Restoration Strategies Science Plan Progress

Long-Term Plan
Communications Meeting
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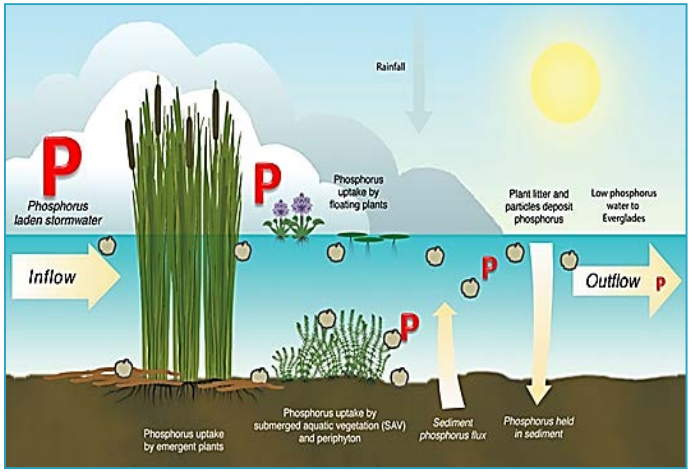
Phosphorus Sources, Forms, Flux, & Transformation Processes in the STAs

Study Objectives/Purpose

- Characterize P sources, speciation, cycling, and transport in STAs, and understand mechanisms and factors influencing P reduction in low P environment
- Use results to recommend enhancements or new operational and management strategies to further improve STA performance



Phosphorus Sources, Forms, Flux, & Transformation Processes in the STAs

Progress

- Measurement of STA P flux
  - For stagnant, low flow, and high flow controlled events
  - Completed data collection for one stagnant event [surface water quality, enzyme activity, soil porewater, redox]
- Continuing STA data mining and analysis
- Developed methods for field collection and laboratory enzyme activity measurements
- Performed low altitude remote sensing trial for vegetation
- Performed initial avian surveys

Use of Soil Amendments/Management to Control P Flux

Study Objective/Purpose

Determine if flux of P from the soil in STAs can be reduced with soil amendments or management techniques such as soil inversion or addition of a limerock cap

Use of Soil Amendments/Management to Control P Flux

Progress

- **Developed Draft Phase I report**
  - Literature review on soil amendments and management techniques an evaluated previous findings relevant to controlling P flux in wetlands
  - More than 100 materials that sorb P have been tested as a soil amendment; however, only a few of these products would be suitable for use in the STAs
  - No published data were found that document the long-term treatment efficacy of soil amendments or soil management techniques to reduce outflow total P
  - Performed preliminary feasibility to implement selected amendments & techniques in STAs for both experimental & full-scale implementation cost estimates

Use of Soil Amendments/Management to Control P Flux

Progress

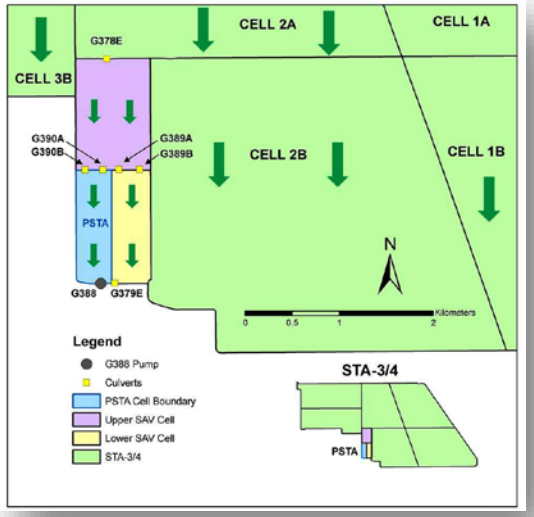
- All Phase I activities for this study have been completed and the results are described in Phase I Summary Report

- Considering the uncertainties in treatment efficacy, potential impacts to STA operations and the economics associated with implementing any of these technologies at full-scale in the STAs, the study will move forward with planning for a field-trial of soil inversion in the STA-1W Expansion Area but will not proceed with study Phases II and III for testing soil amendments or any other soil management technique elsewhere in the STAs.

Periphyton-based Stormwater Treatment Area (PSTA): Performance, Design & Operational Factors

Study Objective/Purpose

Continue investigation of PSTA cell performance to determine design elements, operational factors, and biogeochemical characteristics that enable the PSTA cell to achieve ultra-low outflow TP levels

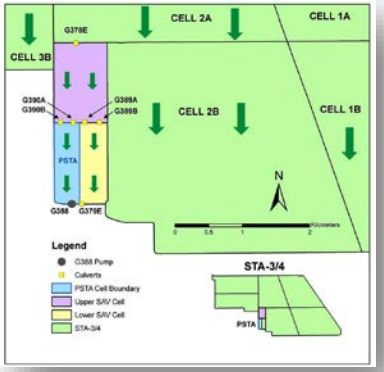


Periphyton-based Stormwater Treatment Area (PSTA): Performance, Design & Operational Factors

Progress

- Evaluated high flow pulse flow events in PSTA Cell
  - Results suggest pulses had no apparent adverse effect on performance
  - Results also suggest that inflow TP >22 ppb generally did not result in outflow TP <13 ppb

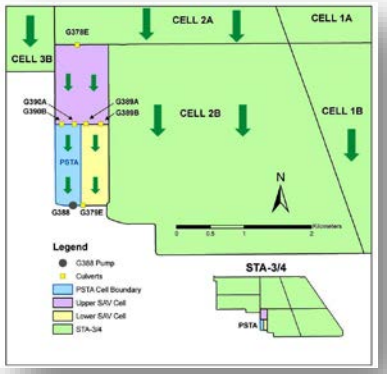
- Evaluated PSTA Cell inflow & outflow P data collected every 3 hours (RPA) to understand potential factors influencing performance
  - Two different operational stages (depths) evaluated did not directly influence TP removal rate from the PSTA Cell, and time of the day did not appear to influence outflow TP concentrations
  - Lower outflow TP was observed during the wet season and during sustained flow rates



Periphyton-based Stormwater Treatment Area (PSTA): Performance, Design & Operational Factors

Progress

- Developed improved POR annual water & P budgets
  - The majority of the flow to the cell was through inflow structures
  - Rainfall and ET were relatively small compared to other water budget components
  - Large seepage into the cell resulted from differences between cell stages and surrounding areas
- Preparing interim report on PSTA Cell results to date



Evaluate the Use of Alternative Vegetation Occurring in Low P Environments to Achieve Low P STA Discharge

Study Objective/Purpose

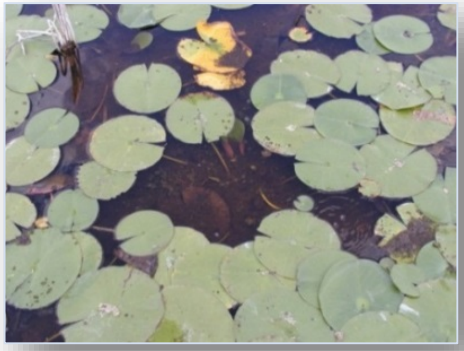
Evaluate nutrient removal efficacy of vegetation that occurs under very low P conditions in STAs and examine major processes and mechanisms underlying P cycling at very low P conditions in STAs

Evaluate the Use of Alternative Vegetation Occurring in Low P Environments to Achieve Low P STA Discharge

Progress

- Defining preliminary path forward for study
  - ***Evaluate the P Reduction Performance of Rooted Floating Aquatic Vegetation (FAV) mixed with Submerged Aquatic Vegetation (SAV)***

- Preliminary Study Tasks:
  - Habitat patch selection
  - In-situ technology methodology development
  - Set-up and long-term field sampling
  - Data analysis and reporting



Impacts of Deep Water Inundation Pulses on Cattail Sustainability

Study Objectives/Purpose

- Evaluate the influence of deep water pulsing on cattails
- Provide recommendations for STA and FEB operations

Impacts of Deep Water Inundation Pulses on Cattail Sustainability

Progress

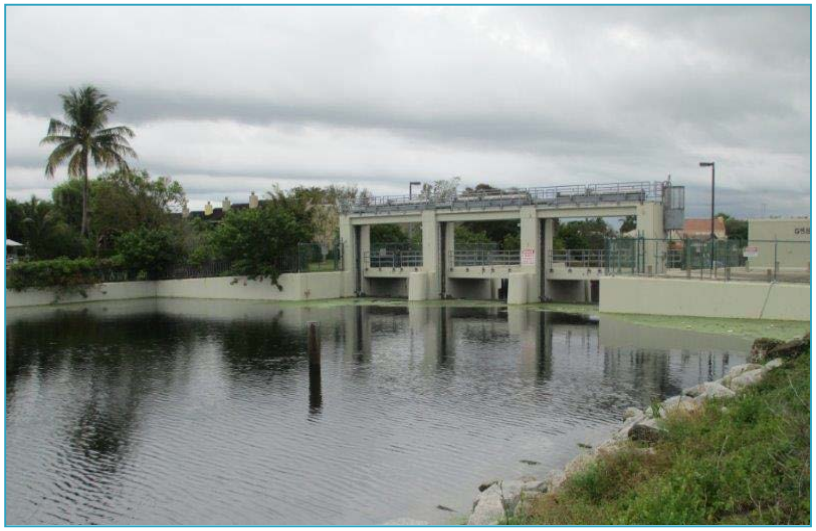
- Began analysis of POR hydrologic data and the in-situ study
  - Plot set-up, initial soil and biomass sampling: **STA-1W Cell 2A & STA-3/4 Cell 2A**
  - Completed 1st and 2nd cattail monitoring events from all plots
  - Water level sensors installed in both STA cells
  - Developed SOPs for study parameters

- Test Cell Study
  - Refurbishing STA-1W North Test Cells
  - Baseline soil sampled collected for laboratory analysis
  - Test cells seeded in early June with cattail seed with an approximate water depth of 6”to improve seed germination
  - The test cell study will be initiated when a healthy mature cattail population is present in the test cells

Development of Operational Guidance for FEB and STA Regional Operational Plans

Study Objective/Purpose

Develop modeling tools and operational protocols for FEBs/STAs to manage storage and flows and minimize STA outflow P concentrations



Development of Operational Guidance for FEB and STA Regional Operational Plans

Progress

- Developing draft reports for field tests conducted in STA-2 Cell 3, STA-3/4 Cell 2A, and STA-3/4 Cell 3A
- Continued refinement of iModel optimization tool for Optimization Framework
- Improved functionality of “WaveOp” tool to assist in real-time operation support

Evaluation of the Influence of Canal Conveyance Features on STA & FEB Inflow & Outflow TP Concentrations

Study Objectives/Purpose

- Determine whether P concentrations change when conveyed through STA inflow and outflow canals
- Evaluate P concentration in sediments and seepage to and from canals

Evaluation of the Influence of Canal Conveyance Features on STA & FEB Inflow & Outflow TP Concentrations

Progress

- The Phase I study of the STA-1W Inflow Basin Canal is complete
- Results presented in STA-1 Inflow Basin Canal Investigation Phase I Report
- Results suggest that the canal acted as a TP source during STA operational period from May 1, 2000 to April 30, 2013
- Mass balance analyses also suggest that the TP load exported from this canal system was mainly particulate phosphorus (PP)
- Conclusions from the Phase I study will be refined and verified in Phase II with field work such as canal cross-section surveys, sediment depth measurement, core sampling, and sediment laboratory testing
- Phase I studies are currently underway for the STA-1W Outflow Canal, the STA-2 Inflow/Supply Canal, and the STA-3/4 Inflow/Supply Canal

Sampling Methods for Total Phosphorus

Study Objective/Purpose

- To determine which sampling regime and method provides most accurate representation of TP
  - GRAB
  - ACF (composite flow)
  - ADT (discrete time)

- Installed and evaluated equipment at:
  - G-310 - discharge from STA-1W
  - G-390B - inflow to STA-3/4 PSTA Cell

Sampling Methods for Total Phosphorus

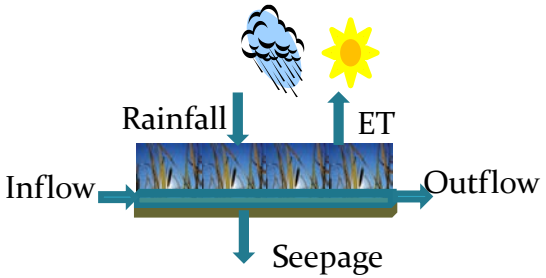
Progress

- ACFs at structures with low flows and potential for reverse flow may not be producing accurate results and may be biased by sampling the same waters repeatedly or by missing some events
- Grab & ADT methods appear to be most reliable for collecting samples
- As habitat, structures likely serve as both acute and chronic sources of TP to the local water column influencing discharge concentrations
  - Fauna, particularly turtles and fish may elevate TP levels through bioturbation
  - Birds, particularly anhingas and to a lesser extent other wading birds and vultures may elevate TP levels through defecation
  - Structures provide habitat for insects, spiders and other flora and fauna and their waste may influence TP concentrations
  - Vegetation control on levees either by herbicides or mowing may be a factor
- Report preparation underway

STA Water & Phosphorus Budget Improvements

Study Objectives/Purpose

- Water and P budgets are an important tool for understanding STA performance
- Need to determine sources of error in water budgets & evaluate methods to reduce the error
- Develop improved water budgets for STA cells in a phased approach for a test case (STA-3/4 Cells 3A and 3B) and then at other locations to meet Science Plan needs



Residual = Outflow + Seepage + ET + Δ Storage – Inflow – Rainfall

STA Water & Phosphorus Budget Improvements

Progress

Phase 1

- Surface water flows were the largest component of the test case water budgets and the largest source of uncertainty in the residuals, and low head differentials across mid-levee culverts were the main source of error
- Seepage was identified as a significant contributor of residual uncertainty for the test case despite constituting a small fraction of water budgets
- Rainfall, ET and Change in Storage were minor contributors for the test case and current estimation methods for these components were found to be acceptable
- Annual water budgets for the test case were greatly improved with revised flow data for the mid-levee culverts, as residuals were reduced from as high as 100% to 8% or less

STA Water & Phosphorus Budget Improvements

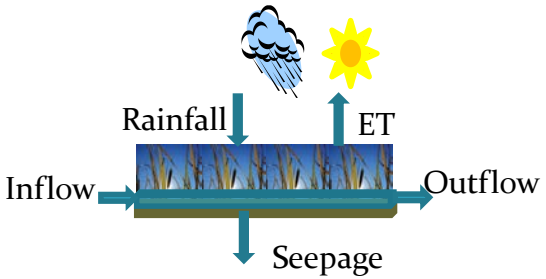
Progress

Phase 2

- Improved flow estimates were completed for the POR for inflow and outflow structures for:

  STA-2 Cells 1-3 and STA-3/4 Cells 1A, 1B, 2A, 2B, 3A, and 3B

- Although the flow data has been improved, ongoing updates to the Water Budget Tool (mainly improved seepage estimation capabilities) will be completed to update water and phosphorus budgets



Summary

- **Restoration Strategies Science Plan Developed to optimize STA treatment performance to meet WQBEL**
- **Nine initial studies in various stages of implementation**
- **Science Plan updates and subsequent results presented in the annual SFER**

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