Periphyton Enzymatic Activities in Stormwater Treatment Areas in Response to Hydraulic Conditions

"While it may seem small, the ripple effects of small things is extraordinary."

Matt Bevin

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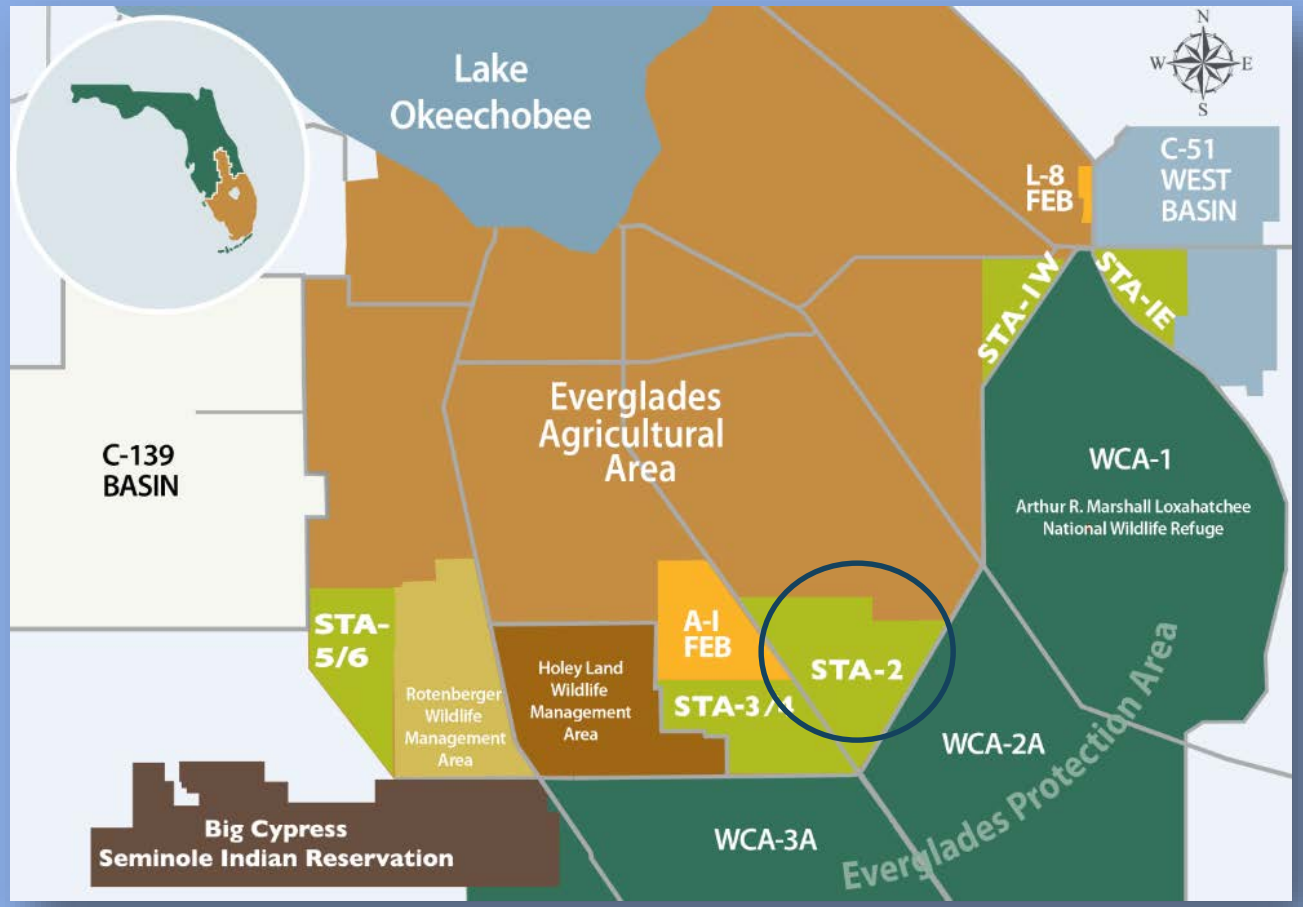
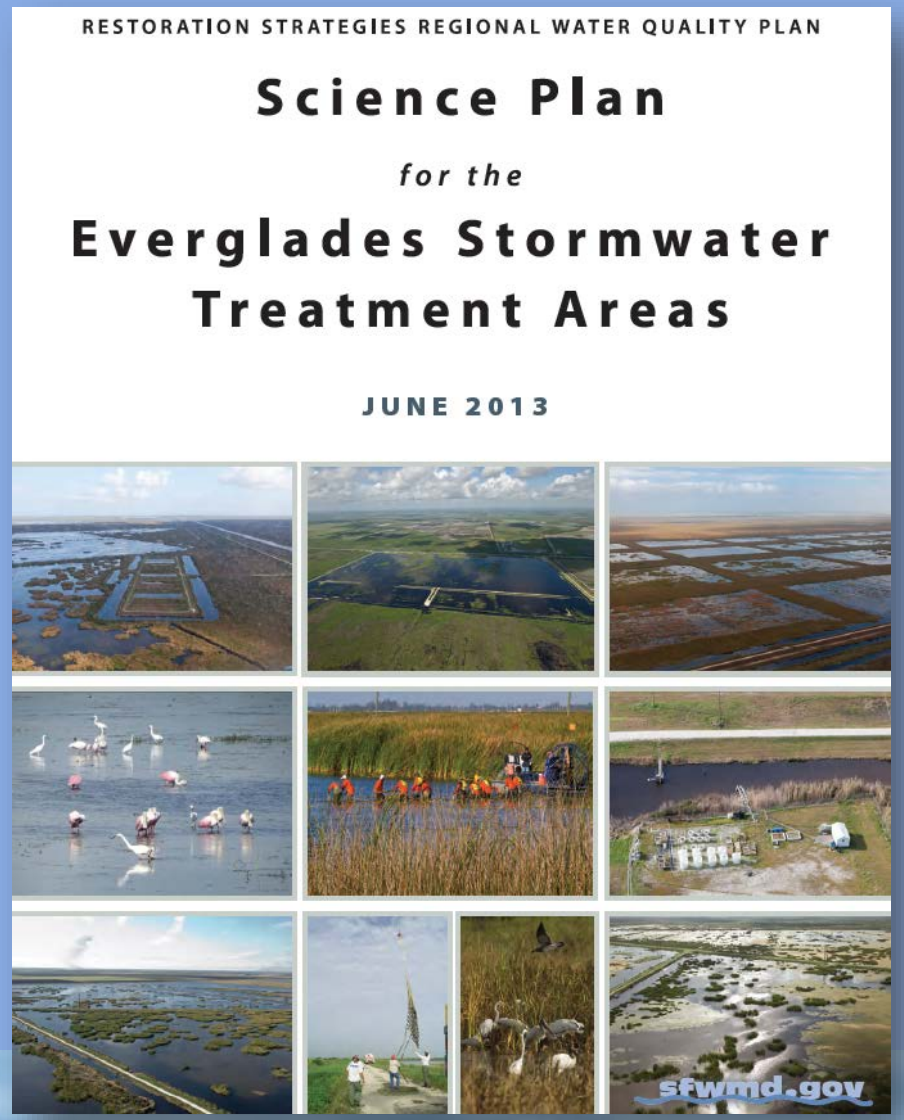
The Stormwater Treatment Areas (STAs) are vital components in Everglades Restoration



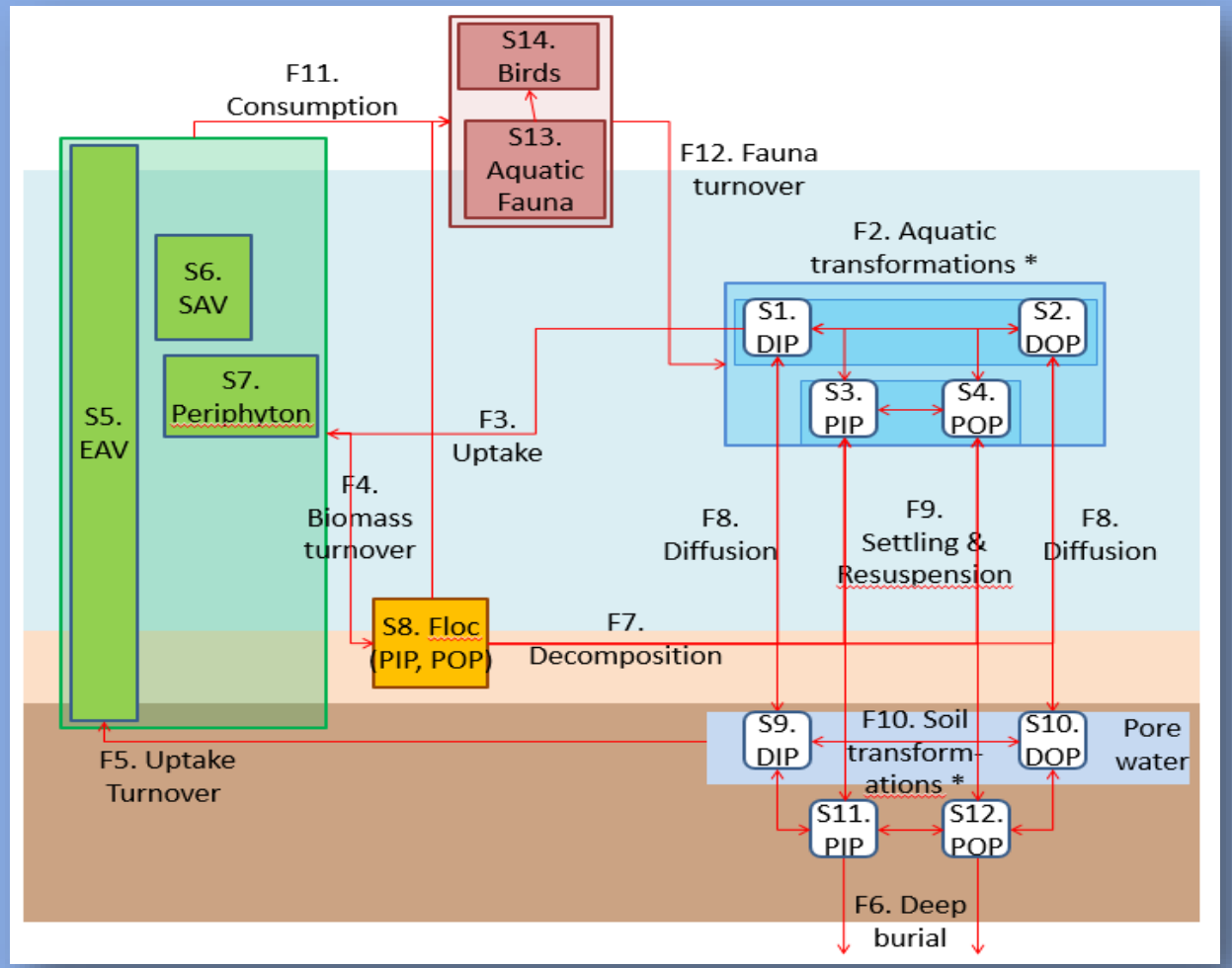


Well-performing STAs have a decreasing nutrient gradient from inflow to outflow and vast coverages of emergent & submerged vegetation communities and associated microbial components.

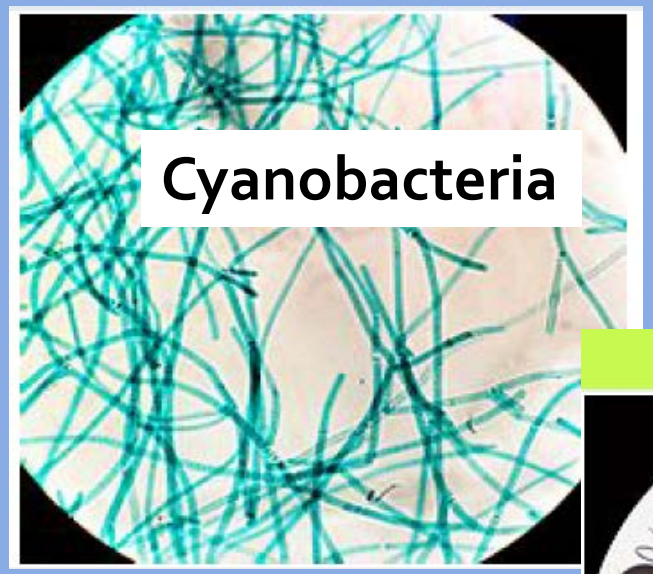
The microbial communities may produce enzymes that act on organic substrates to release needed nutrients.

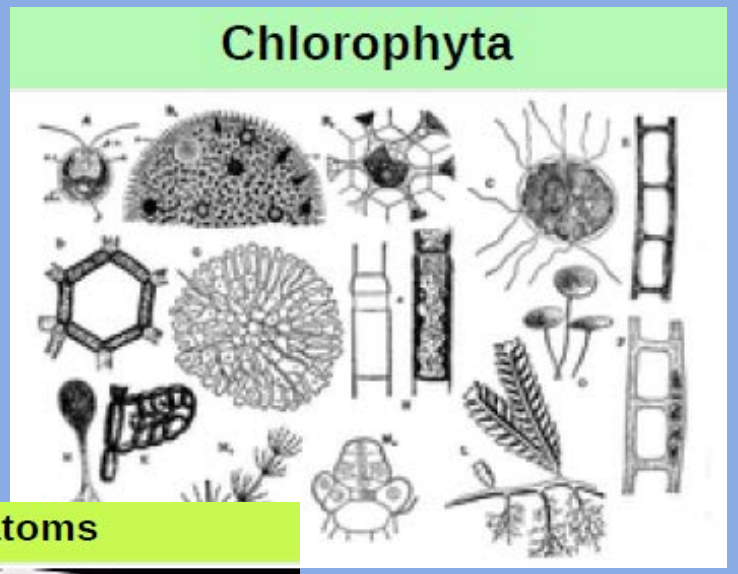
We can use enzyme activity information to gain insight into:

- Nutrient limiting conditions
- Microbial substrate availability along the nutrient gradient
- Options for STA management



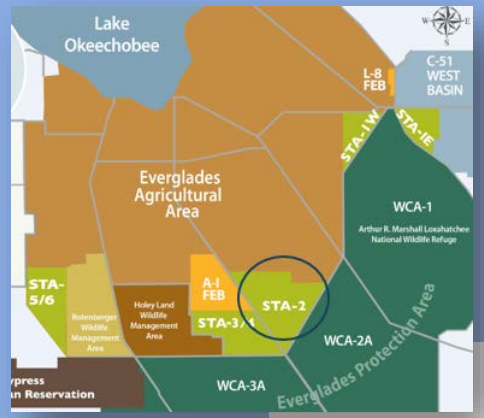
Periphyton is a conglomerate of algae, bacteria, & fungi

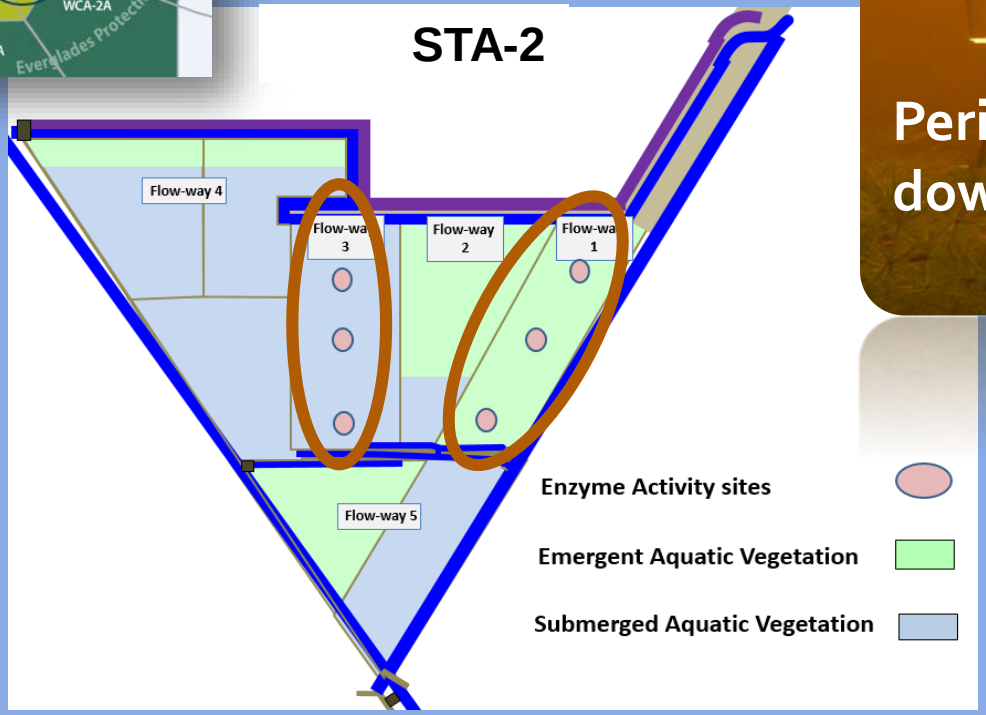




Exoenzymes

Sites were located along the nutrient gradient and enzyme activity was measured during a range of hydraulic conditions.





Our research focuses on quantifying the potential enzyme activity by flow & vegetation.

Phosphorus (P)-acquiring enzymes:

- Alkaline Phosphatase (PHO; monoester P-bonds)
- Phosphodiesterase (BIS; diester P-bonds)

Carbon (C)-acquiring enzyme:

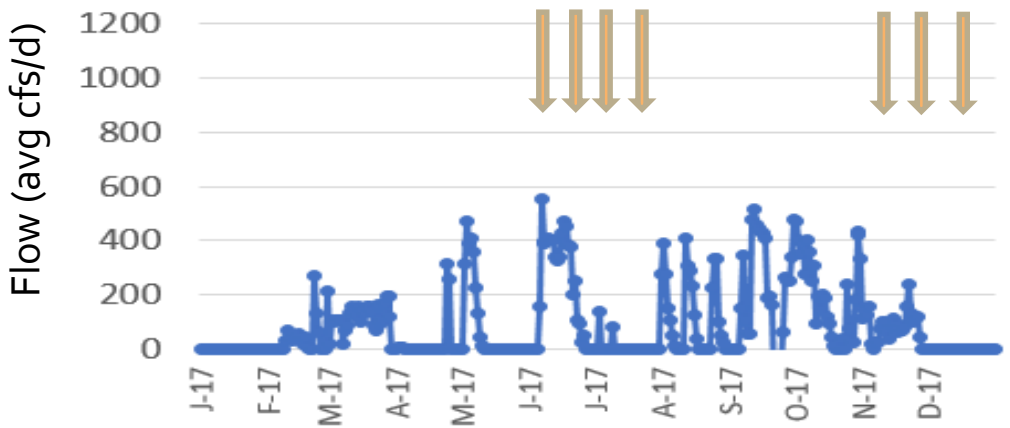
- β-Glucosidase (GLU)

Nitrogen (N)-acquiring enzyme:

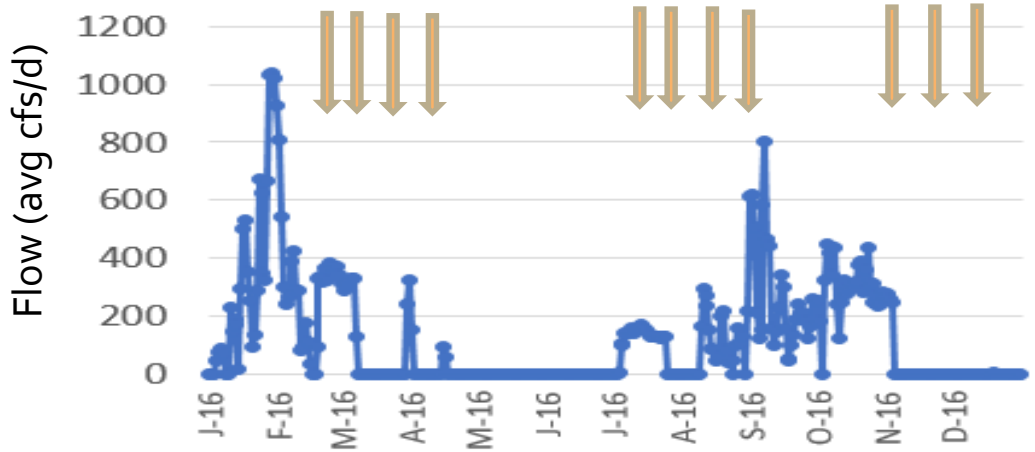
- Leucine aminopeptidase (LEU)

The flows & loadings into the STAs were variable. What were the impacts of the flow conditions on periphyton enzyme activity?

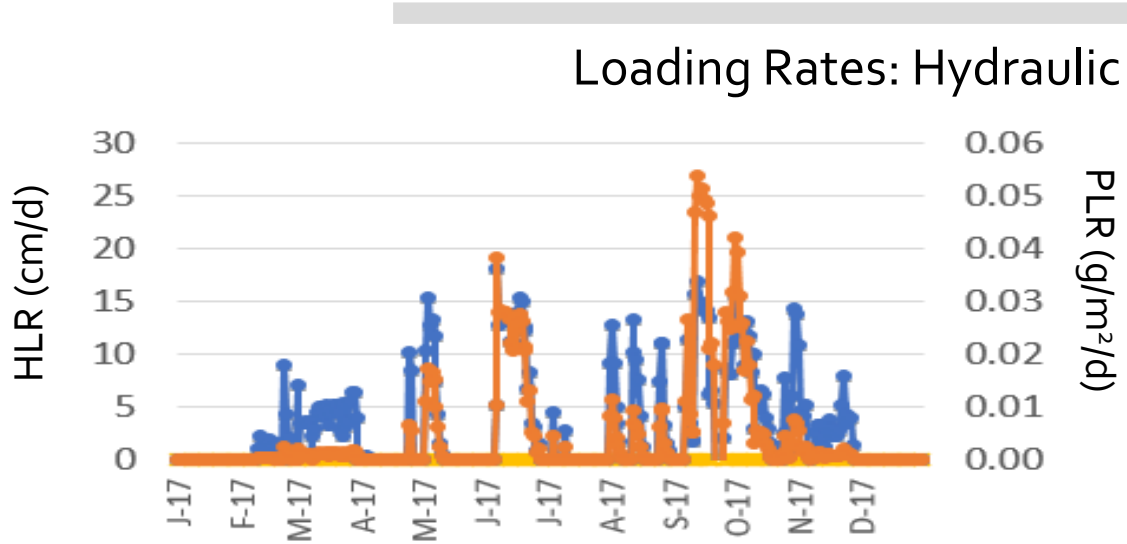
Emergent Vegetation

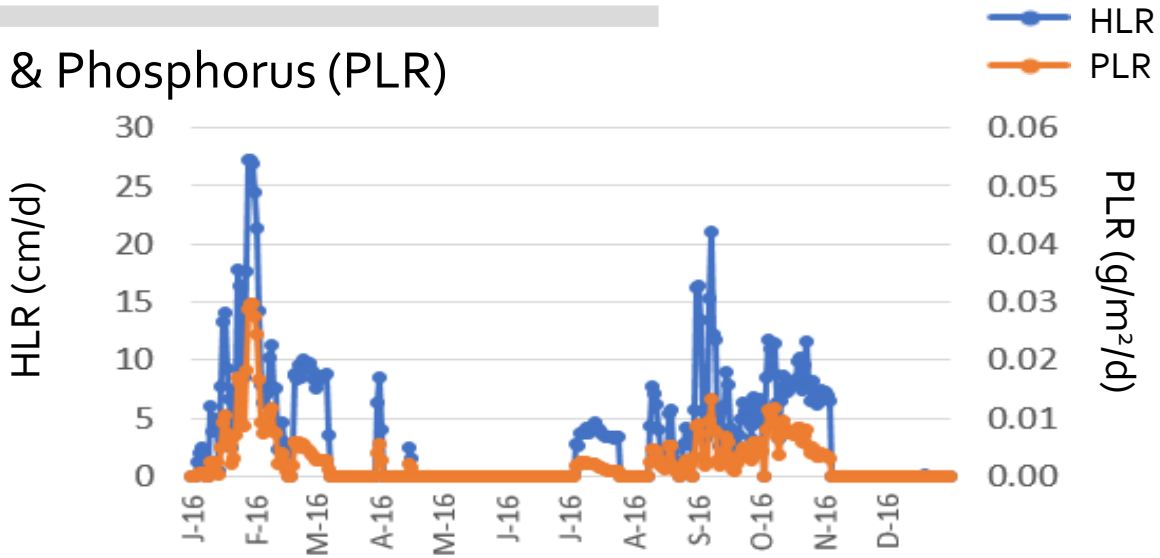


Submerged Vegetation

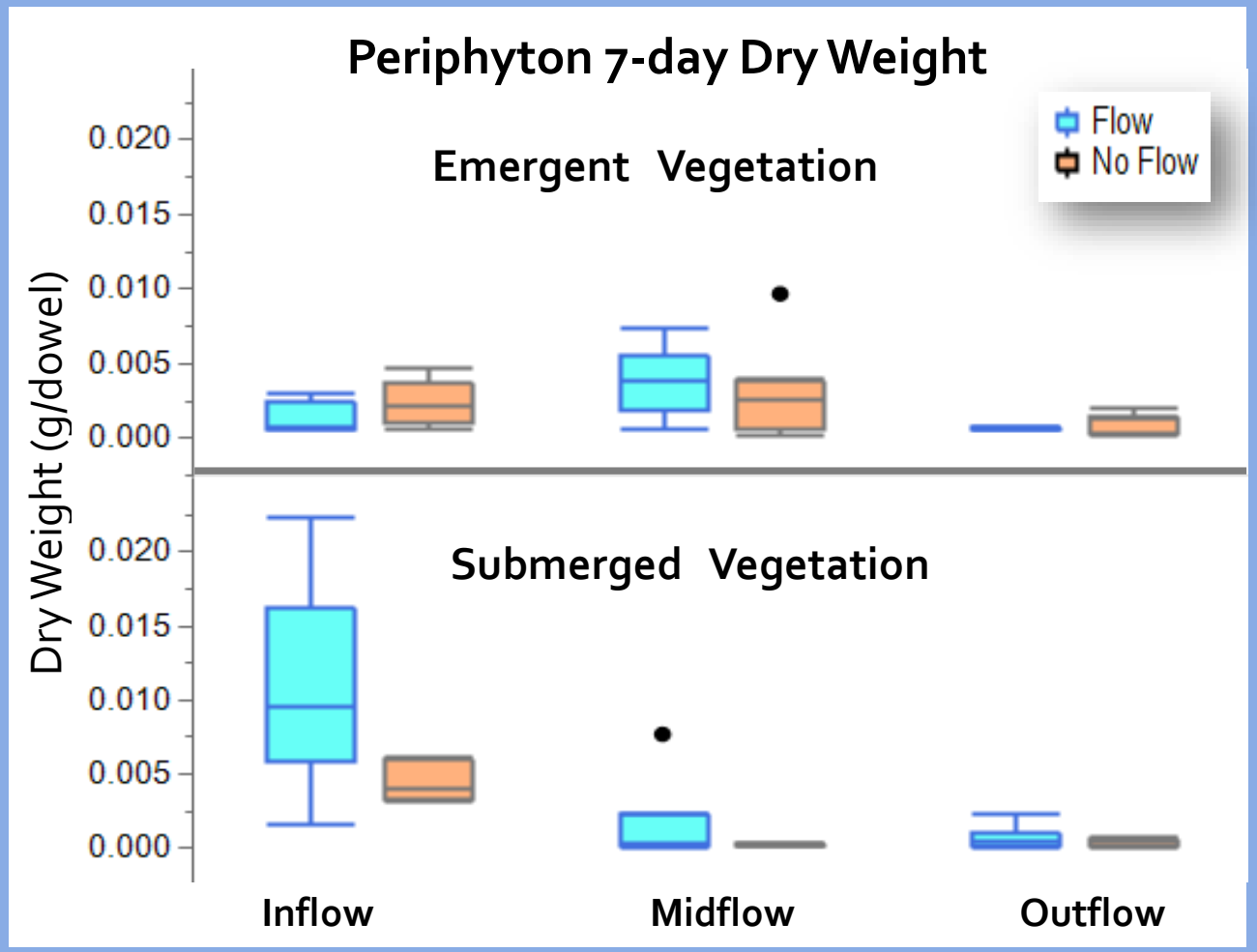


Loading Rates: Hydraulic (HLR) & Phosphorus (PLR)



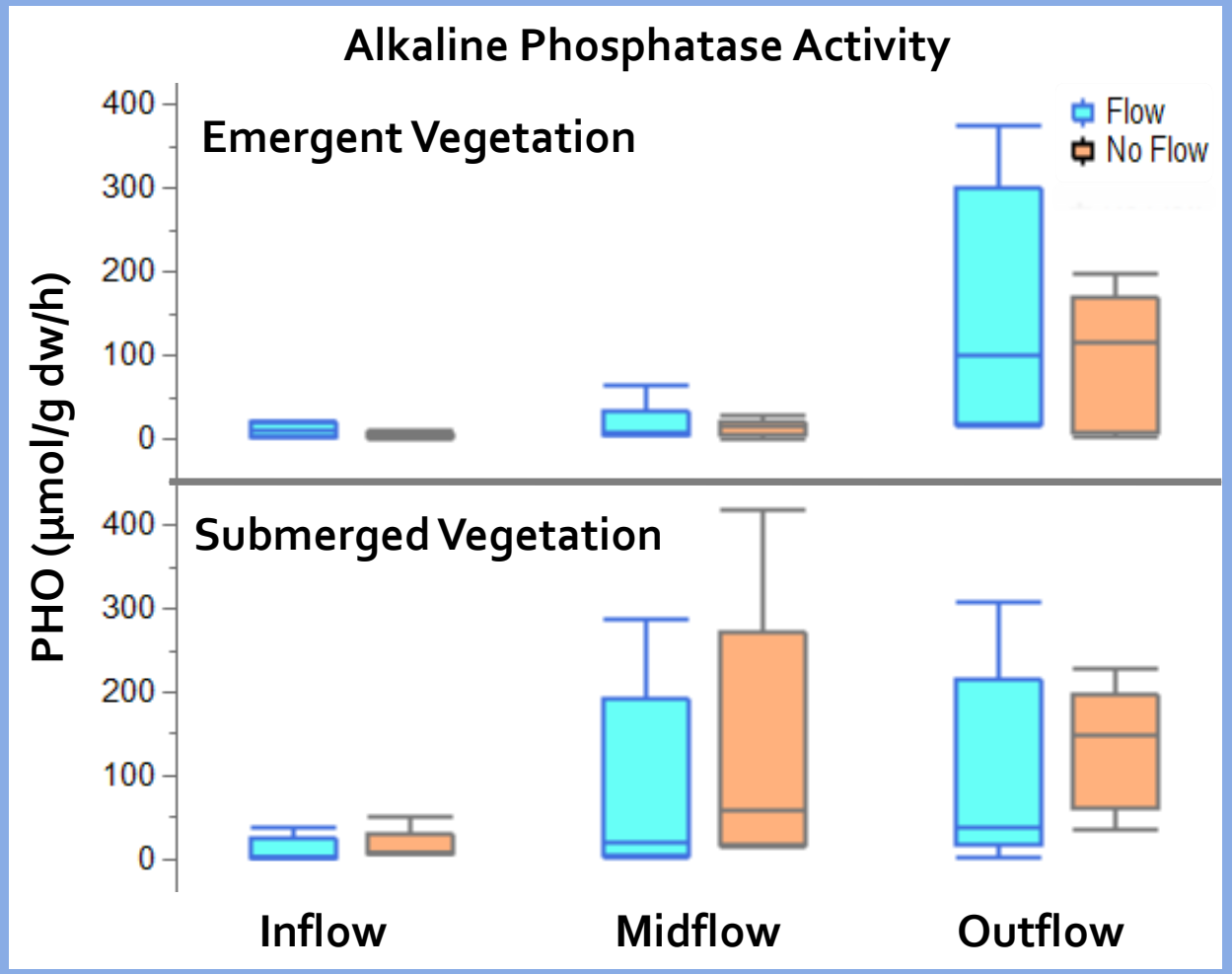


The mass that accumulated on the dowels was greater during flow conditions at the Midflow and Outflow sites.



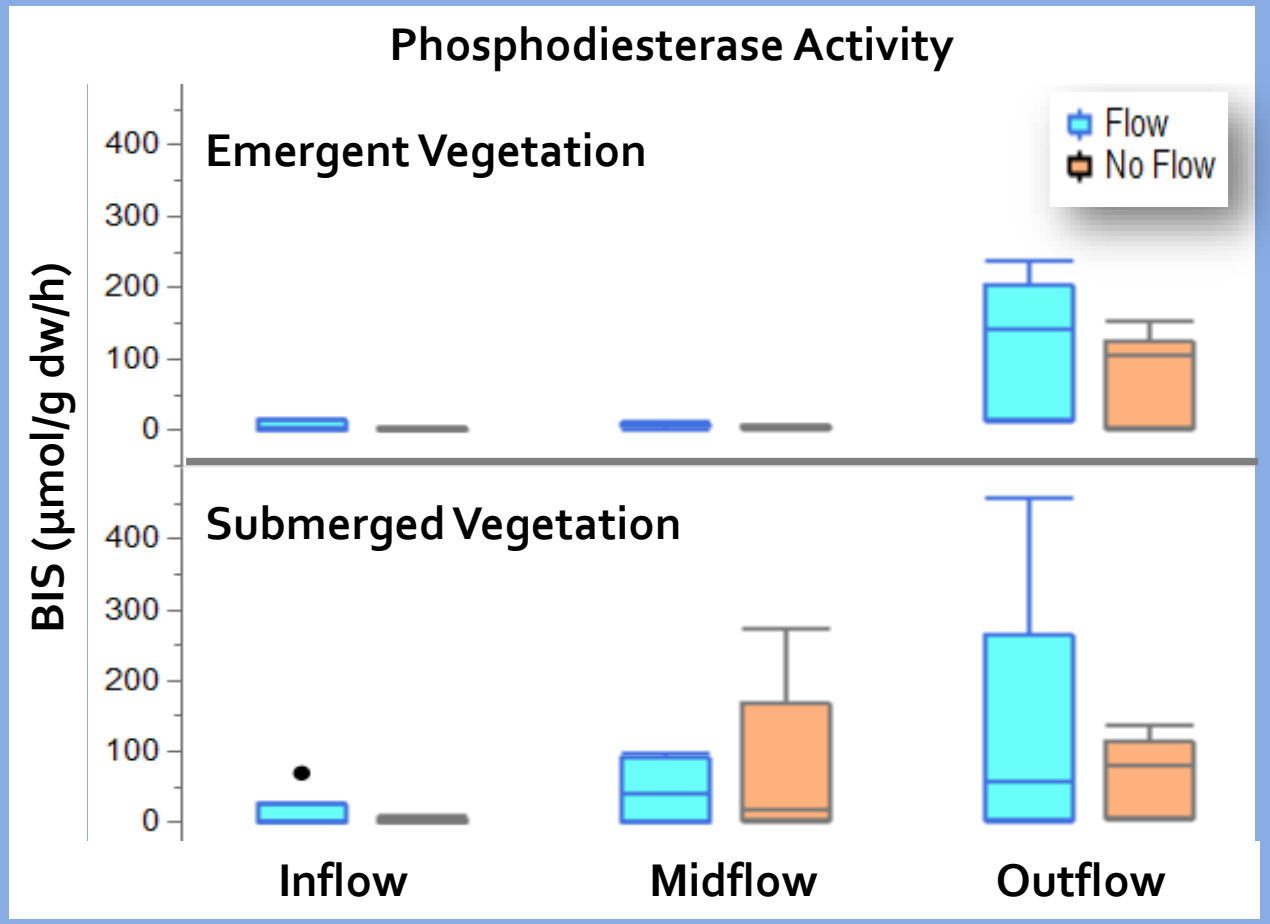
- Opposite trends for Inflows among vegetation communities
- Least amount of mass at outflows
- Organic matter (data not shown):
  - Emergent vegetation: 35-75%
  - Submerged vegetation: 21-50%

The activity of P-acquiring enzyme (PHO) increases along the nutrient gradient.

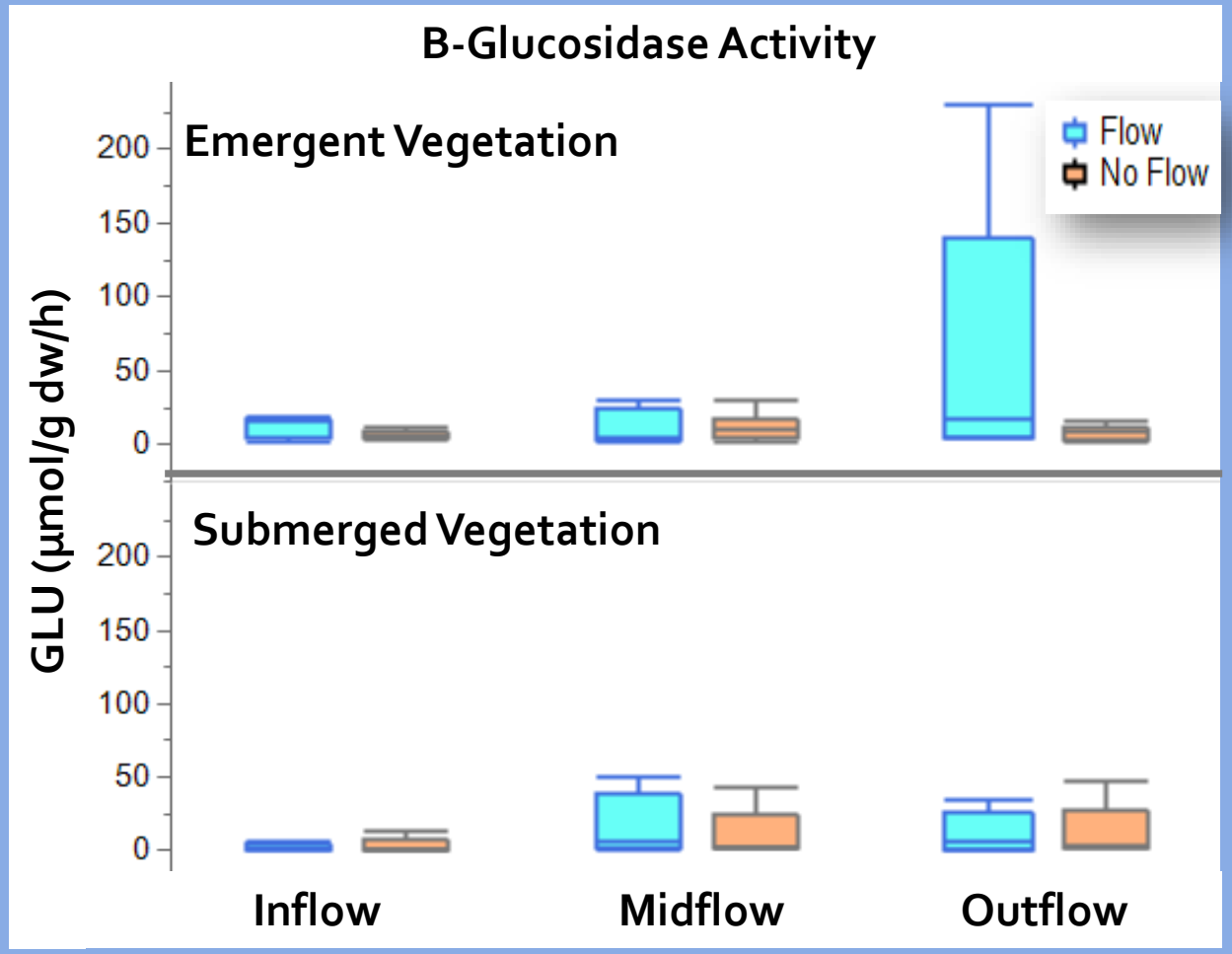


- Enzyme activity generally most variable during Flow conditions
  - Lowest activity at Inflows & not influenced by flow conditions
  - Higher median activity at Midflow & Outflow during No Flow conditions
- Elevated activity at Midflow site in submerged vegetation flow-way

Similar trends with the other P-acquiring enzyme (BIS), indicating that both mono- & diester bounds are being acted upon.

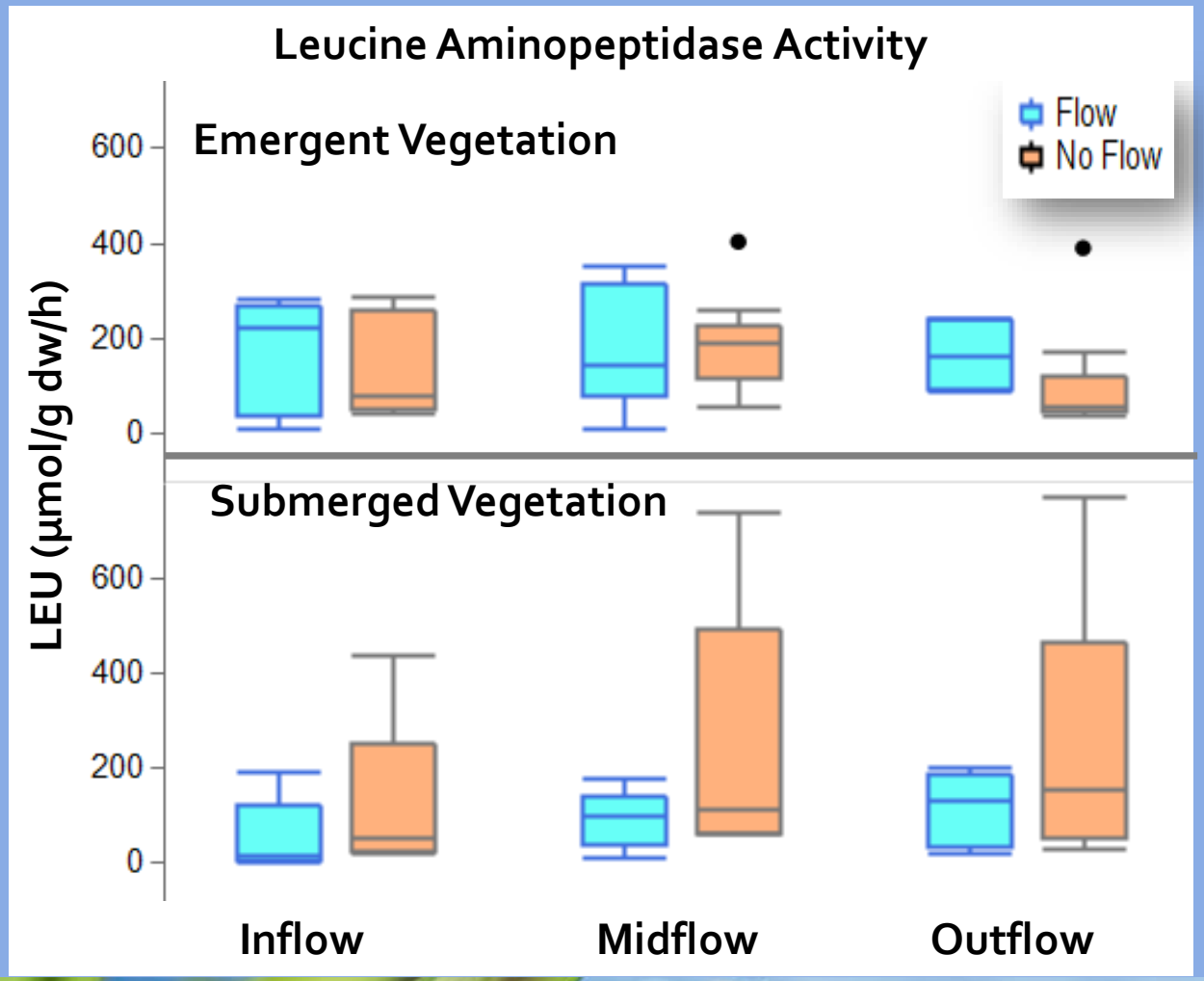


The activity of the C-acquiring enzyme (GLU) was less influenced by flow conditions.



- Increased variability during flow
- Trends similar at Inflows
- Emergent vegetation sites had generally less activity compared to submerged vegetation sites

Contrasting trends among the vegetation communities & flow conditions in activity of the N-acquiring enzyme (LEU).



Emergent vegetation sites:

- During Flow, higher median activity and similar activity along transect
- During No Flow, least activity at Outflow

Submerged vegetation sites:

- Greatest activity at Midflow & Outflow sites
- Higher median activity during No Flow

Summary of Findings

- Enzyme activities differed between vegetation communities
  - Submerged vegetation flow-way may have been more nutrient limited along the gradient
  - N-acquiring enzymes showed opposite responses by vegetation
- P-acquiring enzymes showed the most pronounced increases along the gradient
- Mixed responses in enzyme activity & flow conditions

In the next research phase . . .

The enzyme activity will be measured in <u>both</u> vegetation communities simultaneously in a flow-way where they are co-located (STA-3/4 Cell 3B)

Additional metrics (to better characterize the periphyton):

- Genus ID & bacterial abundance
- Standing crop biomass
- Periphyton growth rate (6-week)

Appreciation to the Microbial Team!

- *South Florida Water Management District:* Delia Ivanoff, Jill King, Sue Newman, Matt Powers, Jake Dombrowski, Odi Villapando, Luis Canedo, Richard Walker, Meifang Zhao, Water Quality Laboratory
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- *DB Environmental, Inc.:* Cassandra Cummins, Dawn Sierer-Finn, Aubrey Frye

"Little things mean a lot"

anonymous

Great things are done by a series of small things brought together.

Vincent Van Gogh

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