Inter-Agency Agreement to Conduct Scientific Studies Relevant to the Stormwater Treatment Areas

Agreement No. 4600003125

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PREPARED FOR: South Florida Water Management District, and
Everglades Agricultural Area Environmental Protection District

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Introduction

Macrophyte vegetation is a prominent biological component of the PSTA Cell, but its role in P removal is not fully understood. Macrophytes may directly assimilate water column and/or soil P, and serve as a host for periphytic growth. Further, macrophyte biomass may be an important source of internally recycled soil P to the water column. We examined the PSTA Cell macrophyte community by conducting a semi-quantitative wet season survey of the cell's vegetation, followed by quantitative sampling along inflow, middle and outflow transects to characterize the biomass and tissue P contents of the vegetative community.

Methods

A semi-quantitative vegetation monitoring scheme was used to determine the relative density and coverage of periphyton, emergent vegetation, and SAV species, using an approach developed by DBE for SAV-dominated STA cells. Relative density was assessed on June 23, 2015, at 39 stations within the PSTA cell and 16 additional locations within the Upper SAV Cell. The presence or absence of various macrophyte species was recorded, along with a density or cover ranking on a scale from 0 to 5. The percent of available substrate area covered by periphyton was also considered to assign each station to one of the six density categories. Similar SAV surveys were conducted in Cell 3B on June 24 2015, and in Cell 2B on July 21, 2015.

Spatial maps of the SAV species distribution were constructed using Arc GISv9 Spatial Analyst (Environmental Systems Research Institute, Redlands, CA). Previous surveys conducted in WY2013 were provided in Chapter 5B of the 2014 South Florida Environment Report (Andreotta et al., 2014).

On a coarser spatial scale, macrophyte vegetation samples were collected from the PSTA Cell on June 24, 2015. Three stations within the inflow (B-transect), middle (G-transect) and outflow (L-

transect) regions were sampled using a 0.5 m x 0.5 m square sampling frame (**Figure 1**). Triplicate quadrat throws were performed at each station and wet biomass was recorded in the field, unless total sample weight was < 0.1 kg. In this instance, low-weight samples were retained in their entirety for later weight determination. Otherwise, a grab subsample of the dominant SAV was retained from each station to determine dry:wet ratio and nutrient contents of the tissues. Dry weight of SAV biomass from within the sampled area (0.25 m^2) was used to calculate standing crop biomass. The dried tissue was then ground and analyzed for tissue N, P, C and Ca concentrations using the methods provide in **Table 1**. Biomass P storage was calculated from the standing crop estimate (g dry mass per m^2) and tissue P content (mg P/kg tissue dry mass).

The surveys of relative density of macrophytes and SAV biomass and nutrient contents were similar to efforts conducted on two dates during the previous wet season, on June 19 and July 7, 2014, respectively.

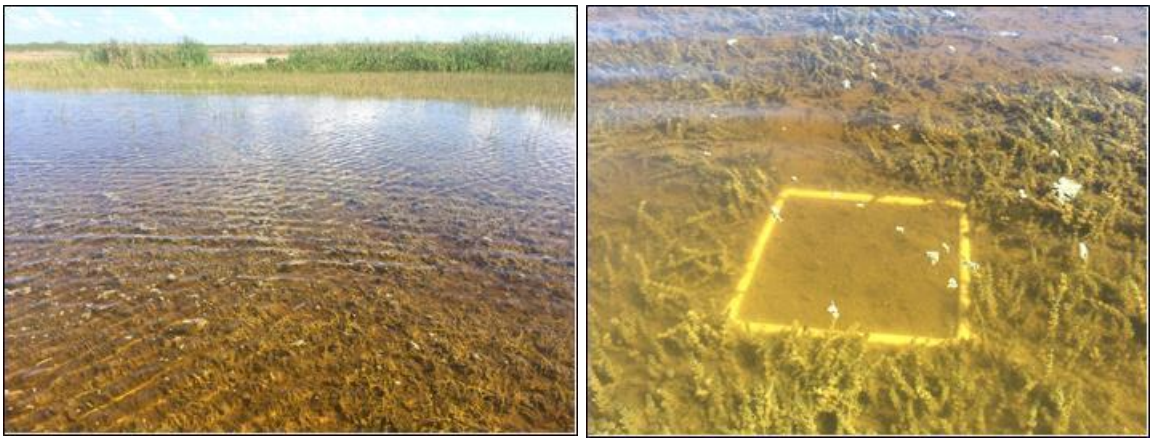

Figure 1. *Chara* beds in the outflow region of the PSTA Cell on June 24, 2015, before (left) and after (right) macrophyte sampling from a 0.5 m x 0.5 m quadrat.

Table 1. Methods for macrophyte and periphyton tissue analysis.

Parameter	Units	Method
TP	mg/kg	EPA 365.2/COE 3-227
TN	%	DBE SOP MVP
TOC	%	DBE SOP MVP
Total Ca	%	EPA/SW 3050B/EPA/SW 7140
Dry Weight	g	ASA 21-2

Results and Discussion

Spatial distribution of macrophytes in the PSTA Cell

The macrophyte community in the PSTA Cell currently is dominated by *Chara* sp., with small populations of *Potamogeton illinoeinsis* and *Najas guadalupensis* near the inflow region of the cell (**Figure 2**). *Potamogeton* has also become established in the outflow region. A second *Najas* species commonly observed in the Upper SAV cell, *N. marina*, was not observed in the PSTA Cell in June 2015. Periphyton coverage was moderately dense or greater throughout the PSTA Cell in June 2015, and *Utricularia* sp. coverage reached moderately dense levels in the middle portion of the cell (**Figure 3**). *Eleocharis* sp. distribution was widespread, though the effects of a recent herbicide treatment were evident during our June 2015 surveys (**Figure 4**).

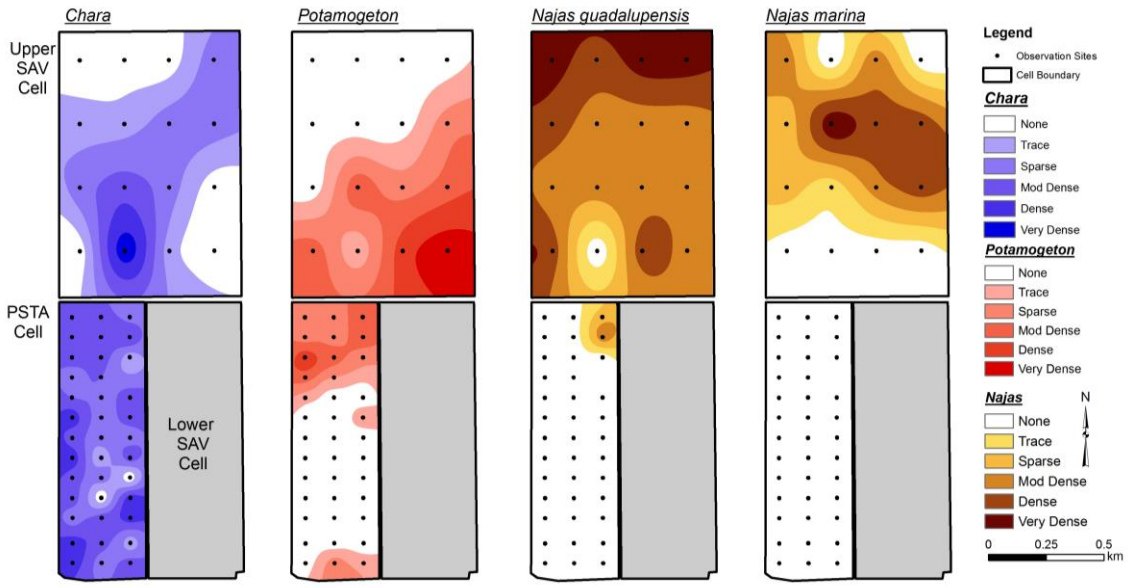

Figure 2. Spatial distribution and relative density of SAV species in the PSTA Cell and Upper SAV Cell, on June 23, 2015.

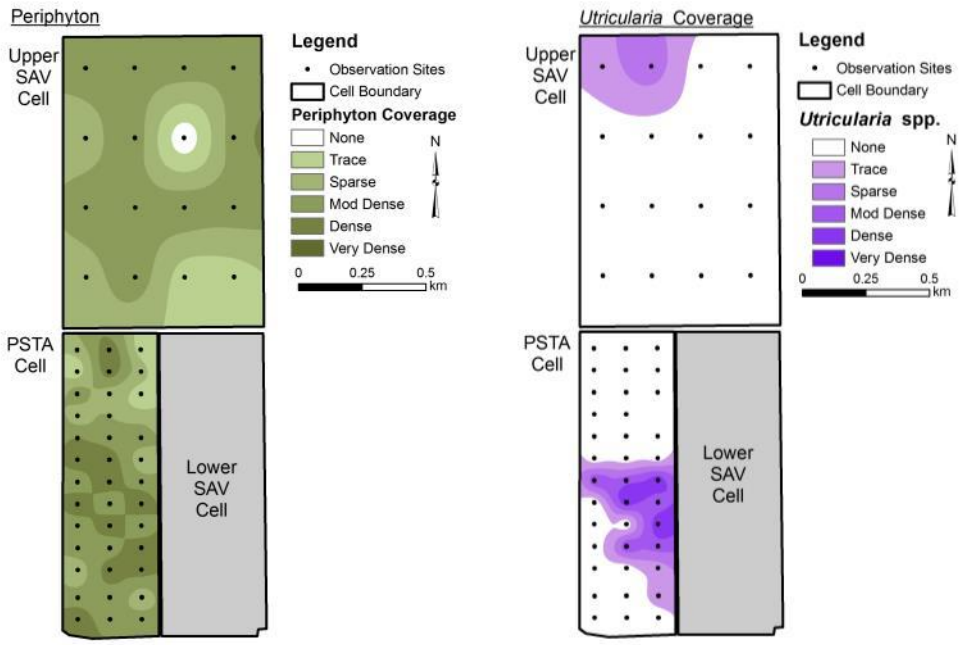

Figure 3. Spatial distribution and relative density of periphyton and *Utricularia* species in the PSTA Cell and Upper SAV Cell, on June 23, 2015.

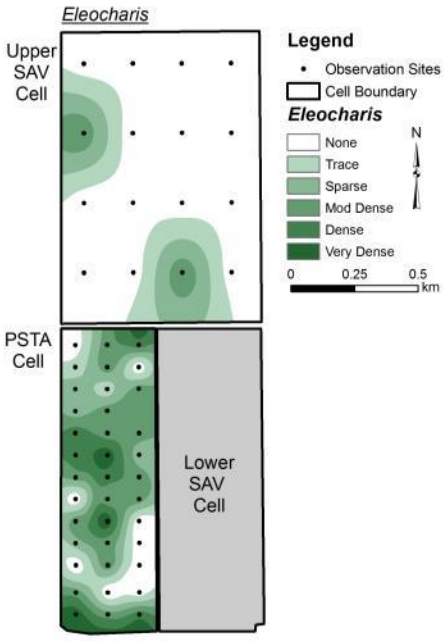

Figure 4. Spatial distribution and relative density of *Eleocharis* in the PSTA Cell and Upper SAV Cell, on June 23, 2015.

SAV species distribution in STA-3/4 Cells 2B and 3B

In the outflow cells of the central and western flow ways of STA-3/4, *Najas marina* is a prominent component of the SAV community (Figures **5** and **6**). This species has only recently become prevalent within the STAs, and warrants further investigation. *Chara* was more commonly observed and at higher relative densities in Cell 3B as compared to Cell 2B, while *Potamogeton* was nearly absent in both cells. *Utricularia* species are widespread in these cells, but typically observed at lower to moderate densities and with little apparent relationship to the prevailing north - south flow direction (Figures **5** and **6**).

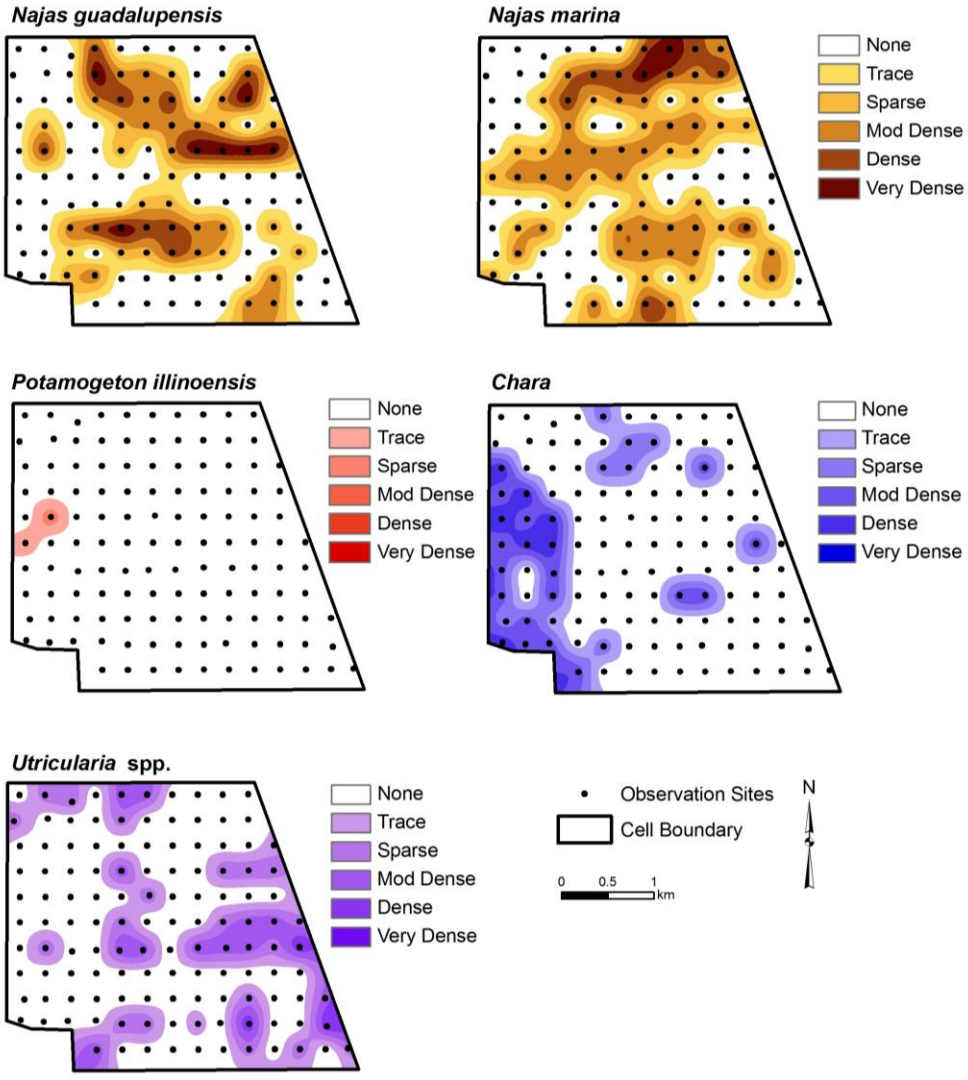

Figure 5. Spatial distribution and relative density of SAV species in STA-3/4 Cell 2B, on July 21, 2015.

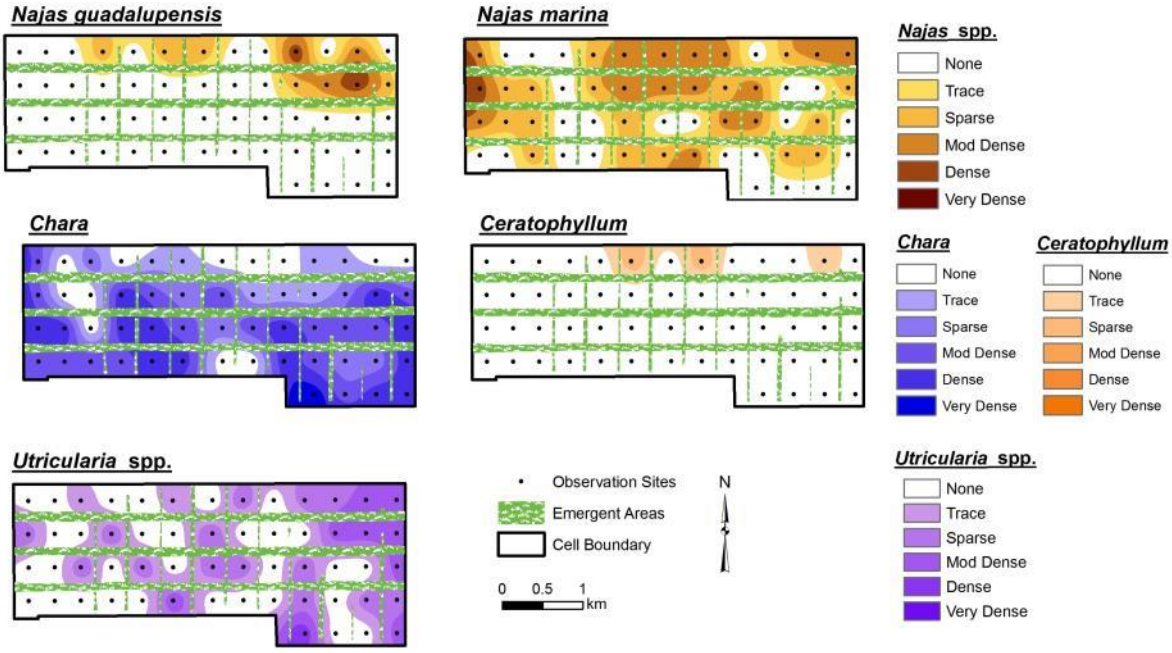

Figure 6. Spatial distribution and relative density of SAV species in STA-3/4 Cell 3B, on June 24, 2015.

Biomass and composition of PSTA Cell macrophytes and periphyton

Across the nine PSTA Cell stations surveyed in June 2015, macrophyte biomass standing crop ranged from 214 to 906 g dry weight/m^2, with a cell-wide average of 499 g/m^2 (**Table 2**). This is comparable to the range in values reported earlier for surveys in this cell: macrophyte standing crop biomass in the PSTA Cell ranged from 146-787 g dry wt./m^2 in July 2014, and 499 – 2119 g dry wt./m^2 in January 2014. These values also are comparable to estimates of SAV biomass in the outflow region of STA-2 Cell 3, a muck based cell. In September 2005, SAV biomass in Cell 3 ranged from 712 – 1325 g dry wt./m^2, and in January 2010, from 103 – 638 g dry wt./m^2, (DBE unpublished data).

Loosely attached, or "easily-dislodged" epiphyte biomass comprised between 15 and 58% of the total weight of macrophyte + periphyton matrix at the nine sites surveyed. The epiphytic periphyton tissue P content was between 242 and 694 mg/kg, with an average of 412 mg/kg. Together, these values provide an estimate of 64 ± 14 mg P/m^2 in the easily-dislodged periphyton biomass.

Table 2. Macrophyte standing crop estimated from replicate throws of a sampling frame (0.5 m x 0.5 m) at three stations along internal transects in the PSTA Cell, on June 24, 2015.

	Station	Dry/Wet Weight	% Dry Weight	Bulk Wet Weight per 0.25 m2 quadrat			Standing Crop Biomass				
	ID	Ratio	%	kg			g dry weight/m^2				
Average				**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**	**Avg**	**SE**
Inflow	B transect	0.1021	10.2	0.75	1.42	0.97	322	538	386	**415**	108
Mid	G transect	0.0651	6.5	1.87	2.20	2.52	480	561	628	**556**	49
Outflow	L transect	0.0872	8.7	1.25	1.52	1.60	462	556	556	**525**	84
SE											
Inflow	B transect	0.0125	1.3	0.22	0.49	0.12	130	129	34	**42**	34
Mid	G transect	0.0088	0.9	0.42	0.21	0.46	105	37	53	**58**	23
Outflow	L transect	0.0080	0.8	0.58	0.47	0.51	249	223	178	**203**	16
Whole cell average			**8.5**							**499**	

The periphyton tissues were P-enriched, relative to the host macrophyte tissues in June 2015 (**Figure 7**). This pattern was also observed in a previous sampling event in July 2014 (**Figure 7**). In contrast to that earlier event, however, there was a marked decrease in the P content of both periphyton and plant tissue P contents in June 2015, from inflow to outflow within the PSTA Cell. This likely reflects the relatively high P content of the *Potamogeton* and *Najas* tissues sampled in the inflow region but not along either the middle or outflow transects in June 2015, due to the presence of *Chara* at these latter sites.

Calcium and organic carbon contents of macrophyte tissues were inversely related (**Figure 8**). Nitrogen contents of the two rooted SAV species were higher than *Chara* (a rootless macroalgae) or *Utricularia*, suggesting a link between soil N availability and tissue nutrients. The emergent rush, *Eleocharis cellulosa*, was low in P, N and especially Ca contents, compared to other rooted macrophytes, and higher in organic carbon (**Figure 8**).

Epiphytes associated with these macrophyte taxa exhibited composition differences, ostensibly related to the host macrophyte. The epiphytes associated with *Najas* had elevated N and P contents, relative to epiphytes on other host plants (**Figure 9**). *Potamogeton* epiphytes contained comparably high calcium contents to the epiphytes on *Chara*, despite the latter having ~2.5 times the calcium associated with the host plant tissues.

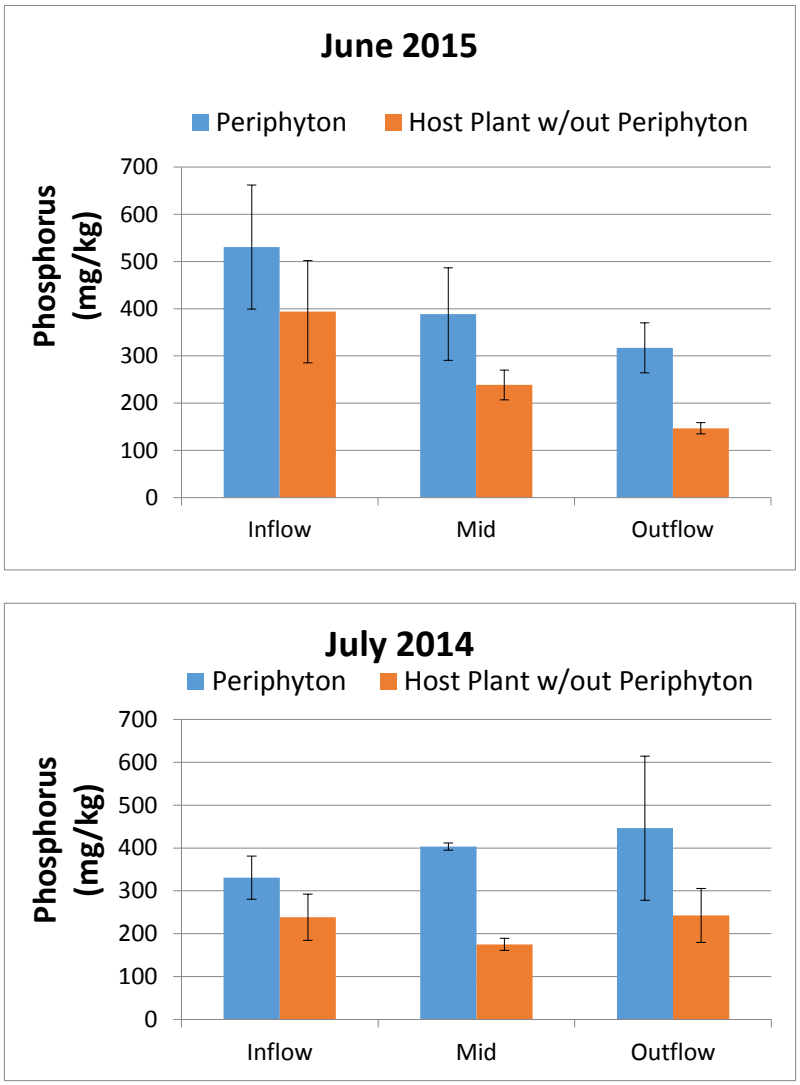

Figure 7. Phosphorus content of periphyton and its associated host macrophyte, along three internal transects within the PSTA Cell, on two sampling dates.

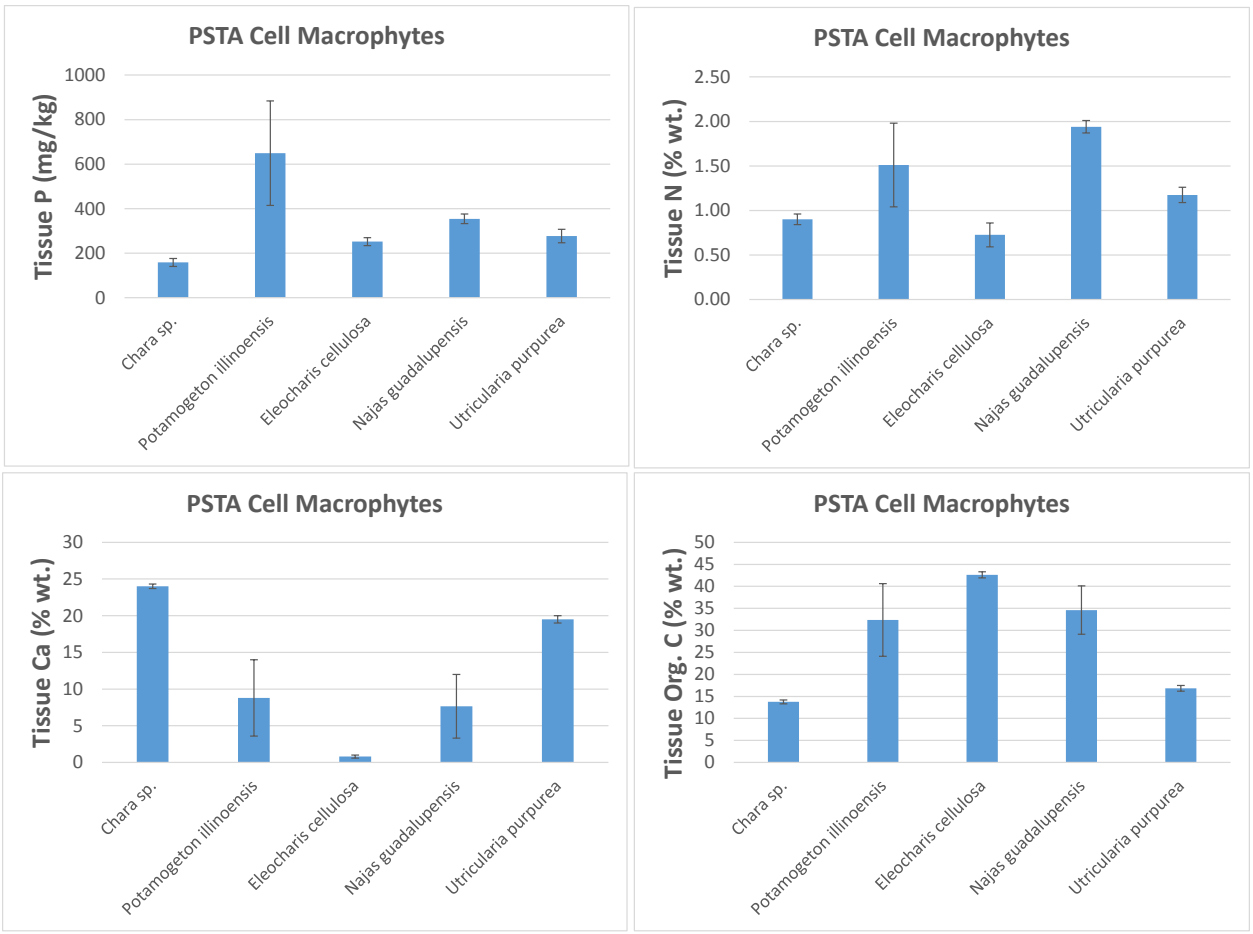

Figure 8. Comparison of tissue composition of five macrophyte species found within the PSTA Cell on June 24, 2015. Error bars denote the standard error around the mean value for 2-7 samples per species.

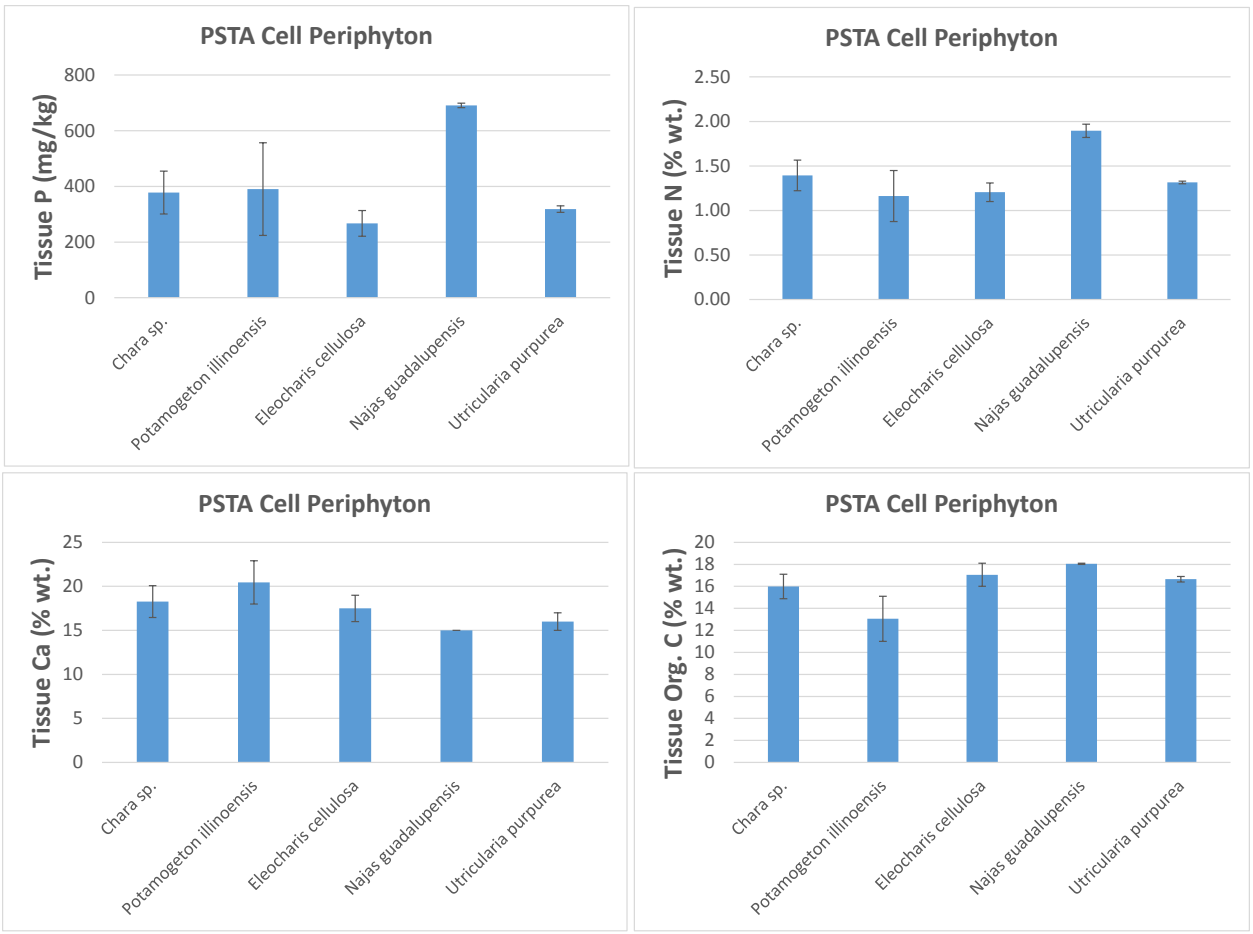

Figure 9. Comparison of the nutrient composition of periphyton tissues associated with five macrophyte species found within the PSTA Cell on June 24, 2015. Error bars denote the standard error around the mean value for 2-7 samples per species.

As noted above, differences in host plant tissue chemistry and morphology appear to influence the nutrient status of periphyton growing on the plant surfaces. To provide a common basis for comparison, the phosphorus contents of periphyton on *Chara* within the PSTA Cell were assessed for five sampling dates (**Figure 10**). Results of the most recent three dates represent the average of 2-3 samples of periphyton on *Chara* per transect, while the results from earlier surveys represent a single grab sample along each of the three transects. These data show high variability in P content of the periphyton associated with *Chara* in the PSTA Cell, with higher values in July 2014 and June 2015 than the other three dates (**Figure 10**). These data also suggest that the periphyton may be becoming gradually enriched over time, particularly in the inflow and mid region of the PSTA cell. Additional epiphytic periphyton sampling therefore will be performed in FY2016 to better characterize this temporal trend.

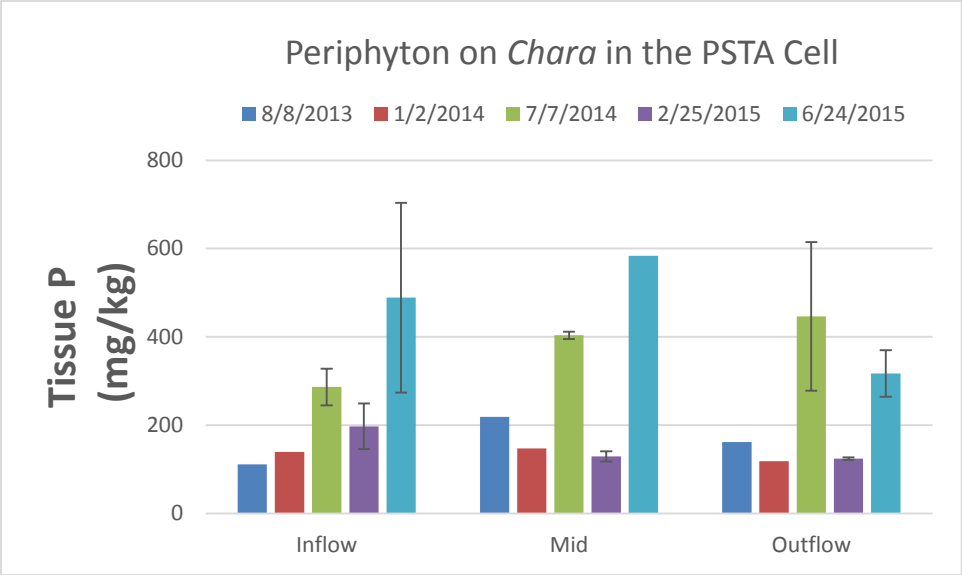

Figure 10. Phosphorus concentrations of periphyton associated with Chara along inflow, mid and outflow transects within the PSTA Cell, on five dates between August 2013 and June 2015.