ASSESSMENT OF VEGETATIVE AND EDAPHIC CHARACTERISTICS OF THE BUCKTOWN CREATED MARSH: YEAR ONE

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Introduction

The research reported herein is an evaluation of the vegetative and edaphic characters of the Bucktown area mitigation marsh. This created wetland area was constructed immediately outside the Lake Pontchartrain levee in the greater "Bucktown" area of New Orleans, and can be classified as a brackish marsh based on vegetative composition (Hester et al. 2005). Construction, using hydraulic dredging, was accomplished in Summer of 2000 with a target area of 3.5 acres and elevation of 1.5 to 2.0 NGVD (Burke and Kleinpeter 2001). The dredge material source was the adjacent Bucktown Harbor. Material was allowed to settle and consolidate for approximately two years prior to the initiation of planting (Burke and Kleinpeter 2001). Installation of 1,030 trade gallons and 8,000 vegetative plugs of salt-hardened *Spartina alterniflora* (Vermillion accession) were completed by August 2, 2003 (Burke and Kleinpeter 2001). Currently, the perimeter of the wetland is actively used by the local public for recreational activity (Mark Hester pers obs). This work expands upon a previous characterization that focused exclusively on the characterization of the vegetation and elevation of a small number of plots in the marsh creation site (Hester et al. 2005). More general information and documentation on the Bucktown Created Marsh can be found at SaveOurLake.org (see the coastal program webpage).

Methods

Study Implementation

Twenty (20), 1.0-m^2 permanent plots were established on June 30, 2006 throughout the Bucktown created marsh site, with 5 replicate plots being established in each of four habitat types described in a previous assessment completed prior to Hurricane Katrina (Hester et al. 2005). Habitat types consisted of streamside marsh, low marsh, high marsh, and scrub-shrub habitat. Two sediment elevation tables, one in the low marsh habitat type and one in the scrub-shrub habitat type, were also established at this time. A continuous-recording water-level gage was also installed in the low marsh habitat type at this time.

Variables Measured

After the installation of all permanent infrastructure vegetative cover was assessed visually. Immediately thereafter, soil cores were collected to a depth of 15 cm with a 5-cm diameter corer to determine soil bulk density. At this time soil interstitial water was collected using a soil sipper device (McKee et al. 1988) and aliquots were characterized for pH, salinity, nutrient status, and total sulfide concentration. Interstitial pH was determined using a handheld Orion pH meter (model # P2001A). Salinity was determined using a YSI salinity/conductivity meter (model # EC 300). Total sulfides were determined using a ThermoOrion combination sulfide-selective electrode (model # 96-16) on a sample aliquot that was preserved immediately after collection in the field using ThermoOrion SAOB buffer. Interstitial samples for nutrient characterization were filtered through 0.45 filters frozen and transported to the Microbial Testing Laboratory at Southeastern Louisiana University for determination of nitrate-nitrite-N and ammonia-N by EPA methods 353.2 and 1690 respectively. Elevation of all plots and an additional 36 locations within the marsh creation site were determined using a laser level and stadia rod to provide a thorough baseline characterization of this area. All elevations are currently presented as relative to the lowest survey elevational point, but will be tied to NGVD and the water-level gage at the site for future evaluations.

Statistical Analyses
Total vegetative and *S. alterniflora* cover were analyzed in a repeated measures one-way ANOVA RBD framework using the MIXED model procedures of SAS 9.1. All data collected at only one point in time were subjected to univariate one-way ANOVA analysis using the MIXED procedures of SAS 9.1. *Spartina alterniflora* and vegetative total cover for the Bucktown marsh as a whole were compared to a previous vegetative survey conducted in summer of 2005 (Hester et al. 2005) using one sample t-tests through the TTEST procedures of SAS 9.1. Vegetative community composition of permanent plots in both summer and fall of 2006 were evaluated for gradients using nonmetric multidimensional scaling analysis, performed using PC-ORD 4.0. For this analysis the Sorensen distance matrix wax employed, with initial dimensionality of 6 axes and stepwise reduction of a single dimension until optimal stress reduction was achieved. Stability criterion was set to 0.00010 and the number of model runs was 40 for real data and 50 for randomized data. See Clarke (1993) for discussion of this technique.

Results

Biotic Characterization
In both summer 2006 and fall 2006 *S. alterniflora* cover was higher in low marsh and streamside marsh areas than high marsh and scrub-shrub areas (Figure 1; Contrast F= 60.47, P<0.001; Contrast F= 48.50, P<0.001). A significant interaction of time and total vegetative cover was detected (Figure 1; F= 6.330, P=0.005), resulting from low marsh and streamside marsh cover remaining essentially constant in both summer and fall of 2006, while total vegetative cover in both high marsh and scrub-shrub areas increased in fall compared with summer of 2006. In summer 2006 total vegetative cover was highest in low marsh and streamside marsh areas (Figure 1; Contrast F= 32.08, P<0.001). However, no significant difference in total vegetative cover was detected in fall of 2006, indicating that all habitat types were producing similar cover. A marginally significant interaction of time and vegetative zone was detected for *S. alterniflora* cover (Figure 1; F= 3.111, P=0.056), resulting from the decrease of *S. alterniflora* cover for zone 4 in the fall with all other zones showing an increase in *S. alterniflora* cover at this time. The average cover of *Spartina alterniflora* for the Bucktown marsh area as a whole increased from summer 2005 to summer 2006 (Figure 2; t = 2.576, P=0.018). Average total vegetative cover tended to be higher in summer 2006 compared with summer 2005, although the trend was only marginally significant (Figure 2; t=1.952, P=0.066). *Spartina alterniflora* average and maximum height in fall of 2006 was significantly greater in low marsh and streamside marsh areas compared with low marsh and scrub-shrub areas (Figure 3; Contrast F= 57.29, P=0.001; Contrast F= 38.85, P<0.001, respectively). Analysis of summer 2006 vegetative cover by NMS indicated that two primary gradients existed (p=0.196). Axis two, which is responsible for most of the separation in the data set, reflects *S. alterniflora* cover (Figure 4: Pearson r = -0.933, Kendall Tau = -0.959). Axis one provides some additional separation of plots, primarily through the presence of *Iva frutescens* cover (Figure 4: Pearson r = -0.832, Kendall Tau =- 0.459). Analysis of fall 2006 vegetative cover by NMS indicated that one primary gradient existed (p=0.0196), which appeared to primarily be a function of *S. alterniflora* cover (Figure 5; Pearson r = 0.910, Kendall Tau = 0.968).

Abiotic Characterization
Relative elevation within plots was found to be significantly different, with low marsh and streamside marsh areas being significantly lower than high marsh and scrub-shrub areas (Figure 7; Contrast F= 17.54, P=0.003). No significant effect of vegetation type on soil bulk density was

detected, although the contrast of high marsh with all other zones approached significance (Figure 7; Contrast $F=4.31$, $P=0.060$). Although not examined statistically, the relative elevation of 55 surveyed points within the Bucktown created marsh are presented for qualitative evaluation (Figure 8). Interstitial water could not be acquired from any of the low marsh plots, but was obtained for all of the remaining plots. This was likely due to recent draining of the low marsh from tidal action coupled with recent rain events leading to pooling of rain water in more interior marsh areas. The interstitial water acquired from the remaining zones have chemical characteristics that support it being recently deposited rain water that is coming into equilibrium with soil processes (e.g., minimal salinity and total sulfides below detectable limits). Total sulfide concentrations in all interstitial water samples were below detection (0.01 ppm). Interstitial salinity was significantly higher in streamside marshes than high marsh and scrub-shrub zones (Figure 9; Contrast $F=320.44$, $P<0.001$). Interstitial pH was significantly higher in the scrub-shrub zone than streamside marsh and high marsh zones (Figure 9; Contrast $F=10.60$, $P<0.0116$). Interstitial nitrate-nitrite-N was significantly lower in streamside marshes than high marsh and scrub-shrub zones (Figure 10; Contrast $F=31.93$, $P<0.0299$). Interstitial ammonium-N was marginally significant, but higher in high marsh than scrub-shrub and streamside marshes (Figure 10; Contrast $F=12.86$, $P<0.0697$). No significant effect of vegetative zone on interstitial potassium was detected (Figure 11). A marginally significant effect of vegetative zone was found for interstitial phosphorous in which the high marsh zone had less interstitial phosphorous than the scrub-shrub zone.

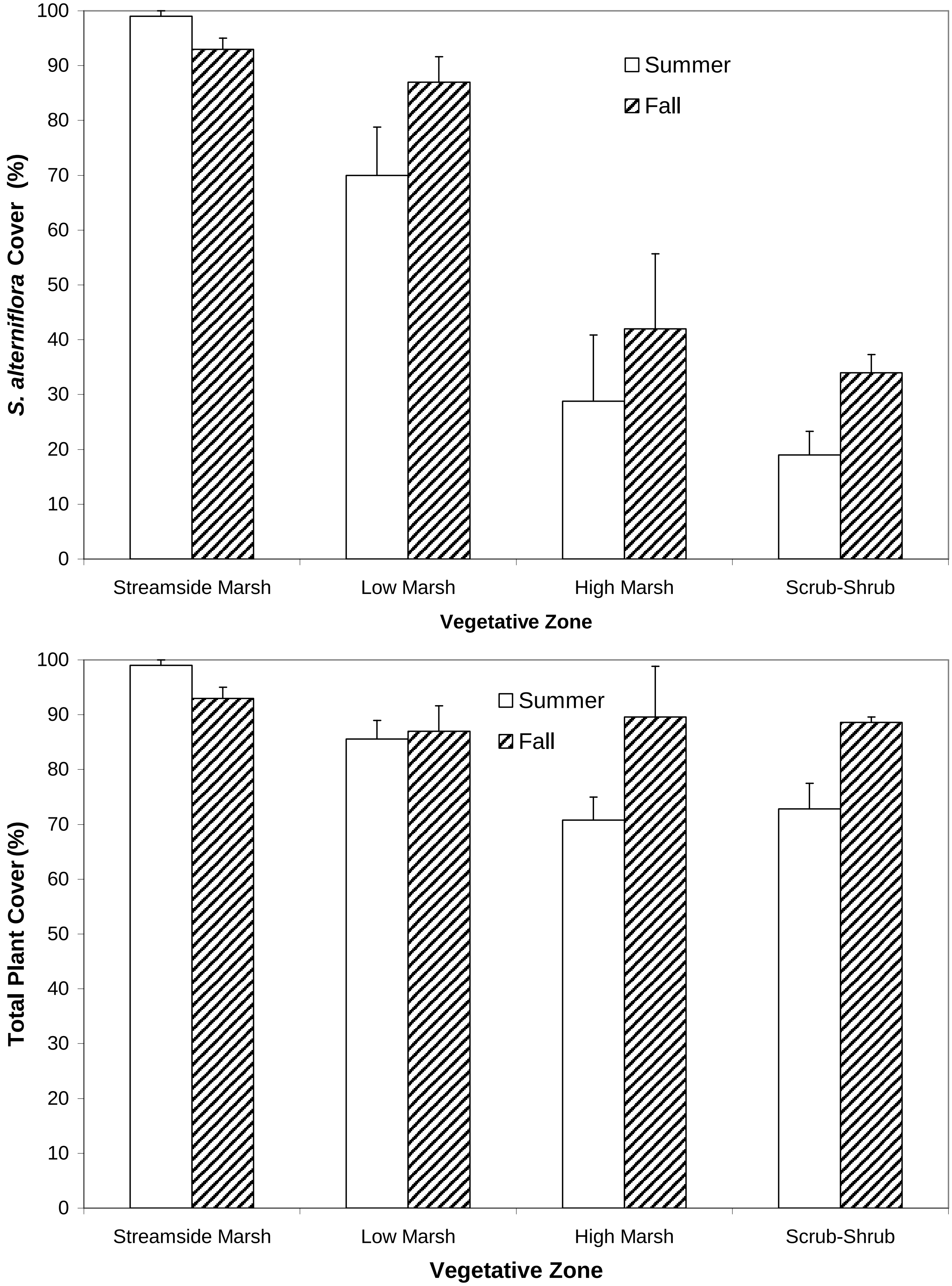


Figure 1. The effect of vegetative zone on *Spartina alterniflora* cover and total plant cover (mean +/- standard error) during the 2006 growing season zone.

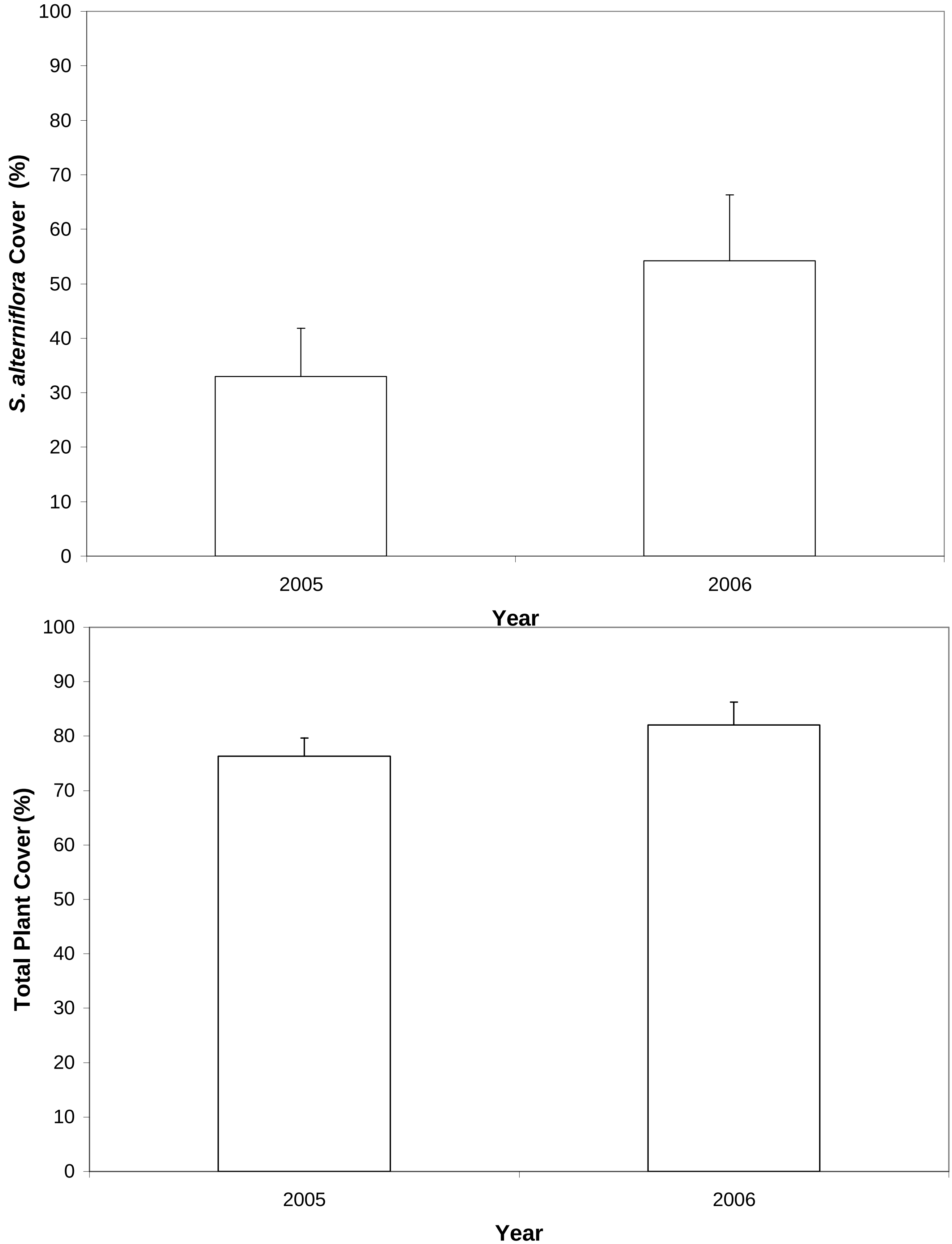


Figure 2. The effect of year on average summer *Spartina alterniflora* cover and average total plant cover (mean +/- standard deviation).

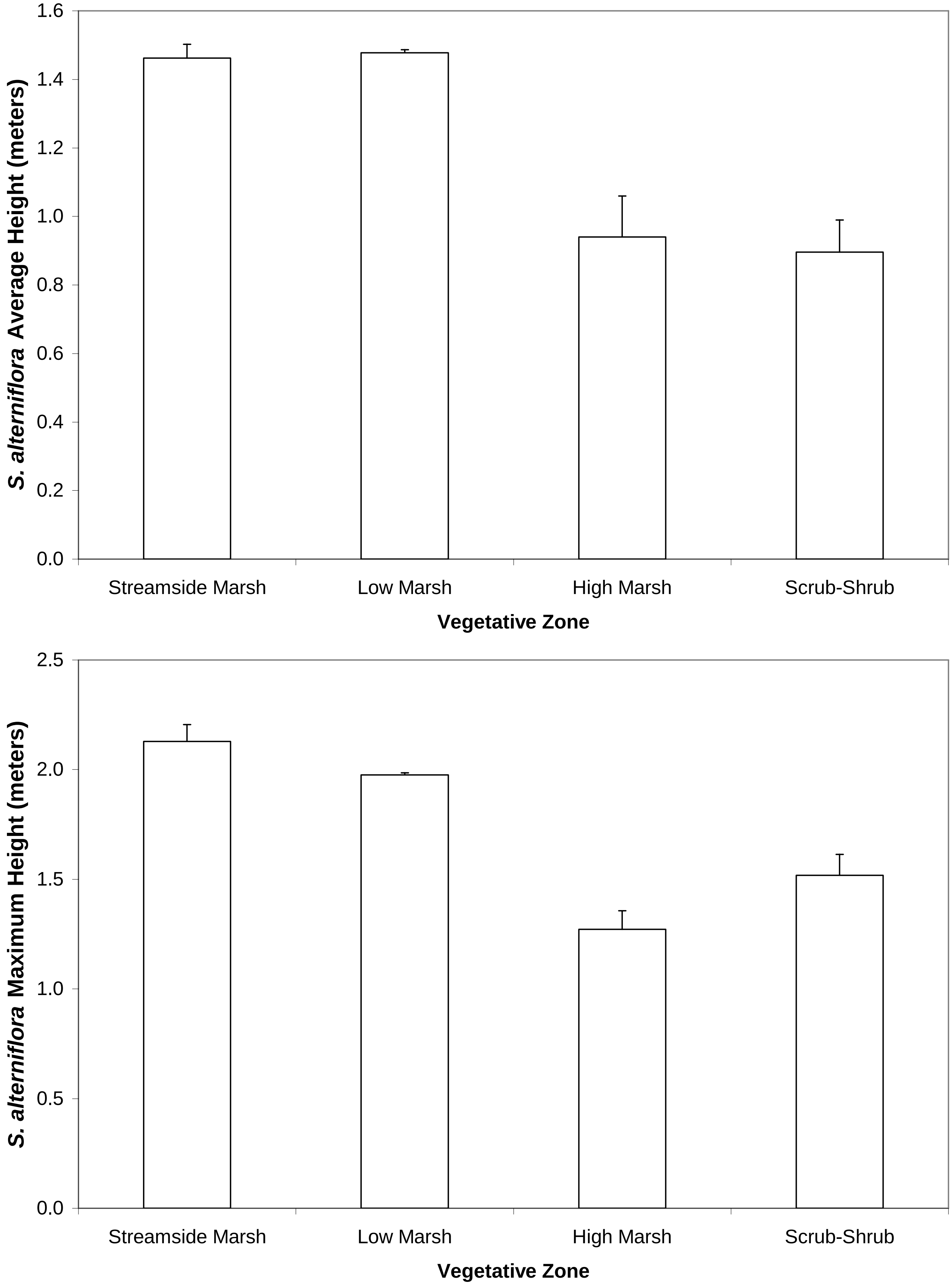


Figure 3. The effect of vegetative zone of *S. alterniflora* average and maximum height (mean +/- standard error) during the 2006 growing season zone.

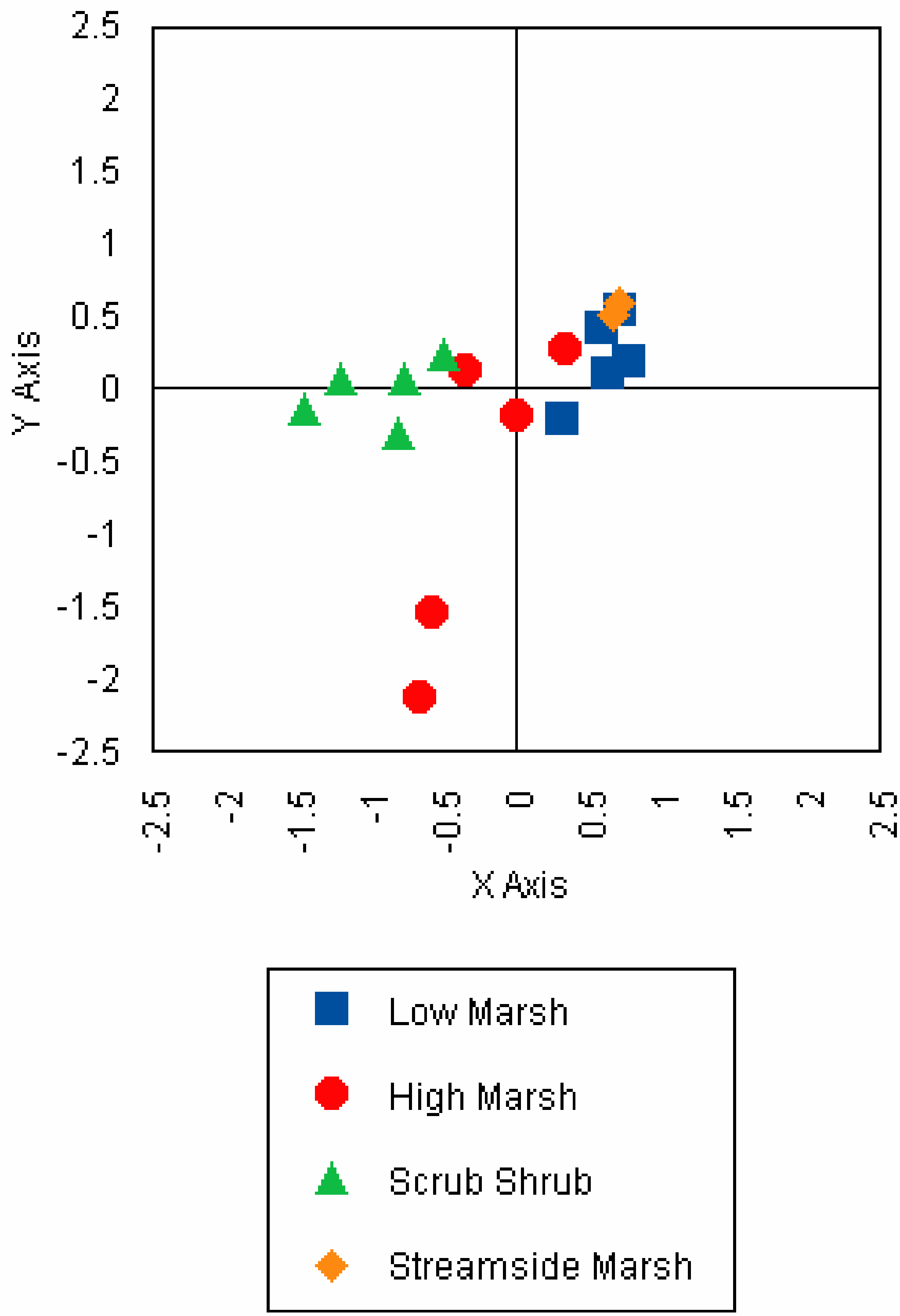


Figure 4. Similarity of permanent plots and vegetative zones for summer 2006 as determined by nonmetric multidimensional scaling. X axis negatively correlates with *S. alterniflora* cover. Y axis negatively correlates with *Iva frutecens* cover.

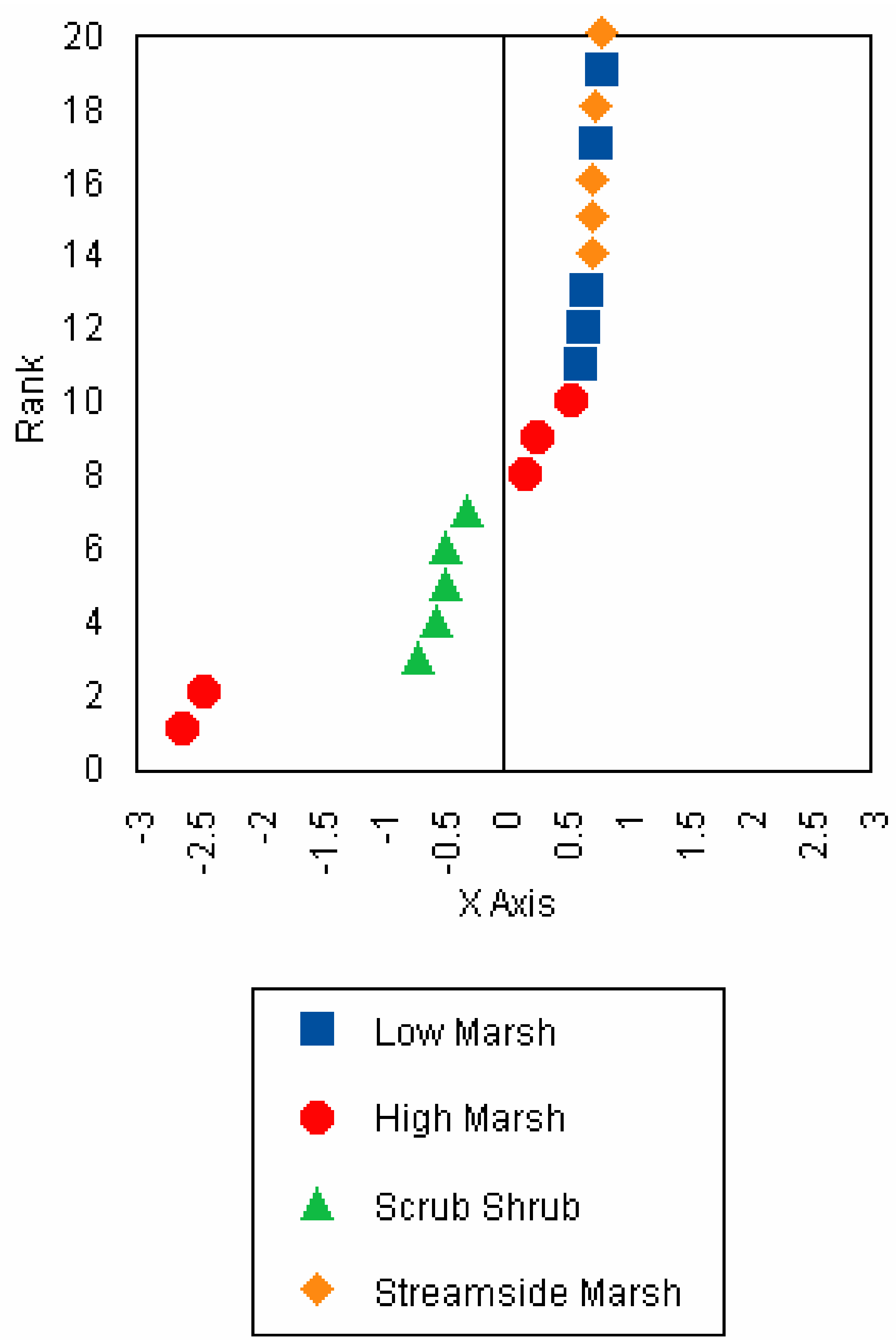
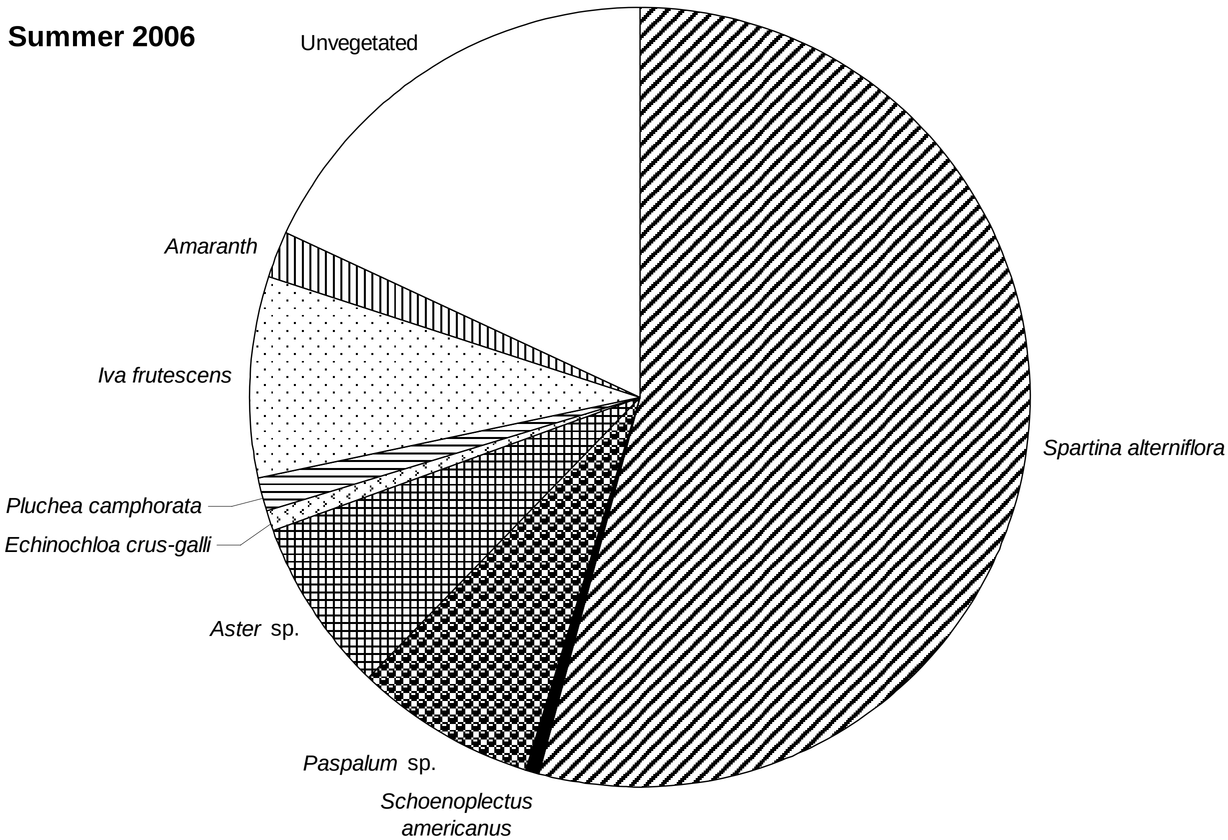


Figure 5 Similarity of permanent plots and vegetative zones for fall 2006 as determined by nonmetric multidimensional scaling. X axis correlates with *S. alterniflora* cover



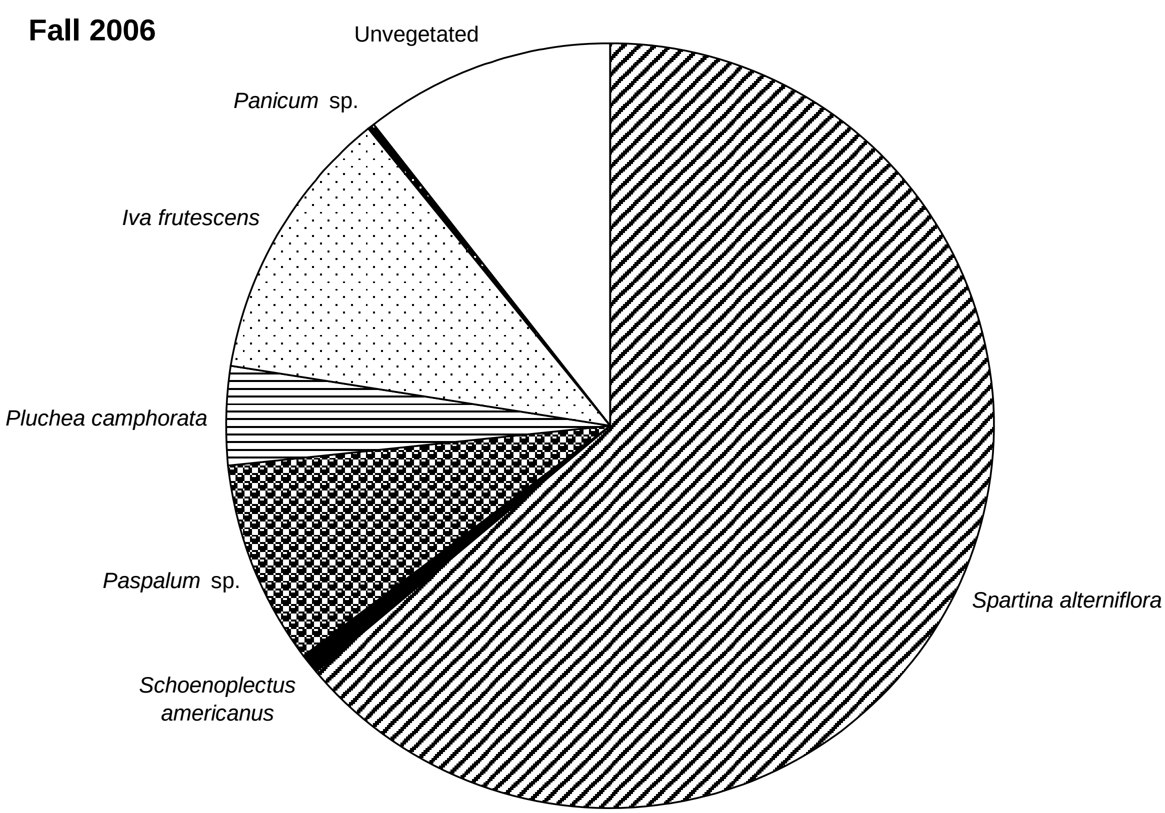


Figure 6. The effect of season on (summer and fall 2006) species composition (mean).

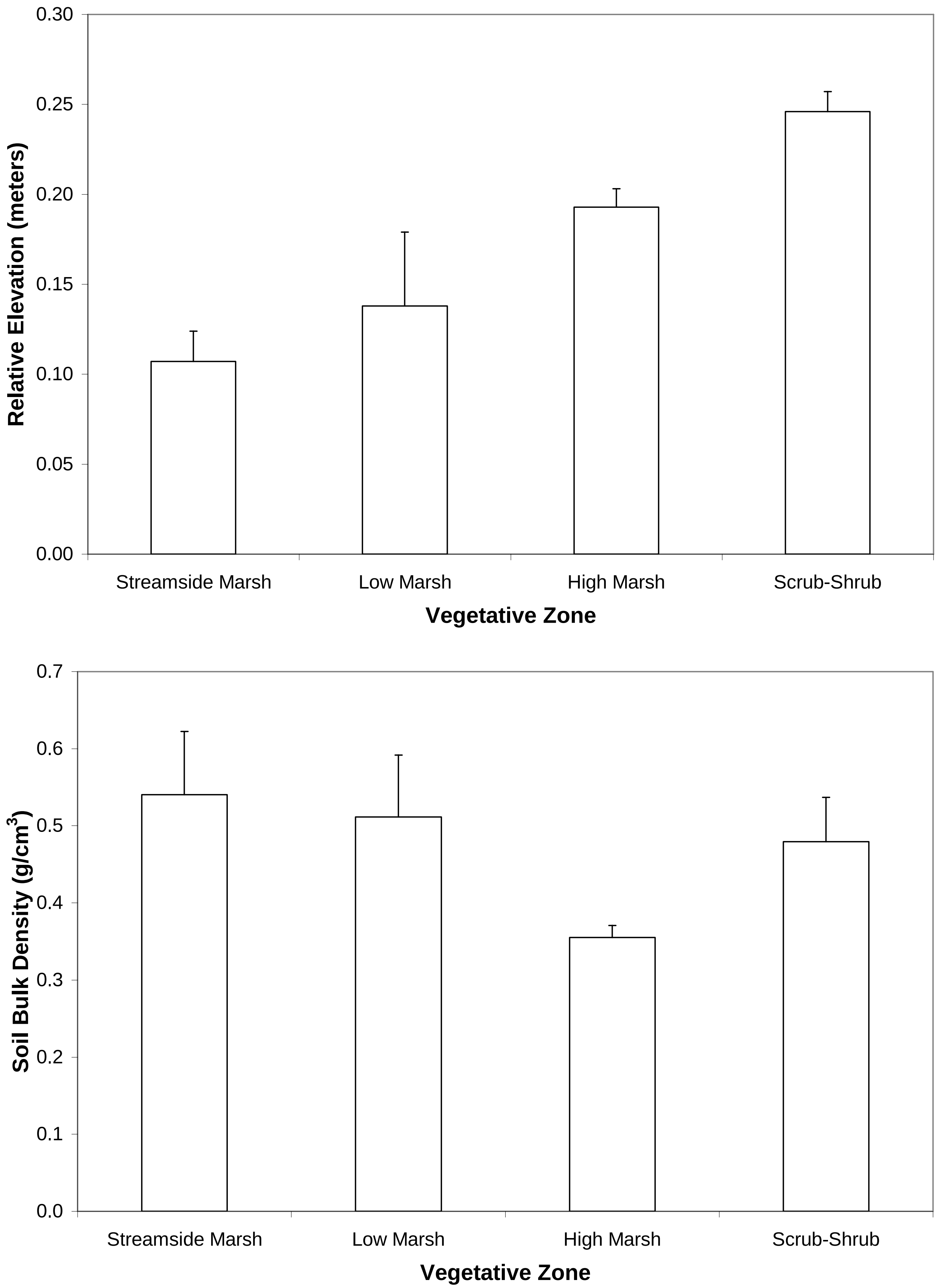


Figure 7. The effect of vegetative zone on relative elevation and soil bulk density (mean +/- standard error) for the 2006 growing season zone.

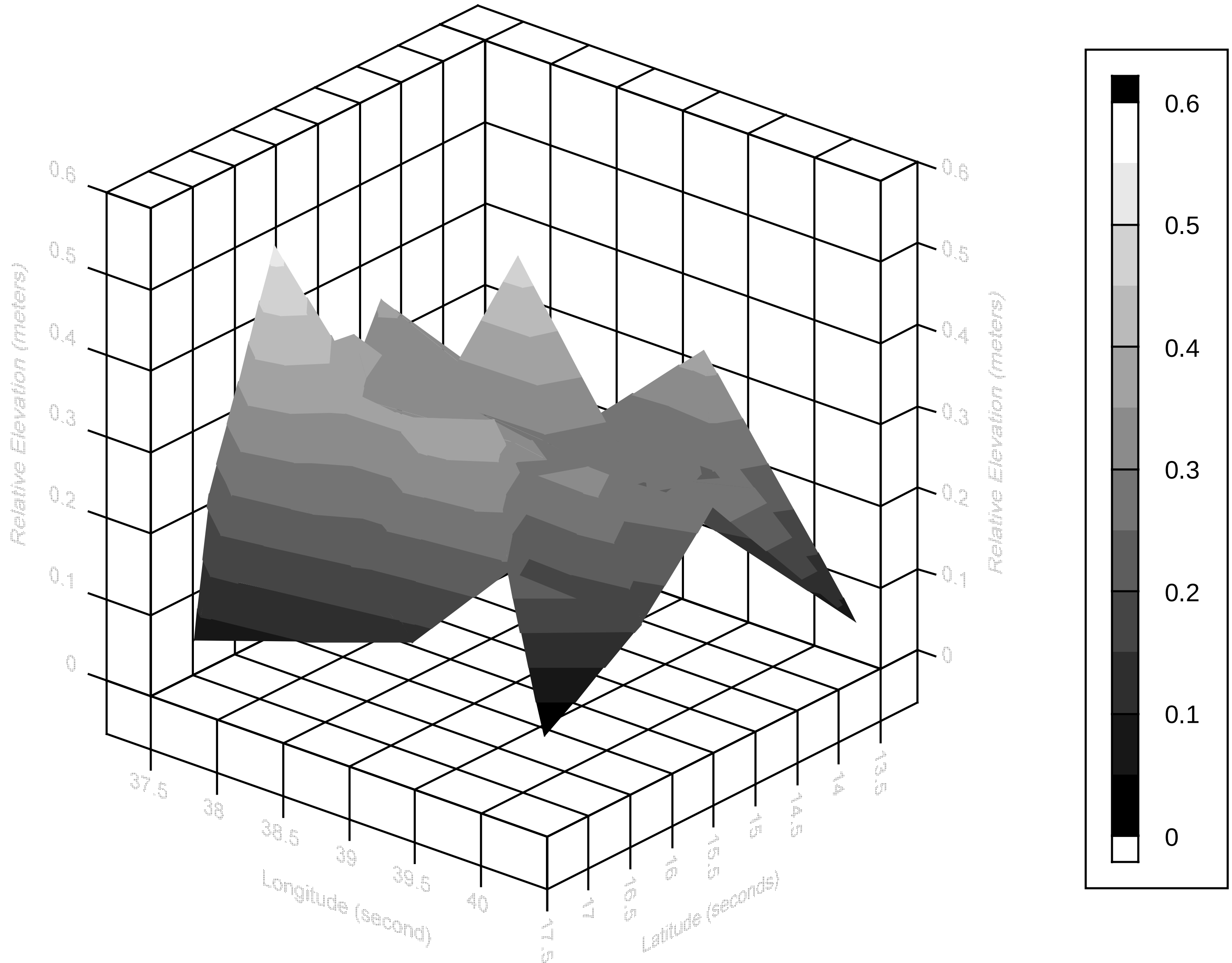


Figure 8. Profile of relative elevation within the created Bucktown Marsh (fall 2006). Latitudes are seconds of N 30 01. Longitudes are seconds of W 90 07. For reference, the levee would be located to the right rear side of this figure.

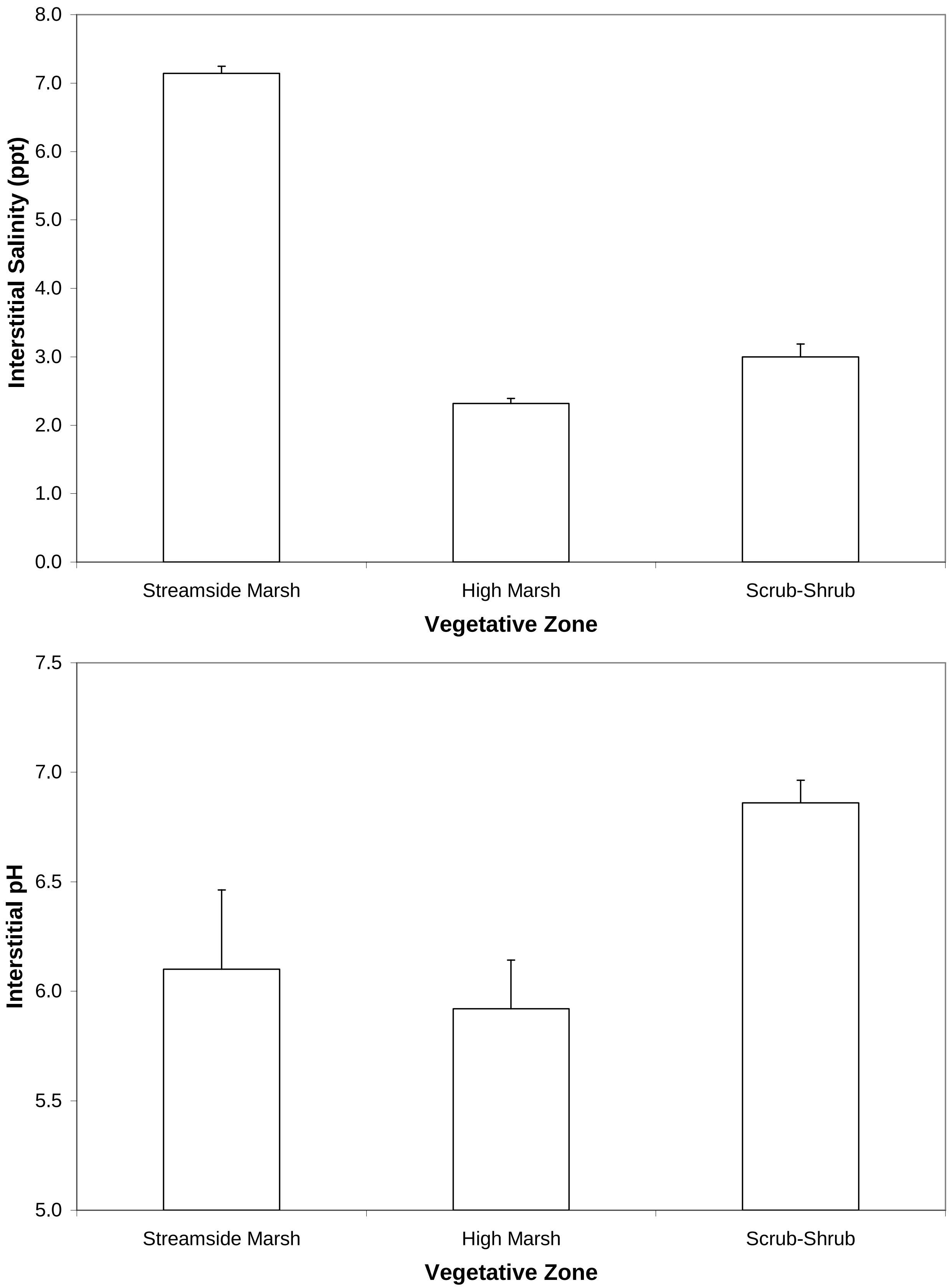


Figure 9. The effect of vegetative zone on interstitial salinity and pH (mean +/- standard error; fall 2006).

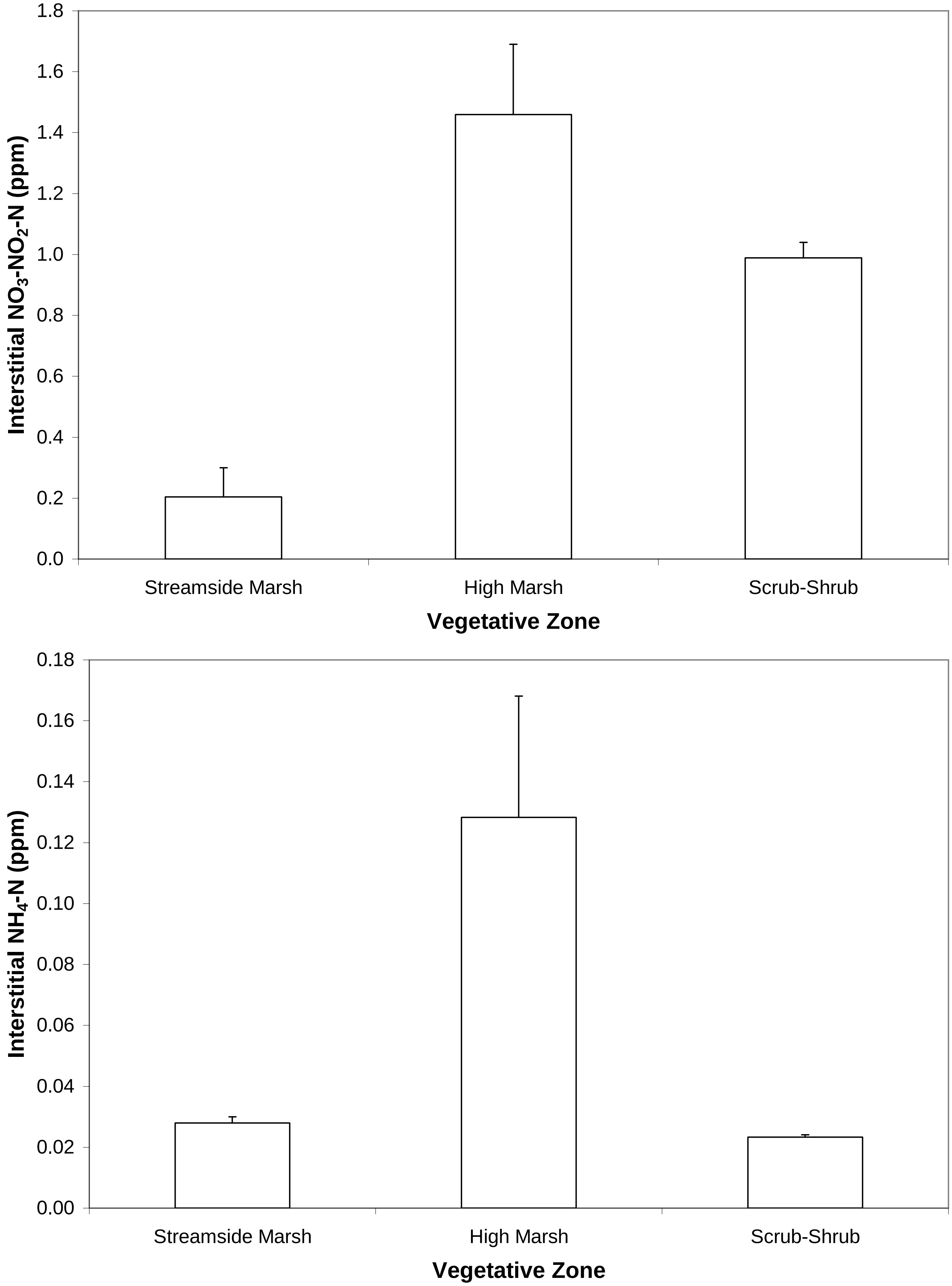


Figure 10. The effect of vegetative zone on interstitial NO_3-NO_2-N and NH_4-N (mean +/- standard error; fall 2006).

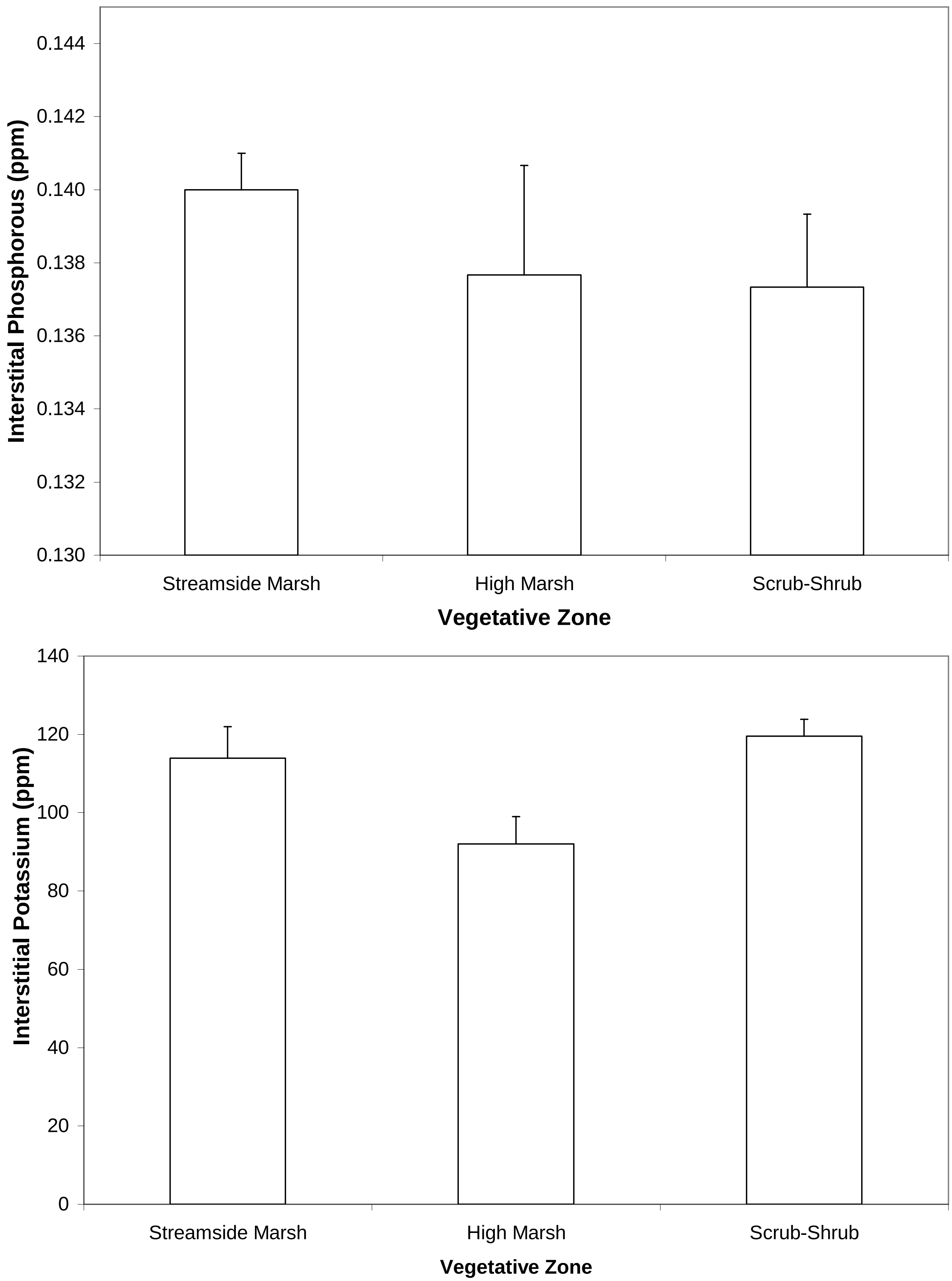


Figure 11. The effect of vegetative zone on interstitial phosphorous and potassium (mean +/- standard error; fall 2006).

Conclusions

The Bucktown marsh project continues to be a success in regard to both the extent and composition of the vegetative community as well as the character of the marsh soil. Although permanent research plots were established prior to Hurricane Katrina the overall response and recovery of this marsh to such a major disturbance appears to be excellent. Surveys of vegetation indicate that robust and dense stands of *S. alterniflora* are present in those zones where they would be anticipated, i.e., streamside and low marsh. The relatively diverse vegetative community occurring in the low marsh zone likely reflects the reduced environmental stresses of this habitat and is appropriate for such a marsh type in Louisiana. The substantial presence of *Iva frutescens* in the scrub-shrub zone suggests that this created wetland, beyond its collection of distinct vegetative habitats, also functions to provide critical habitat for faunal usage. The presence of native Louisiana species provide further evidence that this created wetland is emulating a natural local system in terms of the vegetative community. The only introduced plant species found at this site barnyard grass (*Echinochloa crus-galli*), which, however, is typically valued as a food source for birds (USDA). Soil characters all appear to be within appropriate ranges for a wetland of this type and should be amenable to continued expansion of vegetation. It should be noted that the draining of the marsh soil pore water coupled with the recent rainfall likely resulted in a dilution of certain soil metrics such as total sulfides, salinity, and nutrients. However, current success and health of the present vegetation suggests that the values determined for soil variables are not far from the typical for this area and long-term monitoring will allow for more exact estimates to be constructed. As further monitoring is conducted and other data sources, such as the sediment elevation tables, become available, projections of the long-term health and resilience of this created wetland will be developed. Particularly, long-term trends regarding sediment movement and accretion dynamics will be elucidated. Importantly, little perturbation of the area was noted after the passing of Hurricane Katrina, indicating this wetland has a high degree of resilience.

Literature Cited

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McKee, K. L., and I. A. Mendelssohn. 1989. Response of a fresh-water marsh plant community to increased salinity and increased water level. Aquatic Botany. 34:301-316.

LPBF Lake Pontchartrain Basin Foundation website: http://www.saveourlake.org/

USDA PLANTS database: *Echinochloa crus-galli*: http://plants.usda.gov/java/profile?symbol=ECCR