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

P Flux Study

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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

STA-3/4 Cell 3B Facing East

STA-3/4 Cell 3A

STA-3/4 Cell 3B

STA-2 FW 3

STA-2 FW 3 SAV

STA-2 FW 1
P Flux Study Components

- Water Quality
- Flux Measurements
- Microbial
- Soils
- Particulates
- Vegetation
- Wildlife
- Data Integration and Synthesis
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

<table>
<thead>
<tr>
<th>Method</th>
<th>Parameters</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autosampler</td>
<td>Total phosphorus (TP)</td>
<td>Every 4 hours</td>
</tr>
<tr>
<td></td>
<td>Total nitrogen (TN), Total organic carbon (TOC)</td>
<td>Daily composite</td>
</tr>
<tr>
<td>Grab</td>
<td>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</td>
<td>Weekly</td>
</tr>
<tr>
<td>Field</td>
<td>pH, Dissolved oxygen, Specific conductance, Temperature</td>
<td>Every 30 minutes</td>
</tr>
</tbody>
</table>
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
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
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

- 2019 South Florida Environmental Report, Chapter 5C, Appendix 5C-1

- 2018 South Florida Environmental Report, Chapter 5C, Appendix 5C-3

- Final Project Reports and GEER presentations can be made available
Questions

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