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SHORT COMMUNICATION

EFFECTS OF BLACK MANGROVE (*AVICENNIA GERMINANS*) EXPANSION ON SALTMARSH (*SPARTINA ALTERNIFLORA*) BENTHIC COMMUNITIES OF THE SOUTH TEXAS COAST

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INTRODUCTION

Black mangroves are becoming more common in several areas along the Texas coast and encroaching on existing saltmarsh habitats (Everitt et al. 2007, 2008, 2010). Expansion has been documented through the use of aerial photography on South Padre Island (Everitt et al. 2007, 2008, 2010), through Texas General Land Office land surveys in the Matagorda and San Antonio Bays area (White et al. 2002), and anecdotally in the Corpus Christi and Port Aransas areas. Both black mangrove (*Avicennia germinans*) and saltmarsh, composed primarily of smooth cordgrass (*Spartina alterniflora*), are productive estuarine habitats that support a diverse group of benthic organisms. They serve as nursery ground for many species of fish and invertebrates and provide a source of organic nutrients (Chen and Twilley 1999, Stevens et al. 2006). *Avicennia germinans* and *S. alterniflora* are found in similar estuarine locations and can be found in close association (Britton and Morton 1989, Kangas and Lugo 1990). The distribution of these species is largely dependent on climate and salinity (Penfound and Hathaway 1938, Sherrod and McMillan 1985, Kangas and Lugo 1990, Saenger 2002). However, environmental factors such as freshwater inflow, salinity, and nutrient levels can favor the expansion of black mangrove into *Spartina* habitats from which *S. alterniflora* do not often recolonize (Eady 2007).

Abiotic factors play a large role in controlling *Spartina* and *Avicennia* interplay. *Spartina alterniflora* dominate at lower elevations where inundation occurs regularly and soils have more reducing characteristics (Patterson et al. 1993). *Avicennia germinans* dominate in areas of higher elevation with soils that are more oxidized, better drained and have higher salt contents (Patterson et al. 1993). *Spartina alterniflora* is more dependent on freshwater inflow than *Avicennia*. Though both species do well in a wide range of salinity (Chapman 1974, 1976), *Avicennia* has a greater tolerance for increased salinity levels, maintaining production at sa-

linities exceeding 40 (Patterson and Mendelssohn 1991). A severe drought in Louisiana caused significant dieback of *S. alterniflora* stands but did not affect *Avicennia* (McKee et al. 2004). In contrast, *S. alterniflora* is more cold tolerant, rapidly recolonizing after winter freezes cause dieback of *A. germinans* (Stevens et al. 2006).

Avicennia germinans is the only species of mangrove commonly found on the Texas coast, and winter freezes have limited permanent stands of this species to the southern coast of Texas (McMillan 1986, McMillan and Sherrod 1986, Lonard and Judd 1991). However, recent mild winters have allowed the distribution of black mangroves to expand northward along the Gulf of Mexico (GOM) coast (Everitt et al. 2010). The interaction between *A. germinans* and *S. alterniflora* is a complex process. *Avicennia germinans* outshades *S. alterniflora* in times of mild winters but is out competed for space in areas of mixture (Stevens et al. 2006). However, *S. alterniflora* may also facilitate *A. germinans* expansion by trapping *Avicennia* propagules and allowing them to establish.

While much research has been done on black mangrove expansion and the effects of mangrove—saltmarsh competition (Stevens et al. 2006, Everitt et al. 2007, 2008, 2010), little has been done on how the biotic communities compare in Texas. Several studies have investigated how macrofaunal assemblages compare in other parts of the world, though infaunal studies are lacking. Studies done previously have determined that mangroves generally support lower densities of fish and invertebrates than other vegetated habitats (Sheridan and Hays 2003). However, densities of fish and invertebrates in saltmarshes were lower than densities of fish and invertebrates in mangroves along the Australian coast (Bloomfield and Gillanders 2005). Changes in vegetated community composition are expected to have some effects on the benthic communities these biogenic habitats support (Posey 1988). The structurally complex habitat cre-

ated by stem and root structures of *A. germinans* and *S. alterniflora* may attract different groups and species of organisms. Mangroves also tend to acidify their substrate, which may also affect community composition (McKee 1993).

This study examined the effects of mangrove expansion on benthic communities. This was accomplished by examining plant composition, benthic community composition, and belowground root biomass. Two sites were examined: Corpus Christi Pass, Corpus Christi, TX where mangroves have become more common in the last decade and the Lower Laguna Madre, South Padre Island, TX where mangroves are well established. This research seeks to provide preliminary results to provide direction for future studies examining the interplay of *S. alterniflora* and *A. germinans* habitat on benthic communities. We hypothesize that the more established site of South Padre Island will have greater numbers of species than the newer communities of Corpus Christi, and that *A. germinans* habitats will have lower diversity of infaunal organisms than *S. alterniflora* habitats.

MATERIALS AND METHODS

Wetland Plant Composition

Sites were selected in tidal marsh habitats, one in the Lower Laguna Madre, South Padre Island, TX and one at Corpus Christi Pass in the Upper Laguna Madre, Corpus Christi, TX (Figure 1A). Both were in 10–15 m long sections of mixed habitats of *A. germinans* and *S. alterniflora*. Marsh vegetation along the Texas coast exhibits a zonation pattern with *S. alterniflora* in more submerged areas with *A. germinans* further inshore from *S. alterniflora*.

Plant composition was quantified in our field sites. Transects were initiated within the fringing stands of *S. alterniflora* and extended perpendicular to shore into stands of *A. germinans*. Three transects were spaced 50 m apart along the shoreline. Percent composition of live wetland plant species was determined every 1.5 m using a 1 m² quad-

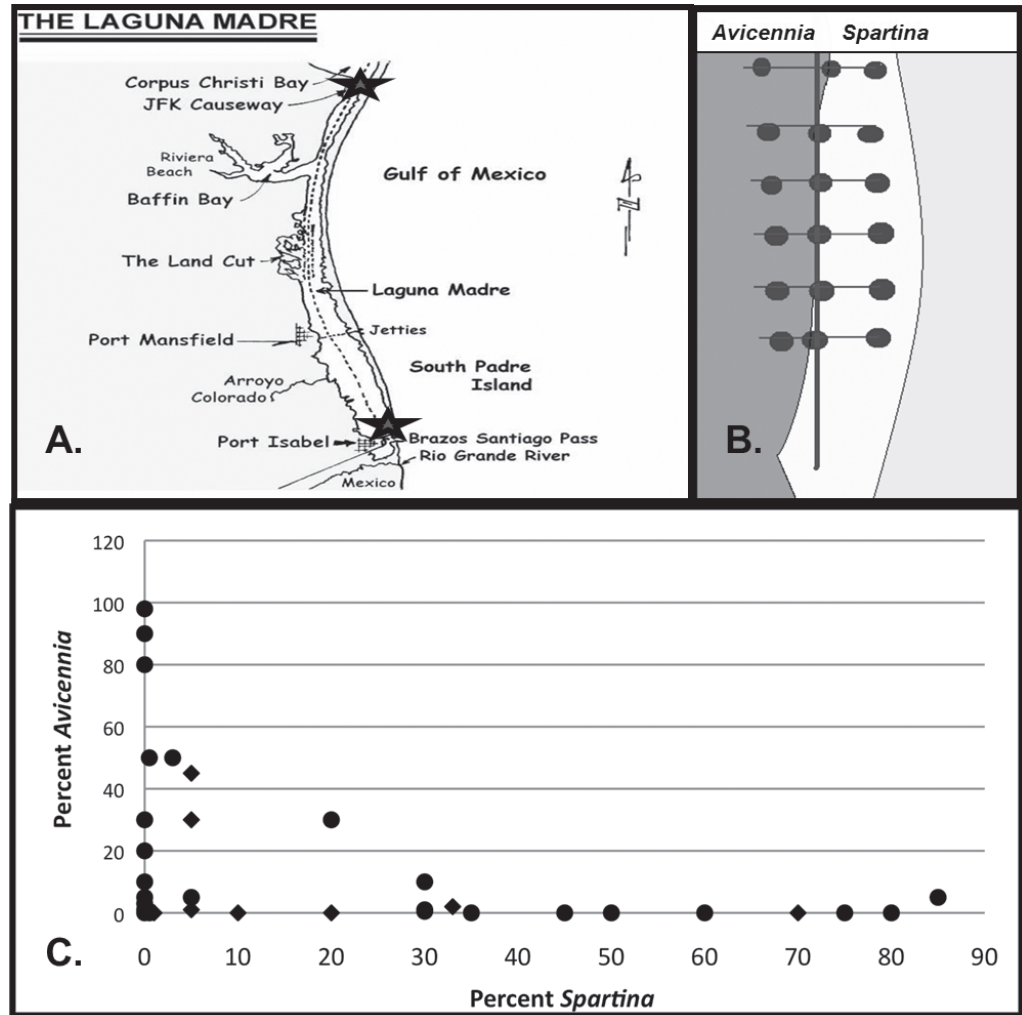


Figure 1. A. Map of Texas coastline with experimental sites marked by stars. B. Diagram of transect sampling design. Circles represent where cores were taken for community sampling. Plant composition transects were set up in the same way but spaced farther apart. C. Comparison of percent cover of *Spartina alterniflora* and *Avicennia germinans* along transects at both field sites ($r = -0.47$). Corpus Christi values are represented by diamonds ($n = 9$), South Padre Island values are represented by circles ($n = 40$).

rat. Data points which contained neither *A. germinans* nor *S. alterniflora* coverage were removed from the data set. The data points were then \log_{10} transformed to meet assumptions of normality. A correlation between *A. germinans* and *S. alterniflora* cover at both the Corpus Christi and South Padre Island sites determined the interaction between species as they compete for space along the coastline.

Belowground Root Biomass

Belowground root biomass was sampled using a core (10 cm diameter x 10 cm depth) at the Corpus Christi site. Logistics prevented belowground root biomass from being examined at the South Padre Island site. Cores were taken in conjunction with plant composition transects but with stations spaced every 25 m. At each of these stations, one core was taken in each habitat: the zone of overlap, *A. germinans*, and *S. alterniflora* habitats ($n = 3/\text{habitat}$) and placed in a 250 μm biobag. Cores were about 1 m apart within stations. Samples were washed in the biobag, roots and stems were separated, and then samples were dried in a drying oven

at 50°C for one week. Data were log transformed to meet normality assumptions. Total mass (g), root and stem mass (g), density (#/m²), percent root, and percent stem data were analyzed using a one-way ANOVA with habitat as the fixed effect. Tukey's post-hoc test was used to determine which parameters differed between species.

Benthic Core Sampling

Core samples (10 cm diameter x 10 cm depth) were taken every 3 m along a 15 m section of coast for a total of 6 stations. At each of these stations, one core was taken in the middle of the 3 habitat types (zone of overlap between *A. germinans* and *S. alterniflora*, *A. germinans*, and *S. alterniflora* habitats) for a total of 6 cores per habitat type (Figure 1B). There was about 1 m between each habitat core within a station and 3 m between station cores. All samples were taken within one week in early fall of 2009. Samples were placed into 250 µm biobags and washed in the field. Samples were fixed in 10% formalin, then washed and transferred to jars of 45% isopropyl alcohol. All organisms were sorted using dissecting microscopes. Polychaetes were identified to family and all other organisms were identified to species.

Species diversity was calculated with the Shannon-Weiner Index and counts were expressed as number/m². Data were log₁₀ transformed to meet normality assumptions for parametric statistics. A two-way analysis of variance (ANOVA) with site and habitat as fixed factors was used to analyze species richness, diversity, number of organisms/m², total crustaceans, total mollusks and total polychaetes. If the interaction between site and habitat was not significant, Tukey's post hoc test was used to compare all pairwise differences for both site and habitat (Sokal and Rohlf 1995). All statistical analyses were performed using SAS software version 9.1.3, and $p \leq 0.05$ was considered significant.

RESULTS

Wetland Plant Composition

Avicennia germinans and *S. alterniflora* were inversely correlated with a narrow region of mixing for both sites ($r = -0.47$, $p = 0.001$; Figure 1C). Visual

observations at both sites indicate *S. alterniflora* dominate deeper waters along the south Texas coast.

Belowground Root Biomass

Belowground root biomass was not significantly different between habitats for any of the parameters measured (all $p > 0.2$). This could be because of the small sample size or that belowground structure differs more than the actual biomass.

Benthic Core Sampling

The South Padre Island (SPI) site was significantly higher in organism counts (lognm²), species richness (logS), diversity (logH), and total polychaetes (logtotpoly) than was Corpus Christi Pass (CC) ($F_{1,30} = 5.17$, $p = 0.03$; $F_{1,30} = 12.44$, $p = 0.0014$; $F_{1,30} = 10.81$, $p = 0.0026$; $F_{1,30} = 28.51$, $p < 0.0001$, respectively; Figure 2 A–D). Sites did not differ in total mollusks (logtotmoll) or total crustaceans (logtotcrust) ($F_{2,30} = 2.46$, $p = 0.12$; $F_{2,30} = 0.19$, $p = 0.66$, respectively). There was no significant interaction of site and habitat for any of the parameters measured (lognm²: $F_{2,30} = 1.11$, $p = 0.34$; logH: $F_{2,30} = 0.66$, $p = 0.52$; logS: $F_{2,30} = 0.49$, $p = 0.61$; logtotpoly: $F_{2,30} = 0.36$, $p = 0.70$; logtotmoll: $F_{2,30} = 0.76$, $p = 0.47$; logtotcrust: $F_{2,30} = 0.28$, $p = 0.75$).

Habitat data was combined across sites because there was

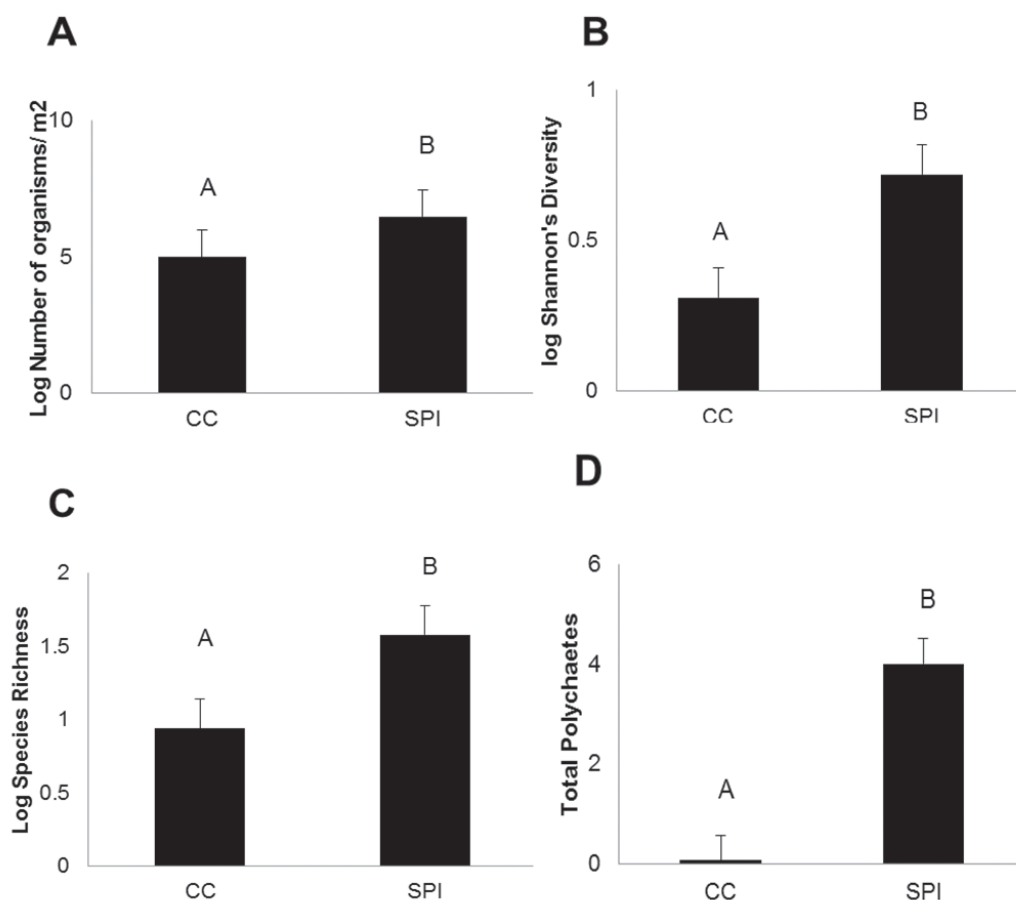


Figure 2. Site differences for benthic community sampling (mean \pm sd). Letters represent significant differences among sites ($n = 18$). **A.** Abundance. **B.** Diversity. **C.** Species richness. **D.** Total polychaetes. CC - Corpus Christi; SPI - South Padre Island.

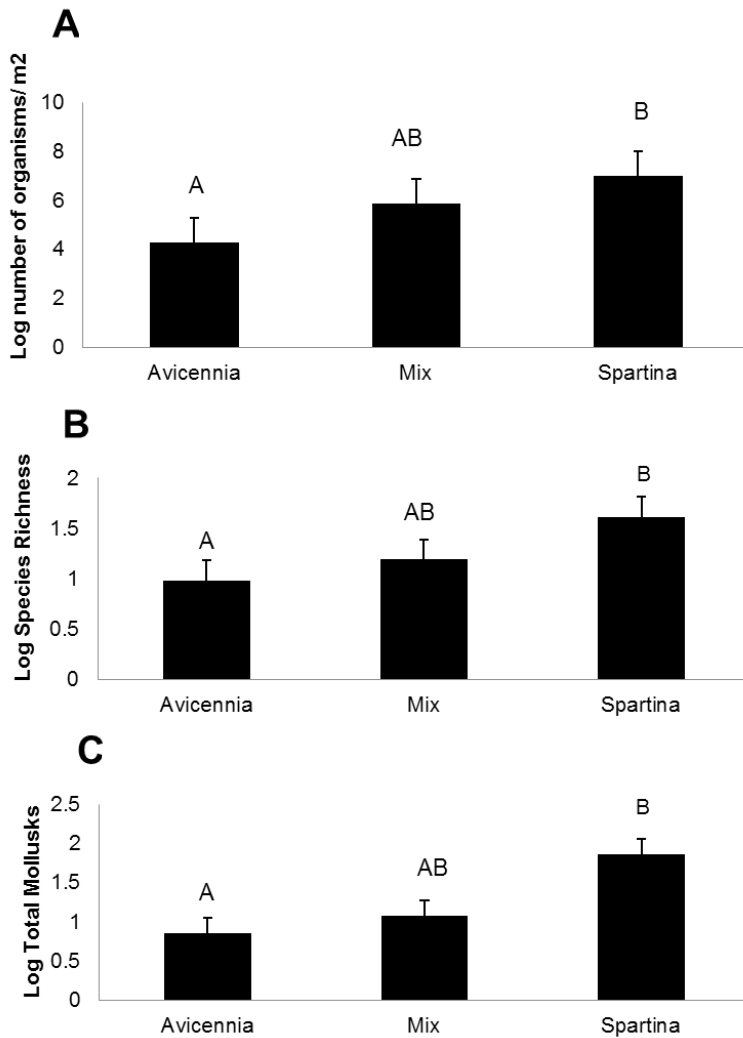


Figure 3. Habitat differences for benthic community sampling (mean \pm sd). Letters represent significant differences among habitats ($n = 6$); sites were combined for this analysis. **A.** Abundance. **B.** Species richness. **C.** Total mollusks.

no significant interaction between site and habitat. Habitats differed significantly in organism counts ($\log n m^2$), species richness ($\log S$), and total mollusks ($\log \text{totmoll}$) ($F_{2,30} = 5.78$, $p = 0.0075$; $F_{2,30} = 3.67$, $p = 0.03$; $F_{2,30} = 3.74$, $p = 0.03$, respectively; Figure 3 A–C). *Spartina alterniflora* habitat had significantly higher organism counts, species richness and more mollusks than the *A. germinans* habitat though the mixed habitat did not differ from either of the others. There were no differences between habitats for diversity ($\log H$), total polychaetes ($\log \text{totpoly}$) or total crustaceans ($\log \text{totcrust}$) ($F_{2,30} = 2.18$, $p = 0.13$; $F_{2,30} = 0.89$, $p = 0.42$; $F_{2,30} = 0.07$, $p = 0.93$, respectively).

DISCUSSION

The South Padre Island site was more diverse than the Corpus Christi site. Differences between sites were not unexpected as the South Padre Island site has a longer history of mangrove establishment. The nature of the field sites was also different topographically. For example, the South Padre site had a shallower grade sloping out of the water than the Corpus Christi site which was along a pass cut through Mustang Island. This difference in site topography is because in Corpus Christi the majority of black mangrove and salt marsh overlap occurs along passes or cuts rather than as barriers along the coast. Despite the differences in sites there were consistent differences among habitats.

The zone of habitat overlap was not different in any of the measured parameters from either the *S. alterniflora* or *A. germinans* habitats. This was not surprising because there is very little overlap of the habitats (Figure 1C). *Spartina alterniflora* habitats were more speciose than *Avicennia* habitats, though this may possibly be a function of tidal height. *Spartina* marshes are being pushed into more subtidal habitats as *A. germinans* prefer the higher intertidal areas. Our study sites did not provide a tidal height comparison, as black mangroves were always present higher in the marsh, as is also the case in Louisiana and Florida (Patterson and Mendelssohn 1991). However, a previous study on *S. alterniflora* and *Phragmites australis* competition found no changes in *S. alterniflora* benthic communities with tidal height (Posey et al. 2003). It is therefore possible that we are losing infaunal species and diversity in the intertidal zone as *S. alterniflora* is outcompeted. Loss of diversity will lead to less resilient and productive areas that are already subjected to numerous other threats.

Previous studies on the interplay between *A. germinans* and *S. alterniflora* have shown no differences in ecosystem processes between the ecotones (Perry and Mendelssohn 2009), though there are differences in soil chemistry and fauna (Patterson and Mendelssohn 1991; Stevens et al. 2006). Our data indicates that *A. germinans* and *S. alterniflora* habitats also differ in the benthic infauna they support. Benthic communities provide crucial services to ecosystems (Snelgrove et al., 1997) and changes in the benthic community may affect higher trophic levels, and the community structure of our coastal systems. This study seeks to provide baseline data for future studies conducted on the interplay of *A. germinans* and *S. alterniflora* habitats.

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LITERATURE CITED

- Britton, J.C. and B. Morton. 1989. Shore Ecology of the Gulf of Mexico. University of Texas Press, Austin, TX, USA, 387 p.
- Chapman, V.J. 1974. Salt Marshes and Salt Deserts of the World. Interscience Publishers, New York, NY, USA, 392 p.
- Chapman, V.J. 1976. Mangrove Vegetation. J. Cramer Publishers, Vaduz, Liechtenstein, 447 p.
- Chen, R. and R.R. Twilley. 1999. A simulation model of organic matter and nutrient accumulation in mangrove wetland soils. *Biogeochemistry* 44:93–118.
- Eady, S. 2007. Effects of snail grazing and environmental factors on the expansion of mangroves into salt marshes. MS thesis. Texas Christian University, Fort Worth, TX, USA, 81p.
- Everitt, J.H., C. Yang, K.R. Summy, F.W. Judd, and M.R. Davis. 2007. Evaluation of color–infrared photography and digital imagery to map black mangrove on the Texas gulf coast. *Journal of Coastal Research* 23:230–235.
- Everitt, J.H., C. Yang, S. Sriharan, and F.W. Judd. 2008. Using high resolution satellite imagery to map black mangrove on the Texas gulf coast. *Journal of Coastal Research* 24:1582–1586.
- Everitt, J.H., C. Yang, F.W. Yang, and K.R. Summy. 2010. Use of archive aerial photography for black mangrove populations. *Journal of Coastal Research* 26:649–653.
- Kangas, P.C. and A.E. Lugo. 1990. The distribution of mangrove and saltmarsh in Florida. *Tropical Ecology* 31:32–39.
- Lonard, R.I. and F.W. Judd. 1991. Comparison of the effects of the severe freezes of 1983 and 1989 on native woody plants in the lower Rio Grande Valley, Texas. *Southwestern Naturalist* 36:213–217.
- McKee, K.L. 1993. Soil physico–chemical patterns and mangrove species distribution: Reciprocal effects? *Journal of Ecology* 81:477–487.
- McMillan, C. 1986. Isozyme patterns among populations of black mangrove, *Avicennia germinans*, from the Gulf of Mexico–Caribbean and Pacific Panama. *Contributions in Marine Science* 29:17–25.
- McMillan, C. and C.L. Sherrod. 1986. The chilling tolerance of black mangrove, *Avicennia germinans*, from the Gulf of Mexico coast of Texas, Louisiana and Florida. *Contributions in Marine Science* 29:9–16.
- Patterson, C.S. and I.A. Mendelssohn. 1991. A comparison of physicochemical variables across plant zones in a mangal/salt marsh community in Louisiana. *Wetlands* 11:139–161.
- Penfound, W.T. and E.S. Hathaway. 1938. Plant communities in the marshland of southeastern Louisiana. *Ecological Monographs* 8:1–56.
- Perry, C.L. and I.A. Mendelssohn. 2009. Ecosystem effects of expanding populations of *Avicennia germinans* in a Louisiana salt marsh. *Wetlands* 29:396–406.
- Posey, M.H., T.D. Alphin, D.L. Meyer, and J.M. Johnson. 2003. Benthic communities of common reed *Phragmites australis* and marsh cordgrass *Spartina alterniflora* marshes in Chesapeake Bay. *Marine Ecology Progress Series* 261: 51–61.
- Saenger, P. 2002. Mangrove Ecology, Silviculture, and Conservation. Kluwer Academic Publishers, Dordrecht, The Netherlands, 372 p.
- SAS Institute Inc., SAS OnlineDoc 9.1.3, Cary, NC: SAS Institute Inc., 2002–2005.
- Sheridan, P. and C. Hays. 2003. Are mangroves nursery habitat for transient fishes and decapods? *Wetlands* 23:449–458.
- Sherrod, C.L. and C. McMillan. 1985. The distribution, history, and ecology of mangrove vegetation along the northern Gulf of Mexico coastal region. *Contributions in Marine Science* 28:129–140.
- Snelgrove, P.V.R., T.H. Blackburn, P.A. Hutchings, D.M. Alongi, J.F. Grassle, H. Hummel, G. King, I. Koike, P.J.D. Lamshead, N.B. Ramsing, V. Solis–Weiss, and D. Freckman. 1997. The importance of marine sediment biodiversity in ecosystem processes. *Ambio* 26:578–583.
- Sokal, R.R. and F.J. Rohlf. 1995. *Biometry: The Principles and Practice of Statistics in Biological Research*, 3rd ed. W.H. Freeman and Co., New York, NY, USA, 880p.
- Stevens, P.W., S.L. Fox, and C.L. Montague. 2006. The interplay between mangroves and saltmarshes at the transition between temperate and subtropical climate in Florida. *Wetlands Ecology and Management* 14:435–444.
- White, W.A., T.A. Tremblay, R.L. Waldinger and T.R. Calnan. 2002. Status and trends of Matagorda Bay and San Antonio Bay. Final Report, contract 01–241–R. Texas General Land Office, Austin, TX, USA, 70 p.