Landscape Scale Patterns of Nutrient Use Efficiency with in *Cladium jamaicense* in the Florida Everglades

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Abstract

Changes in freshwater flow and nutrient enrichment have affected nutrient and organic matter input to the Everglades (Turner *et al*., 1999). The aforementioned changes have had a direct impact on the flora and fauna of the marsh ecosystem. It has been shown that plants located in eutrophic areas are less efficient at reabsorbing nutrients than those found in oligotrophic areas (Strachurski & Zimka 1975). *Cladium jamaicense* (sawgrass) was studied at sites which were found in close proximity to canal inflows and others that were located down marsh from canal inputs. There was no significant difference in reabsorbtion efficiency based on site location. This research was conducted at sites located throughout the southern Everglades allowing an accurate conclusion to be drawn about nutrient efficiency changes in sawgrass over a wide geographic spectrum. We observed the nutrient use efficiency of phosphorus (PUE) and nitrogen (NUE) in *C. jamaicense*; which is the predominate macrophyte found throughout the Everglades. Due to the dramatic differences (almost double) in nutrient use efficiency it was evident that sawgrass is limited by phosphorus and not nitrogen.

Introduction

Phosphorus (P) and nitrogen (N) are two potentially limiting nutrients in the Everglades. One way to discern nutrient limitation in oligotrophic systems such as the Everglades is to quantify nutrient use efficiencies in dominant plants (Vitousek, 1982). Examining both P and N use efficiency relative to landscape position (e.g. proximity to canals or in regions with naturally higher nutrient inputs) allows us to investigate the effects of nutrient availability on the ecosystem. Our objective in this study was to quantify relative nutrient availability across the FCE LTER landscape using nutrient use efficiency in sawgrass. The working questions for this research were:

1. How efficiently does *Cladium jamaicense* retain tissue nutrients when leaves die?

2. How does landscape position affect nutrient use efficiency (e.g. Proximity to canals)?

Figure 1: Landsat image of South Florida, and the ecotone regions. Study sites in yellow

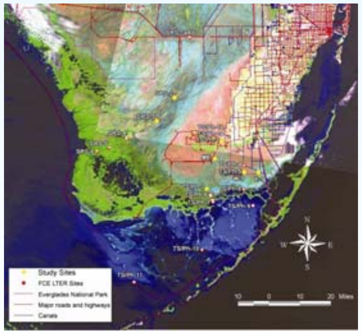


Figure 2: (Below) View of TS/PH-3. Depicted: There are three, meter square plots at each site. One live leaf and dead leaf were gathered from each plot and then homogenized resulting in one final live and one final dead sample for each site.

Methods

We sampled live and dead sawgrass tissue by collecting the newest leaf and the oldest senesced leaf that had not yet been cast off by the plant. This collections occurred in the months of August and September 2001. The leaves were collected in three different basins: Shark River Slough, Taylor Slough and C-111 Everglades National Park panhandle region. There were a total of seven sites, two in Shark River Slough (SRS-2, SRS-3), three in Taylor Slough (TS/Ph-2, ME, TS/Ph-3) and two in the C-111 basin (E-1, W-3). The TS/Ph-2 site is within 2 km of the L31W canal. The E-1 site is adjacent to the C-111 canal. Also SRS-3, TS/Ph-3, and W-3 are located near the estuarine ecotone. The remaining sites are interior locations. This experiment was done in conjunction with a leaf tagging experiment focused at quantifying sawgrass mortality rate. One live and one dead leaf were collected (as described above), from each of three permanent productivity plots at each site. After collection, the leaves were oven-dried at 70°C for forty-eight hours. The live and dead leaves were homogenized using an amalgamator, and the samples were then analyzed for total N (TN) using a Carlo-Erba elemental analyzer, and TP using the Solorzano and Sharp (1980) method. We calculated the nutrient use efficiency as a ratio using the following equation: 1-(live leaf nutrient content/Dead leaf nutrient content). This equation was used to calculate both NUE and PUE. Finally, site and basin differences were analyzed using ANOVA.

Table 1: Total phosphorus and nitrogen for homogenized live and dead samples in micrograms and milligrams of nutrient per site

Site Abbrevation	Basin	Leaf Status	µg/P per gram dw	mgP/g per gram dw	µg/N per gram dw	mgN/g per gram dw
SRS-2-1	SRS	Live	334	0.334	0.008	8.20
SRS-2-1	SRS	Dead	88	0.088	0.005	4.98
SRS-2-2	SRS	Live	360	0.360	0.007	7.11
SRS-2-2	SRS	Dead	102	0.102	0.005	5.22
SRS-2-3	SRS	Live	294	0.294	0.007	7.10
SRS-2-3	SRS	Dead	106	0.106	0.004	4.38
SRS-3-1	SRS	Live	343	0.343	0.008	7.78
SRS-3-1	SRS	Dead	85	0.085	0.005	5.16
SRS-3-2	SRS	Live	264	0.264	0.007	7.43
SRS-3-2	SRS	Dead	44	0.044	0.004	4.07
SRS-3-3	SRS	Live	302	0.302	0.009	8.76
SRS-3-3	SRS	Dead	38	0.038	0.004	3.56
TS/Ph-2-1	TS	Live	1818	1.818	0.009	8.66
TS/Ph-2-1	TS	Dead	53	0.053	0.005	4.73
TS/Ph-2-2	TS	Live	292	0.292	0.009	9.04
TS/Ph-2-2	TS	Dead	55	0.055	0.006	6.36
TS/Ph-2-3	TS	Live	288	0.288	0.009	8.95
TS/Ph-2-3	TS	Dead	103	0.103	0.005	4.82
ME-1	TS	Live	245	0.245	0.008	8.23
ME-1	TS	Dead	101	0.101	0.005	5.47
ME-2	TS	Live	347	0.347	0.008	7.76
ME-2	TS	Dead	53	0.053	0.004	3.64
ME-3	TS	Live	330	0.330	0.007	7.34
ME-3	TS	Dead	66	0.066	0.004	4.42
TS/Ph3-1	TS	Live	258	0.258	0.008	8.26
TS/Ph3-1	TS	Dead	53	0.053	0.005	5.07
TS/Ph3-2	TS	Live	316	0.316	0.008	8.19
TS/Ph3-2	TS	Dead	46	0.046	0.005	5.00
TS/Ph3-3	TS	Live	278	0.278	0.008	8.01
TS/Ph3-3	TS	Dead	65	0.065	0.005	5.32
E-1-1	C111	Live	274	0.274	0.009	8.71
E-1-1	C111	Dead	56	0.056	0.004	4.00
E-1-2	C111	Live	289	0.289	0.009	8.99
E-1-2	C111	Dead	55	0.055	0.005	4.91
E-1-3	C111	Live	1693	1.693	0.008	7.62
E-1-3	C111	Dead	69	0.069	0.005	4.84
W-3-1	C111	Live	179	0.179	0.007	7.09
W-3-1	C111	Dead	32	0.032	0.004	4.23
W-3-2	C111	Live	166	0.166	0.008	7.82
W-3-2	C111	Dead	31	0.031	0.003	2.98
W-3-3	C111	Live	183	0.183	0.008	7.87
W-3-3	C111	Dead	33	0.033	0.004	3.68

Results and Discussion

Nitrogen content (mg N per gram dw) and P content (µg P per gram dw) are the basic data necessary to calculate NUE and PUE for sawgrass (Table 1). We saw dramatic differences in both P and N content of live versus dead leaves but no major variation across sites. The N:P ratios of live tissue that we observed typically range from 20 to 30 by mass and 40 to 65 as molar ratios. These values are consistent with those of Daoust and Childers (1999). The PUE values we calculated from this data were roughly twice the NUE values for the same plants (figures 3 & 4). This difference suggests that *C. jamaicense* plants at all of our sites were P and not N limited. We were unable to detect any variation in either PUE or NUE with landscape position (ANOVA test for site effect). This result was surprising, given that some of our sites were adjacent to canals while others were located in the interior of large oligotrophic basins. Furthermore, we investigated basin effects on PUE and NUE among our SRS, TS, C-111 sites and found no differences (ANOVA test for basin effect). These results suggest that canal inputs at our sites are not exposing sawgrass to higher levels of nutrients and that there is minimal difference in the degree of P limitation across the landscape we studied.

Figure 3: Phosphorus use efficiency throughout the study sites.

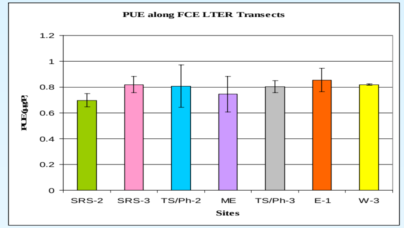
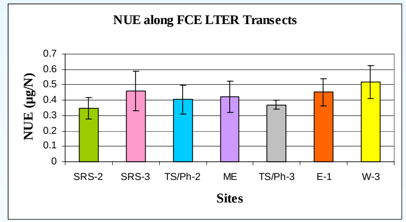


Figure 4: Nitrogen use efficiency throughout the study sites.



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