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Coast 2050 Region 2

TIMBALIER ISLAND PLANTINGS DEMONSTRATION (TE-18)

First Priority List Vegetative Plantings Project of the
Coastal Wetlands Planning, Protection, and Restoration Act
(Public Law 101-646)

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INTRODUCTION

The Timbalier Islands Plantings Demonstration (TE-18) project is a 5 year demonstration of sediment trapping fences in conjunction with vegetative plantings to build dunes along the gulf shoreline of Timbalier Island, in Terrebonne Parish, Louisiana (figure 1). The project was sponsored by the Natural Resources Conservation Service (NRCS) and the Louisiana Department of Natural Resources, Coastal Restoration Division (LDNR/CRD) under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA, Public Law 101-646, Title III). The project area consists of 7,390 linear ft of sand fencing with vegetative plantings at seven sites along the gulf shoreline of Timbalier Island.

Timbalier Island is part of the chain of barrier islands bordering Timbalier Bay in Terrebonne Parish, Louisiana. The island has decreased in size by 58% over the last century (Hester and Mendelssohn 1992) and island width has decreased from an average of 2,789.5 ft to an average width of 1,361.9 ft (850.2 m to 415.1 m) between 1978 and 1988 (Williams et al. 1992). The dunes of Timbalier Island are not well developed and are less than 6.5 ft (1.98 m) above mean sea level (MSL). These factors leave the island highly susceptible to erosion, storm overwash, and breaching. Stabilized sand dunes reduce the likelihood of island breaching and erosion from wave action, storm waves and surges (Mendelssohn and Hester 1988; Mendelssohn et al. 1991).

The goal of the Timbalier Island Plantings (TE-18) Demonstration project is to stabilize portions of bare beach and overwash areas on Timbalier Island by utilizing sediment-trapping fences and vegetation plantings. The specific goals of the project are (1) to increase the percent cover of emergent vegetation behind the sediment-trapping fences and (2) to increase the elevation of areas enclosed by the sediment-trapping fences.

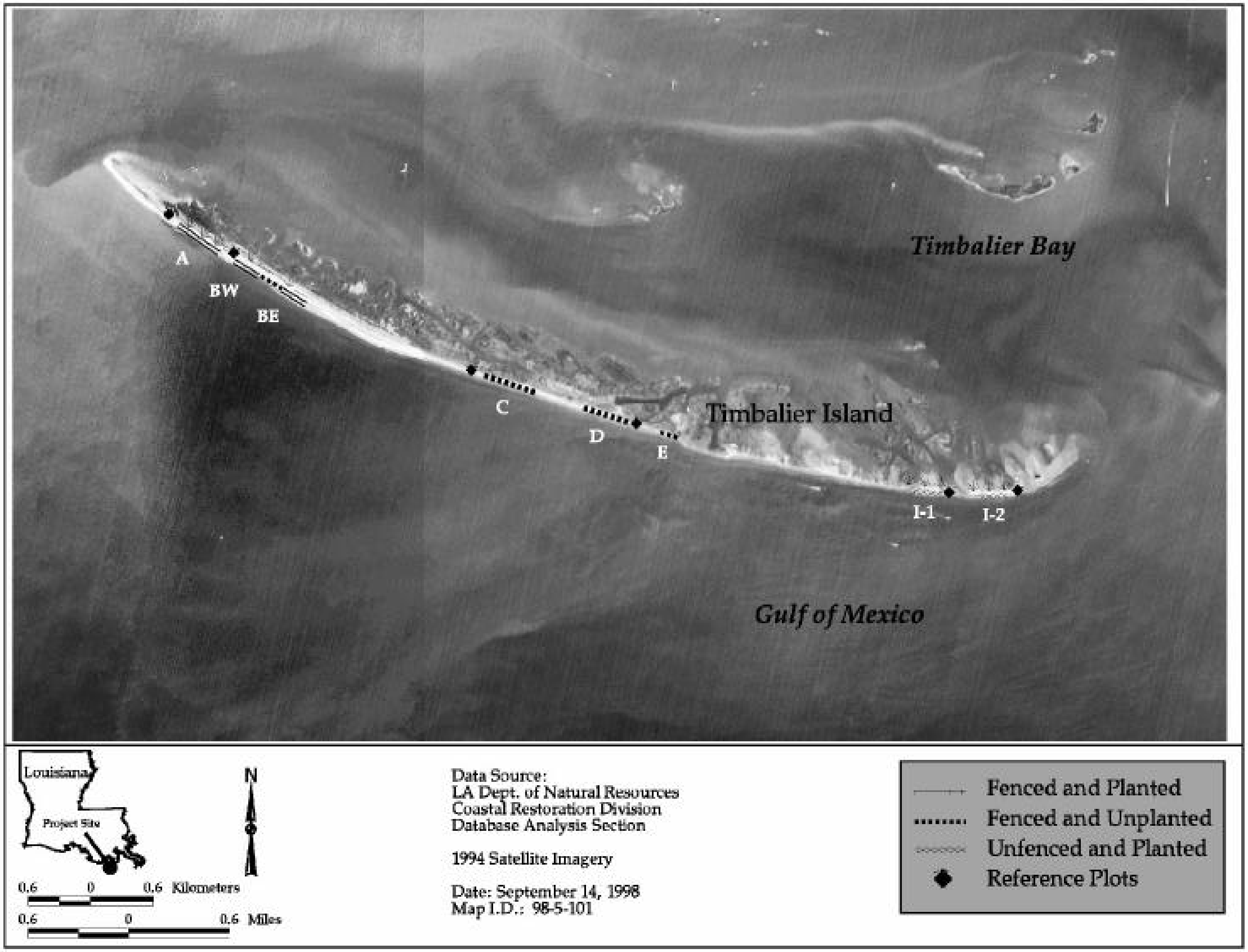

Figure 1. Timbalier Island Plantings (TE-18) Demonstration project features.

METHODS

Project Features

Project goals were to be accomplished by construction of approximately 7,390 linear ft (2,252 m) of sand fencing at seven sites along the length of the island, parallel to the Gulf of Mexico shoreline (figure 1). Each fence site had perpendicular spurs every 50 ft (15.2 m) that extended 25 ft (7.6 m) from the fence bayward (figure 2).

Fence construction was completed in July 1995. However numerous tropical storms impacted the fences and repairs were conducted in October 1995 to sections A thru D. Fence sections E, I-1 and I-2 were damaged beyond repair. Fence sections B thru D were repaired again in July 1996 immediately prior to planting due to additional storm damage.

Spartina patens (marshhay cordgrass) and *Panicum amarum var. amarulum* (Atlantic panicgrass) were planted on the bay side of the fences between the perpendicular fence spurs as indicated by the planting scheme (figure 3). Minor changes were made in the planting design at the time of planting, which took place under the supervision of NRCS in July 1996. Site A was planted as prescribed. No plantings took place in sites C and D, since vegetation was naturally colonizing the sites. Site B was planted on the eastern and western ends, referred to as BE and BW respectively, while the

Figure 2. Typical sand fencing with perpendicular spurs at Timbalier Island Plantings (TE-18) Demonstration project (photo taken July 1996).

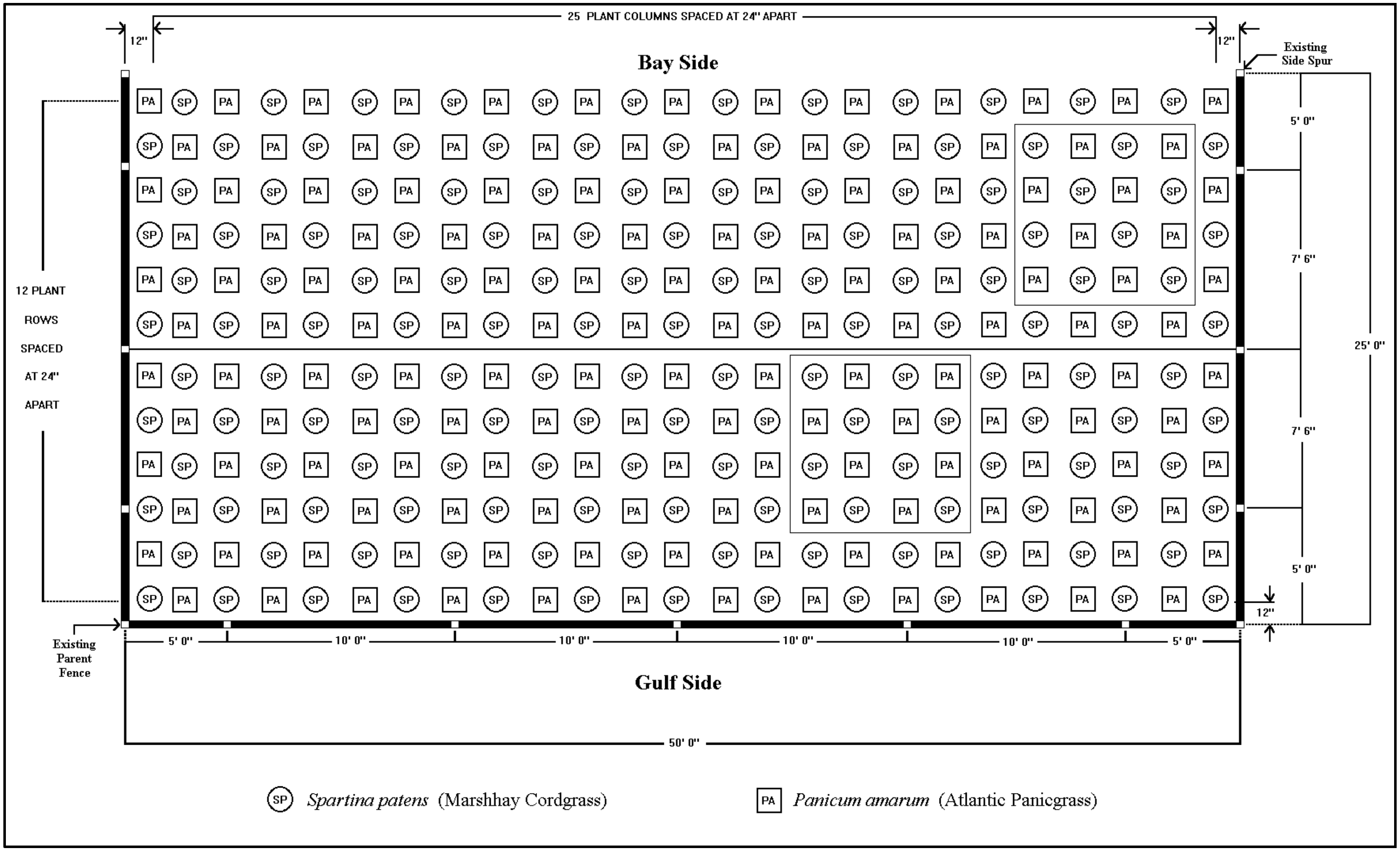

Figure 3. Typical layout for vegetation plantings within a 50 ft segment (fenced or unfenced) including randomly placed 2 m x 2 m vegetation plots at Timbalier Island Plantings (TE-18) Demonstration project.

middle section of the site was not planted since it was naturally vegetated. Sites I-1 and I-2 were planted bayward of the fence sites damaged in the aforementioned storms.

Monitoring Design
Raynie (1998) provides a detailed description of the monitoring design over the entire life of the project.

Aerial Photography: The National Wetlands Research Center (NWRC) in Lafayette, LA obtained 1:12,000 scale near-vertical color-infrared aerial photography of the Timbalier Island Plantings (TE-18) project area on November 21, 1993. This pre-construction photography was checked for flight accuracy, color correctness, and clarity. The original film was archived, duplicate photography was indexed and scanned at 300 dots per inch. Using ERDAS Imagine®, an image processing and geographic information systems (GIS) software package, individual frames of photography were geo-rectified and combined to produce a mosaic of the island, which was then classified to determine the project's land to water ratios and the total acreage of the island (figure 4). The GIS land-water analysis classified the island into three categories: water, land, and unvegetated sand. The water class includes all open water and submerged land. The sand class includes all areas of dry, unvegetated sand (i.e., beaches and ephemeral landforms) exposed at the time of photography. The remainder of the island falls into the land category. The sand class was added to the classification system in an attempt to prevent daily tidal fluctuations from impacting land-water ratios. Together, the land and sand categories comprise the total land area exposed at the time of photography. Due to budgetary constraints and short project life, future aerial photography and land-water analysis was eliminated.

Vegetation: Vegetation sampling was conducted one month post-construction in August 1996, one year post-construction in August 1997, and three years post-construction in August 1999 by LDNR/CRD personnel. Vegetation was sampled at two randomly placed 2 m x 2 m permanent plots, one bayside and one gulfside, within each segment of the planted sites (figure 3). Plots were given the treatment designation of "bayside" or "gulfside," based on the location of the plants with respect to the center line of the fence and the Gulf of Mexico (figure 3). From all 126 plots, percent survival of planted individuals was determined and two plants within each plot were randomly selected to determine tiller number and tiller length. In addition, percent cover of plants and plant species composition were determined in a 0.5 m x 0.5 m subplot, located in the SE corner of the 2 m x 2 m quadrat.

Typically, vegetation data collected in 1996, 1997, and 1999 at the Timbalier Island Plantings (TE-18) Demonstration project would be combined for analysis. Since the data set is unbalanced due to loss of numerous segments and complete sites over time, the data comparisons are made within the set for each year using an unbalanced block design. The assumptions of parametric analysis were tested using Statistical Analysis System (SAS) univariate procedure. When the univariate procedure indicated that data were not normally distributed, square root transformation ($y^{1/2}$) of the data was conducted, which resulted in a near-normal distribution. Percent cover, tiller number, and tiller spread were square root transformed for analysis. Data were analyzed with SAS Analysis of Variance (ANOVA) procedure and the least significant difference (LSD) procedure and tested at the

Figure 4. Mosaic of November 1993 aerial photography of the Timbalier Island produced by USGS/NWRC, Lafayette, LA.

95% confidence level to determine differences among treatments (SAS Institute Inc. 1996). Based on the small P-values produced by the ANOVA, the effect of transforming non-normal data should not diminish the overall conclusions drawn from the analyses. Data were detransformed for presentation.

Elevation: The pre-construction elevation survey was conducted by NRCS in May 1995 and tied into the Louisiana South Zone Coordinate system in the National Geodetic Vertical Datum of 1929 (NGVD) from a known permanent benchmark The second survey was conducted with the one-month post-construction vegetation sampling in July/August 1996. The third survey was completed in July/August 1997 and the fourth survey was completed in August 1999. All elevation surveys were conducted by NRCS using the conventional leveling rod survey technique.

Vertical elevations were collected along transects within the sixth segment from the eastern end of sites A, B, C, and D (figure 5). Elevation data in 1999 was collected only from sites A and C, where the fence segment was still identifiable. Beginning 5 ft (1.5 m) from the side spur of the plot, to reduce direct influence of the fence, five transect lines were established at 10 ft (3.0 m) intervals. The two outermost lines extended 45 ft (13.7 m) past the fencing onto the beach towards the Gulf of Mexico. Along each transect, elevation measurements were taken at 10 ft (3 m) intervals with

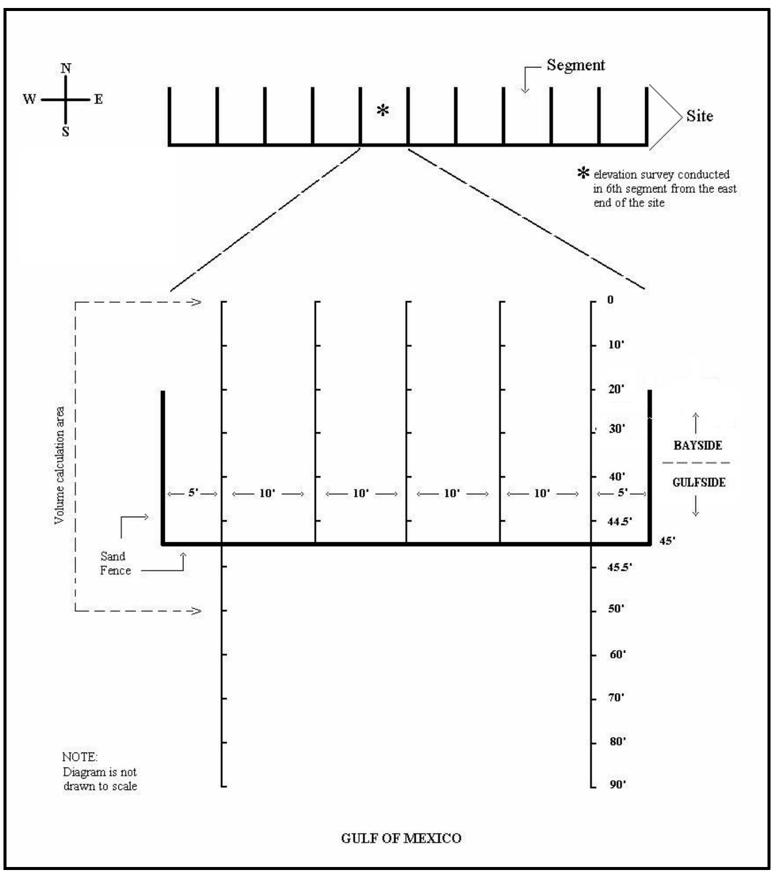

Figure 5. Typical elevation survey schematic within a segment at Timbalier Island Plantings (TE-18) Demonstration project.

additional points at 44.5 ft (13.6 m) and 45.5 ft (13.9 m) to reduce the influence of the fence on the measurements (figure 5). The raw data and blue line drawings from the elevation survey were provided to LDNR/CRD personnel (USDA/NRCS 1997, 1999). An unfenced reference plot, the same dimensions as each fenced segment, was established by NRCS, and surveyed in the same manner as the fenced segments (figure 1). This allowed comparisons of sand accumulation in the fence treatments to unfenced reference areas.

A grid model was generated from the elevation data from each of the elevation plots using ESRI ArcView®, a geographic information system (GIS) software package. A surface was interpolated from the elevation data collected in each of the four fenced segments [50 x 50 ft (15.2 x 15.2 m) including the fence] and their associated reference plots (figure 5). This interpolation was accomplished by ArcView's spline algorithm, which fits a minimum-curvature surface through the input survey points (Environmental Systems Research Institute 1996). The mean elevation of this surface was then multiplied by the length and width of the survey segment to calculate the segment's total volume (figure 6). In addition, a typical dune profile was developed for each plot for each sample period. The typical dune profile was the average elevation at each interval along all transects in the 50 x 50 ft (15.2 x 15.2 m) plot, including the fence (i.e.; all measurements along each transect were averaged to obtain the average dune elevation at each transect interval). Average change in dune height was then calculated from the average dune profiles by calculating the difference between the highest point on each typical dune profile at time i and time $i+1$ for the 50 x 50 ft (15.2 x 15.2 m) plot (figure 5). These data will be used to compare the effects of sediment fences on sediment trapping and dune development over time.

Since fence construction in July 1995, numerous storm events have impacted the project (Townson and Gaudet 1998). By the 1999 sampling period, site A was the only one which remained undamaged and from which data could be collected. Site BW, intact in 1997, had sustained enough debris damage to negate adequate vegetation or elevation data collection (figure 7).

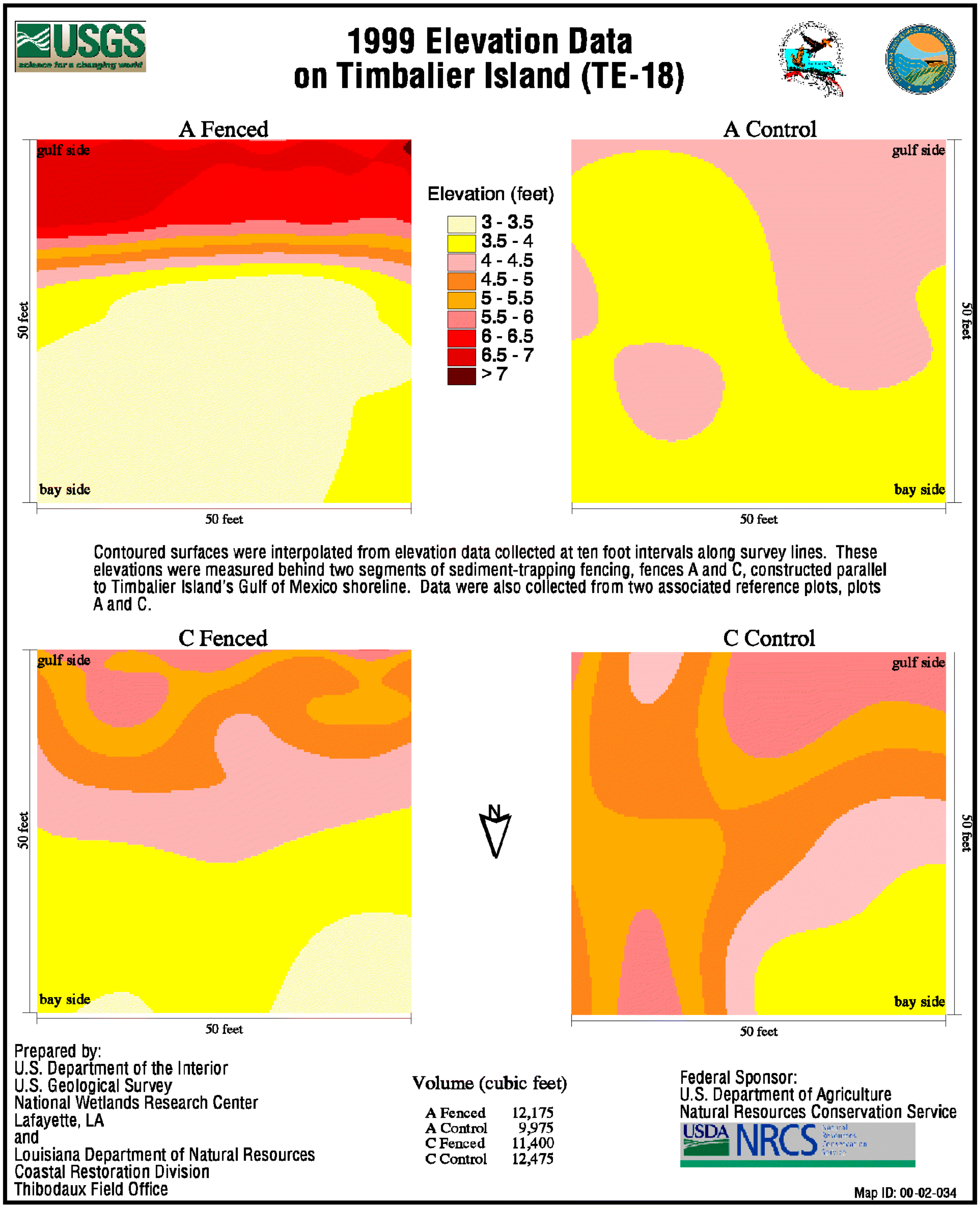

Figure 6. **Elevation contours developed from USGS/NWRC data with calculated volume changes for site A and C fenced segments and control plots surveyed at Timbalier Island Plantings (TE-18) Demonstration project.**

Figure 7. Typical fences after impacts from storm waves and debris at Timbalier Island Plantings (TE-18) Demonstration project (photo taken July 1998).

RESULTS

Aerial Photography: According to the GIS land-water analysis, at the time of the 1993 photography, the island was composed of 810.89 ac (328.16 ha) land and 204.59 ac (82.80 ha) unvegetated sand. Combining these two classes results in a total area of 1015.48 ac (410.95 ha) (figure 8). No post-construction aerial photography is available for comparison of the island at this time.

Vegetation: Townson and Gaudet (1998) reported that 1 month and 1 year post-construction percent survival of planted vegetation in bayside plots was significantly higher than gulfside plots. The 3 year post-planting vegetation sampling in August 1999, which was conducted only at site A, also showed a significantly higher (P = 0.0211) survival of planted vegetation in the bayside plots than in the gulfside plots. Bayside plots had a survival rate 23 % higher than the gulfside plots (table 1). Location effects were also significant both 1 month and 1 year post-construction (Townson and Gaudet 1998). However, by the 3 year post-construction sampling period, no location effects could be tested due to destruction of all but one fence segment.

One month post-planting, Townson and Gaudet (1998) reported significantly higher mean percent cover in bayside plots when compared to gulfside plots. However, they found no significance in mean percent cover 1 year post-planting. Townson and Gaudet (1998) also note the same trend in mean percent cover in regard to location. However, by the 3 year post-planting sampling period, mean percent cover of vegetation within the bayside plots at site A was not significantly different (P = 0.1296) than in the gulfside plots of site A. Mean percent cover in the bayside plots was 8% higher than in the gulfside plots (table 1).

In addition to mean percent cover for 1999, five of the most common species (appendix A) were compared for cover bayside versus gulfside. Three of the five species, *P. amarum*, *S. patens*, and *Solidago sempervirens* (seaside goldenrod), showed significantly higher percent cover (P = 0.0078, 0.0001, and 0.0001, respectively) bayside than gulfside while the percent cover of *Vigna luteola* (deer pea) and *Machaeranthera phyllocephala* (camphor daisy) was significantly higher (P = 0.0122 and 0.001, respectively) gulfside than bayside (table 2).

Tiller number and lateral spread within the bayside plots was significantly higher (P = 0.0001 and 0.0038, respectively) than within the gulfside plots 1 month post-planting (Townson and Gaudet 1998). One year post-planting, lateral spread remained significantly higher (P = 0.02) in bayside plots, but differences in tiller numbers between bayside and gulfside plots were no longer significant (P = 0.08) (Townson and Gaudet 1998).

Tiller numbers and lateral spread measurements for the vegetation plantings 3 year post-planting were not analyzed. The number of plants from which data could accurately be determined was too small to be tested. It was impossible to determine which tillers were associated with particular plants due to growth patterns which also reduced the number of valid tiller spread measurements.

The analysis of vegetation data collected in August 1996 and August 1997 includes only a comparison between sites A and BW, since they were the only sites that remained intact (Townson

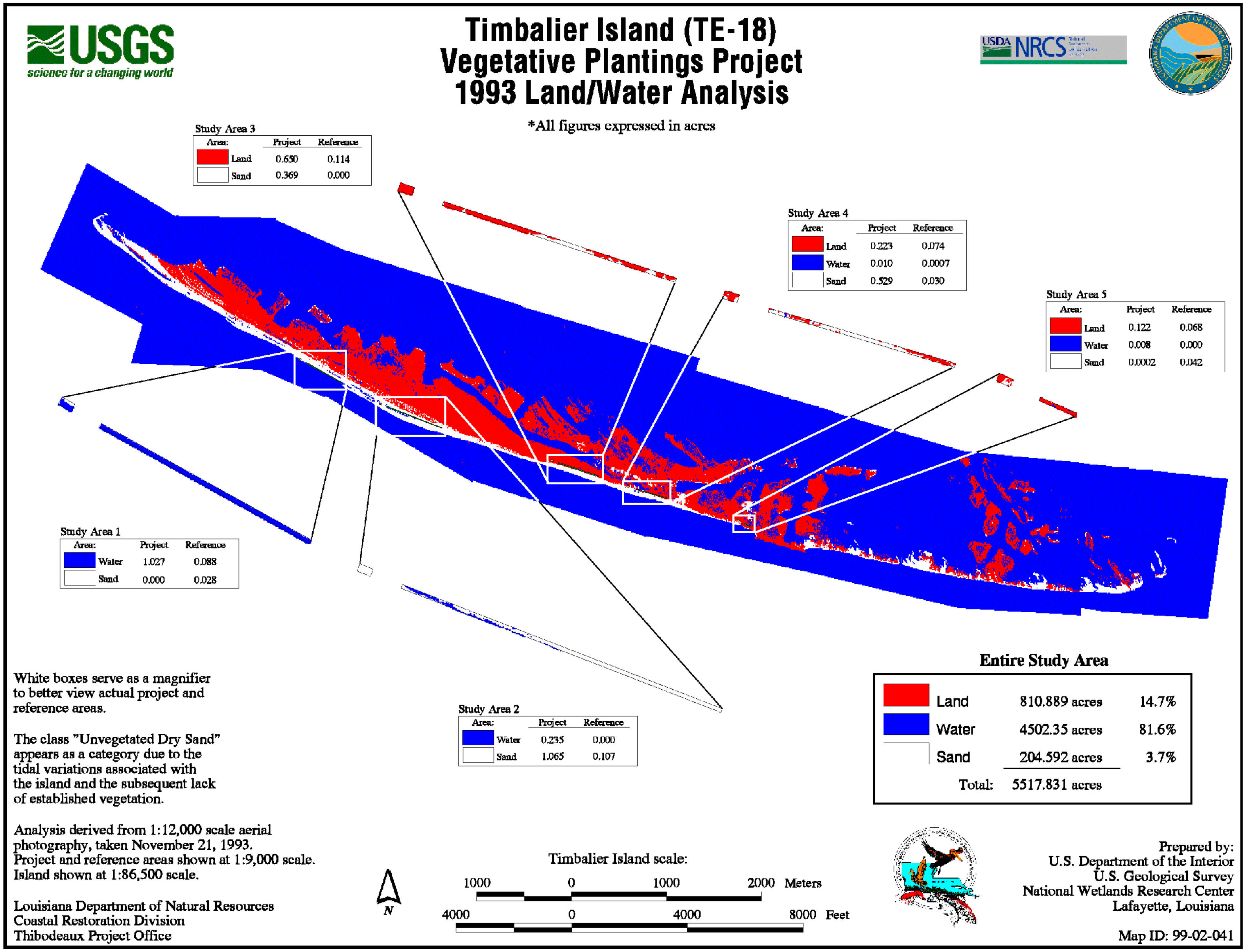

Figure 8. Land-water analysis from the 1993 aerial photography of Timbalier Island Plantings (TE-18) Demonstration project.

Table 1. Mean percent survival and mean percent cover for August1996 (1 month post-planting), August 1997 (1 year post-planting), and August 1999 (3 years post-planting) vegetation sampling at Timbalier Island Plantings (TE-18) Demonstration project (n = number of plots).

		Mean % Survival			Mean % Cover		
Site	Treatment	1996	1997	1999	1996	1997	1999
A	Bayside	99	99	64	53	54	56
A	Gulfside	87	89[c]	41	22	34	48
BW	Bayside	95	94	---[a]	33	44	---[a]
BW	Gulfside	86	83	---[a]	26	43	---[a]
BE	Bayside	100	---[a]	---[a]	42	---[a]	---[a]
BE	Gulfside	100	---[a]	---[a]	51	---[a]	---[a]
I-1	Bayside	99	---[a]	---[a]	15	---[a]	---[a]
I-1	Gulfside	57	---[a]	---[a]	2	---[a]	---[a]
I-2	Bayside	97	---[a]	---[a]	10	---[a]	---[a]
I-2	Gulfside	95	---[a]	---[a]	4	---[a]	---[a]
Mean	**Bayside**	**98** (n = 63)	**98**[b] (n = 39)	**64**[b] (n = 29)	**38** (n = 62)	**51**[b] (n = 39)	**56**[b] (n = 29)
	Gulfside	**87** (n = 63)	**88**[b] (n = 39)	**41**[b] (n = 29)	**22** (n = 63)	**36**[b] (n = 39)	**48**[b] (n = 29)

[a] Although vegetation may have been present, data could not be collected due to inability to relocate vegetation plots within damaged fences.

[b] 1997 mean includes only the sites sampled, A and BW; 1999 mean only includes site sampled, A.

[c] Dune movement may have resulted in shifting of plot and/or vegetation within the plot resulting in an increased number of plantings within the plot.

and Gaudet 1998). Townson and Gaudet (1998) compared sites A and BW, the only sites intact through 1998, for differences among years. No significant differences were detected in percent survival or tiller number, however, percent cover was significantly higher 1 year post-planting when compared to 1 month post-planting. The analysis of yearly vegetation data collected in August 1996, August 1997, and August 1999 includes only site A since this was the only site intact at the time of all sampling. The overall percent survival, 53%, for 1999 was significantly lower (P = 0.001) than for 1996 and 1997 (93% and 94%, respectively; table 1). Transformed percent cover data for the three sampling periods indicated a significant difference (P = 0.003) among years. Mean percent cover for 1996 was significantly different from 1997 and 1999, but 1997 and 1999 mean percent

Table 2. Mean percent cover in site A for five dominant species of vegetation from 1999 sampling at Timbalier Island Plantings (TE-18) Demonstration project (n = number of plots).

		Mean Percent Cover	
Species	Common name	Bayside	Gulfside
Panicum amarum	Bitter panicum	16 (n = 25)	9 (n = 14)
Spartina patens	Marshhay cordgrass	22 (n = 22)	7 (n = 10)
Vigna luteola	Deer pea	10 (n = 29)	17 (n = 29)
Solidago sempervirens	Seaside goldenrod	10 (n = 21)	3 (n = 3)
Machaeranthera phyllocephala	Camphor daisy	17 (n = 3)	26 (n = 25)

covers were not significantly different from each other. By year, mean percent cover increased from 38% in 1996, to 44% in 1997, and to 52% in 1999 (table 1).

Townson and Gaudet (1998) reported tiller numbers and lateral spread by species for 1 year post-planting. In 1999 at site A, plant species were recorded for the randomly selected plants where tiller data was collected. In the plots where specific plants could be identified, approximately 50% of the fifteen *P. amarum* plants and 50% of the eighteen *S. patens* plants showed extensive tiller production such that it was impossible to separate one plant from another (figure 9). With such limited data, no analysis was conducted on tiller number and spread as related to species for the 1999 vegetation sampling.

<u>Elevation</u>: Reference plots at site A and B showed the greatest cumulative increase in volume of sediment through 1 year post-construction (Townson and Gaudet 1998). The 1999 elevation survey sampled only sites A and C, fenced and reference (figure 1). The data showed that site A reference had the greatest accumulation during the four-year period, but the greatest accumulation since the 1997 sampling occurred in site A fenced (figure 10). The dune in the C fenced site appeared to add sediment toward the Gulf of Mexico, while the dune in the A fenced site appeared to maintain itself (figure 11). The reference plots of site A and C showed an average accumulation since 1995 greater than that in the fenced areas of the sites. Sites A and C reference, respectively, had an increase in volume of 976 ft^3/yr (28 m^3/yr) and 792 ft^3/yr (22 m^3/yr) while their fenced counterparts showed an average rate of accumulation of 893 ft^3/yr (25 m^3/yr) and 730 ft^3/yr (21 m^3/yr), respectively. Since the last sampling, the only site to show an increase in accumulation rate was site C fenced with a volume change of 595 ft^3/yr (17 m^3/yr). During this time, site A fenced showed a decrease in accumulation rate of 30 ft^3/yr (0.8 m^3/yr), site A reference's accumulation rate decreased by 2067 ft^3/yr (59 m^3/yr), and site C reference decreased by 1499 ft^3/yr (42 m^3/yr).

Figure 9. Bayside of dune exhibiting extensive growth of planted and natural vegetation at Fence A Timbalier Island Plantings (TE-18) Demonstration project. Note dune in the background and vegetation plot corner post in foreground (photo taken August 1999).

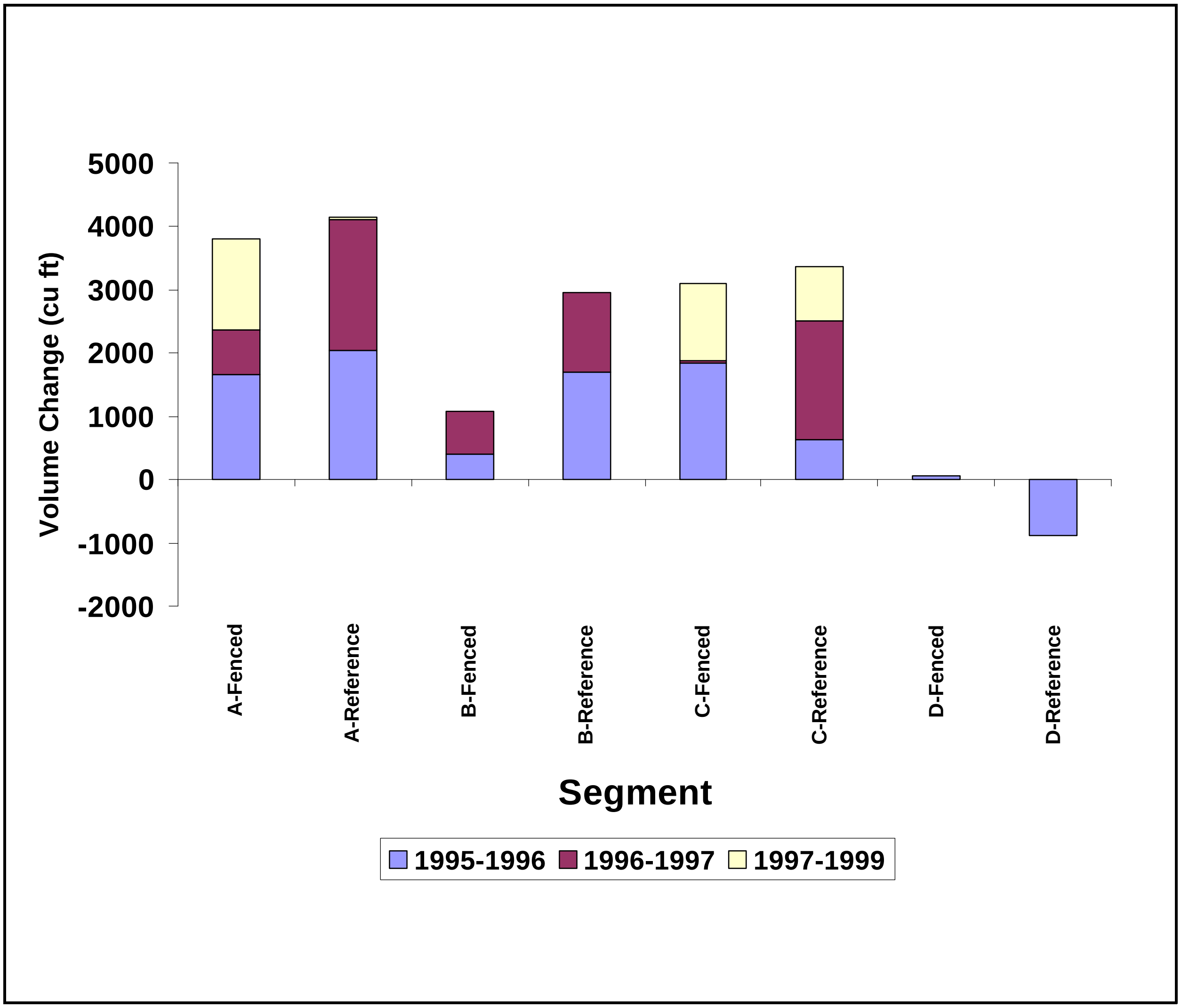

Figure 10. Cumulative volume changes in segments and reference plots (1995 - 1999) at Timbalier Island Plantings (TE-18) Demonstration project.

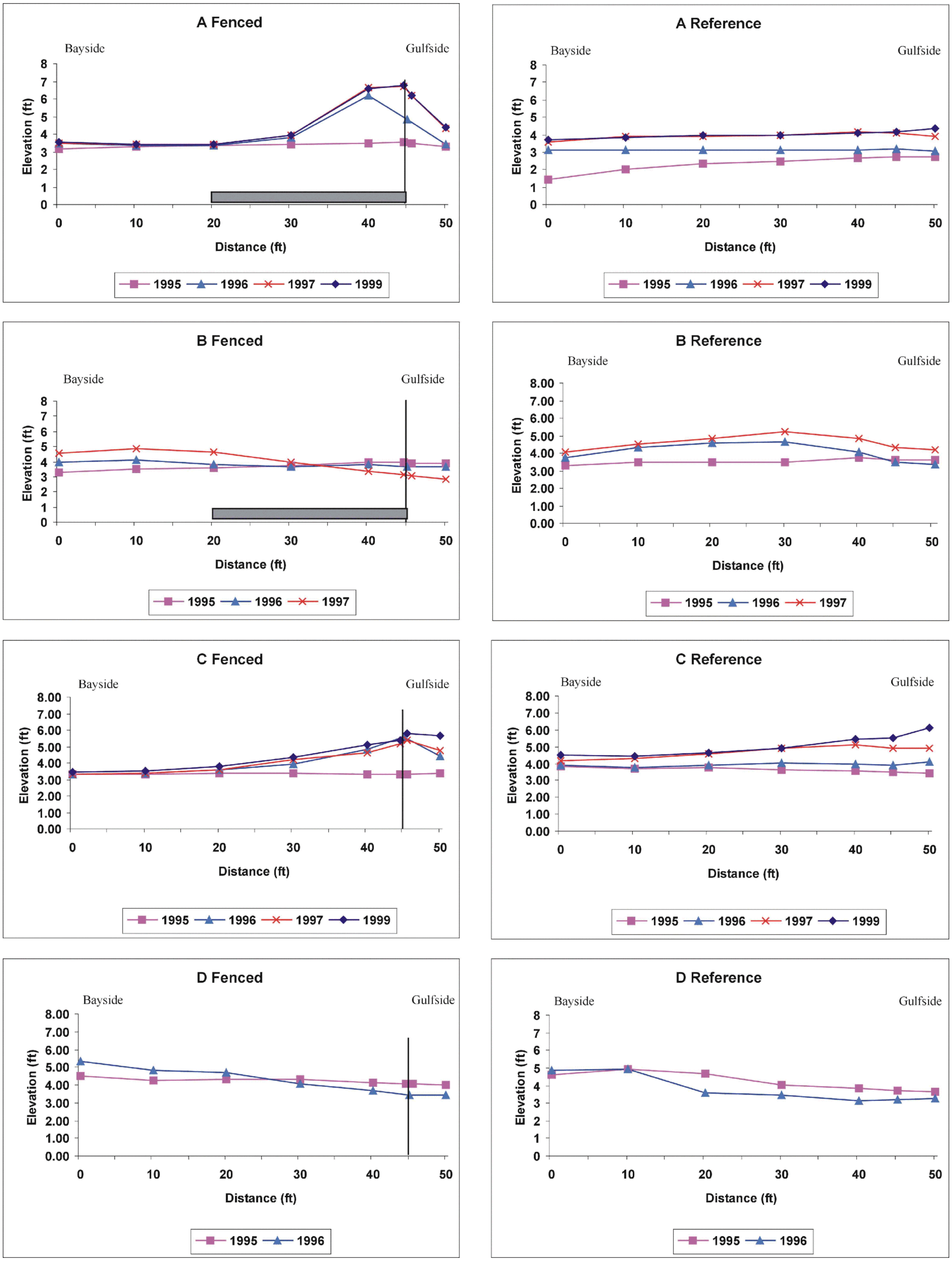

Figure 11. Comparison of average elevation profiles for each sample period in one segment and one reference plot per treatment at Timbalier Island Plantings (TE-18) Demonstration project (note line indicates position of fence and grey area denotes the area planted).

DISCUSSION

The results from the fencing and plantings in the Timbalier Island Planting Demonstration (TE-18) project produced results similar to earlier sediment fencing/vegetation planting projects conducted on the island by Mendelssohn et al. (1991). NRCS topographic survey data from 1995 - 1999 showed fenced segments averaged 0.7 ft yr^{-1} (0.21 m yr^{-1}) of dune height increase and the reference plots averaged 0.4 ft yr^{-1} (0.12 m yr^{-1}). This is a slight decrease in the rate of dune height gain for both fenced and reference plots (table 3), indicating that sediment trapping bayward of the fences, has slowed after the first 2 years. Volumetric changes per linear foot of beach were calculated to

Table 3. Change in mean dune height and volume of sediment per year determined through NRCS elevation surveys (1995 -1999) at Timbalier Island Plantings (TE-18) Demonstration project.

		Mean dune height change (ft/yr)				Mean volume Change (ft^3/yr)			
Site	Treatment	1995 - 1996	1996 - 1997	1997 - 1999	1995 to 1999	1995 - 1996	1996 - 1997	1997 -1999	1995 to 1999
A	Fenced/ Planted	2.2	0.5	0.0	0.8	1373	724	694	893
A	Reference	0.4	1.0	0.1	0.4	1703	2089	22	976
B	Fenced/ Planted	0.1	0.8	---[a]		336	689	---[a]	
B	Reference	0.8	0.6	---[a]		1417	1257	---[a]	
C	Fenced/ Unplanted	1.8	-0.2	0.2	0.6	1533	28	595	730
C	Reference	0.2	1.0	0.5	0.5	517	1914	415	792
D	Fenced/ Unplanted	0.7	---[a]	---[a]		48	---[a]	---[a]	
D	Reference	0.0	---[a]	---[a]		-734	---[a]	---[a]	
Mean	**Fenced**				**0.7** [b]				**812** [b]
	Reference				**0.5** [b]				**884** [b]

[a] Data could not be collected due to inability to re-establish elevation transect lines within damaged fences.
[b] Mean includes only the sites sampled in 1996, 1997, and 1999 (A and C).

compare results of this study to others in the literature (Savage and Woodhouse 1969, Dahl et al. 1975, Myer and Chester 1977, Woodhouse et al. 1976, Knutson 1980). Rates of sand accumulation per linear foot of beach were determined by dividing the average volume change in each plot by the 50 ft (15.2 m) width. Volumetric accumulation in the reference plots averaged 30.1 ft^3/ per linear foot of beach ft/yr (2.8 m^3/linear m of beach/yr) in 1997 and 17.7 ft^3/ per linear foot of beach ft/yr (1.6 m^3/linear m of beach/yr) in 1999. However, the fenced areas averaged 15.6 ft^3/ per linear foot of beach/yr (1.4 m^3/linear m of beach/yr) and 16.2 ft^3/ per linear foot of beach/yr (1.5 m^3/linear m of beach/yr) in 1997 and 1999, respectively. Mendelssohn and Hester (1988) found fences accumulated an average of 78% more sediment than unfenced references on Timbalier Island, whereas this project showed 32% less accumulation in the fenced treatments than in the reference plots for the last sampling period. The average annual dune growth within the fences, based upon measurements in one (1) segment, was within the range of dune growth in the Mendelssohn et al. (1991) Timbalier Island fencing project, and less than coastal sand fencing projects reported in the literature (Savage and Woodhouse 1969, Dahl et al. 1975, Myer and Chester 1977, Woodhouse et al. 1976, Knutson 1980). Average annual dune growth in this study was 0.7 ft (0.21 m), whereas Mendelssohn et al. (1991) reported annual dune growth of 0.16 - 0.85 ft (0.05 - 0.26 m) on Timbalier Island. The small sample size and location of most reference plots to the west of the fence sites (figure 1) probably contributed to the results, because of the dominant direction of sand movement has been from southeast to northwest (Meyer-Arendt and Wicker 1981).

Based upon measurements in a 50 ft (15 m) wide segment at each fenced, annual sand accumulation was 16 ft^3/linear foot of beach/yr (1.5 m^3/linear m of beach/yr) in 1997 and 18 ft^3/linear foot of beach/yr (1.7 m^3/linear m of beach/yr) in 1999. Mendelssohn et al. (1991) reported sand accumulations of 7.5 - 45.2 ft^3/ft/yr (0.7 - 4.2 m^3/m/yr) on Timbalier Island based on a 15 ft (4.6 m) wide plot. Knutson (1980) reported 89.4 ft^3/ft/yr (8.3 m^3/m/yr) at a dune building project in Cape Cod, and additional studies in North Carolina, Texas, and Oregon reported sand accumulations of 90.5, 116.3, and 147.5 ft^3/ft/yr (8.4, 10.8, and 13.7 m^3/m/yr) respectively (table 4). These data further indicate that the sand supply is limited and dune-building is not comparable to East coast projects where sand supplies are greater. The slight decline in annual accumulation in 1999 may indicate a simple redistribution of the sand after the dunes attain a particular height or that sand supply may have decreased since much of the eastern end of the island has eroded.

Timbalier Island has historically exhibited accretion at the western end, while eroding from the east (Meyer-Arendt and Wicker 1981). Although it might be assumed that increased dune height would correspond with increased volume of sediments, the data collected indicated a different relationship. The dune height increased in the immediate area of the fence which accounts for only a small area of the total plot. In the unfenced, i.e. reference plots, the sand seems to accumulate throughout the plot resulting in greater accumulation for the plot. The latest changes in dune height from the 1999 survey show less drastic increases or decreases but rather a change in position of the highest points indicating a shift, generally gulfward, of the material deposited. The change in volume of sediment per year decreased for both fenced and reference plots for site A, and for the reference plot of site C, compared to earlier observations. This may be due to a general shifting of material or lack of additional sand being put into the system from natural processes. However, since only one segment of a site is sampled, no definitive conclusions are possible.

Table 4. Comparison of annual sand accumulation in Massachusetts, North Carolina, Louisiana, Texas, and Oregon sediment fencing projects.

Location	Investigators	Sand Accumulation ft^3/ft	Sand Accumulation m^3/m
Nauset Beach, Cape Cod, Massachusetts	Knutson (1980)	89.4	8.3
Ocracoke Island, North Carolina	Woodhouse, Seneca, and Broome (1976)	90.5	8.4
Timbalier Island, Louisiana	Mendelssohn and Hester (1988)	7.5 - 45.2	0.7 - 4.2
Timbalier Island, Louisiana	Townson et al. (2000)	16.2	1.5
Padre Island, Texas	Dahl, Fall, Lohse, and Appan (1975)	116.3	10.8
Clatsop Plains, Oregon	Myer and Chester (1977)	147.5	13.7

The percent survival of vegetation transplants, within the undamaged portion of the project, were higher than those reported by Mendelssohn and Hester (1988). Mendelssohn and Hester (1991) found *Panicum amarum var. amarulum* had a 73 % survival after 15 months, while our study showed 93% survival after 12 months for *Panicum amarum var. amarulum* and *S. patens* transplants in all treatments and 53% survival after three years (table 1). Percent survival of the vegetation transplants was significantly different by site (table 1) during the Timbalier Island Planting (TE-18) Demonstration project, as was reported in the Mendelssohn and Hester (1991) study.

The conditions at the time of planting may have improved the survival rate of the plantings at Timbalier Island Plantings (TE-18) Demonstration project. Within the six-month period up to and including planting in July 1996, a near normal amount of precipitation was recorded for the area according to the National Drought Mitigation Center's Standardized Precipitation Index (SPI), whereas the one-month period between planting and the first sampling in August 1996 was moderately wet (figure 12) possibly contributing to the 93% survival rate of plantings. Additionally, the 1997 SPI data showed a near normal precipitation for the 12 months previous to sampling, which would indicate potentially good survival condition. However the SPI for January to August 1999 indicates moderately dry conditions, which could affect the lower survival (53%) rates found 3 years post-planting (figure 12).

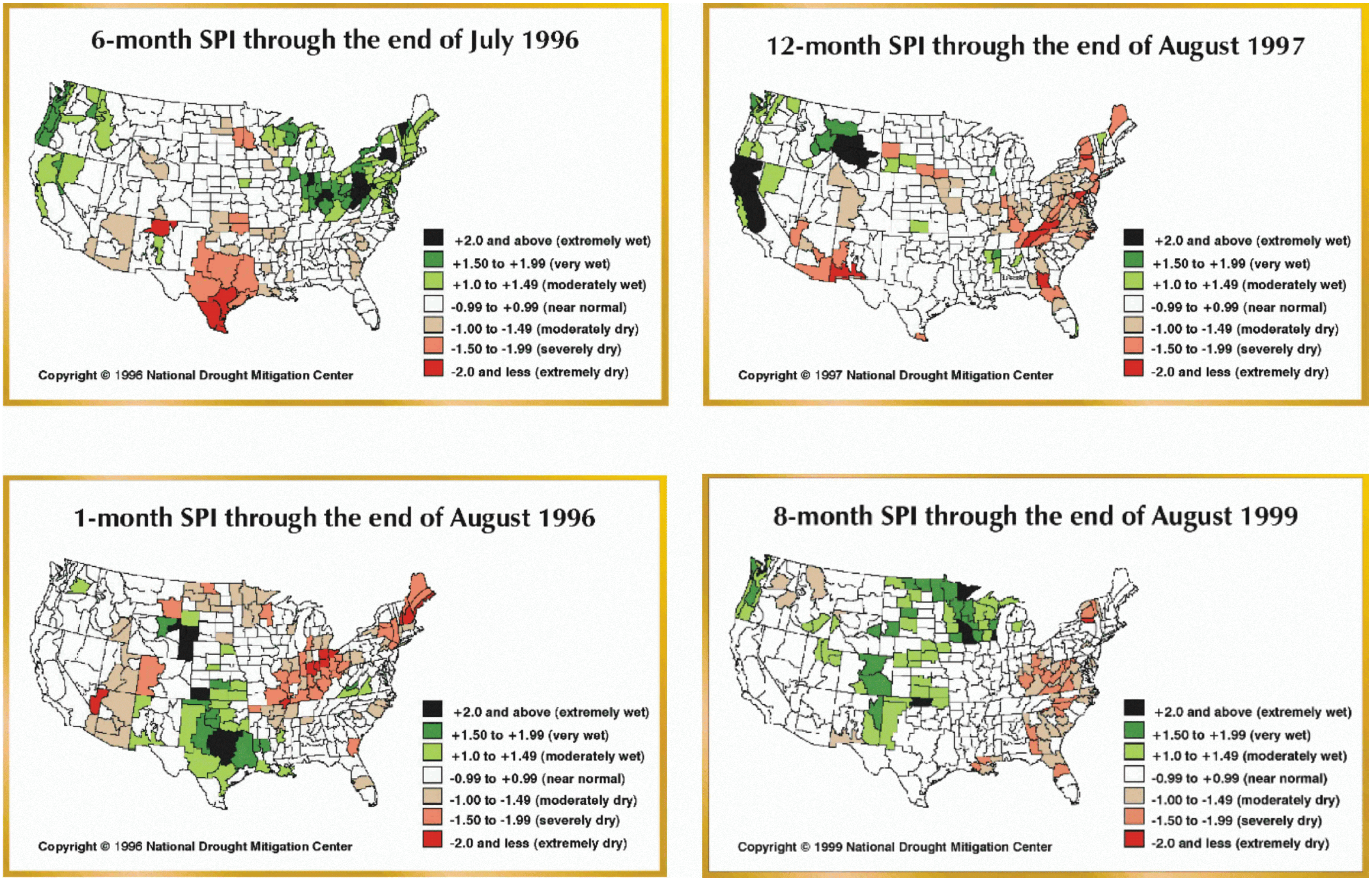

Figure 12. **Standardized Precipitation Index (SPI) for various time periods during the sampling at Timbalier Island Plantings (TE-18) Demonstration project (National Drought Mitigation Center1996a, 1996b, 1997, 1999).**

Soil nutrients were not measured during this study, but Mendelssohn and Hester (1988) did report that soil nutrient status may affect transplant survival. Also, differences in herbivory, by site, were noted to affect percent survival during the Mendelssohn and Hester (1988) study. Lower survival rates (73% after 15 months) reported by Mendelssohn and Hester (1988) could have been due to extensive herbivory during their study period. They reported total decimation of *Panicum amarum var. amarulum* transplants, and reduction in cover of *S. patens*, and *Heterotheca subaxilaris* (camphorweed) of approximately 30 % when compared to vegetation in 16.1 ft^2 (1.5 m^2) exclosures. Herbivore impacts appeared minimal among the plantings in the present project study. It's possible herbivore populations may have been significantly impacted by the effects of Hurricane Andrew in 1992.

The higher survival of planted vegetation within the bayside plots, when compared to gulfside plots, may be due to rapid accumulations of sand in the fences. Sand aggradation closer to the fence may have exceeded the transplants' ability to grow in the gulfside segments. Mendelssohn and Hester (1988) noted that the sand fence design used in the Timbalier Island Plantings (TE-18) Demonstration project (figure 2) accumulated the most sand during the first year of construction. However, a straight fence design, without spurs, collected 164% more sand than the design used by NRCS after 3 years (Mendelssohn and Hester 1988). Also, soil moisture may be reduced as dune height increases (Mendelssohn and Hester 1988). Survival also appears to be a function of location because the western sites, A, BE, and BW in 1996 and A in 1997, had higher survival rates than the eastern sites (table 1).

Total plant coverage increased between the 1996 and the 1999 sample measurements as transplants grew (table 1) and additional species invaded the area (appendix A). Compared to the 1997 measurements, percent coverage was minimal in the first month of growth of the plants. Planting took place in July just prior to the seed production/maturation period of the plants (Radford et al. 1968, USDA/SCS 1981), which may have contributed to the limited amount of growth or coverage produced during the first growing season. In 1996, bayside plant cover was higher than gulfside cover possibly due to the sheltering effect of the fencing and corresponding dunes. After the second growing season, the effect of location and treatment, bay versus gulf, diminished with no significant differences. As the decline of *Panicum amarum var. amarulum* and *S. patens* occurred in the gulfside plots, two species, *V. luteola* and *M. phyllocephala*, flourished on the dunes, therefore maintaining cover (figure13). Our results support work from Mendelssohn and Hester (1988) which showed that, with time, percent cover was less dependent on transplant survival, as other species colonized the site. They found coverage of >75% in areas with transplant survival of <1% nine months post-planting. Fertilization, a factor positively affecting percent coverage in their study, could effect natural colonization by vegetation without transplants (Mendelssohn and Hester 1988). With only sites A and BW remaining in 1997, the close proximity of the western sites decreased the effect of location on percent cover.

Comparisons of tiller production, i.e. tiller number, and lateral spread, by the transplanted vegetation, one month after planting and after one year of growth, shows the same relationship to location as survival and percent cover. Bayside plots, 1 month post-planting, exhibited greater tiller numbers and lateral spread than gulfside plots. However, within 1 year post-planting, no significant differences

Figure 13. ***Machaeranthera phyllocephala*** **emerged as the dominant vegetation on the dunes of site A, replacing many** ***Spartina patens*** **and** ***Panicum amarum var. amarulum*** **plants (photo taken August 1999).**

in tiller number by location were determined in the remaining treatments (Townson and Gaudet 1999). Lateral spread within the bayside plots remained significantly higher between sample times, indicating that transplants spread better when tillers are produced early. After 1 year, the gulfside plots seemed to produce as many tillers given enough time; however, they had not spread as far within 1 year post-planting as those plants in the bayside plots (Townson and Gaudet 1998). Additionally, in 1999, it was impossible to collect enough tiller number and spread data. While the flourishing vegetative growth, both from planted and naturally colonizing species, made the collection of this particular data difficult, the results are obviously positive (figure 9).

CONCLUSION

Both *Panicum amarum var. amarulum* and *S. patens* displayed excellent transplant survival and growth when the sand fence remained intact. Differences were observed in bayside and gulfside plots that may indicate potential benefits from delayed or no planting in the area closest to the fences. Once the dune is formed, fertilization, transplantation, or even waiting for natural colonization may be more effective. The abundant presence on the dunes of a facultative upland species, *M. phyllocephala*, three years after planting may indicate that continued survival of certain coastal species on the dunes may not be limited by drought, sand movement, or storm induced disturbance. Continued observation of species composition and species performance in the remaining site over the final monitoring period will provide more data, which should contribute to our understanding of the dynamics of barrier island dune plant communities.

Preliminary results from the first year of the project indicate that sediment fencing and vegetative plantings, as in numerous other studies, can be used to trap sand and build a dune (Savage and Woodhouse 1969, Dahl et al. 1975, Myer and Chester 1977, Woodhouse et al. 1976, Knutson 1980, Mendelssohn and Hester 1988, Mendelssohn et al. 1991, Hester and Mendelssohn 1992). However, results, 3 years post construction, also appear to confirm Mendelssohn and Hester's (1988) conclusion that the only way to maintain a vegetated dune on Louisiana's barrier islands is through maintenance of a beach wide enough to dissipate wave energies. A well established dune cannot prevent the natural transgression of the shoreline and will eventually erode as the shoreline narrows. This is evidenced by the fact that all treatments have eroded from east to west, as the barrier island's natural process of westward erosion occurs (Meyer-Arendt and Wicker 1981). The dunes do serve as sand reservoirs during high tides and waves that provide sediment to the dynamic beach profile (Van der Meulan and Gourlay 1969, Leatherman 1979a, b, c). The continued monitoring of the one remaining fenced site will provide more information on how dunes that have been established for longer periods of time respond to shoreline erosion. Given the distance of the dune at this site from the shore and barring severe storms and hurricanes in the area, this site may survive to provide one last vegetation and elevation data set and thus more information on sediment fencing and vegetative plantings in this area.

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Appendix A

Vegetation Sampling Species List

Appendix A. Percent of plots by species occurrence from 1996, 1997, and 1999 vegetation sampling at Timbalier Island Plantings (TE-18) Demonstration project.

		1996			1997			1999		
Scientific Name	**Common Name**	**Bay**	**Gulf**	**Total**	**Bay**	**Gulf**	**Total**	**Bay**	**Gulf**	**Total**
Agalinas maritima	Purple false-foxglove							**7**		**3**
Ambrosia artemesifolia	Common ragweed								3	2
Andropogon glomeratus	Bushy beardgrass							28	3	16
Aster sp.								3		2
Baccharis halimiflora	Saltbush							28		14
Batis maritima	Saltwort		2	1	3		1			
Conyza bonariensis	Large-head horseweed							14	7	10
Croton punctatus	Beach croton					8	4	3		2
Distichlis spicata	Seashore saltgrass	3	2	2	3	1	1			
Eleocharis parvula	Dwarf spikesedge							3		2
Eleocharis sp.								3		2
Eragrostis secundiflora	Red lovegrass							10		5
Erigeron procumbens	Beach daisy fleabane							3		2
Eustoma exaltum	Catchfly prairie gentian				15		8			
Fimbristylis castanea	Large marsh fimbry				18		9	28		14

Scientific Name	Common Name	1996 Bay	1996 Gulf	1996 Total	1997 Bay	1997 Gulf	1997 Total	1999 Bay	1999 Gulf	1999 Total
Heliotropium curassavicum	Seaside heliotrope		2	1						
Heterotheca subaxillaris	Goldenaster				15	5	10			
Ipomea pes-capreae	Beach morning glory								3	2
Ipomea sp.					3		1			
Limonium carolinianum	Carolina sealavender				5		3	3		2
Machaeranthera phyllocephala	Camphor daisy							10	86	48
Panicum amarum var. amarulum	Bitter panicum	71	51	61	93	92	92	86	48	67
Paspalum vaginatum	Seashore paspalum	3		2	5		3			
Phragmites communis	Common reed								3	2
Sabatia stellaris	Rose of Plymouth				50		25			
Sabatia sp.								31		16
Sacciolepis striata	American cupscale							3		2
Sesuvium portulacastrum	Seaside purslane					3	1			
Spartina alterniflora	Smooth cordgrass				3	3	3		3	2
Spartina patens	Marshhay cordgrass	44	51	48	80	77	78	76	34	55
Solidago sempervirens	Seaside goldenrod				13		6	72	10	41

Scientific Name	Common Name	1996 Bay	1996 Gulf	1996 Total	1997 Bay	1997 Gulf	1997 Total	1999 Bay	1999 Gulf	1999 Total
Vigna luteola	Deer pea	3		2	90	64	77	100	100	100
	unknown				3		1	3		2

Note: The LDNR/CRD reference for naming plant species is:

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