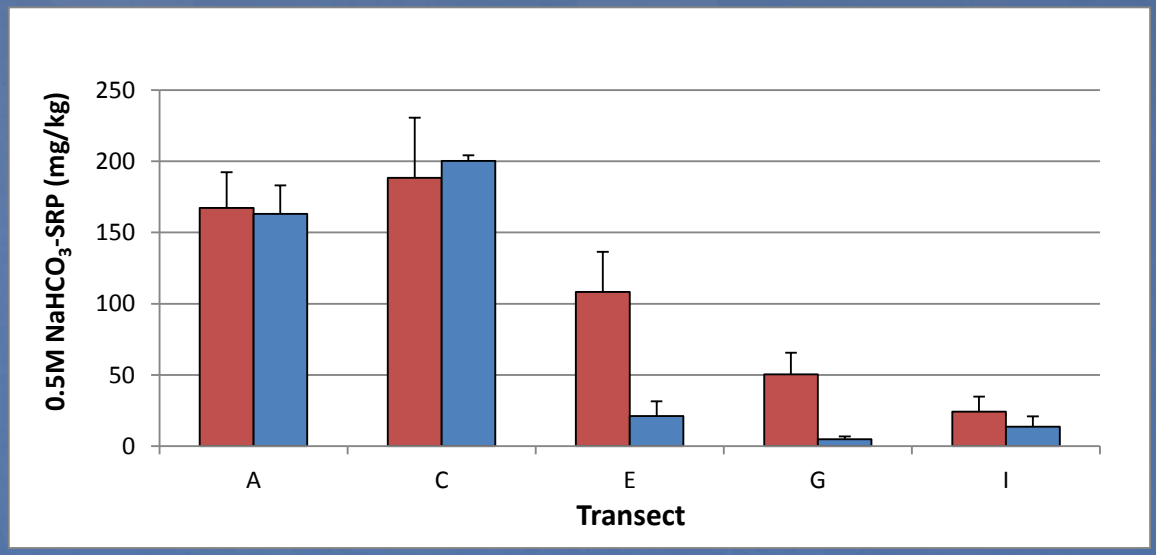


Mean (±1 S.E.) Soil Accretion and P Accumulation Rates were Statistically Insignificant (P > 0.05) between the Two Time Intervals

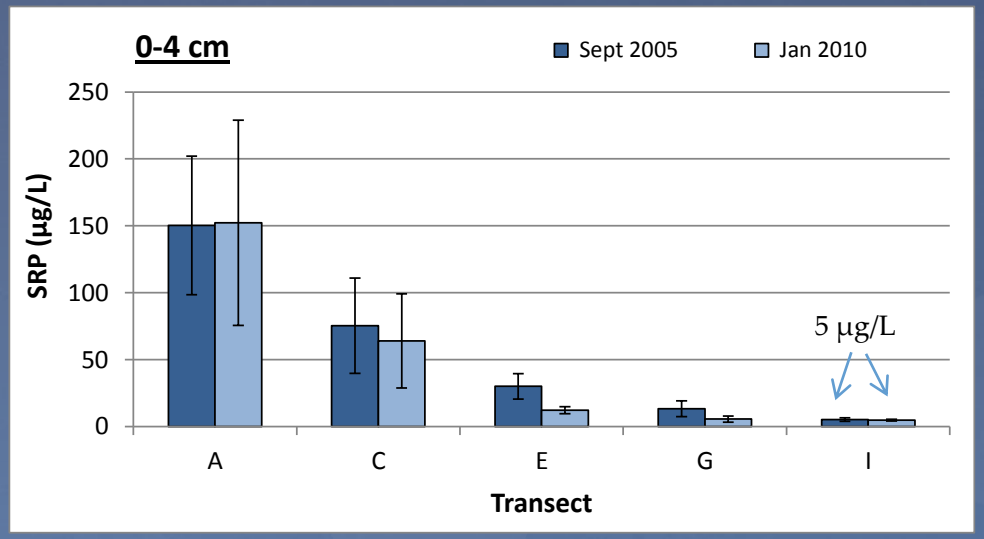
	1999-2005	2005-2010
Soil Accretion Rate (cm/yr)	1.1±0.07	1.3±0.44
P Accumulation Rate (g P/m^2-yr)	1.1±0.26	1.2±0.58

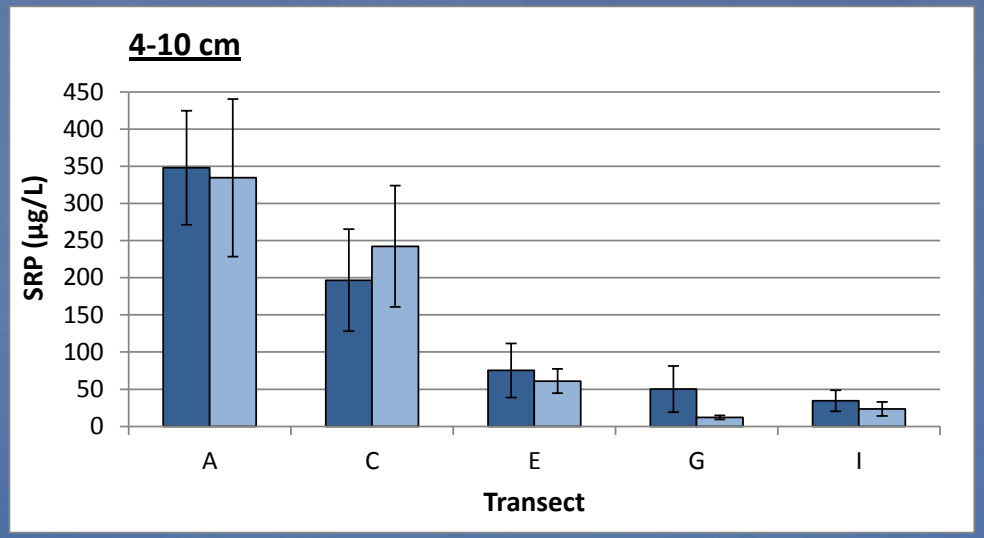
Extractable SRP in 0-4 cm Soil Layer





Porewater SRP Concentrations

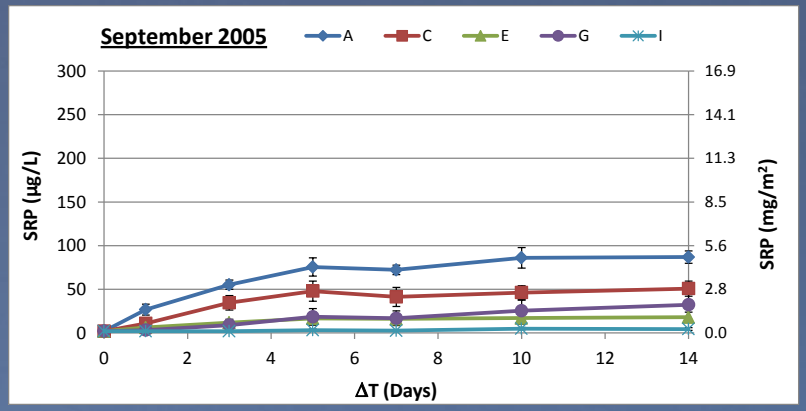


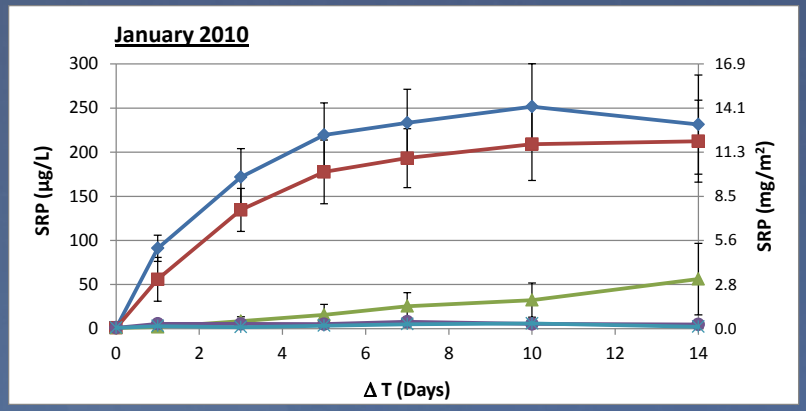


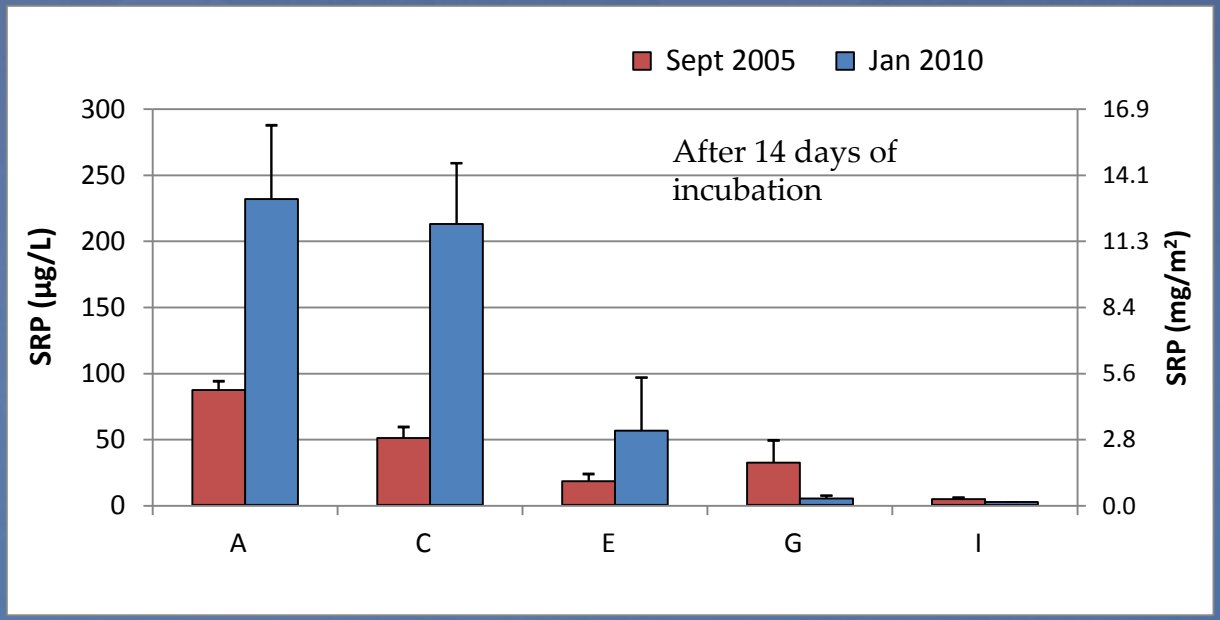
Lab Incubation: Methods

- Well-mixed soil from 0-4 cm depth layer
- Incubated in 500-mL Erlenmeyer flasks with 400 mL of low P outflow water under anoxia
- 14-day incubation in the dark
- No resuspension of soils during incubation

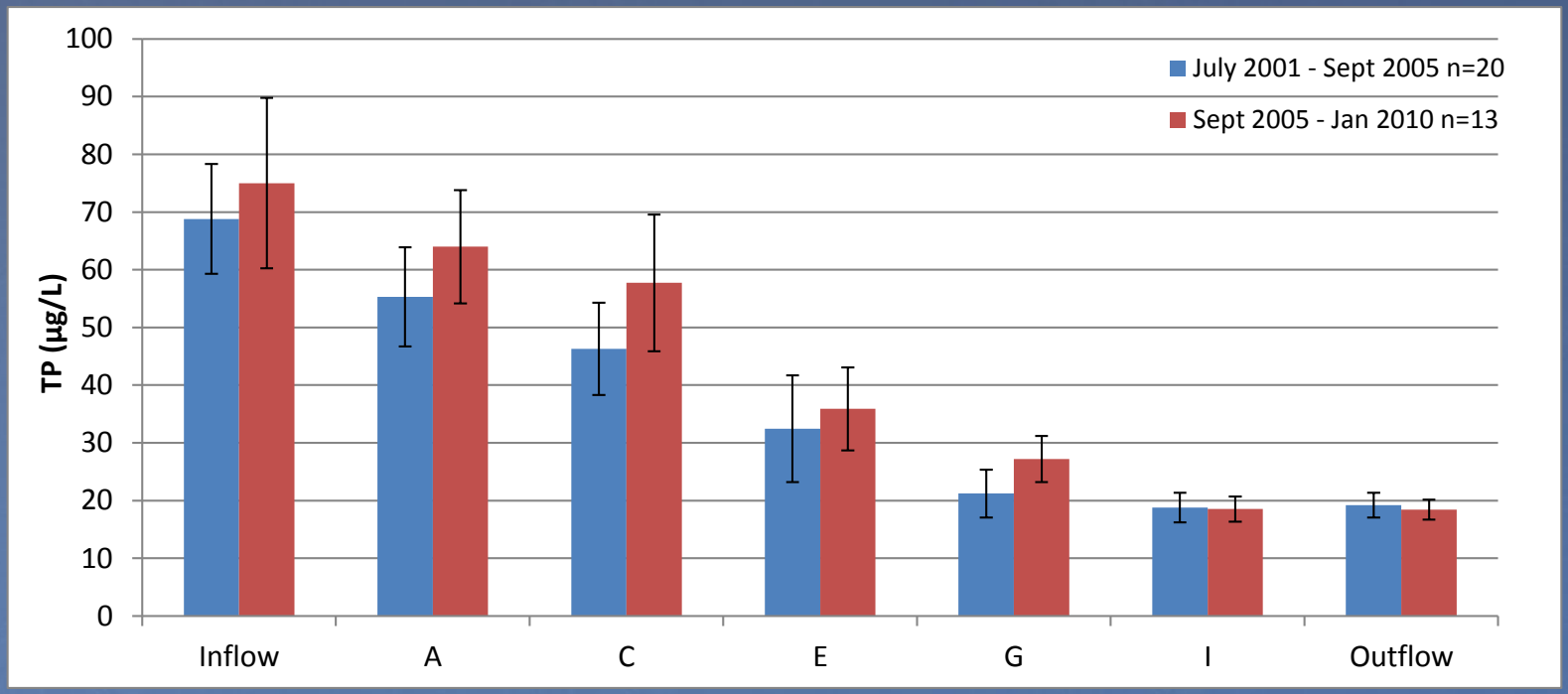
Lab Incubation: Net Potential SRP Release







Total P Concentrations in the Water Column Along the Flow-Way



P Settling Coefficients (m/yr)

	Transect					Entire Cell
	A	C	E	G	I	
July 2001-Sept. 2005 (n=20)	40	25	27	31	27	26
Oct. 2005-Jan. 2010 (n=13)	23	13	21	21	23	22

Soil P Accumulation Rates vs. P Removal Rates from the Water Column

	June 1999-Sept. 2005	July 2001-Sept. 2005	Oct. 2005-Jan. 2010
Soil P Accumulation Rate*	1.08		1.16
P Removal Rate*†		1.07	1.24

*All units are g P/m^2-yr

† Based on inflow and outflow TP data from SFWMD

Conclusions

- "So far…so good" - overall P removal capacity has not been diminished after 11 years of operation

- Comparison of measured P gradients before and after 2005:
  - Sedimentation and P accumulation rates in the accrued soil remained the same
  - Little to no change in inorganic P fractions in the accrued soil
  - No changes in porewater P concentrations
  - Increased labile soil P pools after 2005
  - Water column P concentrations increased after 2005, except at the Outflow Transect I, resulting in lower P settling coefficients after 2005
- Further studies are needed to determine the effects of soil accretion on hydraulic efficiency and P dynamics in the STAs
- Further spatial P gradient analyses over time will provide a continuous assessment towards predicting the P removal sustainability of well-performing STA flow-ways, such as Cell 3