Project Name: Quantifying Phosphorus Uptake and Release from Periphyton and Phytoplankton Communities

Project Purpose: Estimate the contribution of periphyton to Phosphorus (P) cycling in the Stormwater Treatment Areas (STAs) specifically in outflow areas where P concentrations are very low (<20 micrograms per liter, µg L^{-1}]).

Introduction:

The ability of STAs to achieve low outflow total P (TP) concentrations depends on the system's capacity to reduce P by transforming it from one form to another. One set of transformations is the P uptake and release by periphyton or phytoplankton. This transformation may be very important, particularly in low-P conditions (i.e., near the STA outflows).

P uptake and release in the periphyton/phytoplankton community in the STAs have not been measured. The influence of periphyton/phytoplankton communities on TP concentrations in surface water at mid-flow and outflow regions within the STA flow-ways may differ depending on the dominant vegetation community and consequently, differences in periphyton community. For example, TP concentrations in surface water at the mid-flow and outflow regions of submerged aquatic vegetation (SAV) dominated flow-ways in STA-2 are higher under stagnant conditions than flowing conditions. In flow-ways dominated by emergent aquatic vegetation (EAV), this increase was not observed.

Phase I of this study consisted of a literature survey that compiled numerous methods to evaluate growth, uptake, and release of P from the periphyton community (Laughinghaus et al. 2019, Appendix A). Each method has advantages and disadvantages. After consideration of these methods, Phase II was developed to measure bioavailability of dissolved organic phosphorus (DOP) and nitrogen (DON) using periphyton and water from outflow regions of an STA.

Objectives:

1. Estimate DOP and DON removal by periphyton and phytoplankton in outflow region of STA treatment flow-ways where TP concentrations are very low (<20 micrograms per liter [µg L^{1}]).
2. Estimate periphyton and phytoplankton growth and senescence rates in STAs where TP concentrations are very low.
3. Evaluate the influence of periphyton and phytoplankton within different dominate vegetation communities (e.g., SAV, EAV).

Applications of Findings:

Estimates of DOP and DON uptake will indicate how labile this material is and determine if periphyton are key to its removal from the water column. This study will generate information critical to understand P reduction mechanisms by periphyton/phytoplankton and potential factors affecting them. Data may support management strategies to achieve lower outflow concentrations. The study supports the Restoration Strategies Science Plan (SFWMD, 2018) to enhance the understanding of mechanisms and factors that affect P removal, particularly those that are key drivers to performance at low TP concentrations (<20 µg/L).

Relevant Science Plan Key Questions & Sub-questions:

- How can internal loading of P to the water column be reduced or controlled, especially in the lower reaches of the stormwater treatment areas (STAs)?
- How can the biogeochemical or physical mechanisms, including internal flux of P, be managed to further reduce soluble reactive P (SRP), particulate P (PP), and DOP concentrations at the outflow of the STAs?

    - What are the key physicochemical factors influencing P cycling in very low-P environments?
    - What are the sources, forms, and transformation mechanisms controlling residual P pools within the STAs, and how do they compare to the natural system?

Proposed Approach

Phase I. Literature Survey

Completed – a list of various techniques to evaluate periphyton P uptake, growth, turnover and release were compiled.

Phase II. Bioavailability Study

Based on the literature survey and evaluation of laboratory experiments that have successfully measured nutrient uptake, the study outlined in this Phase II was developed. This study will measure DOP and DON bioavailability along with periphyton collected from outflow regions of an STA in both SAV and EAV communities. The effect of SAV and EAV periphyton communities on DOP and DON bioavailability will be measured separately and for two seasons (wet and dry). The study will take filtered STA water, inoculate the water with periphyton from either SAV or EAV regions and incubate the water in 2 L flasks for up to 27 days. One set of flasks will be incubated in dark conditions and the other will be incubated in light conditions. Water quality from each of these experimental conditions will be analyzed every 9 days and at the end of the experiment and compared to initial water quality to determine amount of change. This change will be attributed to periphyton.

Phase III. Further Field and Laboratory analyses

Potential field and laboratory analyses, based on further review of past data, Phase II of this study, and the list of methods to evaluate periphyton turnover rates (Appendix A), will be developed. This plan will study the periphyton community over various flow conditions and seasons in SAV and EAV locations of outflow regions of an STA. Potential methods may include but are not limited to periphytometers, microscopic analyses, enzyme assays, pigment analyses, nutrient analyses, stable isotope analysis, metagenomics and metatranscriptomics.

Project Deliverable and Schedule

Phase #	Description	FY20	FY21

		Q4	Q 1	Q2	Q3	Q4
1	Literature Survey (complete)					
2	Bioavailability Study	X	X	X	X	
3	Field and Laboratory Analyses		X	X	X	X

References

Laughinghouse H. D., D. E. Berthold, M. Barbosa and F. W. Lefler. 2019. A review on tropical and subtropical periphyton and phytoplankton processes and methods of quantification. Prepared for the South Florida Water Management District SFWMD. West Palm Beach, FL. 87 pp.