Evaluation of Phosphorus (P) Sources, Forms, Flux, and Transformation Processes in the STAs
P Flux Study

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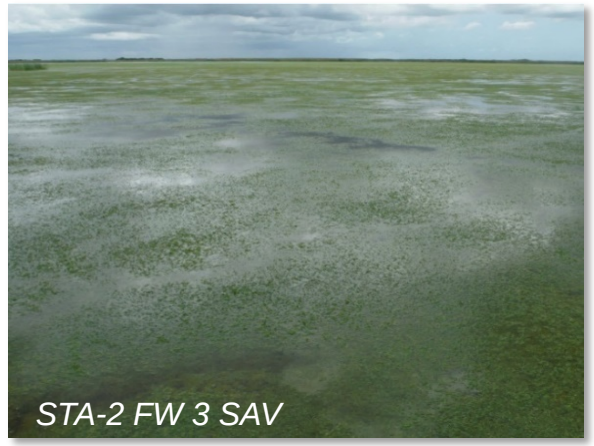
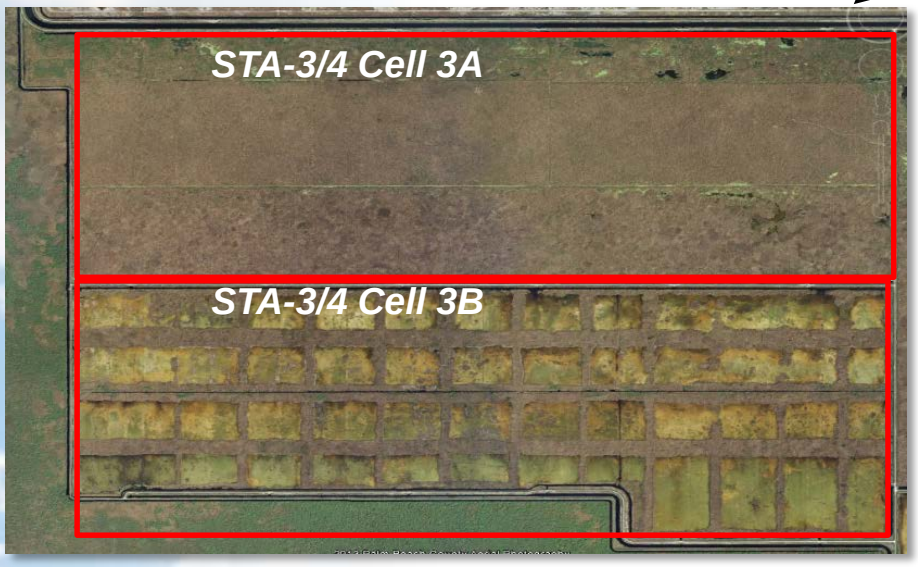
P Flux Primary Objective and Study Questions

- Objective-To understand the mechanisms and factors affecting P treatment performance, especially at the downstream of the treatment flow-ways
- Key Questions-
  - How can internal loading of P to the water column be reduced or controlled, especially in the downstream of the treatment trains?
  - How can the biogeochemical or physical mechanisms be managed to further reduce soluble reactive, particulate and dissolved organic P concentrations at the outflow of the STAs?

Study Locations





P Flux Study Components

Water Quality Flow-way Assessments Study

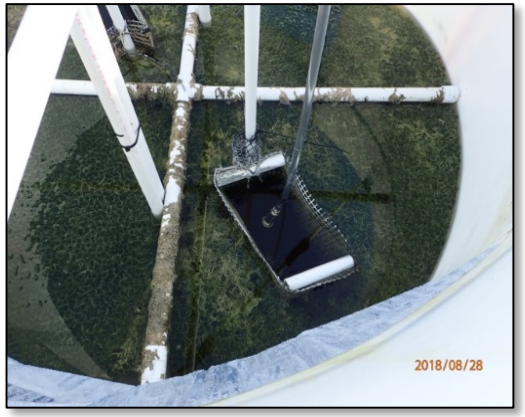
- Objectives
  - Evaluate biogeochemical responses under different flow scenarios
  - Determine factors influencing responses, particularly related to P sources, flux, and species transformations
- Findings
  - Distinct TP gradient from inflow to outflow under no flow/flow conditions
  - TP concentration reduction was higher for Emergent Aquatic Vegetation (EAV) compared to Submerged Aquatic Vegetation (SAV) under both no flow/flow conditions
  - Significant increase in TP concentration under no flow conditions for SAV primarily due to in-situ particulate P production

Method	Parameters	Frequency
Autosampler	Total phosphorus (TP)	Every 4 hours
	Total nitrogen (TN), Total organic carbon (TOC)	Daily composite
Grab	TP, Soluble reactive P, Total dissolved P, Dissolved organic C, TN, Calcium, Magnesium, Potassium, Sodium, Iron, Sulfate, Chloride, Alkalinity, Color, Total suspended solids, Hardness, Chlorophyll	Weekly
Field	pH, Dissolved oxygen, Specific conductance, Temperature	Every 30 minutes

Flux Measurements Study

- Objectives
  - Identify sources/magnitudes of internal phosphorus fluxes and loads in vegetated and unvegetated areas
  - Evaluate changes in TP in the water column

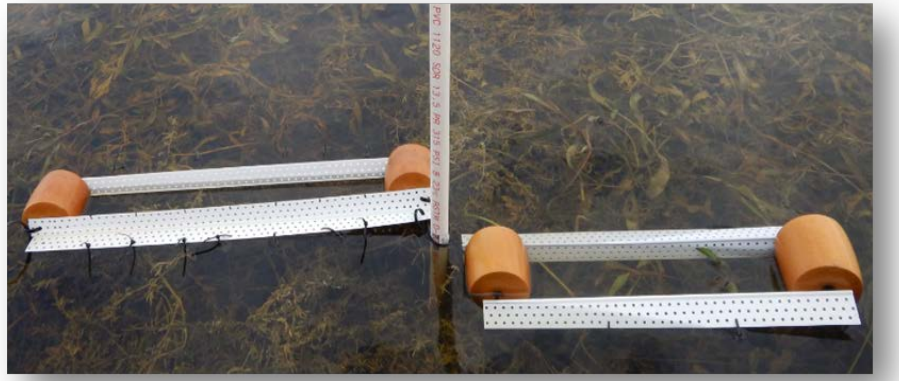
- Findings
  - P concentrations increased during no flow periods
  - Internal P loading occurring within flow-ways likely driven by macrophyte mining and turnover from soils
  - Led to development of Low-P Wetland Event Model (LPWEM)



Microbial Study

Objectives

- Evaluate the patterns and trends in microbial biomass, tissue nutrients, and enzymatic activities along the nutrient gradient with respect to flow and vegetation type



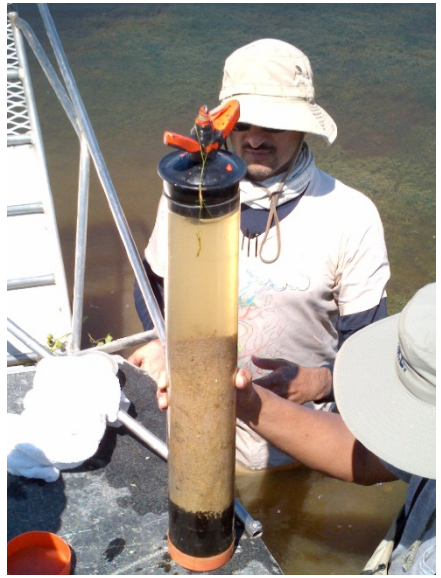
Findings

- Enzymatic activity differed along the nutrient gradient and among study components and vegetation type
- Periphyton/Floc
  - Overall flow affects microbial activity
  - Periphyton accumulation highest at inflows, lowest at outflows
  - Increased P limitation along the gradient from inflow to outflow for both vegetation types

Soil P Characterization Study

- Objectives
  - Evaluate spatial and temporal patterns in forms and storage of P in Stormwater Treatment Areas (STAs) with different vegetation types

- Findings
  - High P enrichment in floc and recently accreted soils close to inflows and decreasing towards outflows
  - Steady long-term nutrient loading to the STAs has resulted in the accumulation of P-enriched materials in the upstream areas
  - P storage is 2-3 times higher in SAV than in EAV
  - Veg community a major influence of the P exchange between water and floc/soil layer



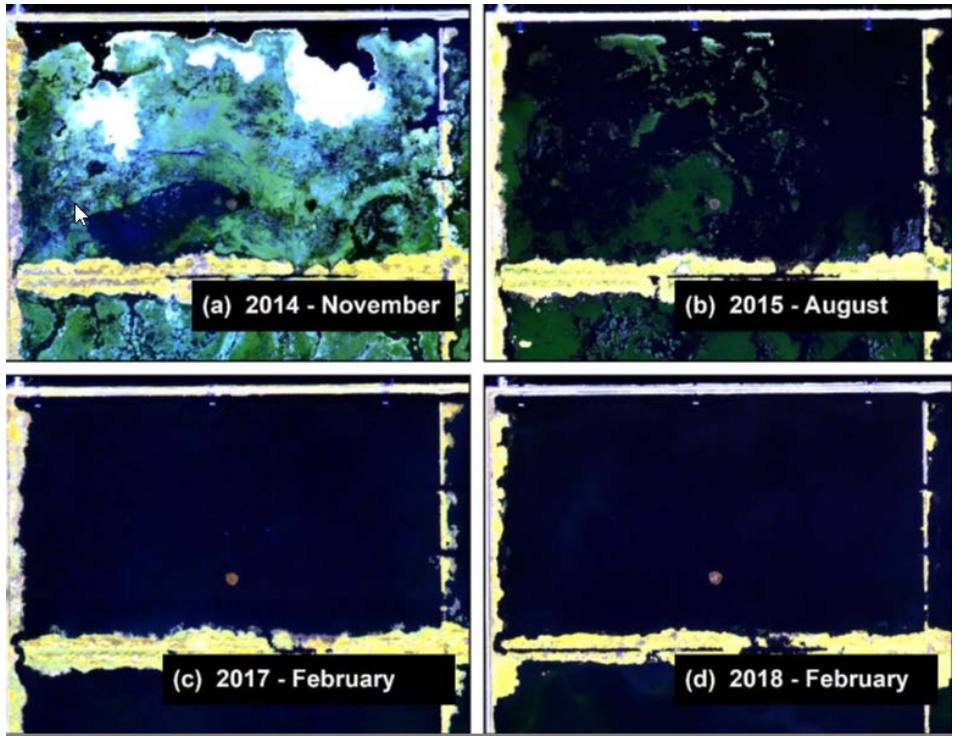
STA-2 FW 3 SAV

STA-2 FW 1 SAV

Vegetation Study

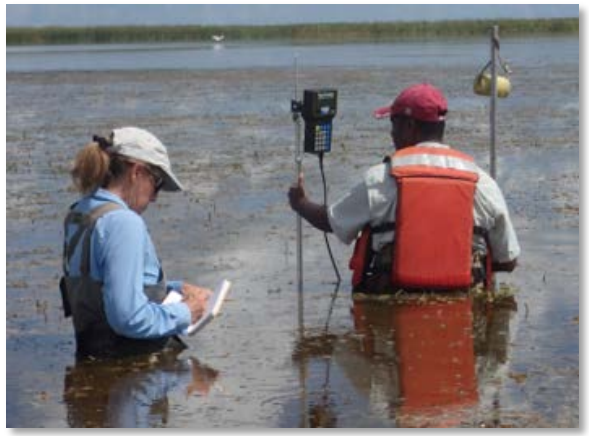
- Objectives
  - Survey and sample plant communities to compile with other project components
  - Pilot study of Worldview satellite imagery to determine vegetation signatures

- Findings
  - Temporal loss of SAV biomass over course of study
  - Nutrient storages significantly higher for EAV compared to SAV
  - *Chara* had highest nutrient storage capacity among SAV species
  - Imagery showed SAV and EAV could be distinguished for SAV areas dominated by single species



Particulates Study

- Objectives
  - Evaluate effects of specific operation and/or environmental conditions in flow operation, veg community structure, and presence of deep area altering particulate processes



- Findings
  - Primary drivers of velocity are gate operations, wind, distance to canals and ditches
  - Local flow fields affected more by wind speed and direction
  - Settling and resuspension and net accumulation highest at inflow sites

Fauna Study

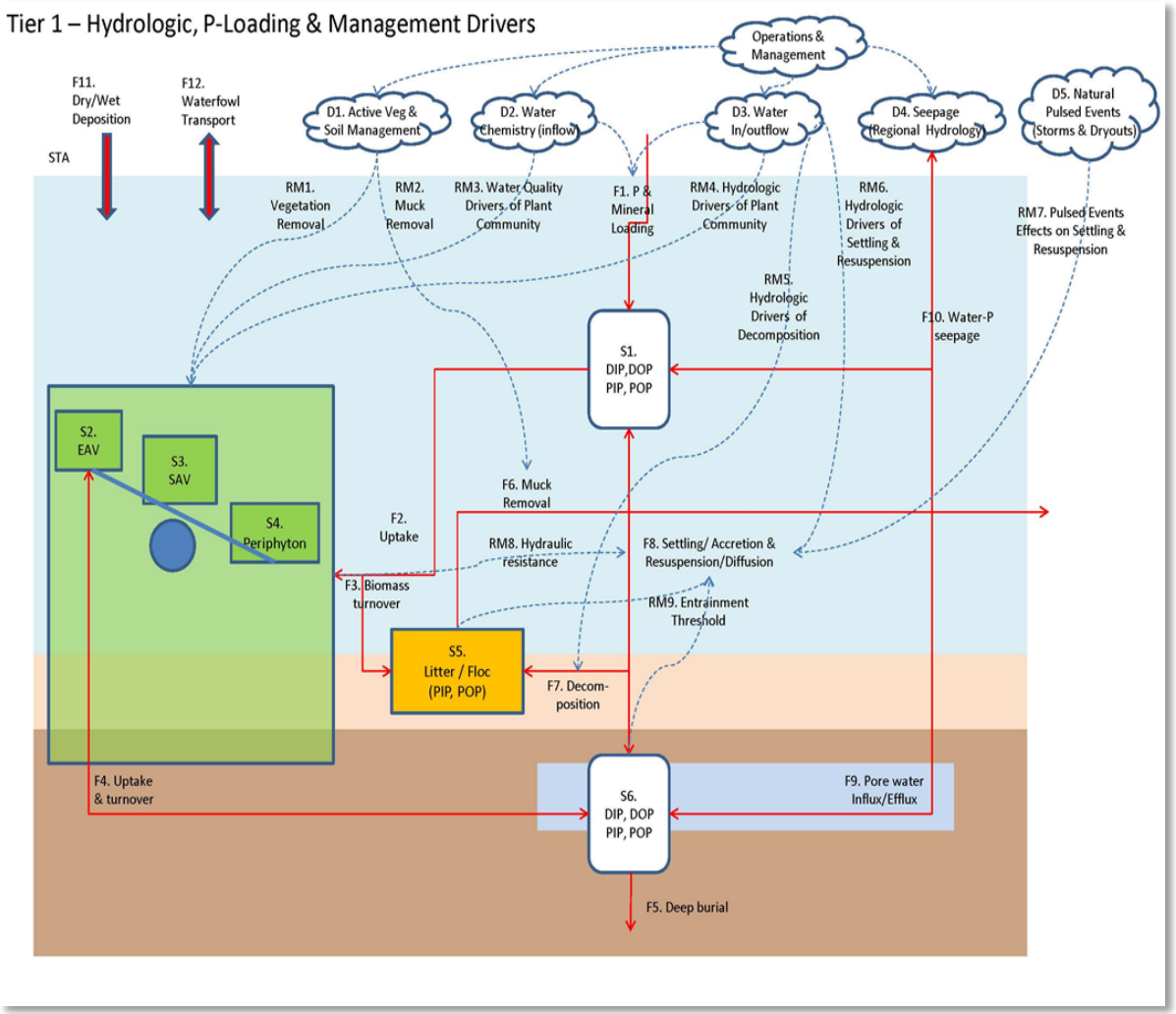
- Objectives
  - Quantify fauna communities and their effects on water quality and vegetation by surveying the density, biomass, and composition of aquatic fauna (fish and large macroinvertebrates) and birds

- Findings
  - In birds,TP loading 4% of total external stormwater inputs of 1.9 g/m/yr for STA-1W
  - Mean density and diversity of fish/invertebrates STAs> Everglades
  - Important mechanism of nutrient cycling within and among STA habitats

Data Integration

- Bottom Up Approach-
  - Identifies fluxes and transformation among the major P reservoirs
  - Key processes captured better for EAV than SAV

- Low-P Wetland Event Model (LPWEM)
  - Two major controlling variables, internal load and flow
  - Developed through evaluation of transect data and effects of varying flows to determine outflow P concentrations
  - Internal loading primarily responsible for outflow concentrations



Resources

- 2020 South Florida Environmental Report, Chapter 5C
  - https://apps.sfwmd.gov/sfwmd/SFER/2020_sfer_draft/v1/sfer_toc_v1.pdf
- 2019 South Florida Environmental Report, Chapter 5C, Appendix 5C-1
  - https://apps.sfwmd.gov/sfwmd/SFER/2019_sfer_final/sfer_toc_v1.pdf
- 2018 South Florida Environmental Report, Chapter 5C, Appendix 5C-3
  - https://apps.sfwmd.gov/sfwmd/SFER/2018_sfer_final/v1/chapters/v1_ch5c.pdf
- Final Project Reports and GEER presentations can be made available

Questions

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