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

Prepared for:
John Lopez, Ph.D., Director
Coastal Sustainability Program
Lake Pontchartrain Basin Foundation
Funding provided through a grant from Shell E&P, New Orleans, LA

Prepared by:
Mark W. Hester, Ph.D.
Jonathan M. Willis, M.S.

Coastal Plant Ecology Laboratory
Department of Biology
University of Louisiana at Lafayette
Lafayette, LA 70504
"Providing the plant knowledge base for enhanced coastal restoration"

March 13, 2008

Introduction

This report summarizes finding from the continued monitoring of soil and vegetative characteristics of the Bucktown area mitigation marsh. Further evaluations of the apparent restoration trajectory of this site are also presented in which we relate current soil and vegetation data to previously collected data. The Bucktown area mitigation marsh, dominated by brackish marsh vegetation (Hester et al. 2005), was constructed immediately outside the Lake Pontchartrain levee in the greater "Bucktown" area of New Orleans with a target area of 3.5 acres and elevation of 1.5 to 2.0 NGVD using hydraulic dredging in the summer of 2000 (Burke and Kleinpeter 2001). Material for the construction was dredged from 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). Contractors completed planting 1,030 trade gallons and 8,000 vegetative plugs of salt-hardened *Spartina alterniflora* (Vermillion accession) by August 2, 2003 (Burke and Kleinpeter 2001). The area immediately surrounding the created wetland is employed extensively for outdoor fitness activities by the local population (e.g., walking, jogging; Mark Hester pers obs). This work is a continuation of vegetative and soil characteristic monitoring initiated in 2006 (Hester et al. 2007), which in turn was developed from an initial survey conducted in 2005 (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 and are so labeled in previous reports. To provide a more inherently spatial description of these sites they are referred to in this report as eastern low marsh (previously low marsh), high marsh (same as previous), scrub-shrub (same as previous), and western low marsh (previously stream side). 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.

Variables Measured

Visual estimation of plant community composition has been assessed in the summer and fall of each year since the inception of the monitoring project. Also, soil bulk density, soil moisture content, and soil organic matter content have been determined annually since the inception of the project. Soil cores were collected to a depth of 15 cm using a 5-cm diameter thin-wall corer in the determination of soil bulk density. Soil samples were then dried at 65º C until a constant weight was reached. Thereafter, soil samples were homogenized using a mortar and pestle and a subsample was combusted at 500 ºC for 5 hours to determine organic matter content through the loss-on-ignition method. Change in marsh surface elevation was determined using two sediment elevation tables (SET) in conjunction with feldspar markers.

Statistical Analyses

Total vegetative and *S. alterniflora* cover were analyzed in a repeated measures one-way ANOVA (analysis of variance) randomized block design 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. 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.

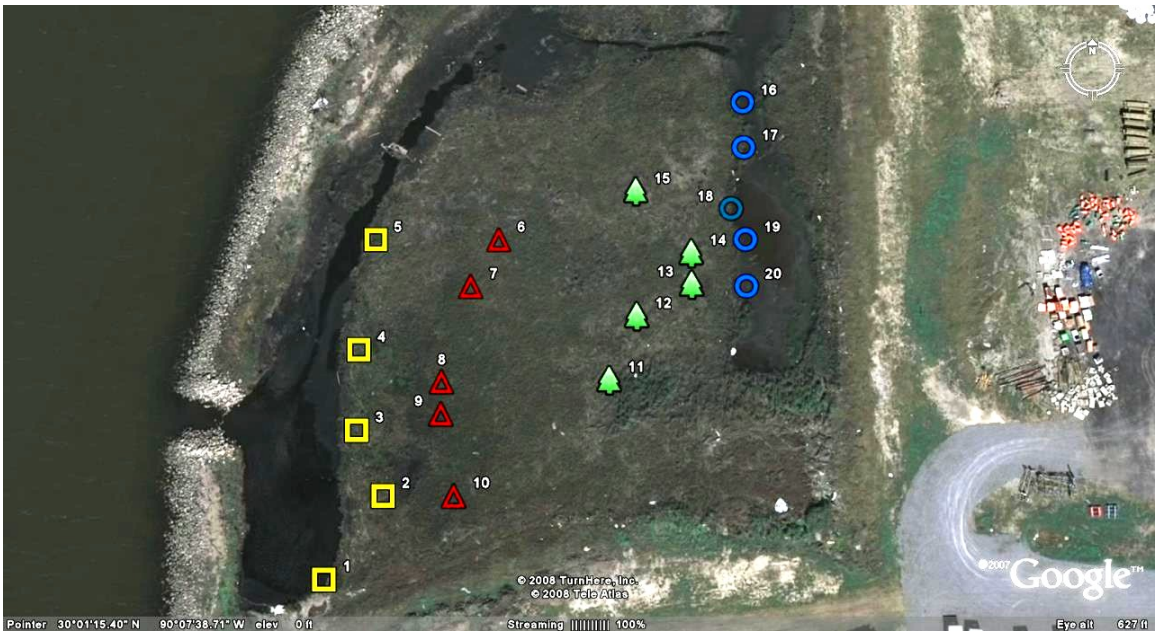
Results

First year readings (summer 2007 to winter 2008) of the sediment elevation tables located at the Bucktown marsh revealed an extremely small decrease in sediment elevation in the Scrub-Shrub habitat area, whereas a substantial increase in elevation was noted for the Western Marsh habitat area (Fig. 1). Cores of feldspar marker horizons in the Scrub-Shrub habitat indicated some minimal accretion (4 mm) had occurred, while the feldspar marker horizon depth in the Western Marsh habitat (10.4 cm) essentially equaled the average sediment elevation change in this zone. Bulk density was not significantly different between zones, although there was a trend towards greater bulk density in the Scrub-Shrub zone than the three marsh zones (Fig. 2, top panel). The Eastern Low Marsh and High Marsh zones had significantly greater soil organic matter content than the Scrub-Shrub and Western Low Marsh Zones (Fig 2, bottom panel; Contrast $F= 7.480$, $P=0.021$). This corresponded to Eastern Low Marsh and High Marsh zones also having significantly greater soil moisture content than the Scrub-Shrub and Western Low Marsh Zones (Fig 2, middle panel; Contrast $F= 5.010$, $P=0.049$).

Spartina alterniflora cover was marginally greater in the Summer of 2007 than the Fall of 2007 (Fig. 3, top panel; $F= 3.552$, $P = 0.084$). In summer of 2007, *S. alterniflora* cover was significantly greater in the Western Low Marsh zone than all other zones (Fig. 3, top panel; $F= 26.797$, $P < 0.001$). Similarly, *S. alterniflora* cover was significantly greater in the Western Low Marsh zone than all other zones in Fall of 2007 (Fig. 3, top panel; $F= 7.951$, $P = 0.015$). Total vegetative cover was significantly greater in Summer 2007 than Fall 2007 (Figure 3, bottom panel; $F= 28.724$, $P < 0.001$). Although all zones had substantial mean total vegetative cover in Summer of 2007 (i.e., >60 %), the high marsh zone had significantly lower vegetative cover than the other zones (Fig. 3, bottom panel; $F= 13.292$, $P= 0.003$). However, by the Fall 2007 sampling the Eastern and Western Low Marsh zones had significantly lower total vegetative cover than the High Marsh and Scrub-Shrub zones (Fig. 3, bottom panel; $F= 15.464$, $P = 0.002$).

Regarding vegetative community composition, seasonal patterns (i.e., Fall and Summer) were relatively constant in both 2006 and 2007 for all vegetative zones (Figs. 4 through 11). However, in 2006 the Western Low Marsh zone exhibited greater species diversity in the Summer, with species composition becoming nearly monospecific *S. alterniflora*

by Fall (Fig. 4). In 2007 the Western Marsh Zone did not demonstrate the same level of species reduction from Summer (6) to Fall (4; Fig. 5). The patterns of species number in the High Marsh zone were fairly consistent in the Summer and Fall of both 2006 and 2007 (Fig. 6, 7). However, a marked decrease in the cover of *Scheonoplectus* spp. from 2006 to 2007 was noted, along with an increase in *Paspalum vaginatum* cover (Fig. 6, 7). A general decrease in species number was noted for the Scrub-Shrub zone from 2006 to 2007, however patterns of species composition were fairly consistent from Summer to Fall within each year (Fig. 8, 9). The Eastern High Marsh zone was monotypically-dominated by *S. alterniflora* in the Summer and Fall of both 2006 and 2007 (Fig. 10, 11), with the only notable change in vegetation characteristic being the aforementioned decrease in cover. Ordination of plots using non-metric multidimensional scaling revealed that in Summer of 2007 two gradients existed by which plots could be separated. The first (x) axis corresponds to the inverse cover of *S. alterniflora*, whereas the second (y) axis positively correlates to *I. frutescens* cover (Fig. 12; $r = -0.992$, $r = 0.771$, respectively). Interestingly, in Fall of 2007 two gradients also existed by which plots could be separated. However, at this point in time axis one (x) remained highly, negatively correlated with *S. alterniflora*, but also now included highly negatively correlated with *I. frutescens*, while axis two (y) was highly positively correlated with *Scheonoplectus americanus*.



Western Low Marsh
High Marsh
Scrub Scrub
Eastern Low Marsh

Image 1. Study site with plot habitat types indentified in above legend. Numbers correspond to plot numbers. Image source is Google Earth accessed 3 17 2008.

Image 2. General view of the Bucktown marsh area from adjacent levee (top panel: Summer 2007; bottom panel Fall 2007).

Image 3. Image of the dredge overflow release structure adjacent to Bucktown marsh area (top panel) and view of the Bucktown marsh area and shoreline from the dredge overflow release structure (bottom panel).

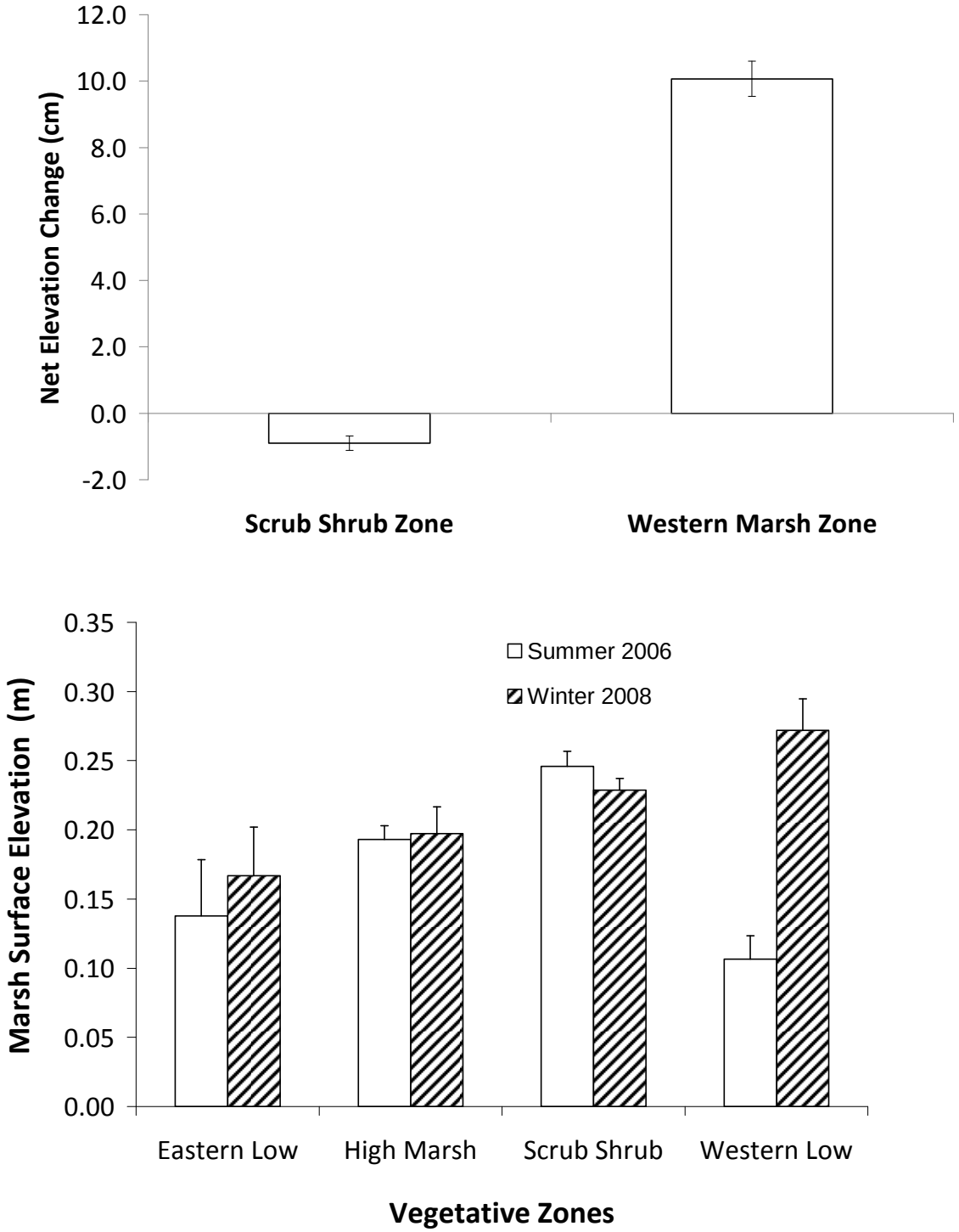


Fig. 1. Top panel: Elevation change in two different vegetative zones at the Bucktown marsh restoration site from Summer 2006 to Winter 2008 (mean +/- se). Note that the depth to the feldspar markers was 0.4 cm for the Scrub Shrub Zone and 10.4 cm for the Western Marsh Zone. Bottom panel: Relative survey elevation corrected to the lowest plot elevation (mean +/-se).

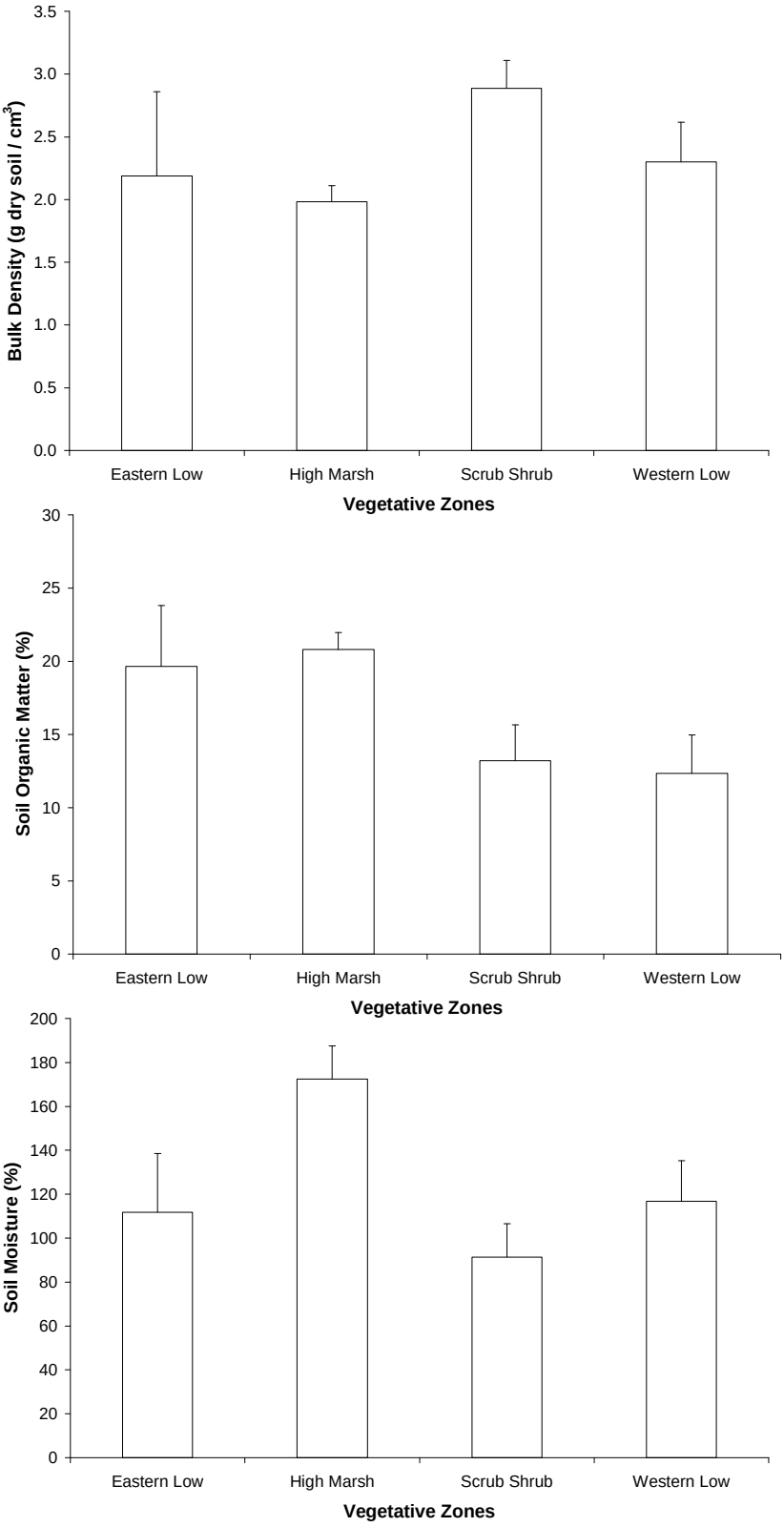
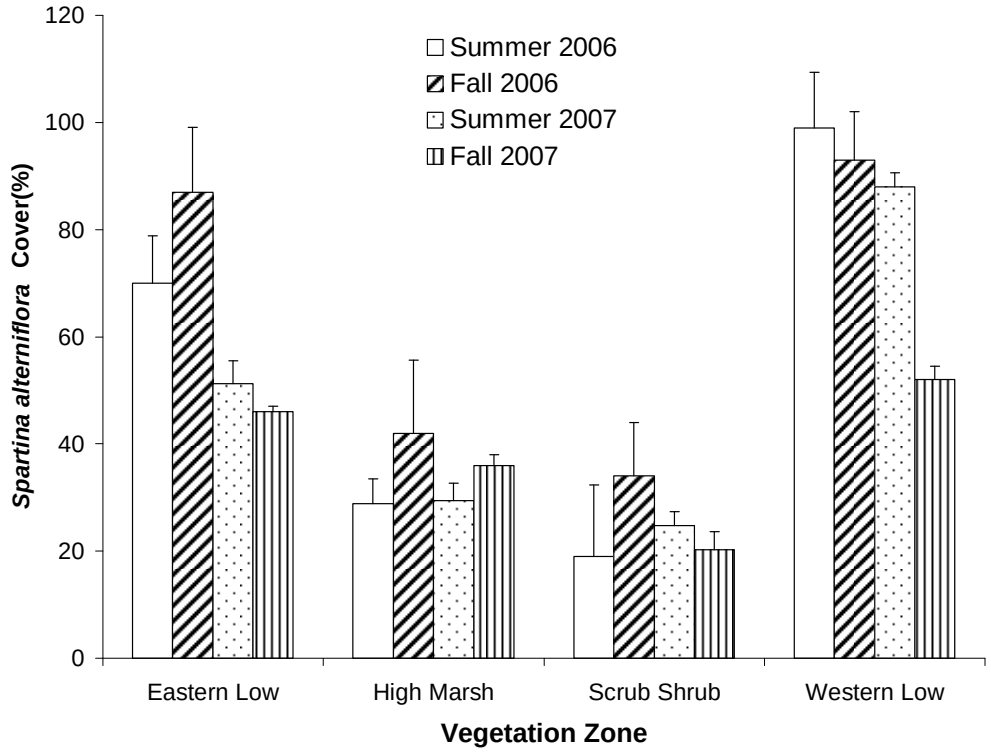


Fig. 2. Soil bulk density (top panel), soil moisture (middle panel), soil organic matter (bottom panel) in the four marsh zones at the Bucktown created marsh site in summer of 2007. (mean +/- se).



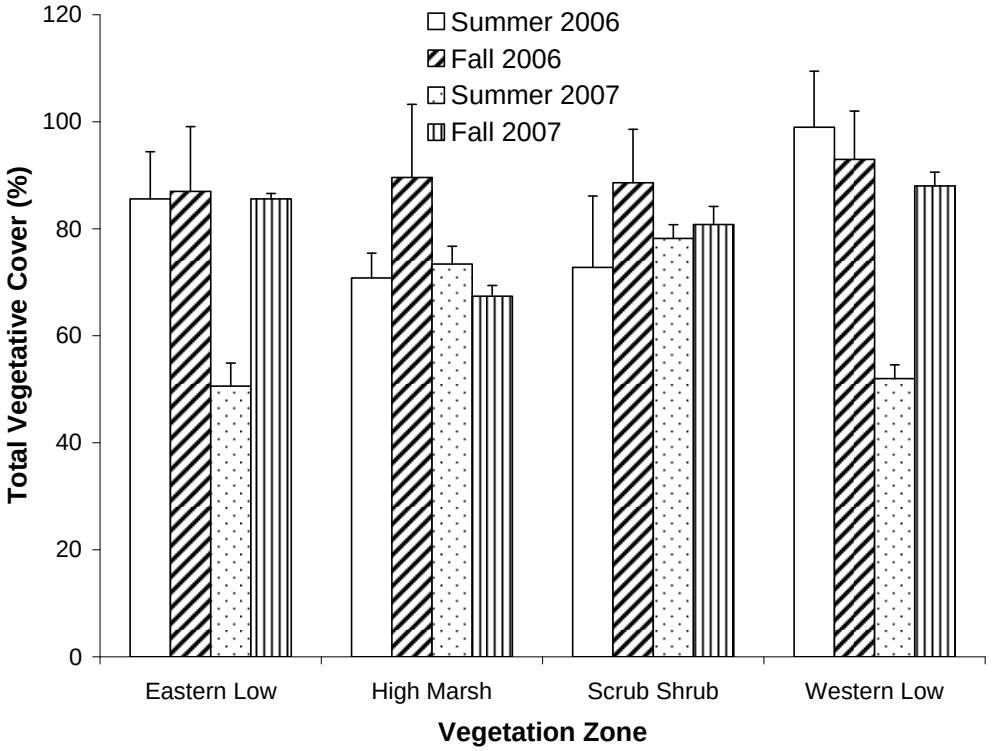


Fig. 3. *Spartina alterniflora* and total cover in the four marsh zones over four sampling periods at the Bucktown created marsh site. (mean +/- se).

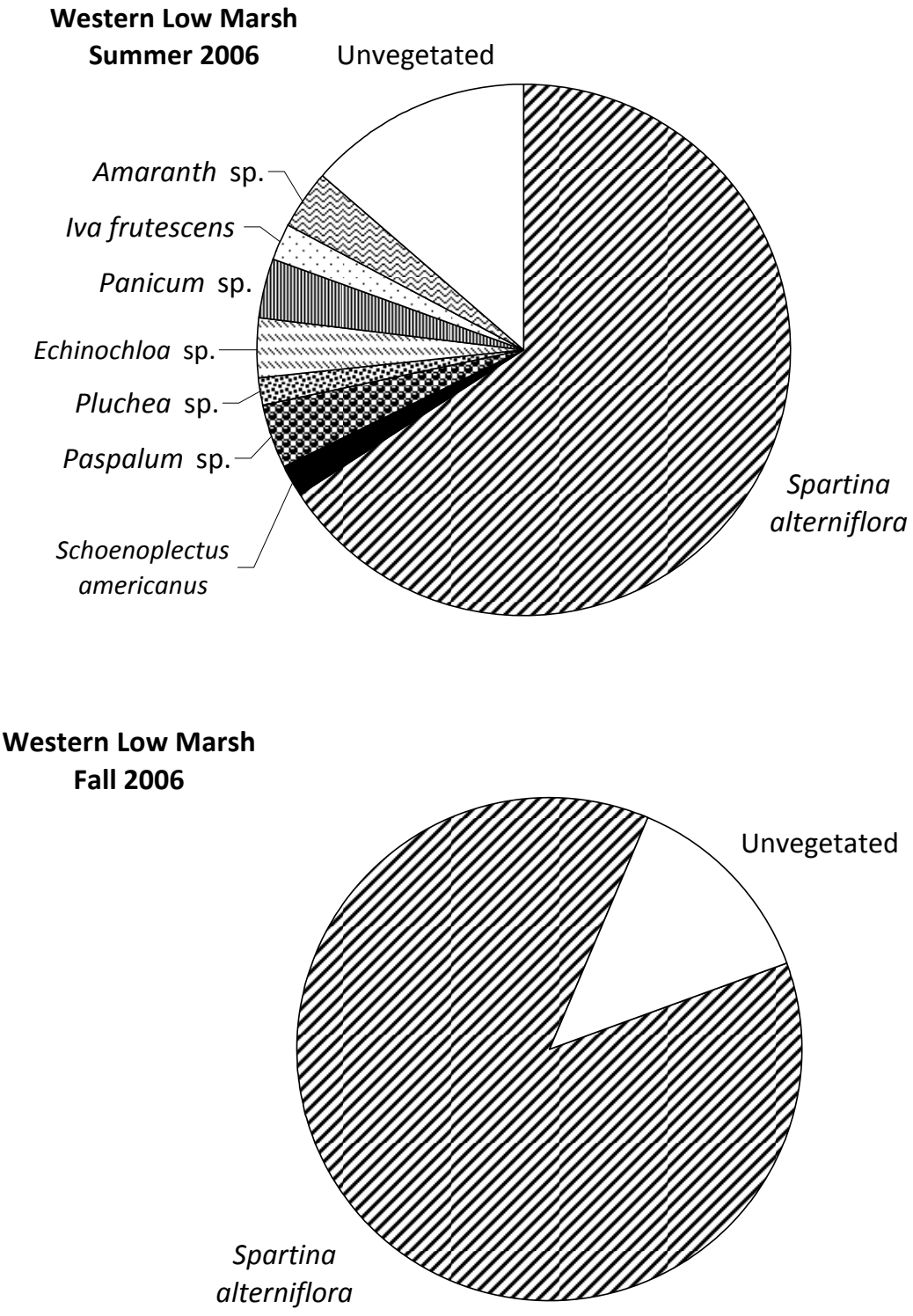


Fig. 4. Vegetative species composition (2006) in western low marsh zone at the Bucktown marsh restoration site (pie slices are average cover values as percentage of plots).

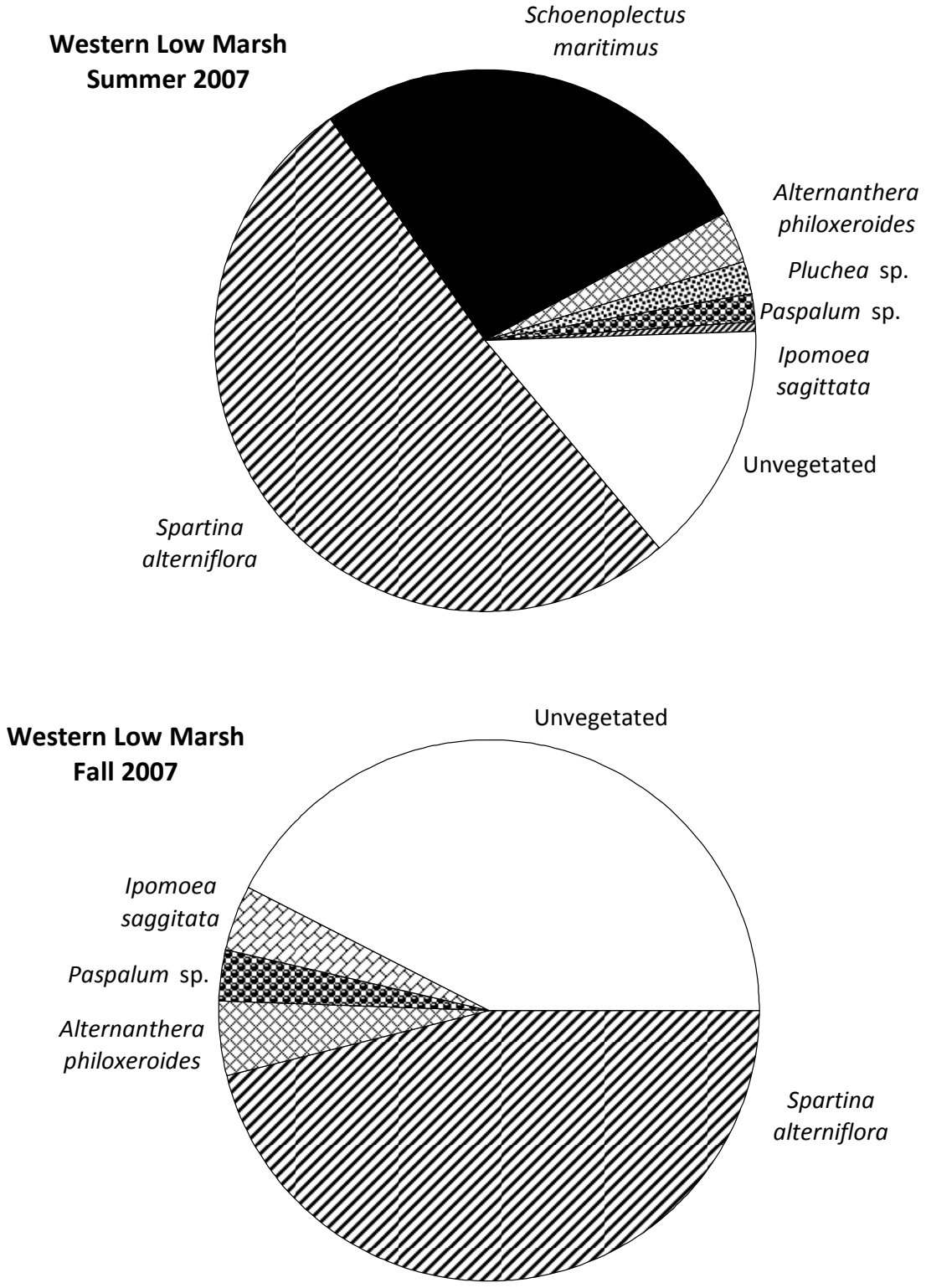
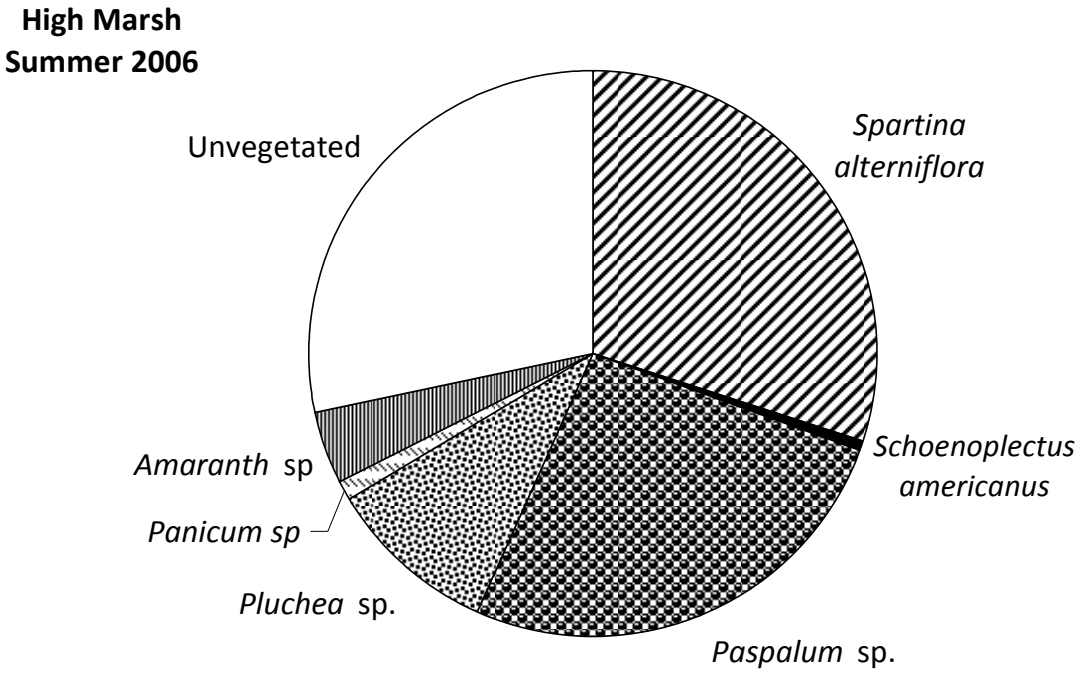


Fig. 5. Vegetative species composition (2007) in western low marsh zone at the Bucktown marsh restoration site (pie slices are average cover values as percentage of plots).



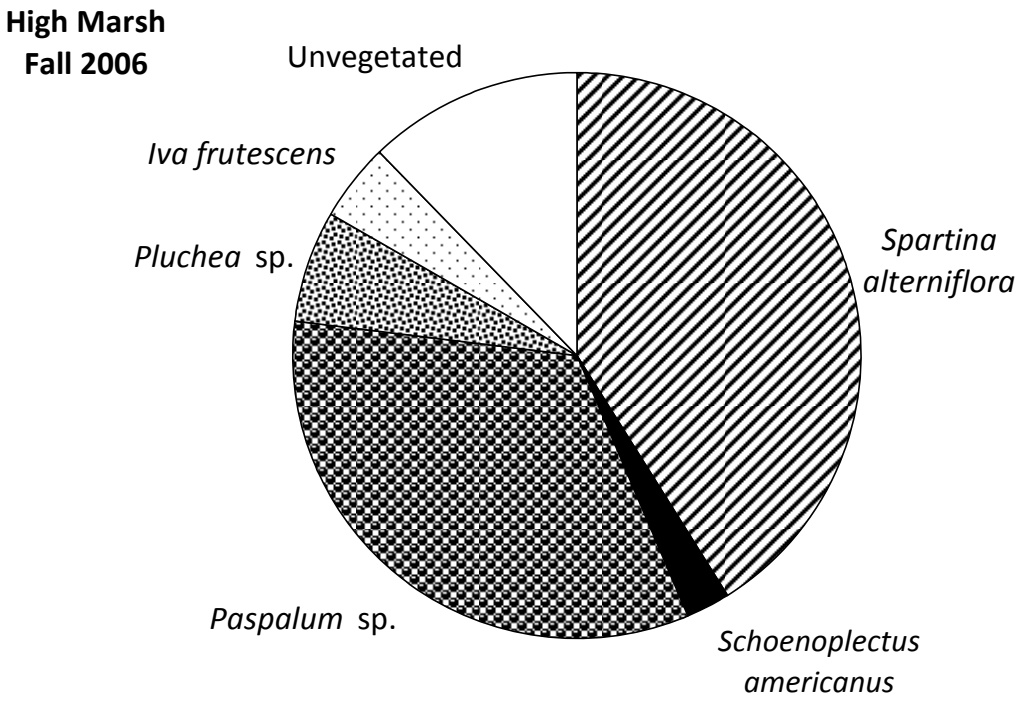


Fig. 6. Vegetative species composition (2006) in high marsh zone at the Bucktown marsh restoration site (pie slices are average cover values as percentage of plots).

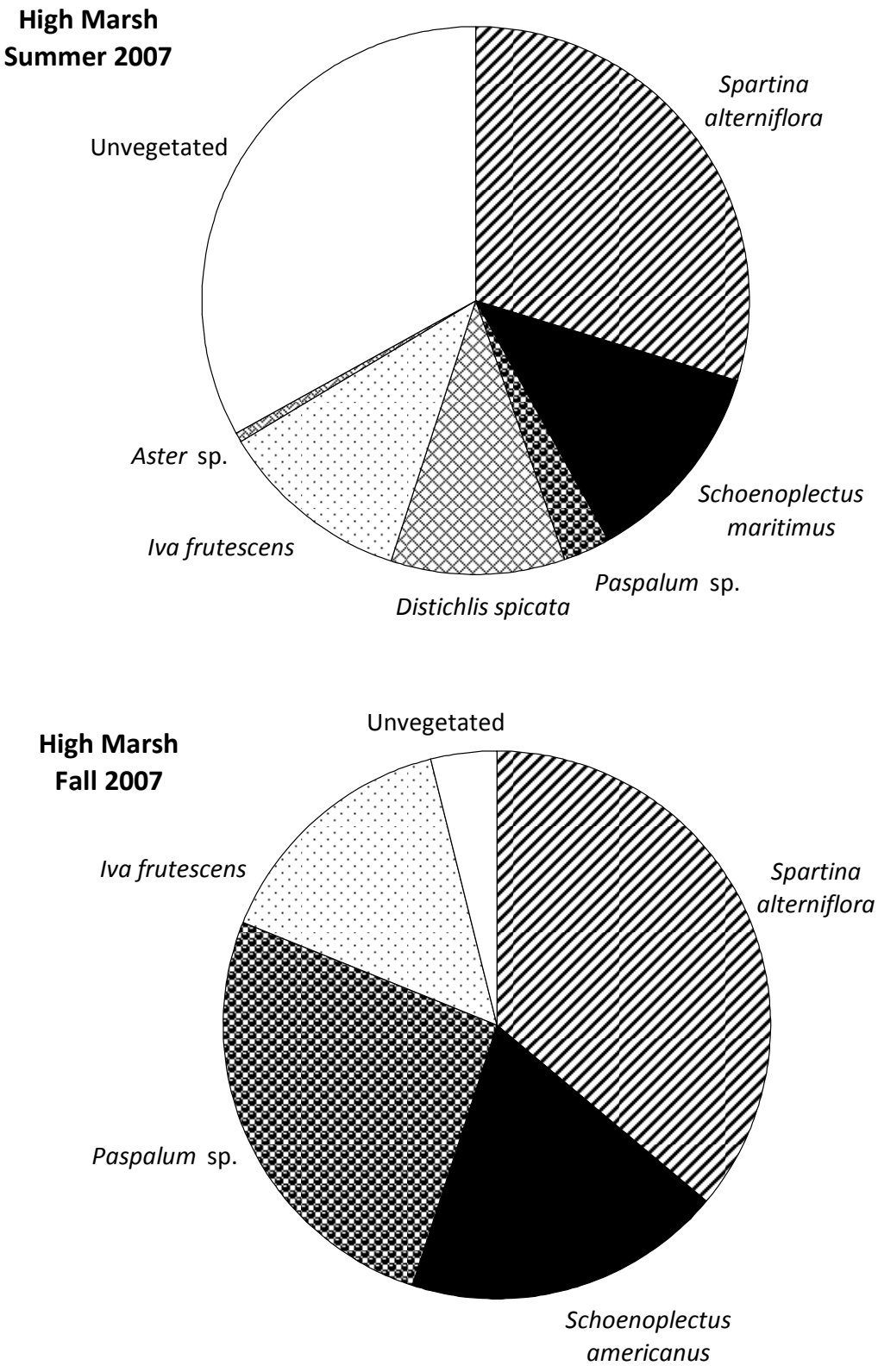
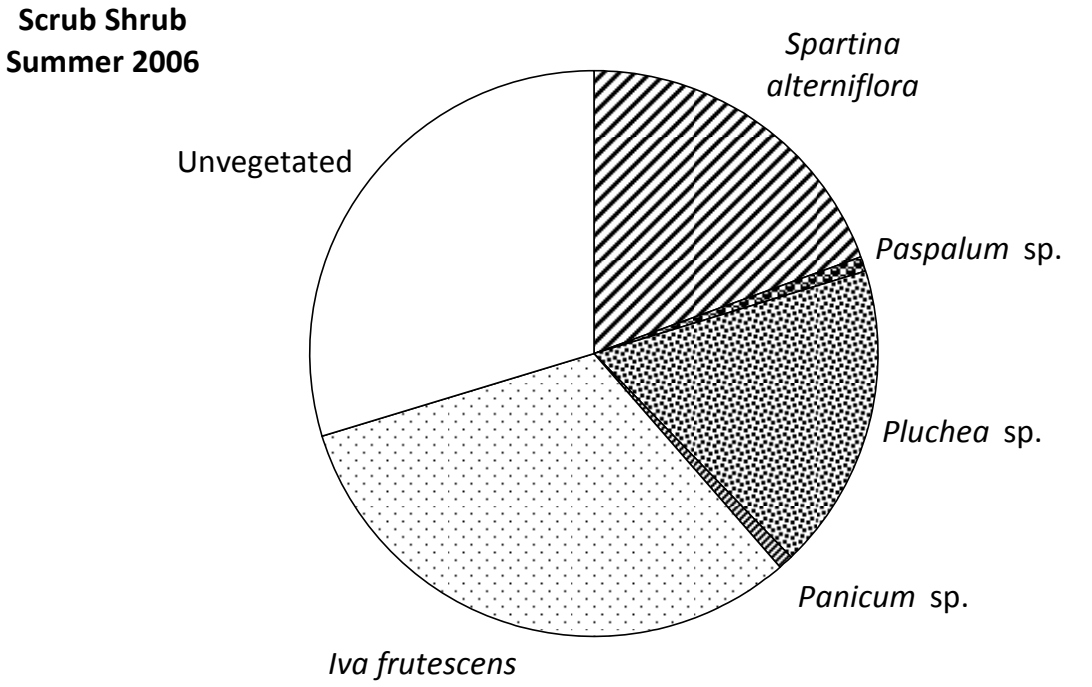


Fig. 7. Vegetative species composition (2007) in high marsh zone at the Bucktown marsh restoration site (pie slices are average cover values as percentage of plots).



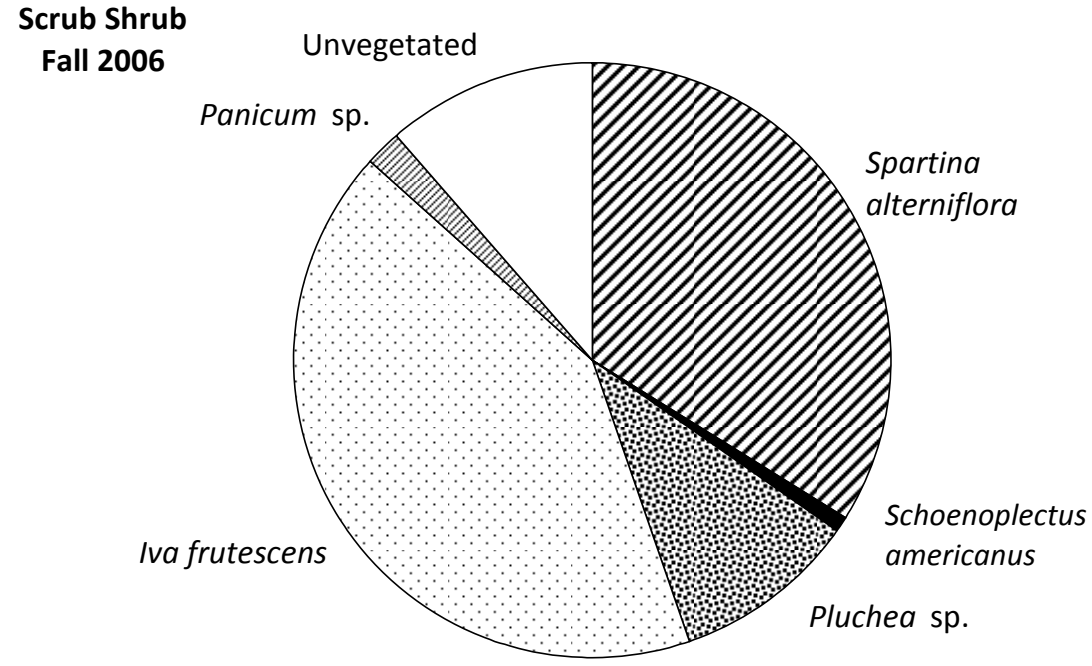


Fig. 8. Vegetative species composition (2006) in the scrub shrub zone at the Bucktown marsh restoration site (pie slices are average cover values as percentage of plots).

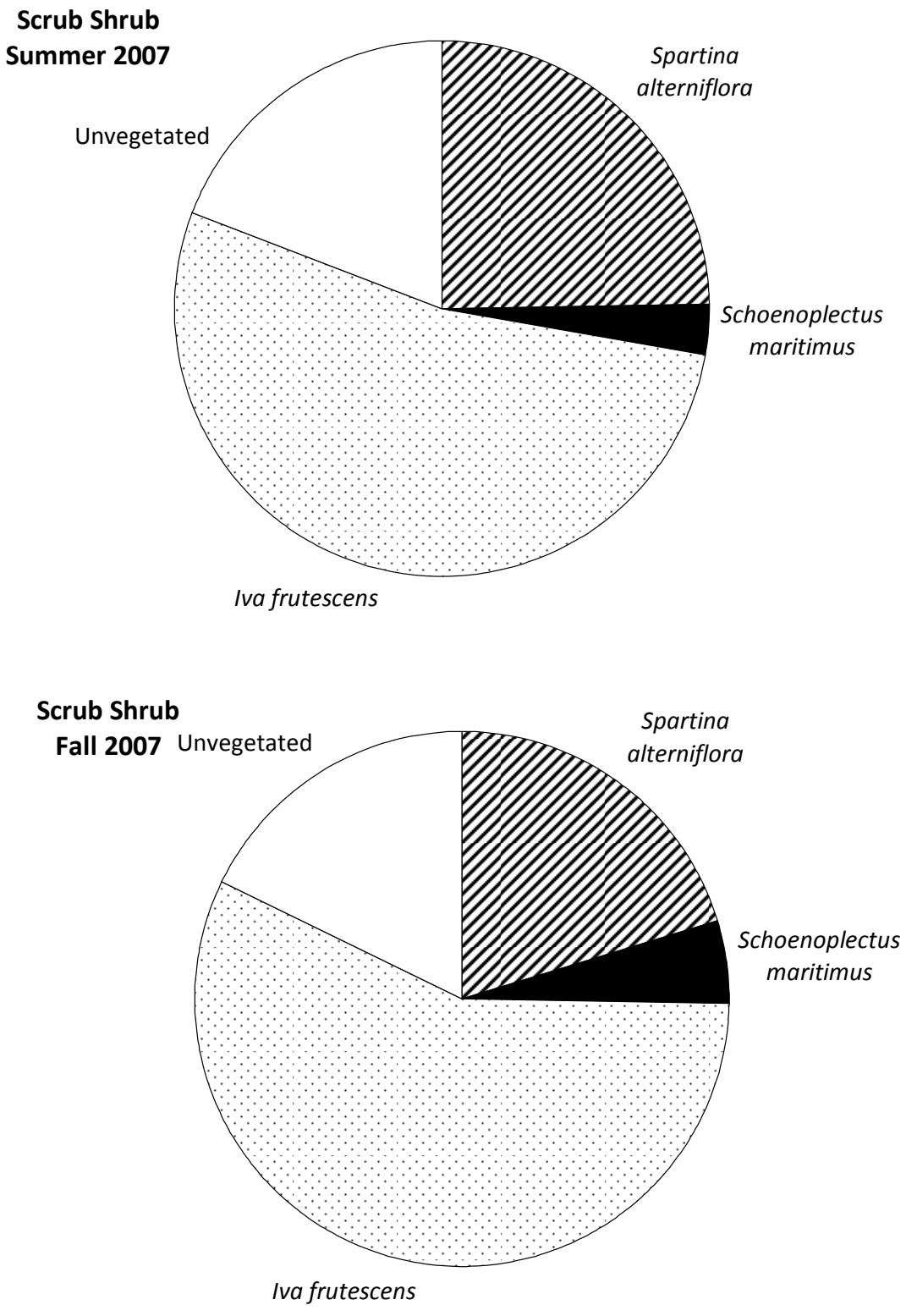


Fig. 9. Vegetative species composition (2007) in the scrub shrub zone at the Bucktown marsh restoration site (pie slices are average cover values as percentage of plots).

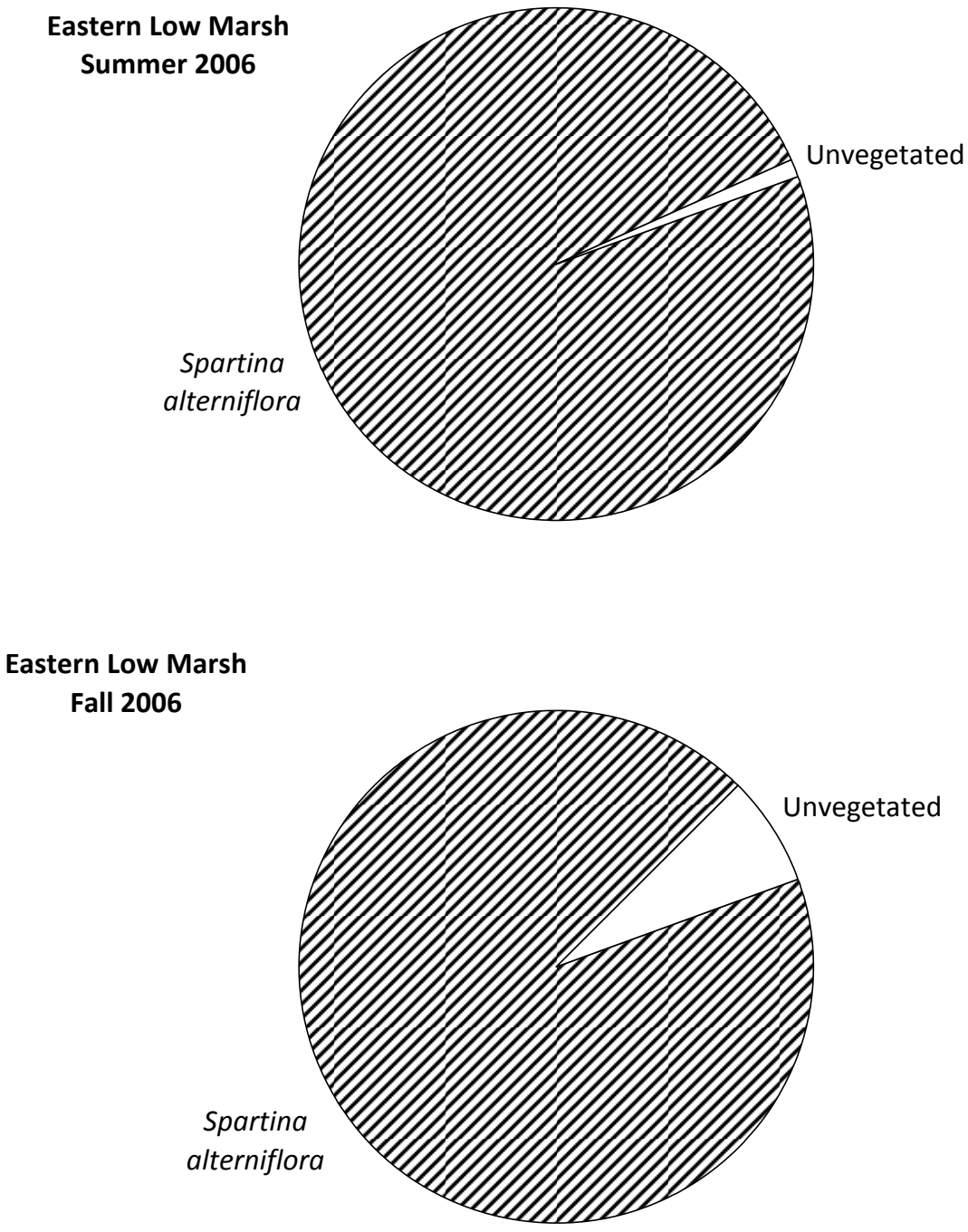


Fig. 10. Vegetative species composition (2006) in eastern low marsh zone at the Bucktown marsh restoration site (pie slices are average cover values as percentage of plots).

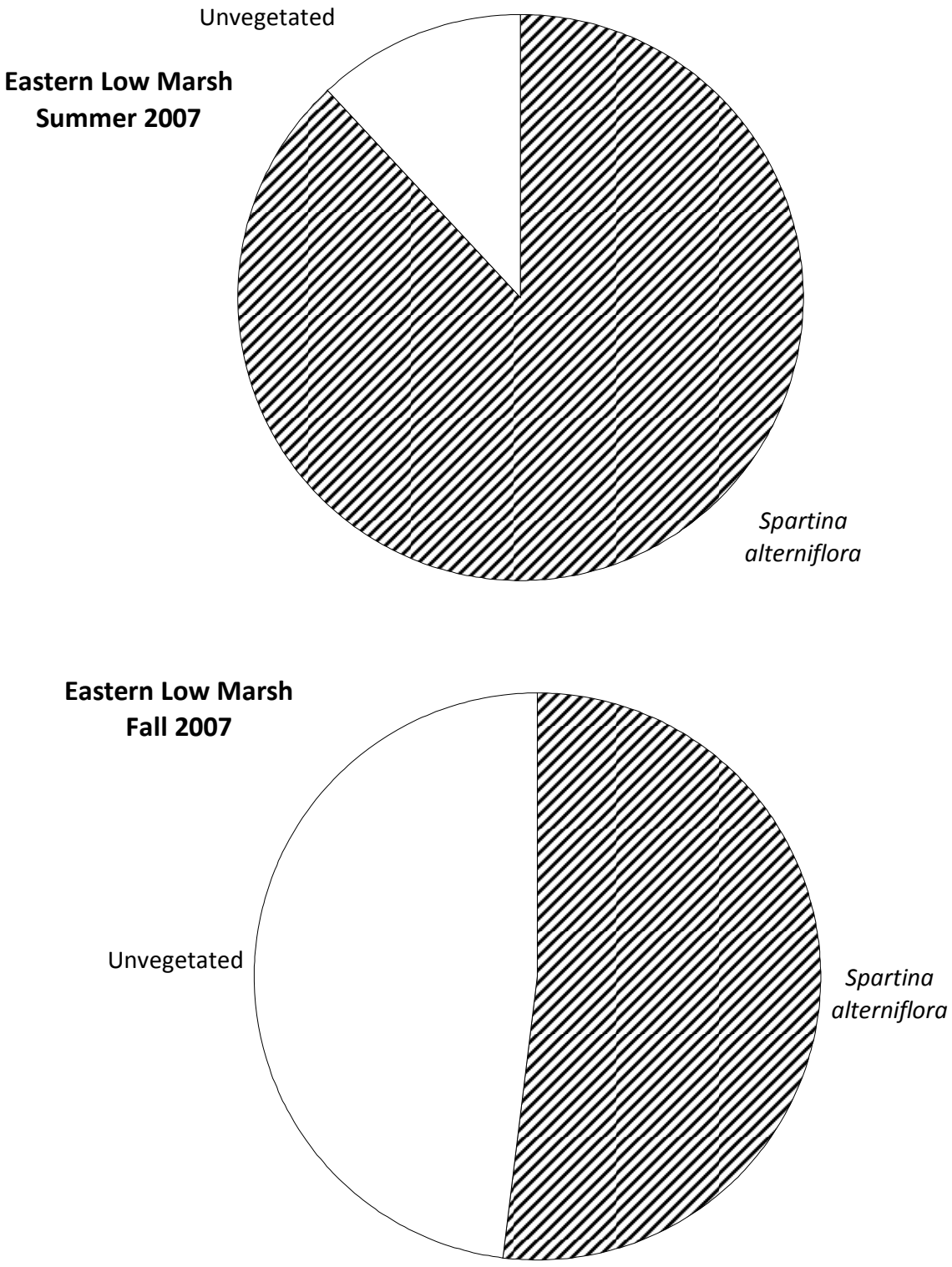


Fig. 11. Vegetative species composition (2007) in eastern low marsh zone at the Bucktown marsh restoration site (pie slices are average cover values as percentage of plots).

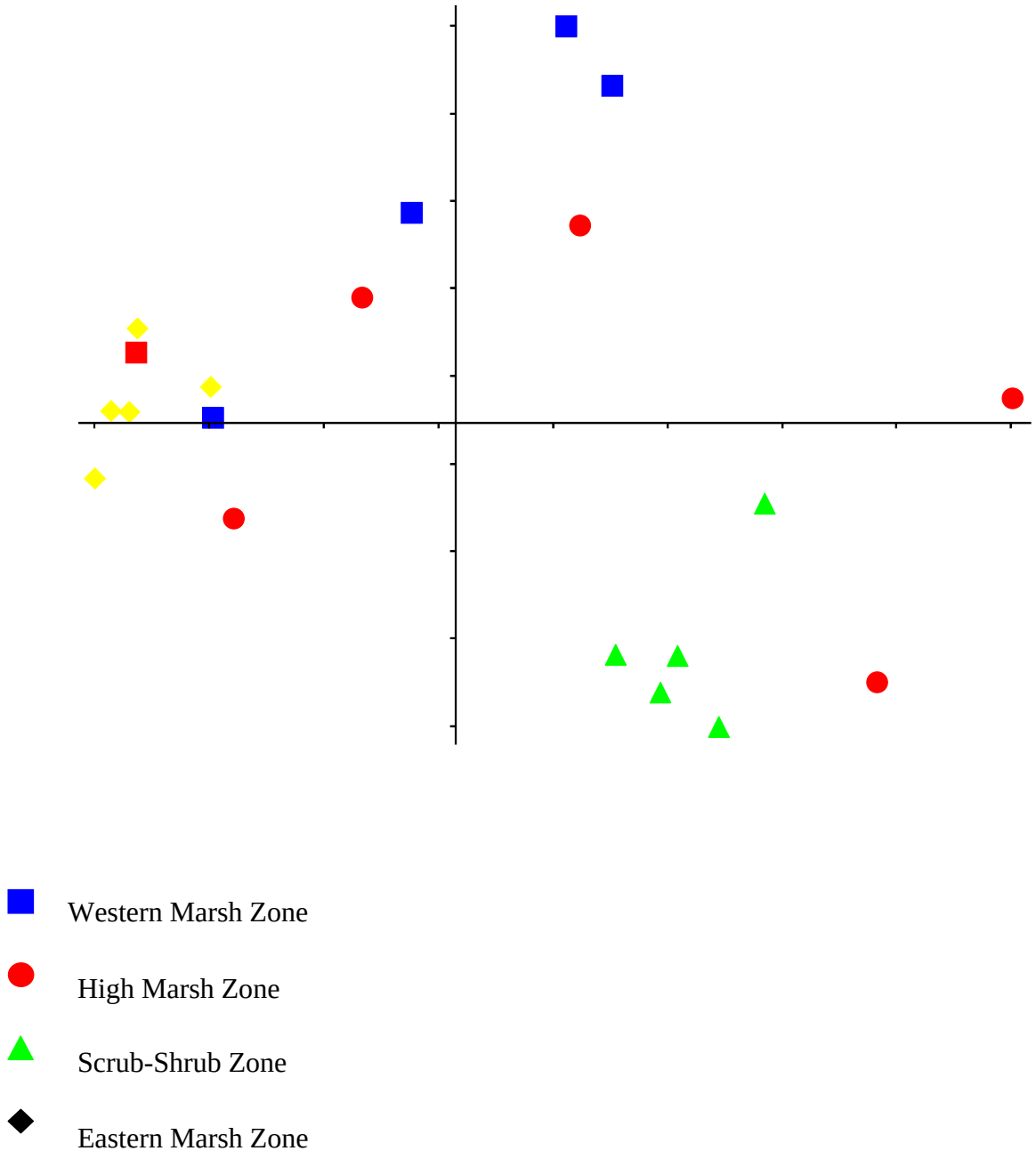


Fig. 12. Similarity of permanent plots and vegetative zones for Summer 2007 as determined by nonmetric multidimensional scaling. X axis inversely correlates with *S. alterniflora* cover; the Y axis correlates with *I. frutescens* cover.

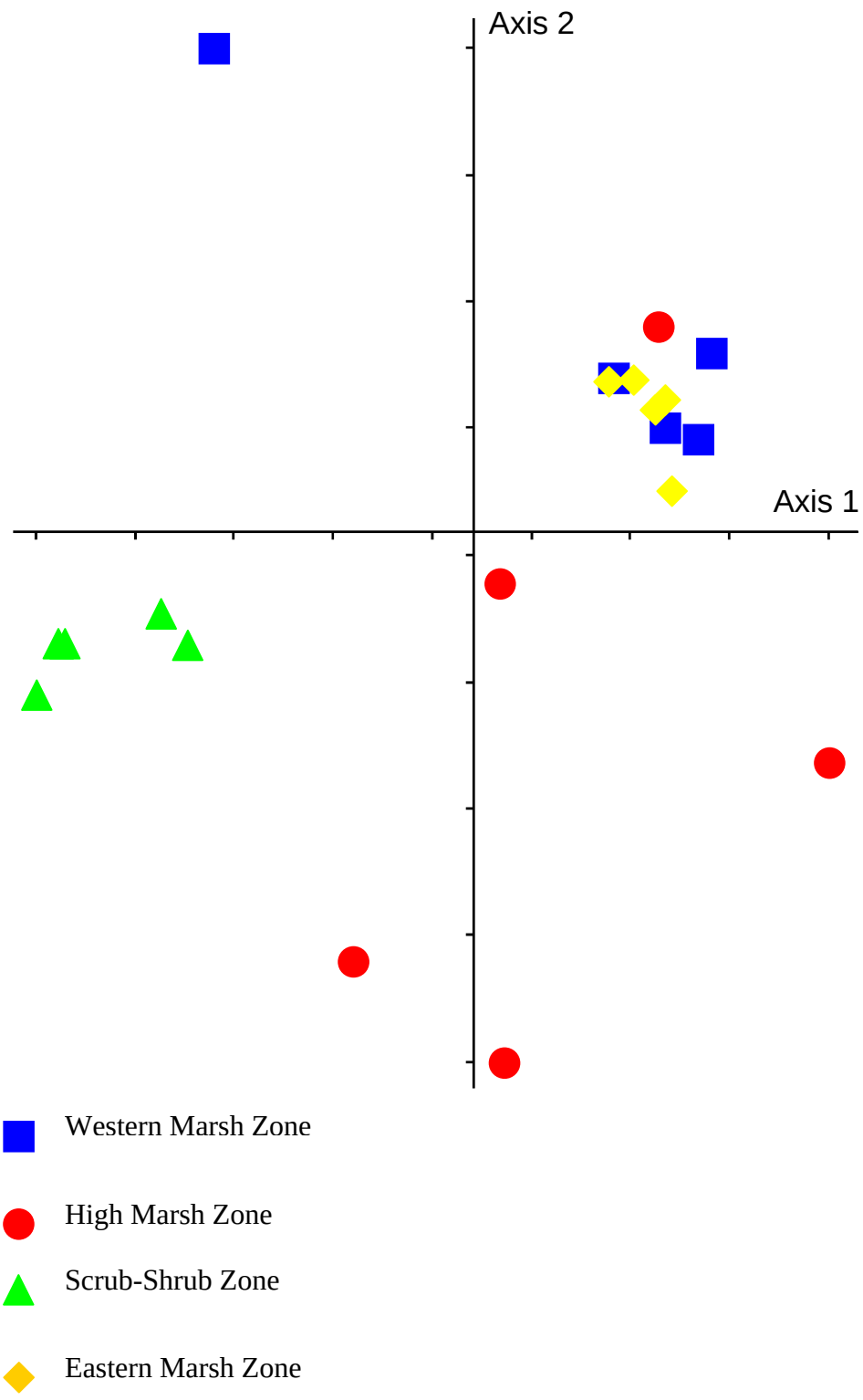


Fig. 13. Similarity of permanent plots and vegetative zones for Fall 2007 as determined by nonmetric multidimensional scaling. X axis correlates with *S. alterniflora* cover; the Y axis correlates with *I. frutescens* cover.

Conclusions

The two years of monitoring data for the Bucktown marsh creation project indicate that the created area is successfully maintaining the vegetative and soil characteristics of a healthy brackish marsh in coastal Louisiana. In general, species composition was determined to be similar to the 2006 vegetative survey. As in the 2006 vegetative sampling, the 2007 vegetative sampling revealed *S. alterniflora* occurring in robust stands in low elevation areas. Importantly, field researchers noted obvious impacts to *S. alterniflora* stands within the Eastern and Western Marsh zones from an apparent anthropogenic source in the Fall 2007 sampling, which somewhat reduced *S. alterniflora* cover. However, in spite of these impacts, fairly high cover of *S. alterniflora* occurred, indicating that this marsh already has attained some degree of resilience. The High Marsh zone continues to display relatively high species diversity typical of this habitat type in Louisiana marsh systems. Within the Scrub-Shrub zone the presence and extent of *Iva frutescens* actually appears to have expanded from 2006 to 2007. This is important as the maintenance of key species, such as *Iva frutescens*, is critical to this area being used as habitat by fauna (Havens et al. 2002). No undesirable species were found during vegetative surveys, with the only introduced species being *Echinochloa crus-galli* and *Alternanthera philoxeroides*. Although *Echinochloa crus-galli* and *Alternanthera philoxeroides* are considered introduced they have become typical components of Louisiana marshes and are not classified as noxious weeds in the state of Louisiana (USDA). The values obtained in the summer sampling for soil bulk density, organic matter, and moisture are all within ranges that would be reasonable for a healthy Louisiana brackish marsh (Edwards and Proffitt 2006; Baustian and Turner 2006). Soil elevation data indicate that a large accretionary event (~10.4 cm) has occurred in the vicinity of the Eastern Marsh zone, with fairly minimal change in elevation occurring in the vicinity of the Scrub-Shrub zone (~0.4 cm). A dredging operation was initiated in an area immediately to the east of the Bucktown marsh creation project in Fall of 2007 and could have been a source for the material comprising the accretionary event. However, this conjecture is presented based primarily on the coincidental timing of the accretionary event and dredging operation. Overall, this marsh appears to be maintaining a trajectory towards sustainability, however, monitoring of vegetative characteristics in the Summer and Fall of 2008 will be necessary to determine whether the Eastern and Western Marsh zones will demonstrate full recovery from the anthropogenic perturbation that occurred in Fall of 2007.

Literature Cited

Baustian , J.J. and R. E. Turner. 2006. Restoration Success of Backfilling Canals in Coastal Louisiana Marshes. Restoration Ecology. 14:636-644.

Burke and Kleinpeter, Inc. 2006. Bucktown Harbor – Marsh Planting Project Annual Report. 2 pp.

Clarke, K. R. 1993. Non-parametric multivariate analyses of changes in community structure. Australian Journal of Ecology 18:117-143.

Edwards, K. R., and E. C. Proffitt. 2003. Comparison of wetland structural characteristics between created and natural salt marshes in southwest Louisiana, USA. Wetlands. 23:344-356.

Havens, K. J., L. M.Varnell, and B. D. Watts. 2002. Maturation of a constructed tidal marsh relative to two natural reference tidal marshes over 12 years. Ecological Engineering. 18:305-316.

Hester, M. W. J. M. Willis, and C. E. Mayence. 2005. Plant Community Composition of the Bucktown Created Marsh: A Preliminary Assessment. Final Report, Lake Pontchartrain Basin Foundation.

Hester, M. W. J. M. Willis. 2007. Assessment of vegetative and edaphic characteristics of the Bucktown created marsh: year one. Final Report, Lake Pontchartrain Basin Foundation.

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

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

USDA PLANTS database: *Alternanthera philoxeroides*:

http://plants.usda.gov/java/profile?symbol=ALPH