

Nutrient retention from urban runoff via vegetative uptake and sedimentation in created wetlands in subtropical Florida

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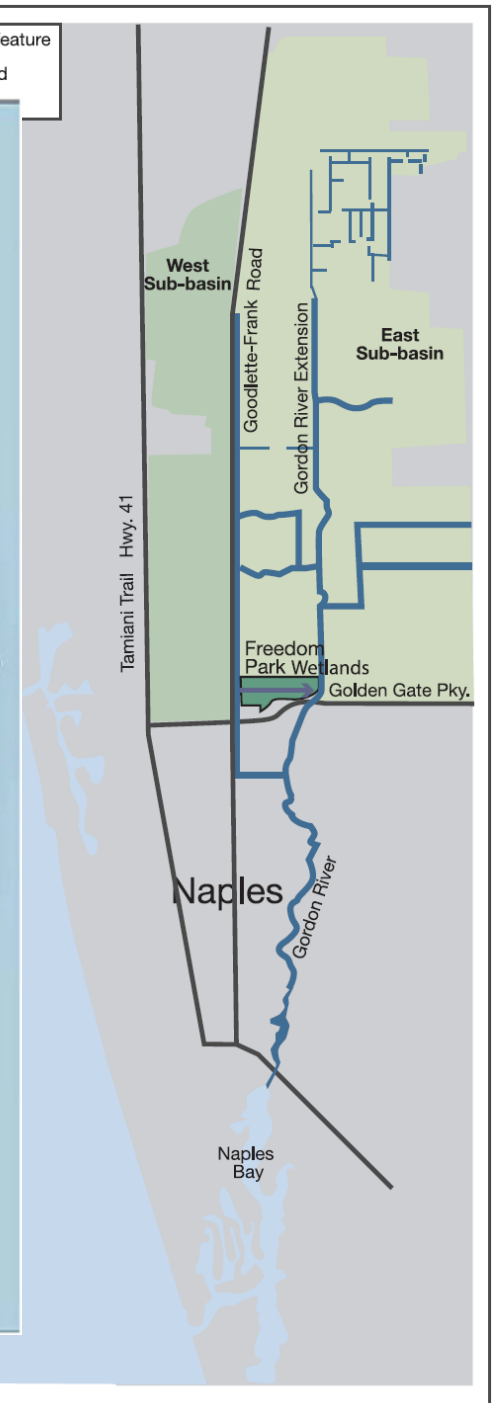
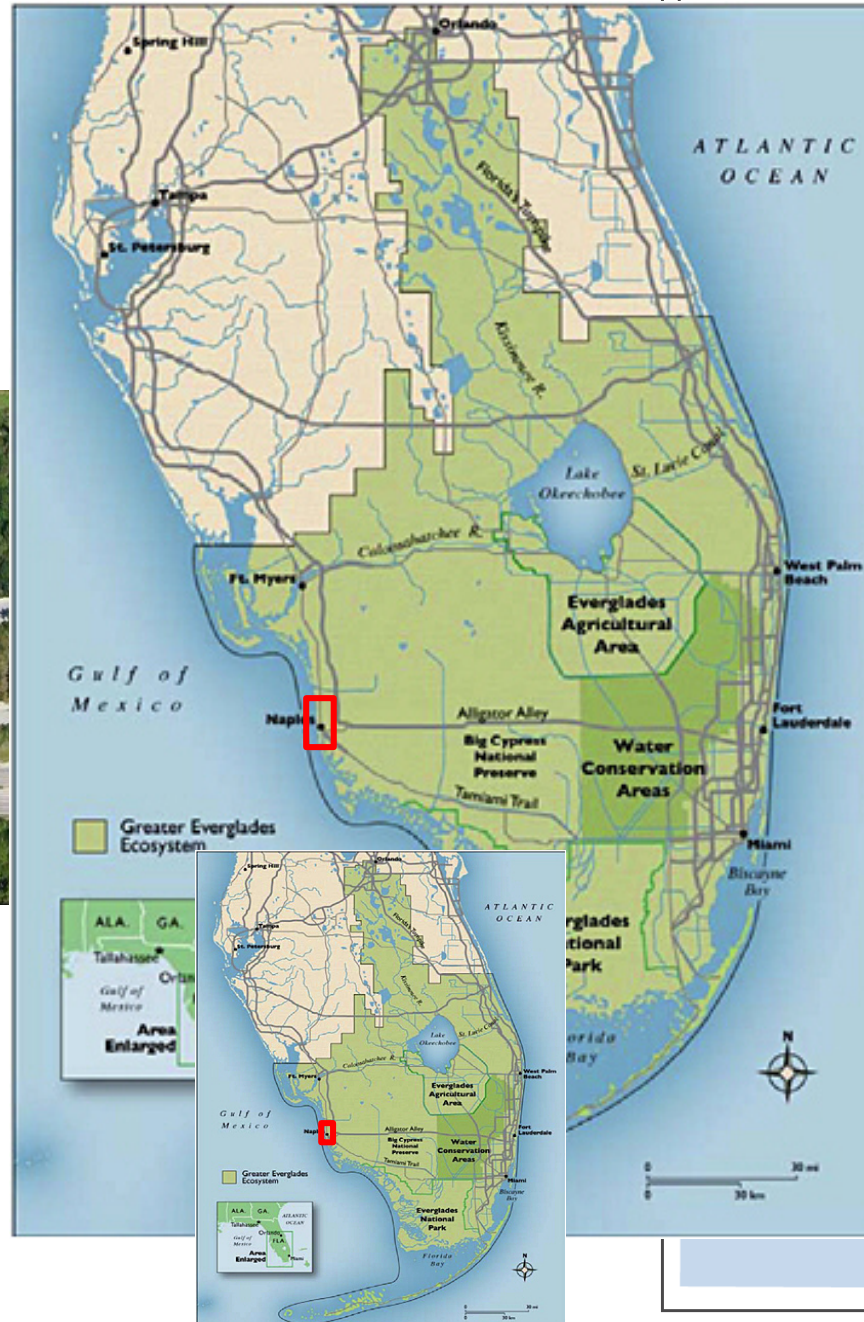
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Wetlands as Pollution Treatment

- Domestic wastewater, agriculture runoff, urban stormwater runoff
- CWs avg. retention: 41% TN removal; 39% TP removal
 - Freedom Park 26% TN and 48% TP (Griffiths & Mitsch, 2017)



Freedom Park



Freedom Park preliminary goals

1. Ecological Goal— Maintain healthy functioning marsh zones to attract diverse wildlife and fish populations;
2. Water Quality Goal— Improve water quality received, treated, and discharged by the stormwater system with a goal of 80 percent reduction in phosphorus and 40 percent reduction in nitrogen concentrations;
3. Hydrologic Goal— Control water levels at an adequate elevation to sustain healthy, viable emergent vegetation and target a frequency of 75 percent yearly inundation; and
4. Recreational/Aesthetic Goal — Provide recreational opportunities for activities such as fishing, birdwatching, hiking with views of clean water free of floating algal mats and vistas of aesthetically pleasing plant communities.

Issues studied:

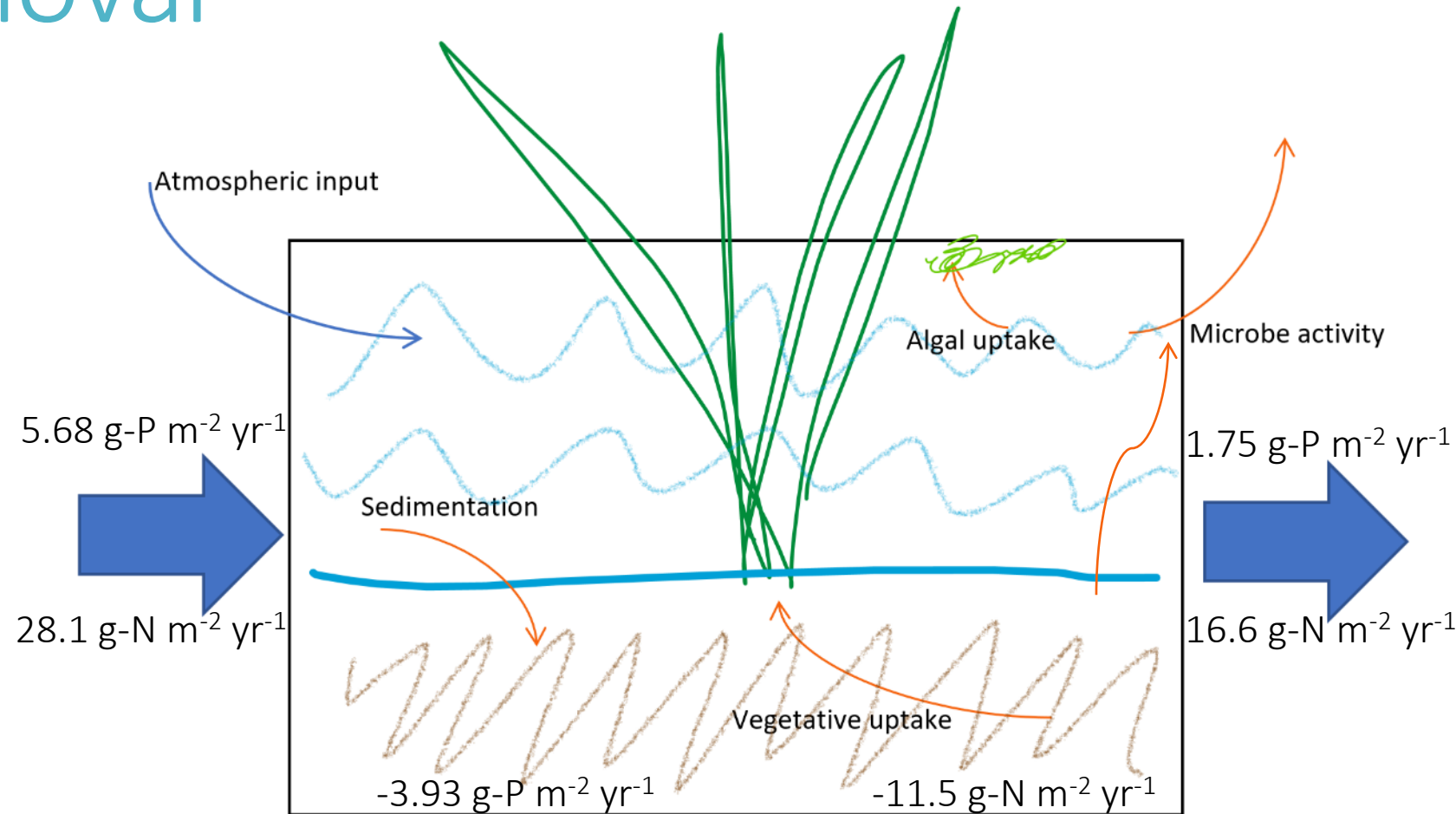
Issue 1: There is a fair amount of exotic vegetation invasion. The makeup of original planting scheme has changed significantly and the site managers need to decide if any sort of exotic control, harvesting, replanting, etc. is necessary.

Issue 2: Multi-year nutrient removal efficiency trends need to be determined and the relative importance of vegetation communities, hydrology, and sedimentation/resuspension.

Issue 3: The overall sources and amounts of inflowing water need to be assessed as to their relative importance on water quality and magnitude and rate of exotic vegetation invasion (shallow water) or vegetation elimination (deep water).

Nutrient Removal

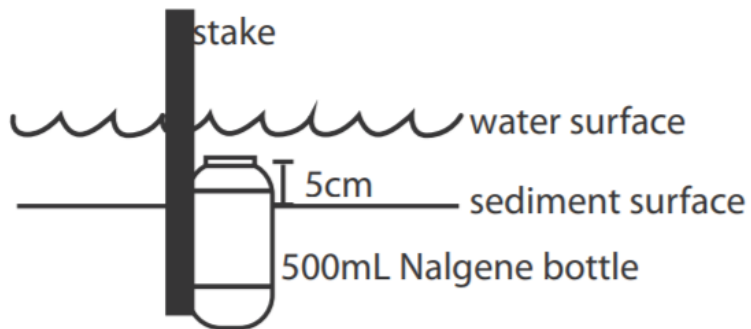
- Nitrogen retention:
 - Vegetative uptake
 - Sedimentation
 - **Microbial activity**
- Phosphorus retention:
 - Plant/**algal uptake**
 - Sedimentation
 - Co-precipitation



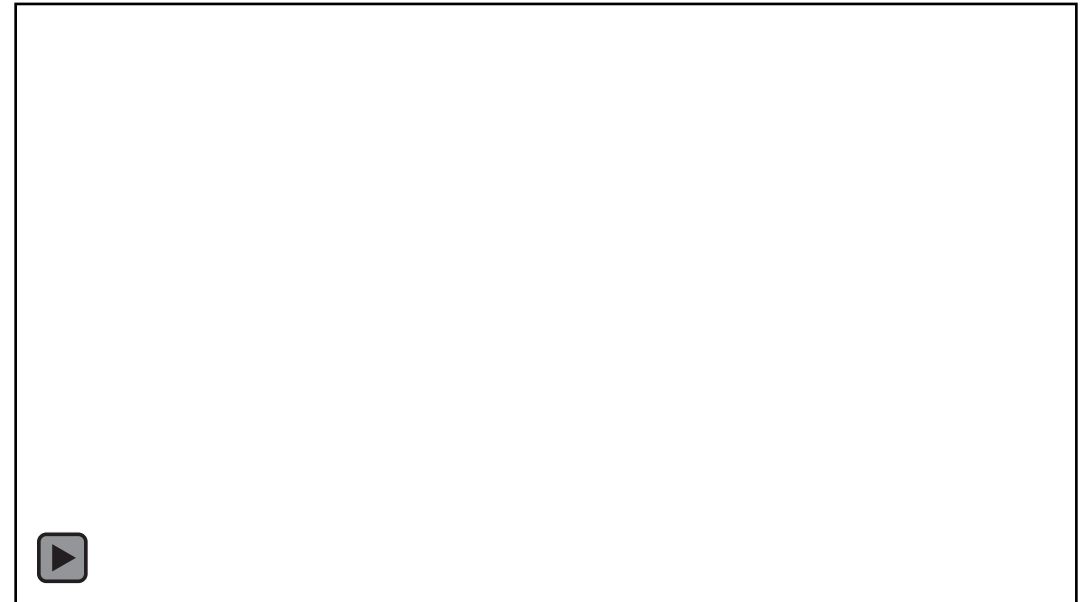
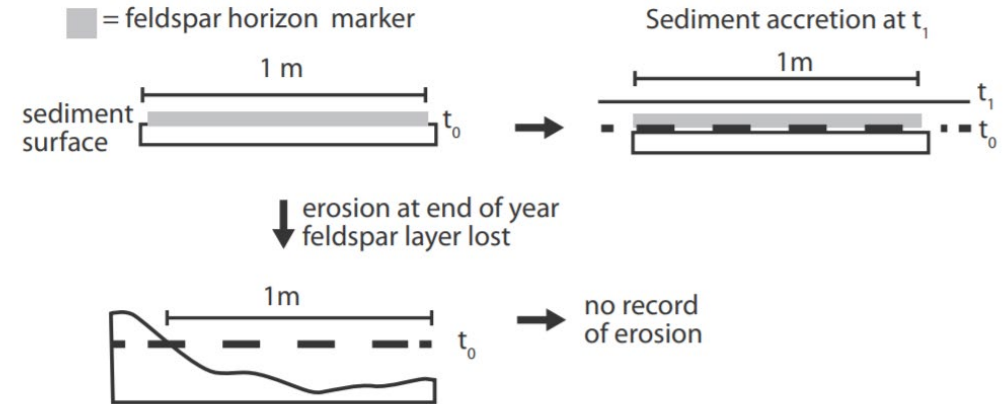
Sedimentation

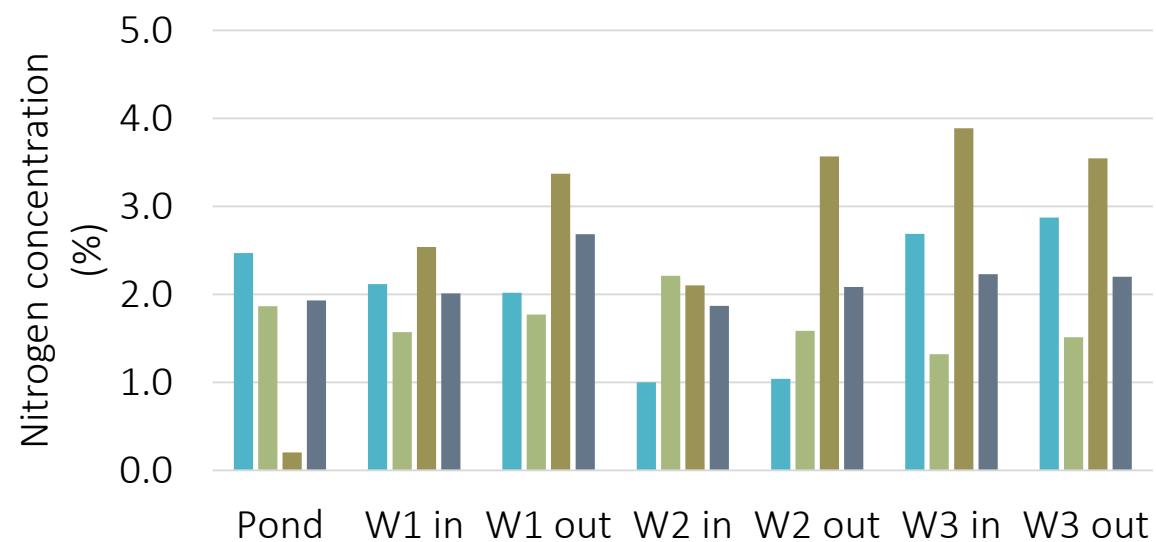
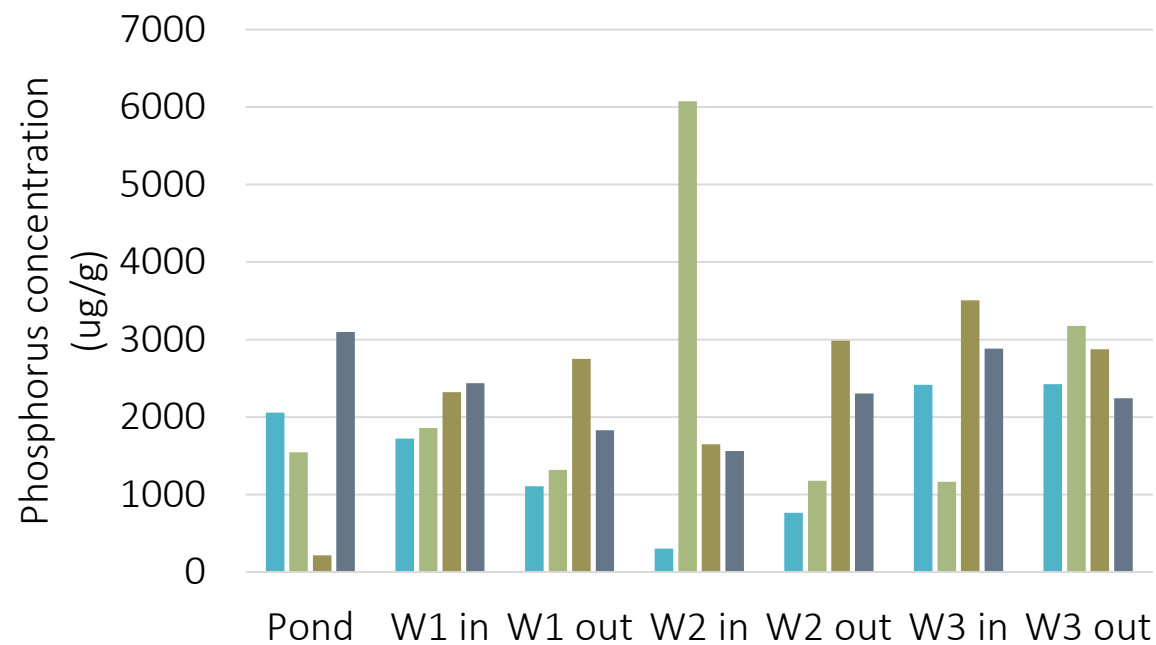
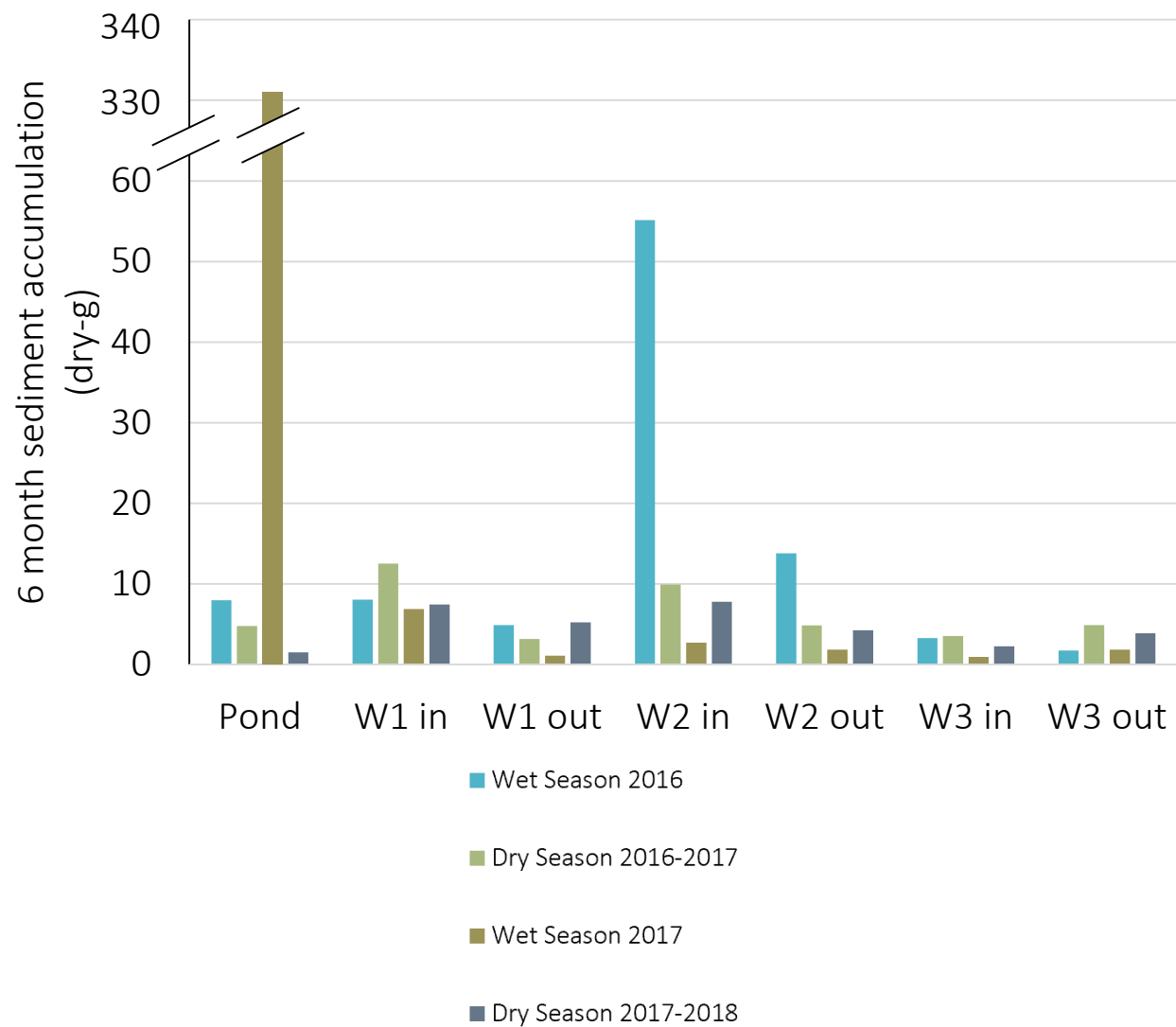
- Bottle sediment traps
 - May 20, 2016 – December 6, 2018
- Horizon markers
 - November 20, 2017 – December 6, 2018
 - “Calibrate” bottle trap method

1) Gross Sedimentation—bottle sediment trap



2) Sediment Accretion—horizon markers



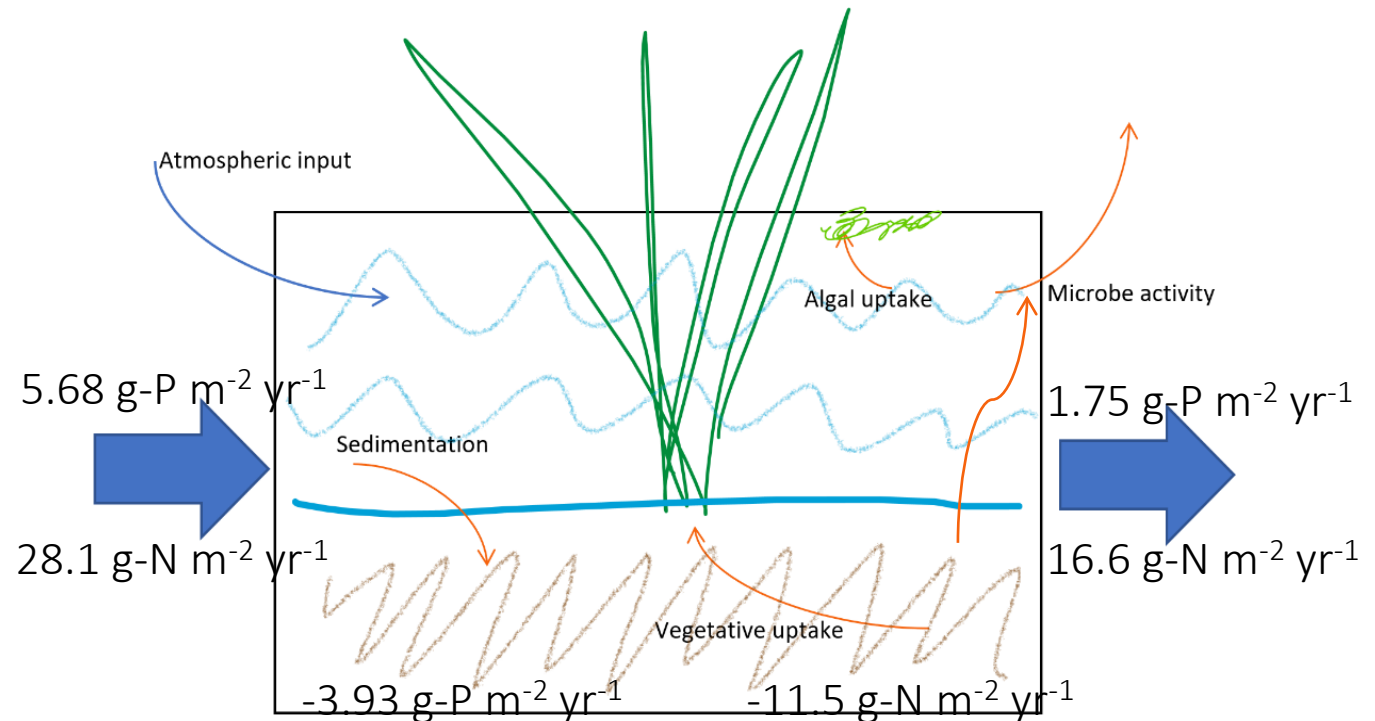


Sedimentation

- ~~$7.41 \pm 1.67 \text{ g-P m}^{-2} \text{ yr}^{-1}$~~ $1.96 \text{ g-P m}^{-2} \text{ yr}^{-1}$
- ~~$76.6 \pm 15.7 \text{ g-N m}^{-2} \text{ yr}^{-1}$~~ $20.3 \text{ g-N m}^{-2} \text{ yr}^{-1}$

- Horizon marker “calibration”

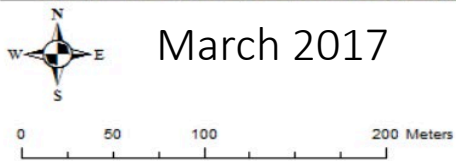
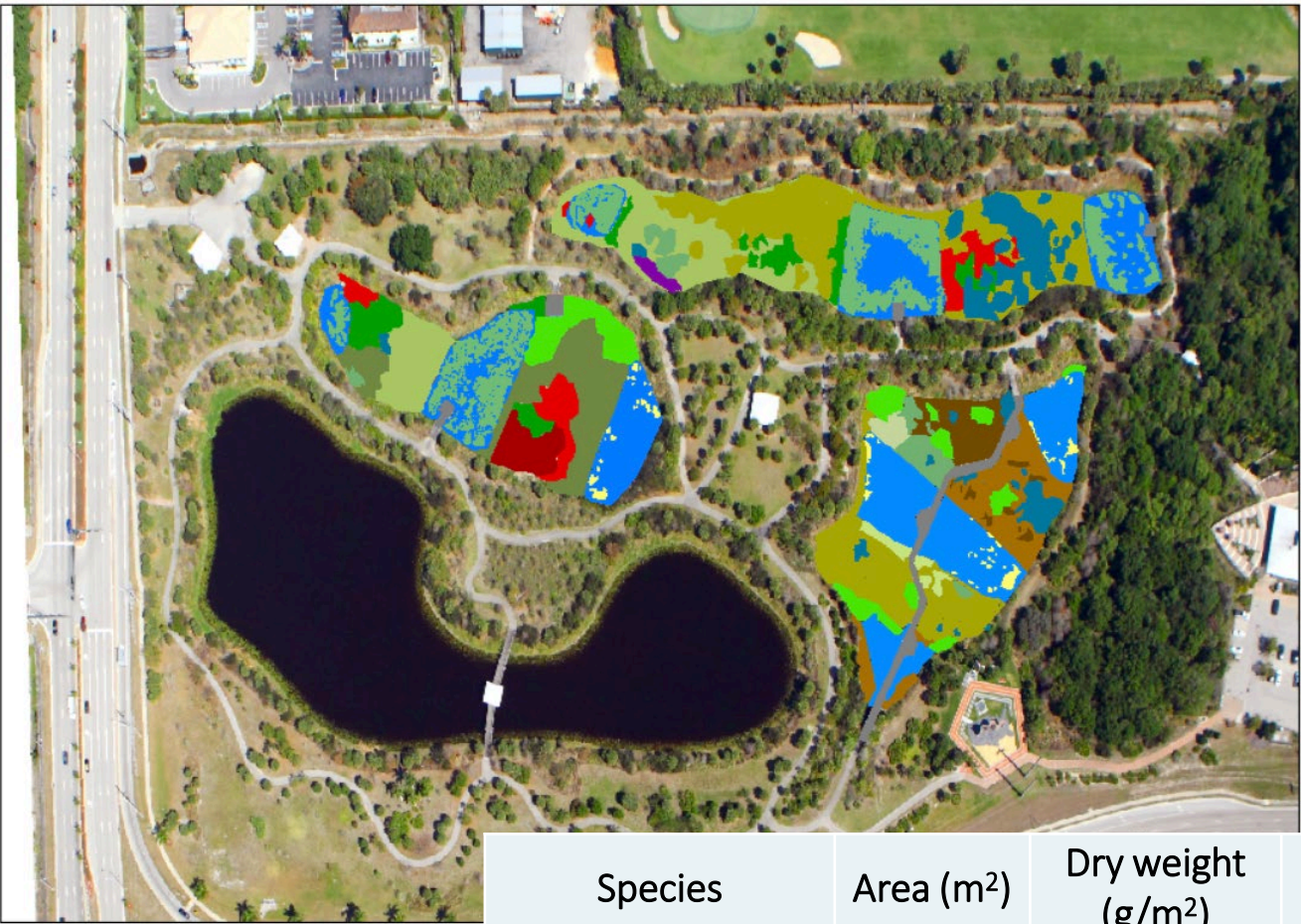
- Additional nitrogen input
→ *Atmospheric deposition?*



Vegetation

- Biomass estimates in September and March
- Subsamples taken for nutrient analysis
- Aerial photography, GIS determination of vegetation communities





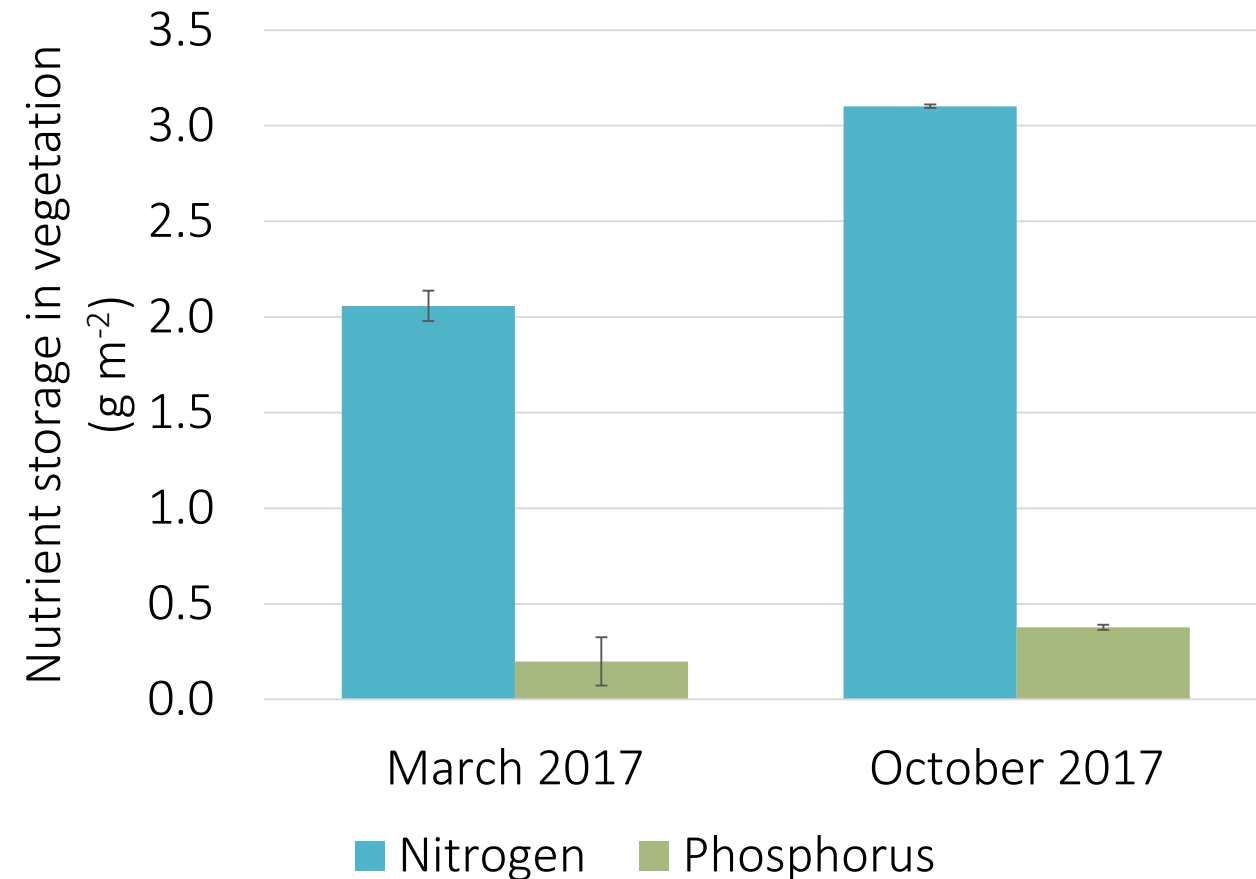
March 2017

- Thalia geniculata*
- Cladium jamaicense*
- Thalia geniculata/Mikania scandens*
- Mikania scandens*
- Mikania scandens/Eleocharis cellulosa*
- Mikania scandens/Pontederia cordata*
- Pontederia cordata*
- Typha* spp.
- Dead *Typha* spp.
- Eleocharis cellulosa*
- Thalia geniculata/Pontederia cordata*
- Nymphaea odorata*
- Nuphar lutea*
- Panicum repens*
- Panicum repens/Mikania scandens*
- Salix caroliniana*
- Open water
- Boardwalk

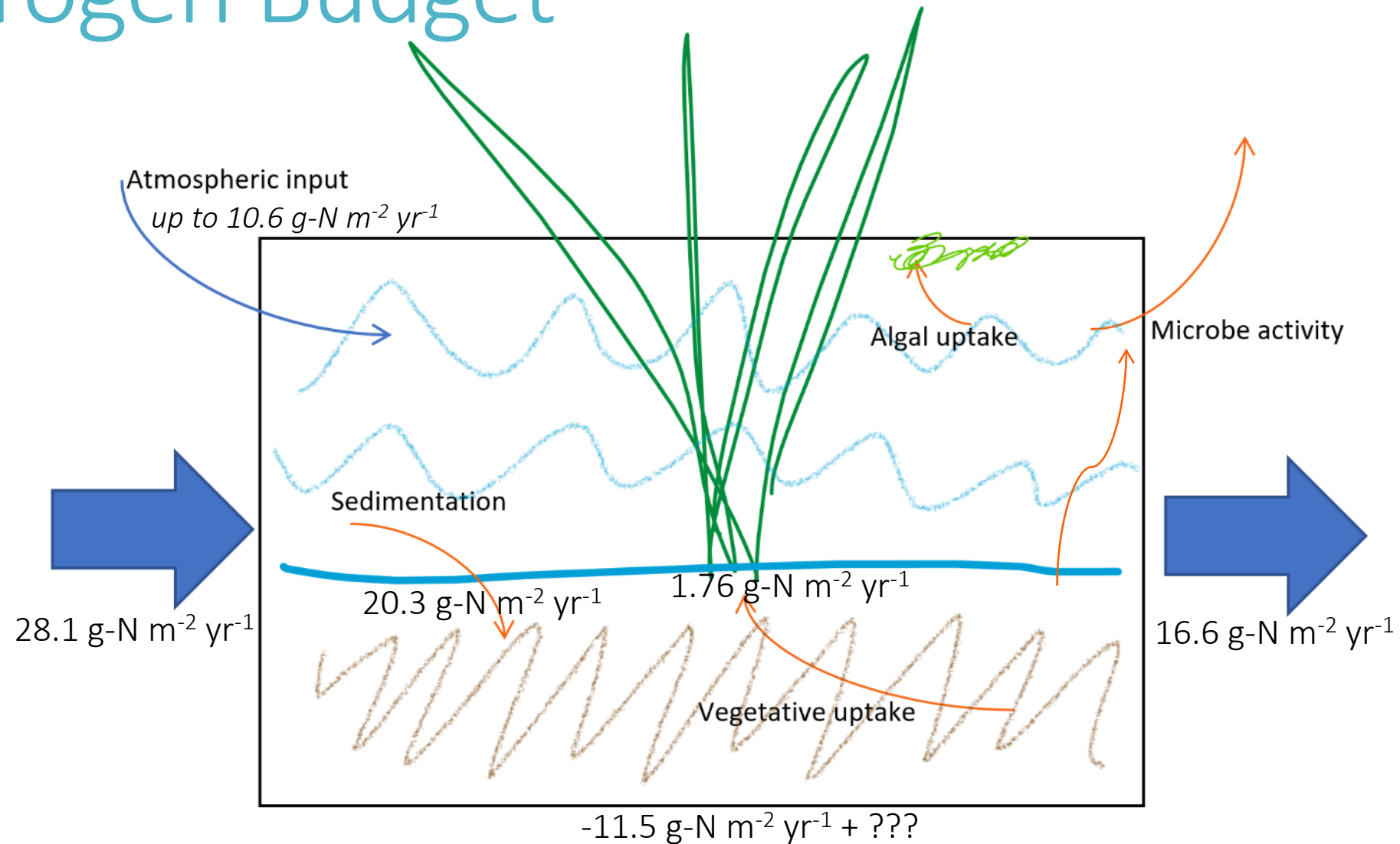
Species	Area (m ²)	Dry weight (g/m ²)	Total dry weight (g)	N (%)	P (ug/g)	N weight (g)	P weight (g)
<i>Pontedaria</i>	171.27	20.0	3425.39	2.345	2590	80.33	8.87
Torpedo grass	1917.86	60.0	115071.39	1.253	1323	1441.85	152.24
Carolina willow	1250.85	330.0	412782.01	2.114	1876	8726.21	774.38
Alligator flag	1677.45	190.0	318714.86	1.621	1737	5166.37	553.61
<i>Typha</i>	880.30	870.0	765859.22	1.194	1056	9144.36	808.75
<i>Eleocharis</i>	2458.33	30.0	73749.81	1.132	901.7	834.85	66.50
Climbing hempvine	5275.01	140.0	738501.29	2.1	3083	15508.53	2276.80
Sawgrass	1278.87	1170.0	1496280.57	0.995	497	14887.99	743.65

Vegetation

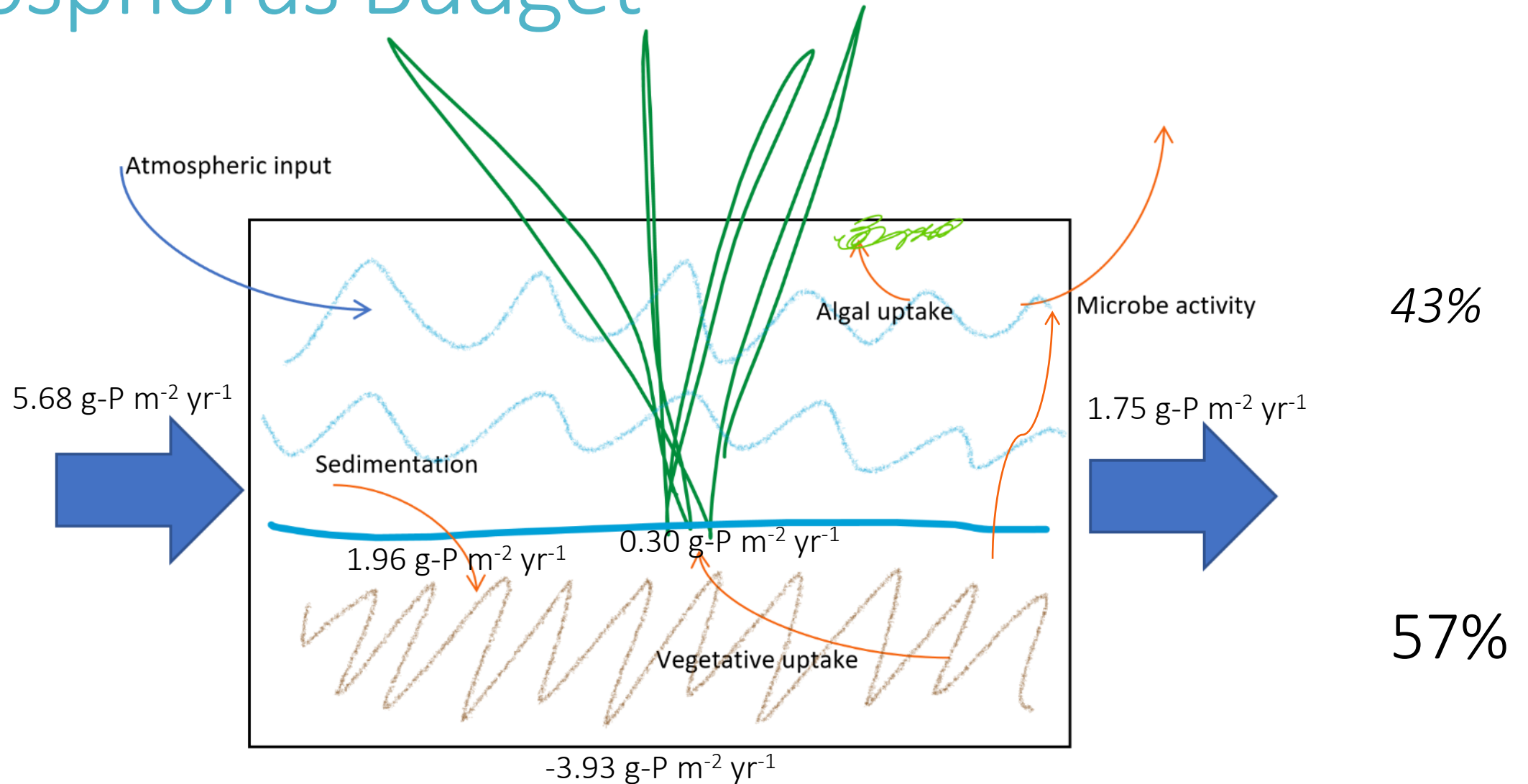
- Through the 2017 growing season
 - N change: +50.75%
 - P change: +89.90%
- $0.30 \text{ g-P m}^{-2} \text{ yr}^{-1}$
- $1.76 \text{ g-N m}^{-2} \text{ yr}^{-1}$



Nitrogen Budget

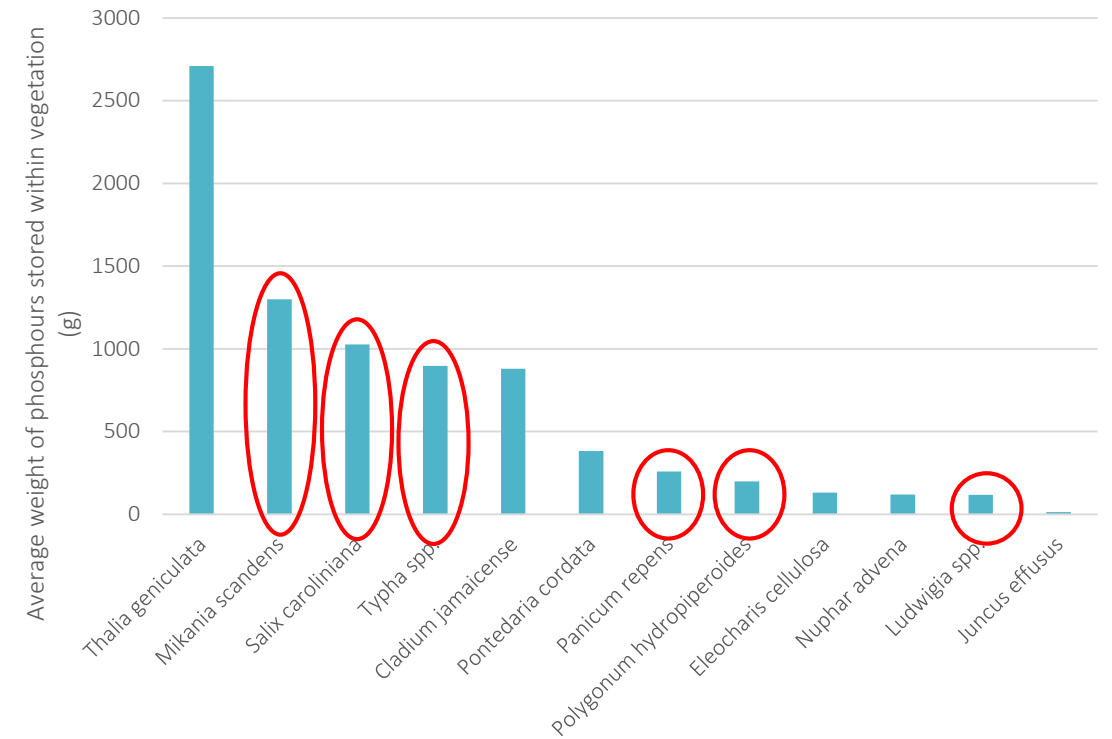
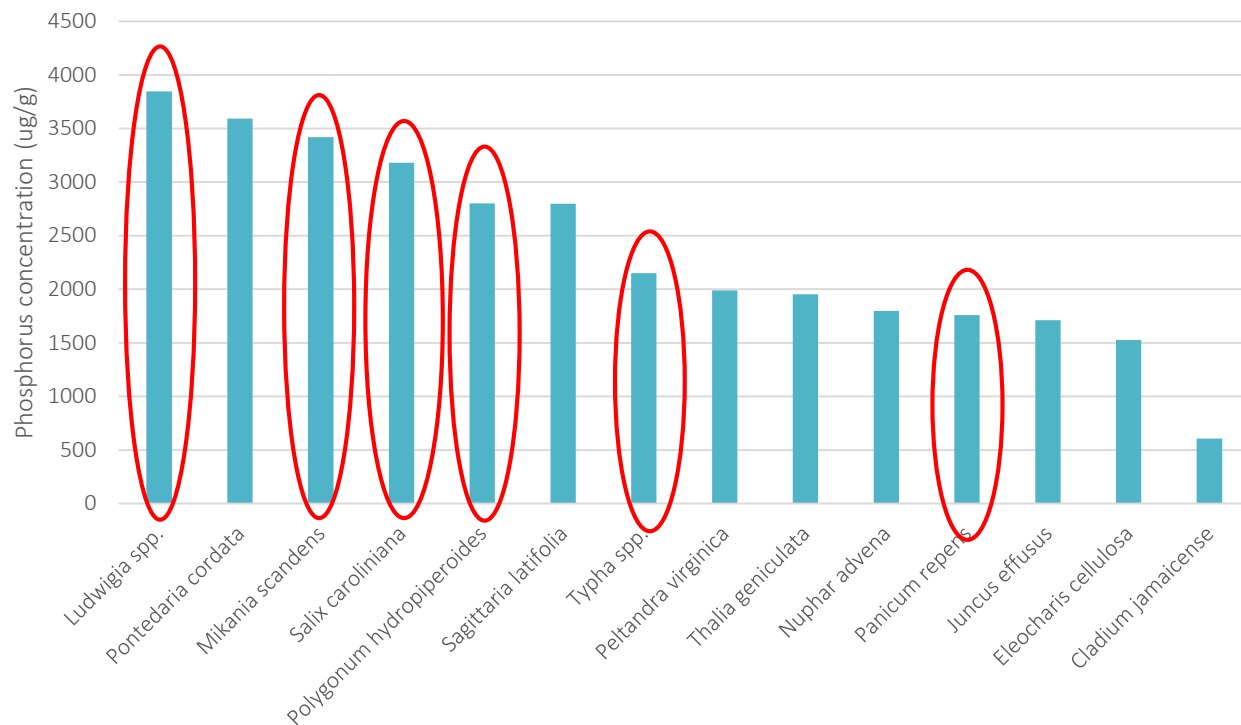


Phosphorus Budget



Proposed issues to research

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Conclusions

- Nitrogen cycle dominated by sedimentation
 - Sustainable N retention: $10\text{-}40 \text{ g-N m}^{-2} \text{ yr}^{-1}$ (Mitsch et al., 2000)
 - Freedom Park retention: $11.5 \text{ g-N m}^{-2} \text{ yr}^{-1}$
 - Focus on microbial activity and vegetative uptake = $\uparrow$ efficiency
- Phosphorus cycle dominated by algal uptake
 - Sustainable P retention: $0.5\text{-}5 \text{ g-P m}^{-2} \text{ yr}^{-1}$ (Mitsch et al., 2000)
 - Freedom Park retention: $3.93 \text{ g-P m}^{-2} \text{ yr}^{-1}$
 - Focus on sedimentation = $\downarrow$ resuspension = $\uparrow$ sustainability
- Priorities need to be implicitly stated prior to creation and wetlands should be managed for those goals



Thank You!

Griffiths, L. N., & Mitsch, W. J. (2017). Removal of nutrients from urban stormwater runoff by storm-pulsed and seasonally pulsed created wetlands in the subtropics. *Ecological Engineering*, 108, 414-424.

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