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For the period December 23, 1996 to May 12, 1999

Coast 2050 Region 4

FALGOUT CANAL - VEGETATIVE PLANTING DEMONSTRATION PROJECT (TE-17)

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

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ABSTRACT

Evaluation of *Spartina alterniflora* (smooth cordgrass) plantings along with 9 different wave damping fence designs to reduce shoreline erosion rates were tested from May 1997 to March 1999 along 1,413 ft (430.9 m) of Falgout Canal, in Terrebonne Parish, Louisiana. The northern bank of Falgout Canal has been reportedly eroding at a rate of 3.0 ft yr^{-1} (0.9 m yr^{-1}) and continued erosion threatens to breach the Falgout Canal marsh management area levee. Also, Coastal Wetlands, Planning, Protection, and Restoration Act (CWPPRA) programmatic evaluation of restoration techniques should provide information useful for developing other projects. Measurements of *S. alterniflora* survival, percent cover, lateral spread, and plant vigor were taken at 3, 7, 12, and 23 months post-planting. Additionally, shoreline position data was collected using shoreline markers and differentially corrected global positioning systems. Aerial photography was collected pre- and post-construction to determine land loss rates. However, this data set was determined to be redundant and not sufficiently accurate at the required scale to adequately determine project effects. *Spartina alterniflora* plantings had a survival rate of only 33.71% 7 months post-planting, and only 11.27% of the plantings were alive 23 months post-planting. Water level data obtained in conjunction with another project indicated that the plantings were flooded 98.07% of the time, at an average depth of 1.21 ft (0.37 m). Shoreline position data indicated that the plantings and wave damping fences had no effect on shoreline erosion rates. However, experimental design problems, such as lack of replicates, interaction of treatments, temporal and spatial variability in the project area due to variable wind and wave orientations, the differential cardinal orientation of the shoreline within and among treatments, the potentially different soil erosion properties along the shoreline, and an insufficient reference shoreline, prevent definitive conclusions from being made concerning treatment effects on shoreline position. However, the poor survival of plantings and the lack of definitive project effects on shoreline erosion rates clearly indicate that these techniques, as implemented in this environment, failed to meet the desired goal of vegetation establishment and reduced shoreline erosion.

INTRODUCTION

The Falgout Canal - Vegetative Plantings Demonstration Project (TE-17) is a 3 year demonstration of vegetative planting in conjunction with various types of wave damping structures to protect a shoreline along Falgout Canal, 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 (CWPRAA, Public Law 101-646, Title III). The project area consists of 1,450 linear ft (442 m) of shoreline along the northern bank of Falgout Canal (figure 2).

Falgout Canal, which connects the Houma Navigation Canal with Lake DeCade, was constructed to allow the transportation of economic goods between the cities of Dulac and Theriot (figure 1). Falgout canal, via the Houma Navigation Canal, may have introduced higher salinity Gulf of Mexico waters into the estuary (Wiseman et al. 1991). The higher salinity water may have affected plant species growth along the Falgout Canal shoreline, which may have exacerbated shoreline erosion. Shoreline erosion, estimated to be 3.0 ft/yr^{-1} (0.9 m/yr^{-1}), may also be attributed to wave energy created by boat traffic (USDA/SCS 1991).

Maintaining the integrity of the Falgout Canal shoreline is important for protecting a large area of marsh (figure 2). This shoreline is the toe of a levee maintained as part of the Falgout Canal Marsh Management (TE-02) project, and breaches in the levees would effect the efficacy of that project. Higher salinity water introduced into the marsh might result in higher mortality rates, or reduce biomass production of the plants (Pezeshki et al. 1987a, Pezeshki et al. 1987b, Pezeshki et al. 1990). Also, shoreline erosion due to boat wakes, is a problem throughout the coastal zone, and additional techniques to reduce the impacts of boat traffic could be useful in other restoration efforts.

Due to the large volume of boat traffic along Falgout Canal, the wave energy created by the boats has caused an erosion problem along the shoreline. The vegetative plantings were placed to protect the shoreline from the wave energy, whereas the structures were built to reduce wave energy, providing protection for the plants. Based on prior studies, *Spartina alterniflora* (smooth cordgrass) successfully reduces the effect of wave erosion and possibly induces sediment deposition (Knutson 1977, Benner et al. 1982, Knutson et al. 1982). A vegetative planting project along Falgout Canal conducted by the LDNR/CRD in 1994 failed, as the vast majority of the *S. alterniflora* plugs planted along the shoreline did not establish. The reasons given for lack of success were high wave energies and herbivory (Steyer 2000). It was felt that the addition of wave damping structures to reduce wave energy may provide the necessary conditions to allow a successful introduction of *S. alterniflora* to the site, thereby reducing shoreline erosion rates along that section of Falgout Canal (USDA/SCS 1991).

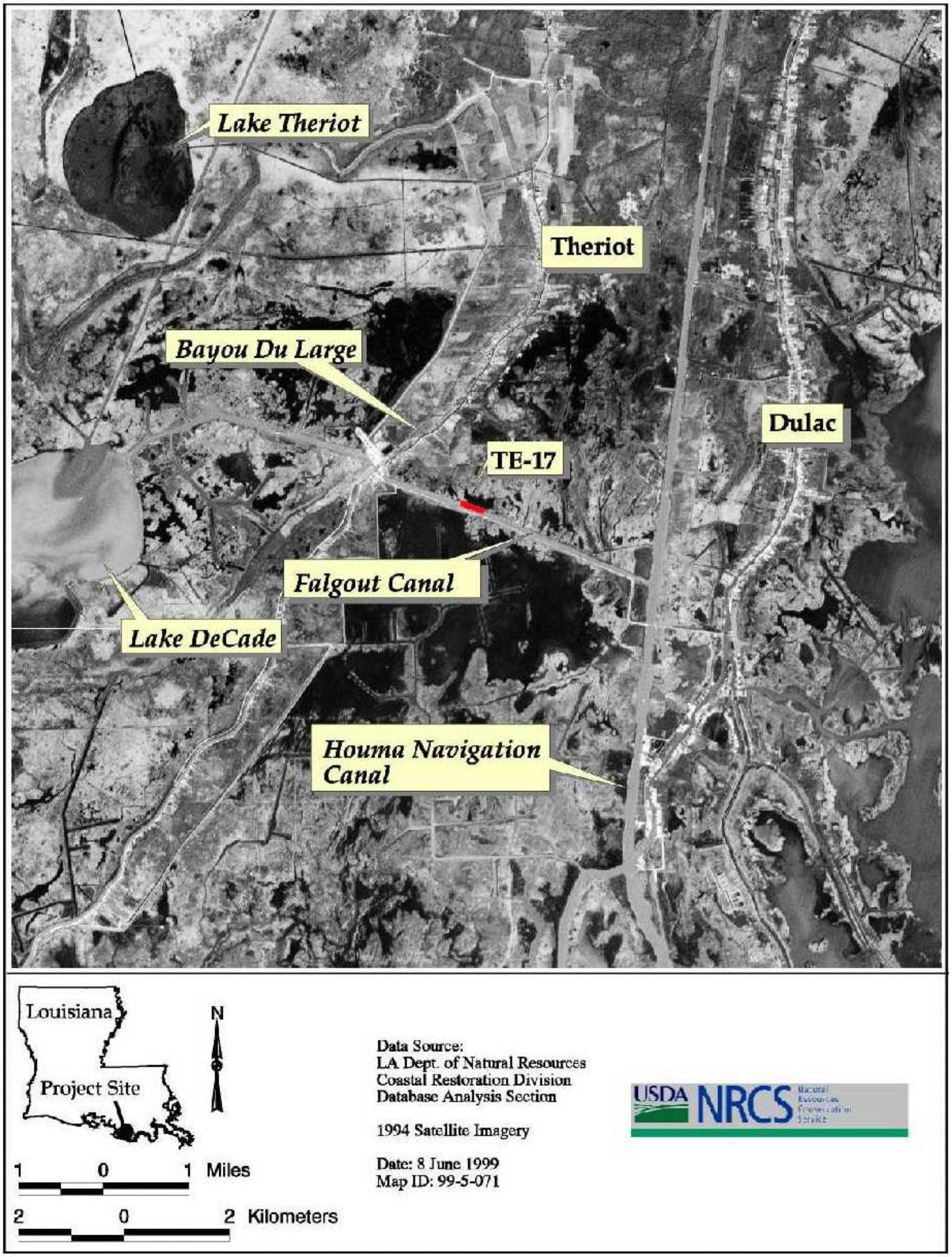

Figure 1. Location and vicinity of the Falgout Canal - Vegetative Plantings Demonstration Project (TE-17) Terrebonne Parish, Louisiana.

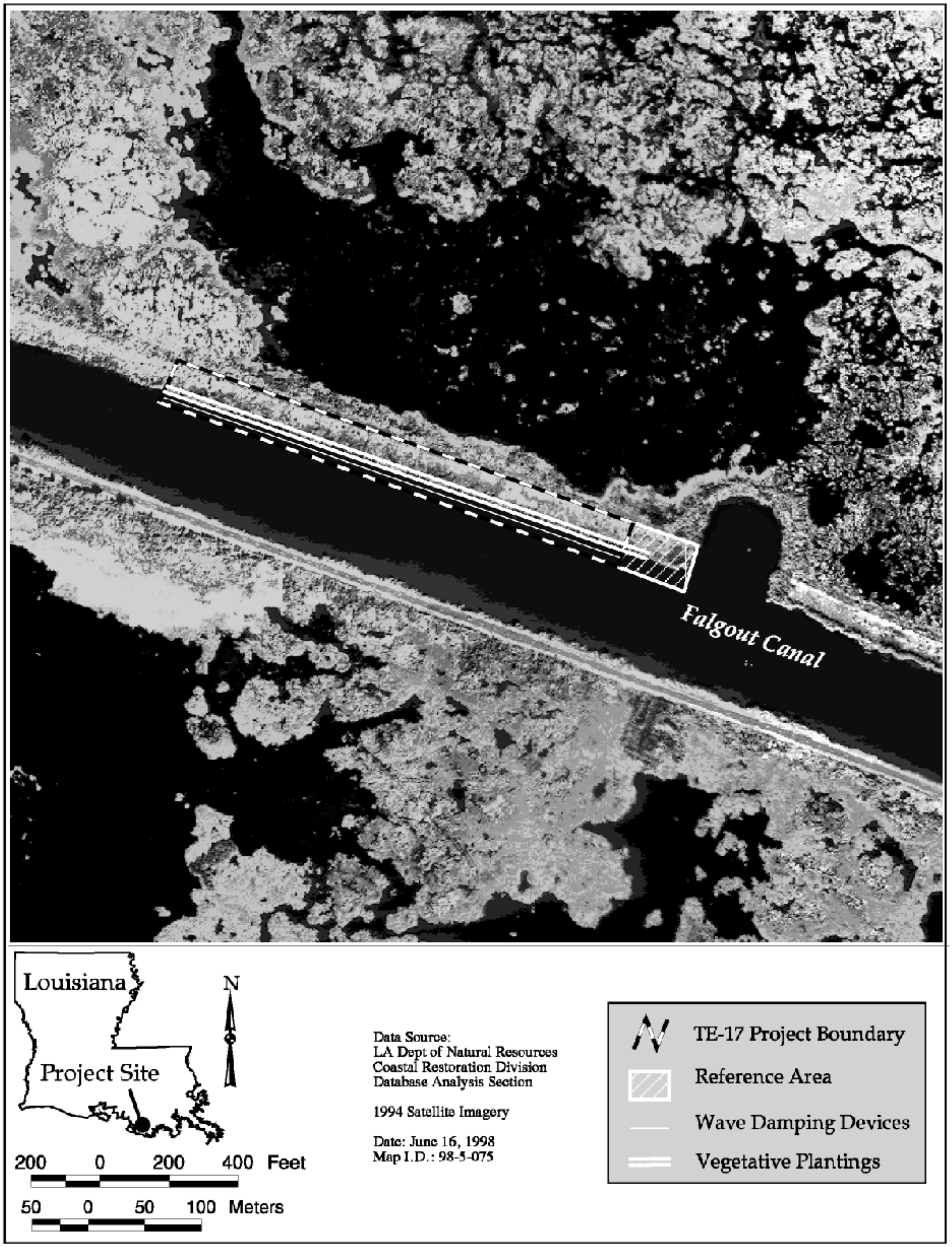

Figure 2. Approximate location of structures, plantings, project and reference area for the Falgout Canal - Vegetative Plantings Demonstration Project (TE-17), along Falgout canal in Terrebonne Parish, Louisiana.

The objectives of the project were to pursue innovative wave protection techniques to protect vegetative plantings and minimize erosion, and to restore of a portion of the northern bank of Falgout Canal through the use of vegetative plantings. The specific measurable goals established to evaluate the effectiveness of the project are:

1) protect a management levee by reducing shoreline erosion along 1,450 ft (442 m) of the northern bank of Falgout Canal through the use of wave damping devices and *S. alterniflora* plantings.
2) determine the effectiveness of wave damping devices of various designs in stabilizing vegetative plantings and reducing shoreline erosion (Ziehr 1998).

METHODS

Project Features

Spartina alterniflora was planted in a single row between the wave damping devices and the northern bank of Falgout Canal on approximately 5.0 ft (1.5 m) centers at the toe of the existing levee (figure 3). Vegetative plantings were also extended into the western portion of the reference area. A total of 300 plants were installed. Vegetative plantings were combined with offshore shoreline protection structures to theoretically reduce wave energy, thereby protecting the plantings.

The wave damping structures consisted of six designs (A-F) encompassing 9 treatments (1-9, figure 4). Each treatment was separated by 164 ft (50 m) and was constructed as near the shore as conditions allowed. Proceeding from west to east, treatments were; (1) Shore perpendicular, four section double sided wooden A-frame (design A), (2) Shore-perpendicular, five section uniaxial geo-grid fence with flared end (design C), (3) Geo-mesh fabric laid on shore (design F), (4) Shore-perpendicular, five section uniaxial geo-grid fence (design D), (5) Shore-parallel, uniaxial geo-grid fence (design E), (6) Shore-perpendicular, four section uniaxial geo-grid fence with flared end (design C), (7) Shore-parallel, single-sided wooden A-frame (design B), (8) Shore perpendicular, five section double sided wooden A-frame (design A), and (9) Shore-perpendicular, four section uniaxial geo-grid fence (design D).

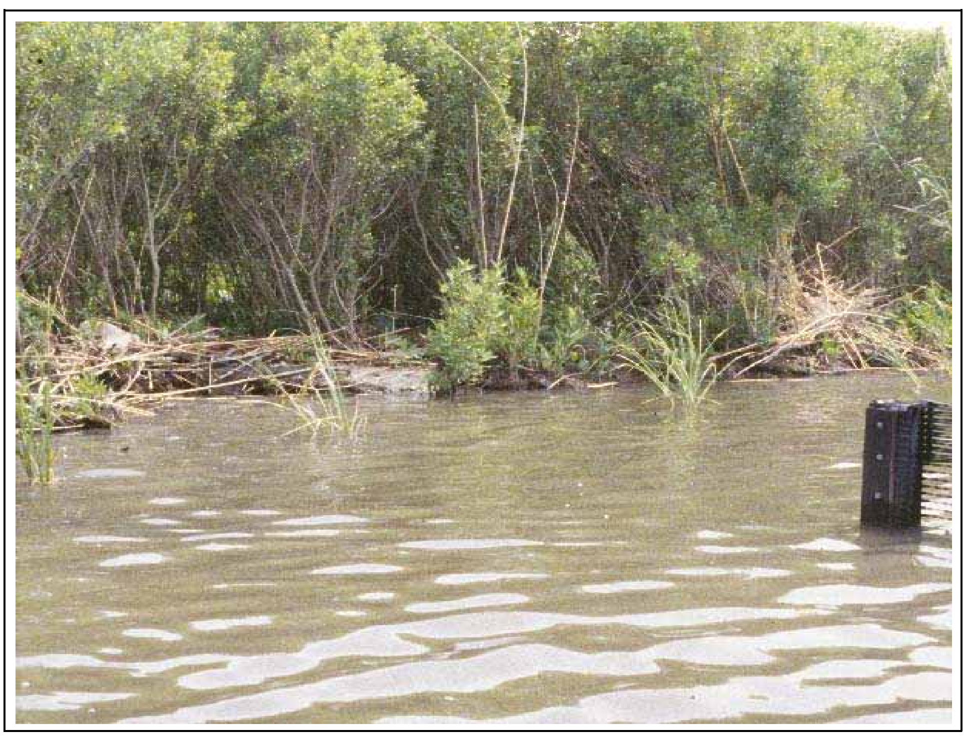

Figure 3. ***Spartina alterniflora*** **plantings along northern shoreline of Falgout Canal at Falgout Canal - Vegetative Plantings Demonstration Project (TE-17) (photo taken April 1997 by NRCS).**

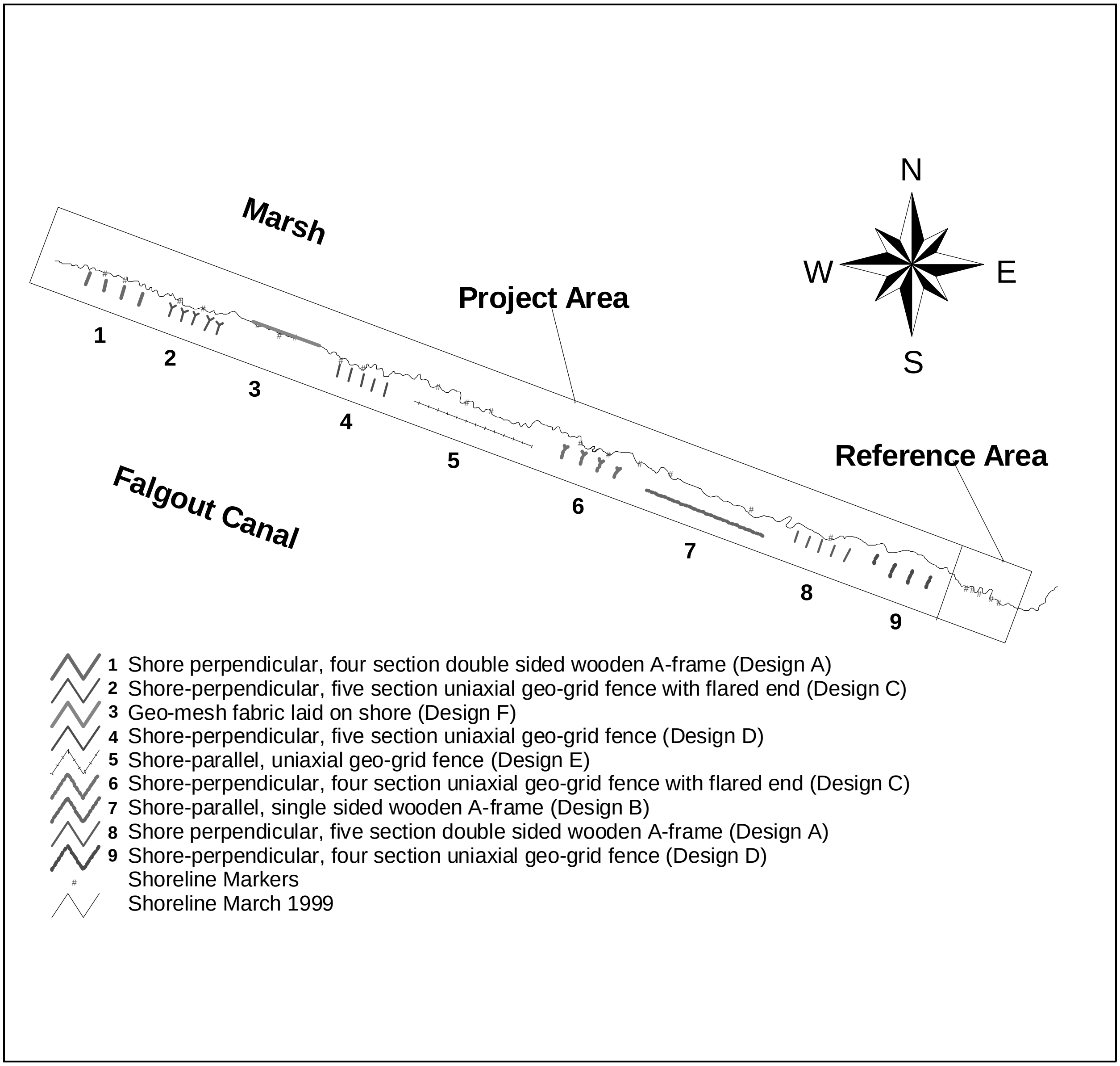

Figure 4. Layout of wave damping treatments, shoreline markers and the March 1999 shoreline for the Falgout Canal - Vegetative Plantings Demonstration Project (TE-17).

Fence treatment (1) is a 20 ft (6.1 m) long wooden grated apex (design A) placed perpendicular to shore on 10 in x 15 ft (25 cm x 4.5 m) pilings, with a base width of 5 ft (1.5 m) and a height of 2 ft (60 cm) (figure 5). Creosote timbers, 20 ft x 6 in x 2 in (6.1 m x 15 cm x 5 cm), were bolted to wooden supports to form a grated apex. Four structures were placed perpendicular to the shoreline approximately 30 ft (9 m) apart, with the top of the structure at +2.5 ft (+76.0 cm) National Geodetic Vertical Datum (NGVD) and the bottom of the apex at +0.5 ft (+15.0 cm) NGVD. Fence treatment (8) is the same as design (A), with 5 structures placed 20 ft (6.1 m) apart. Fence treatment (7) is also, a similar wooden apex design. However, it is design B which is single sided, and was placed parallel to the shoreline (figure 6). (Appendix A-1)

Figure 5. Shore perpendicular, four and five section double sided wooden A-frame (design A; treatments 1 and 8) at Falgout Canal - Vegetative Plantings Demonstration Project (TE-17) (Photo taken March 13, 2000).

Figure 6. Shore-parallel single sided wooded A-frame (design B; treatment 7) at Falgout Canal - Vegetative Plantings Demonstration Project (TE-17) (Photo taken March 13, 2000).

Fence treatment (2) is a 20 ft (6.1 m) long uniaxial geo-grid, supported by 4 in x 4 in x 10 ft (10 cm x 10 cm x 3 m) timber posts (design C). Five structures were placed perpendicular to the shoreline approximately 5 ft (1.5 m) apart, with the top of the structure at +2.5 ft (+76.0 cm) NGVD and the bottom of the fence at -1.0 ft (-30.0 cm) NGVD. The end nearest the shoreline bifurcates at a 90^{o} angle for the last 5 ft (1.5 m) (figure 7). Treatment (4) was similarly spaced, but is design D and lacked the bifurcation at the end. Treatments (6) and (9) used the same construction designs as treatments (2) and (4), respectively, however, only four structures were built with a wider spacing of 30 ft (9 m) apart. (Appendix A-2)

Fence treatment (3) is a geo-mesh fabric laid (design F) on a 100 ft (30.5 m) section of the shoreline and run to the bottom of the canal approximately 15 ft (4.5 m) offshore and 10 ft (3 m) onshore (figure 8). The fabric was secured at the top and bottom with sacks of concrete. (Appendix A-3). Fence treatment (5) is a 100 ft (30.5 m) long uniaxial geo-grid fence (design E), supported by 4 in x 4 in x 10 ft (10 cm x 10 cm x 3 m) timber posts every 5 ft (1.5 m). The fence was positioned parallel to the shoreline, with the top of the structure at +2.5 ft (+76.0 cm) NGVD and the bottom of the apex at -1.0 ft (-30.0 cm) NGVD (figure 9, Appendix A-3).

Construction of the shoreline protection devices began December 23, 1996 and was completed on January 23, 1997. The vegetation was planted May 12, 1997.

Figure 7. Shore-perpendicular, five and four section uniaxial geo-gid fence with flared end (design C) at Falgout Canal - Vegetative Plantings Demonstration Project (TE-17) (Photo taken March 13, 2000).

Figure 8. Geo-mesh fabric laid on shore (design F; treatment 3) at Falgout Canal - Vegetative Plantings Demonstration Project (TE-17). Fabric has been tossed up on shore due to wave action. (Photo taken March 13, 2000).

Figure 9. Shore-parallel, uniaxial geo-grid fence (design E; treatment 5) at Falgout Canal - Vegetative Plantings Demonstration Project (TE-17) (Photo taken March 13, 2000).

The reference area encompassed 0.62 ac (0.25 ha) and was located adjacent to the project area along 164 ft (50.2 m) of the northern bank of Falgout Canal, directly east of the project area (figure 2). Vegetative plantings were placed in the western portion of the reference area, while the eastern end of the reference area was not planted. The reference shoreline had vegetative plantings placed in the area and they were unprotected by wave damping treatments. Also, pre-construction shoreline position data was available for a portion of this area.

Monitoring Design

A detailed description of the monitoring design over the life of the project can be found in Ziehr (1998). Measurable variables chosen to evaluate project effectiveness are aerial photography, shoreline position, and percent survival of vegetative plantings. Aerial photos were dropped after the first post-construction flight due to changes in project boundaries, budget constraints, and duplication with more accurate variables for the measurement of shoreline position. Also, observation of structure conditions were made to evaluate longevity and durability of the different structures that could influence their effectiveness and application.

Vegetative Plantings: Ten plants were randomly chosen to be sampled behind each treatment and 5 plants in the reference area. Due to high mortality rates, 10 plants could not be found in some treatments and smaller samples were taken during some sample periods. Sampling occurred on July 24, 1997 (3 months post-planting), December 10, 1997 (7 months post-planting), May 26, 1998 (1 year post-planting), and March 23, 1999 (23 months post-planting). At 7 months, 1 year and 23 month sample periods, a total count of plants was conducted to give as much information as possible on percent survival. Variables measured during each sample period, included survival, plant vigor, lateral spread, and percent cover.

Percent survival at each time period was calculated by dividing the number of live plants by the total number of plants sampled for that time period, or a complete count was conducted. Plant vigor was subjectively ranked from 1 to 5 with 5 being the most vigorous score. Lateral spread was the distance from the center of the plant to the furthest end of the longest shoot. Percent cover was ocularly estimated within a 6.5 x 6.5 ft (2 x 2 m) square centered on each plant.

Due to low survival of plantings, statistical testing was not conducted. Also, interpreting an individual treatments effect on shoreline position was not conducted due to experimental design problems, such as lack of replicates, interaction of treatments, temporal and spatial variability in the project area due to variable wind and wave orientations, the differential cardinal orientation of the shoreline within and among treatments, the potentially different soil erosion properties along the shoreline, and an inadequate reference shoreline.

Land-Water Analysis: The United States Geological Survey/National Wetlands Research Center (USGS/NWRC) obtained 1:12,000 scale near-vertical color infrared aerial photography on November 21, 1993 (pre-construction) and November 8, 1997 (6 months post-planting). The photography was checked for flight accuracy, color correctness and clarity. The original film was archived, and 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 using differentially corrected global positioning system (DGPS) data, set to achieve sub-meter accuracy. These rectified frames were then assembled to produce a mosaic for the project (figure 2).

ESRI Arcview® geographic information systems (GIS) software package, was used to determine the change in the land to water ratio by comparing the pre- and post-construction land to water ratios. The mosaic's were classified according to pixel value and analyzed to determine land to water ratios in the project and reference areas (figure 10). All areas characterized as emergent vegetation were classified as land, while open water, aquatic beds, and mud flats were classified as water. An accuracy assessment comparing the GIS land-water classification of 100 randomly chosen pixels to aerial photography determined an overall classification accuracy of 99%.

Shoreline Position: Shoreline position was defined as the edge of the live emergent vegetation (Steyer et al. 1995). Twenty four shoreline markers stations, 18 in the project and 6 in the reference area, were established October 10, 1996, following Steyer et al. (1995), and baseline measurements were obtained (figure 4). Due to damage, several shoreline markers were reinstalled on February 4, 1997, and new baseline measurements were obtained. Shoreline position was measured again on May 26, 1998 (1 year post-planting) and March 23, 1999 (2 years post-planting) at all stations. Measurements at each station were averaged, after correction for measurement angles, to obtain a shoreline position. Differences between average shoreline position at each station were then divided by the number of days between measurements and multiplied by 365 days to get an average shoreline change rate per year.

Surveys and DGPS shoreline position data were also obtained along the Falgout Canal shoreline. Surveys and DGPS shoreline position measurements were conducted in the Louisiana State Plane, South Zone Coordinate System, in the North American Datum of 1983 (NAD 83). The pre-construction shoreline position was established January 1997 by T. Baker Smith and Sons, Inc., a professional survey and engineering firm. Post-planting shoreline positions were determined May 1997 (immediate post-planting), May 1998 (1 year post-planting), and March 1999 (2 years post-planting) by LDNR/CRD and USGS/NWRC personnel, using a DGPS set to achieve sub-meter horizontal accuracy for each reading (Trimble Navigation Ltd. 1996). Points were collected approximately every 5 ft (1.5 m) along the shoreline and a best fit line was drawn connecting the points, thereby establishing the shoreline position for the total area (figure 11).

Pre-construction and post-planting shoreline change rates were determined by overlaying all shoreline position data sets using ESRI Arc/Info® and ESRI ArcView® GIS software. A polygon was established for the project and reference areas onshore to a baseline at the back of the existing levee. Within each polygon, the area (m^2) was determined and compared to the polygon formed by the shoreline position data for each sampling time period. The difference between 1 sample period's area and the next sample period's area, determined the total area change over the time period. This change in area was divided by the total length of the polygon (m) to calculate the average shoreline change rate. The shoreline change rate was divided by the number of days between the samples and multiplied by 365 days to get an average annual shoreline change rate. Due to missing shoreline position data in sections of the reference area, pre-construction and immediate post-planting change analysis was conducted on shorelines that were common in both years.

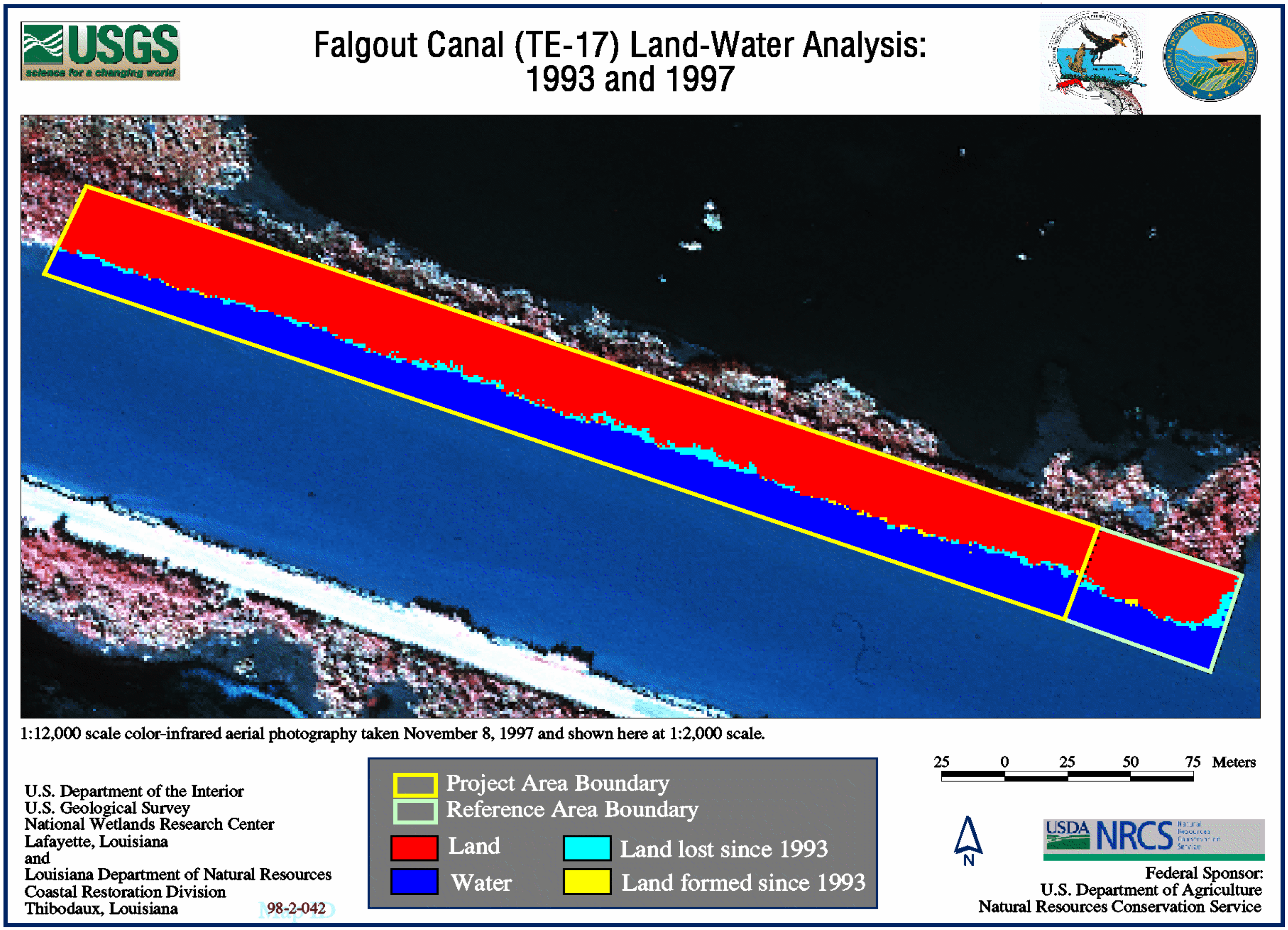

Figure 10. Land loss and land gain shown from overlay of 1993 and 1997 classified aerial photography for the Falgout Canal - Vegetative Plantings Demonstration Project (TE-17).

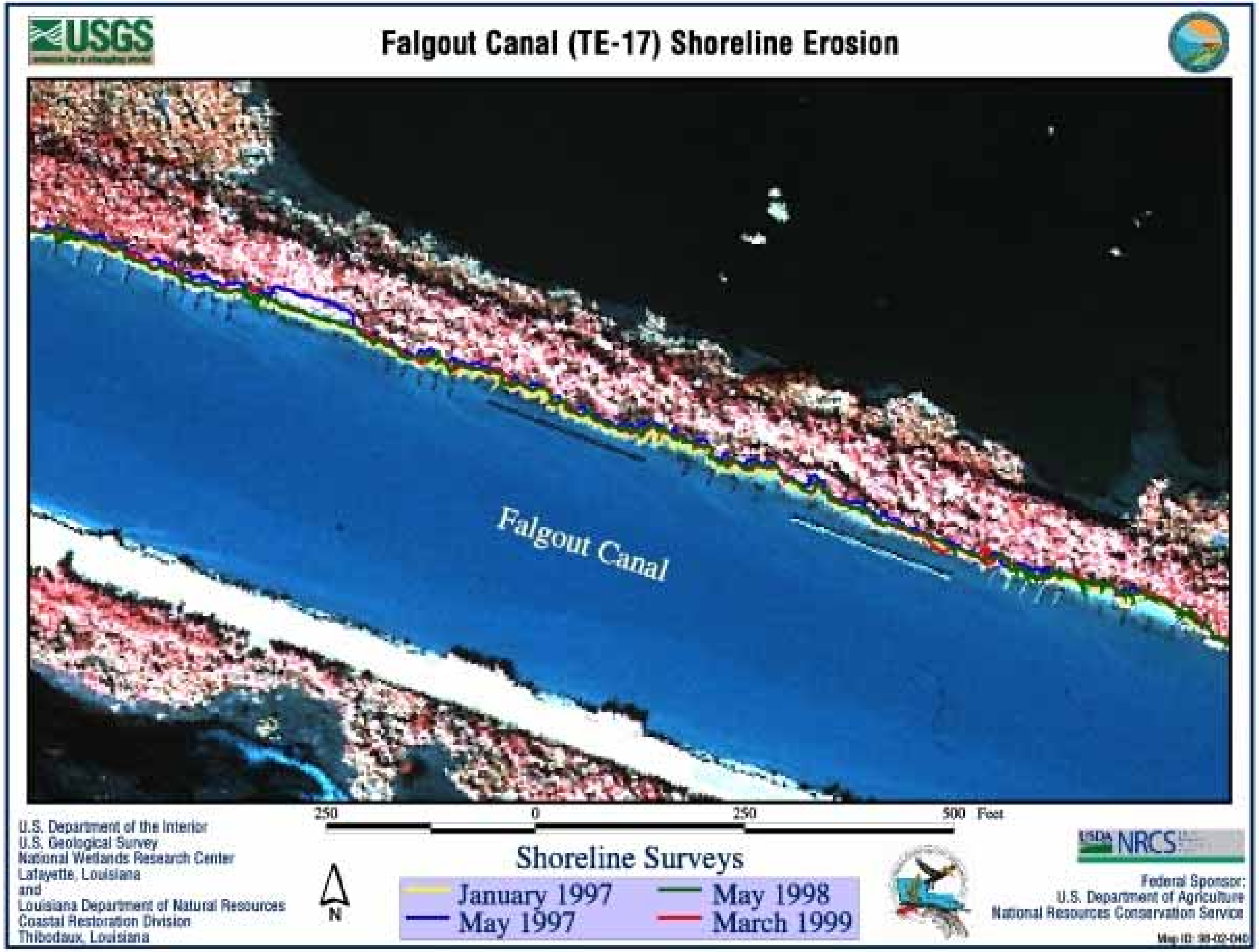

Figure 11. **January 1997 (pre-construction), May 1997 (immediate post-planting), May 1998 (1 year post-planting) and March 1999 (2 years post-planting) DGPS shoreline surveys of the Falgout Canal - Vegetative Plantings Demonstration Project (TE-17).**

Due to experimental design problems mentioned earlier, shoreline position changes were not calculated for individual treatments and should be taken into consideration when interpreting the data. Also, when interpreting shoreline position changes using the DGPS data collected, it should be noted that raw data readings have a potential error of ± 1 m, and this should be considered when determining changes in shorelines with low erosion rates, where time between sampling periods is short. Low erosion rates can cause DGPS shoreline position measurements to fall within the error range and cause analysis of average annual rates to show inaccurate results. Therefore, we believe that interpretation of shoreline position changes for this project are best measured with the shoreline marker data set. However, all data sets are presented.

Water Level: Hourly water level readings were obtained from the USGS data collection platform (DCP) at Houma Navigation Canal at the Dularge Bridge (DCPTE03). Hourly data from May 12, 1997 to October 31, 1998 was analyzed (n = 12,912). Water levels were referenced to NGVD (Garrison et al. 1998) and converted to NAVD using a surveyed "mark" on the DCP platform. The mark was established to NAVD by CEEC Inc., on September 21, 1998, using GPS survey techniques (CEEC1997). By measuring from the mark to the water surface, LDNR/CRD personnel obtained two separate readings of water elevation (NAVD); measurements were recorded on the hour to coincide with the DCP hourly water depth recording. The differences between the raw water levels recorded by the DCP and those measurements made by LDNR/CRD were averaged to obtain a conversion factor. This value, -0.64, was then used to convert all DCP water level readings to NAVD, and an average NAVD elevation was calculated (Figure 12).

Elevation of the sediment surface, at the location of plantings, was determined by direct measurement of the water depth at each plant, during 3 vegetation sampling periods (n = 303). Water depth was averaged for each sampling period to obtain mean water depth for the planting area. Additionally, DCPTE03 water level data from 8:00 to 17:00 on the days of vegetation sampling were averaged to obtain mean water level during the time of sampling. The difference between the DCP mean water level and the mean water depth for the planting area, produces the average sediment elevation (NAVD) during each of three sampling periods (Figure 12).

Depth and duration of flooding of the plantings was then calculated using SAS (SAS Institute, Inc. 1999) to determine percent of time average water elevation (NAVD) exceeded the average sediment elevation (NAVD), as well as the average depth of flooding (Figure 12).

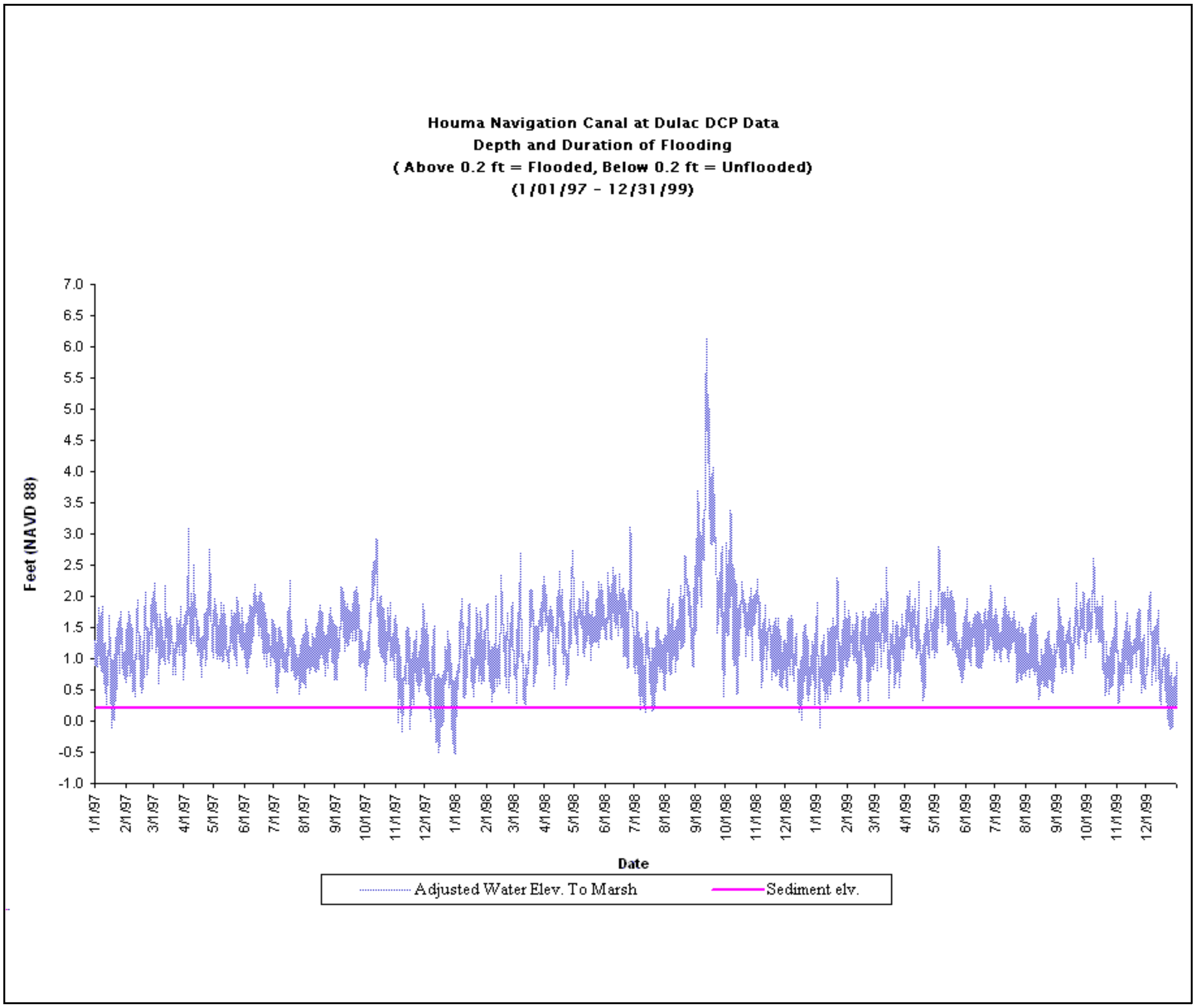

Figure 12. **Flooding of mean sediment elevation in planting area from January 1, 1997 through December 31, 1999 at Falgout Canal - Vegetative Plantings Demonstration Project (TE-17).**

RESULTS

Vegetative Plantings: Mean survivorship of the plantings decreased throughout the sampling period. All plantings sampled in the reference area (n = 5) were dead 7 months post-planting, while the project area averaged 31.71% survival after 7 months (n = 206) (table 1). However, within the project area only 19.85% and 11.27% were alive 12 months and 23 months post-planting, respectively. Treatment types showed varying results. Six of the 9 treatments had no survival 23 months post-planting, while treatments (6), (7), and (9) showed 55.56%, 12.50%, and 33.33% survival, respectively. It should be noted that the reference area showed increased survival after 7 months due to small sample size (n = 5) in the reference area. Due to low sample sizes and low survivorship of the plantings, average cover, lateral spread, and plant vigor were not calculated.

Land-Water Analysis: The GIS landwater analysis showed from pre-construction to 6 months post-planting, the project area lost 3487 ft^2 (324 m^2), or 2.8% of the land, while the reference area lost 861 ft^2 (80 m^2), or 4.9% of it's land (table 2). This would indicate an annual land loss rate of 2.04 $ft^2\ yr^{-1}$ (0.19 $m^2\ yr^{-1}$) in the project area, and an annual land loss rate of 5.16 $ft^2\ yr^{-1}$ (0.48 $m^2\ yr^{-1}$) in the reference area.

Shoreline Position: Shoreline marker measurements indicated that the shoreline in the project area had an average annual erosion rate of 2.6 ft yr^{-1} (0.08 m yr^{-1}), while the reference area prograded at an average annual rate of 1.41 ft yr^{-1} (0.43 m yr^{-1}), between October 10, 1996 and May 26, 1998 (1 year post-construction). However, 2 years post-planting, both project and reference areas showed average annual erosion rates of 1.84 and 0.56 ft yr^{-1} (0.56 and 0.17 m yr^{-1}), respectively

Table 1. Percent survival of plantings during each sample period for all treatments at Falgout Canal - Vegetative Plantings Demonstration project (TE-17).

		Percent Survival			
Treatment	**Planting**	**3 months post**	**7 months post**	**12 months post**	**23 months post**
1	100.00	100.00	0.00	0.00	0.00
2	100.00	80.00	5.00	0.00	0.00
3	100.00	80.00	0.00	0.00	0.00
4	100.00	80.00	25.00	25.00	0.00
5	100.00	90.00	25.00	12.50	0.00
6	100.00	100.00	77.78	72.22	55.56
7	100.00	100.00	45.00	30.00	12.50
8	100.00	80.00	18.75	0.00	0.00
9	100.00	100.00	88.89	38.89	33.33
Project	100.00	90.00	31.71	19.85	11.27
Reference	100.00	40.00	0.00	20.00	0.00

Table 2. Land Water analysis of 1993 and 1997 photography by NWRC at the Falgout Canal - Vegetative Plantings Demonstration project (TE-17).

	Pre-Construction		**Post-Planting**		**Change**	
	Land m^2 (%)	**Water m^2 (%)**	**Land m^2 (%)**	**Water m^2 (%)**	**Land m^2 (%)**	**Water m^2 (%)**
Project area	11533 (64)	6596 (36)	11209 (63)	6717 (37)	-324 (2.8)	121(1.8)
Reference Area	1618 (61)	1052 (39)	1538 (58)	1133 (42)	-80 (4.9)	81 (7.6)

(figure11). The reference area prograded during the first year of the experiment as did most stations on the eastern end of the project behind treatments 1, 2, 3, and 4 (figure 13). The stations in the middle of the project area all showed erosion, and by the second year of the project erosion was measured at all but 6 stations in both the project and reference areas (figure 13).

Comparison of pre-construction and post-planting DGPS shoreline position data indicates that the shoreline in the project area had an average annual erosion rate of 28.48 ft yr^{-1} (8.68 m yr^{-1}), while the reference area eroded at an average annual rate of 3.12 ft yr^{-1} (0.95 m yr^{-1}), between January 1997 and May 1997. Post-planting results indicated that 23 months post-planting the project area shoreline prograded at a rate of 2.59 ft yr^{-1} (0.79 m yr^{-1}), while the reference area shoreline eroded at a rate of 3.51 ft yr^{-1} (1.07 m yr^{-1}) (figure 14). However, since results are suspect due to DGPS data problems as mentioned in the methods, shoreline marker data should be used for interpretations of shoreline position change.

Water Level: Analysis of hourly NAVD water elevation (n = 12,912) from the USGS Houma Navigation Canal DCP, from May 12, 1997 to October 31, 1998, indicated that the average water level was 1.41 ft (0.43 m) NAVD. This indicates that the sediment surface at the planting location was flooded 98.07% of the time, and plantings were flooded at an average depth of 1.21 ft (0.37 m).

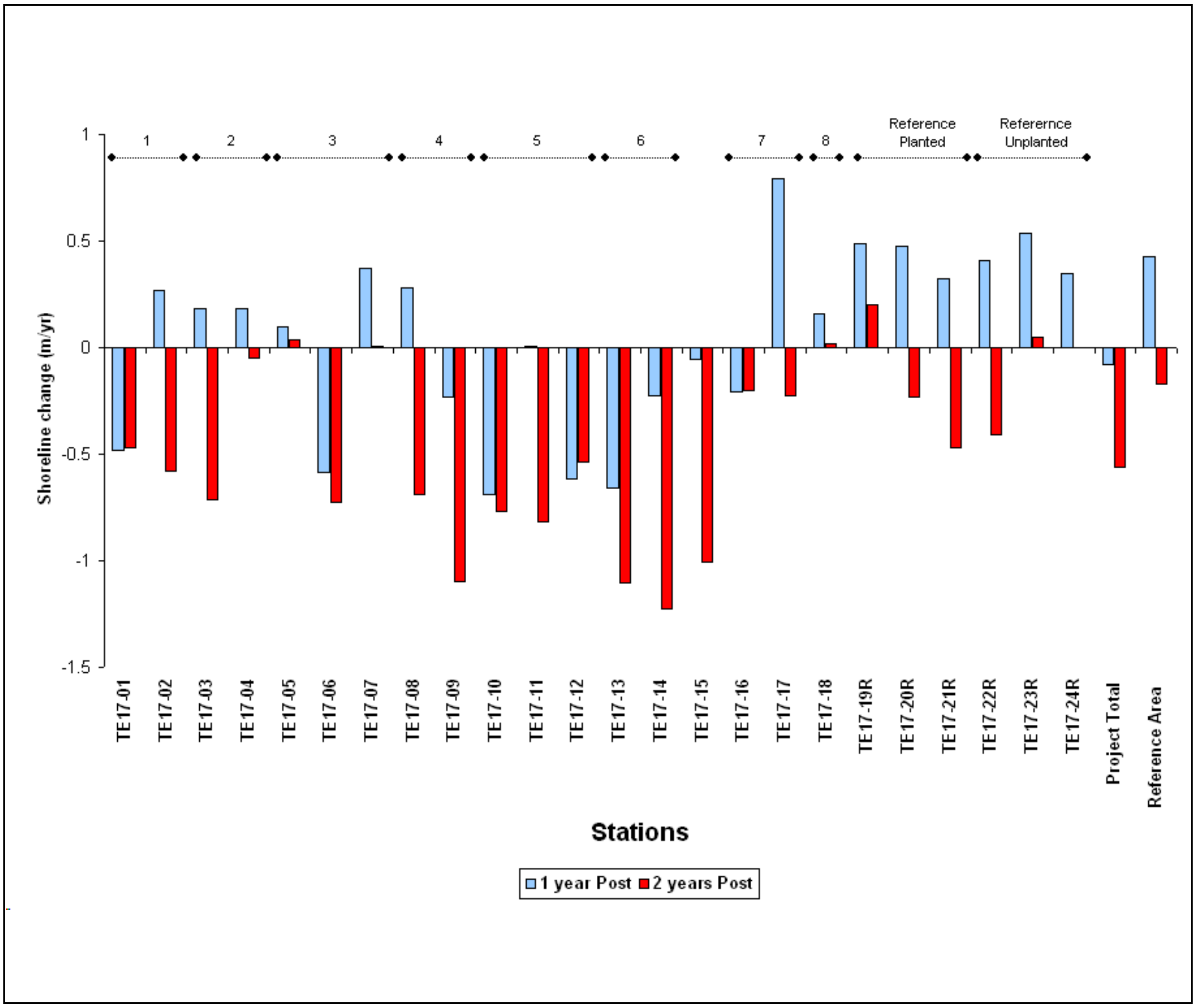

Figure 13. Shoreline change rates from shoreline marker data for all treatments at Falgout Canal - Vegetative Plantings Demonstration project (TE-17). Note: treatment 9 does not have shoreline markers located behind it.

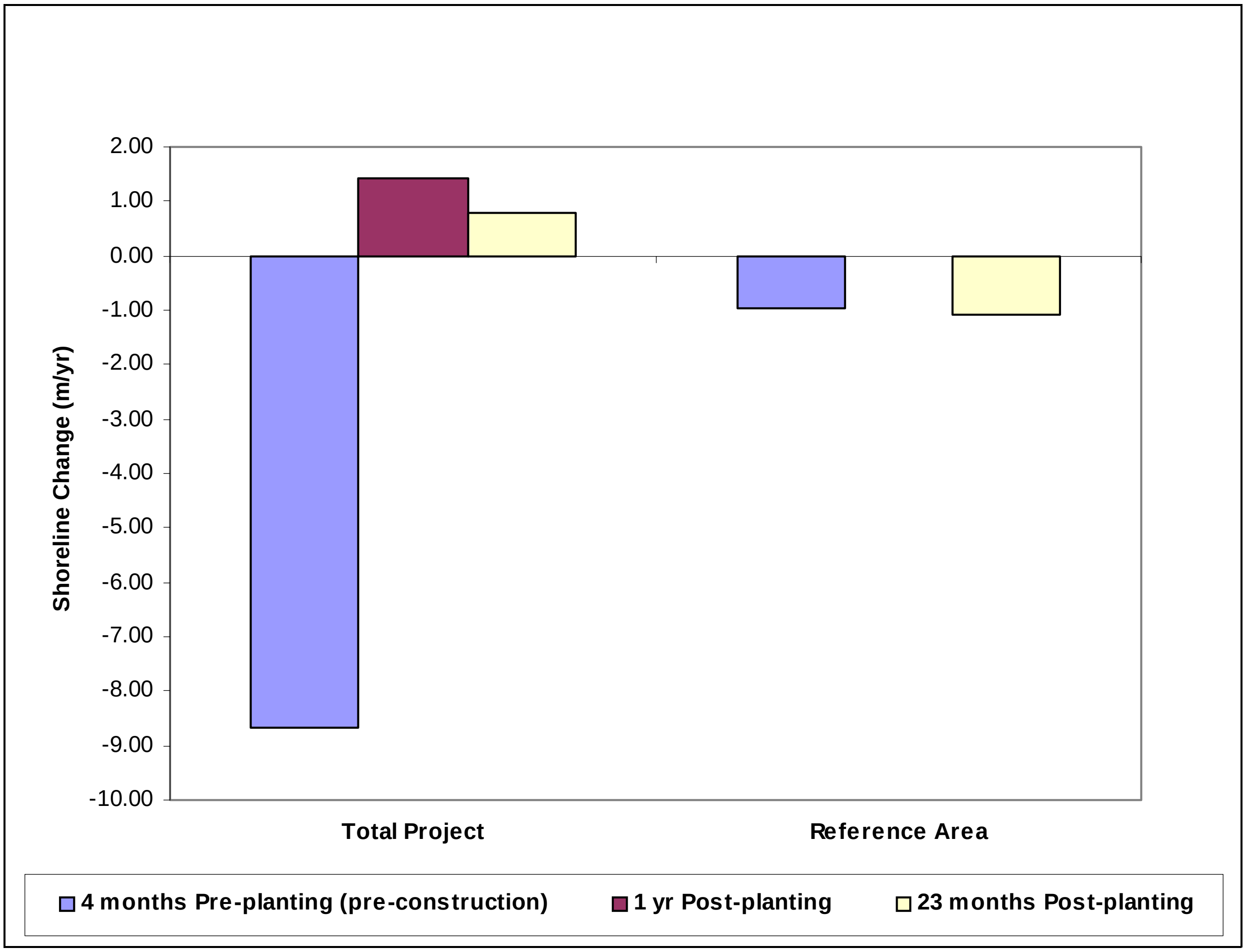

Figure 14. Shoreline change rates from DGPS data for project and reference area at Falgout Canal - Vegetative Plantings Demonstration project (TE-17).

DISCUSSION

The initial goal of protecting a management levee by reducing shoreline erosion along 1,450 ft (442 m) of the northern bank of Falgout Canal through the use of wave damping devices and *S. alterniflora* plantings was not met by the project as indicated by the loss of over 67% of the vegetative plantings within 7 months post-planting (table 1) and no appreciable change in the shoreline erosion rate when compared to the reference area (figure 13). The second goal of determining the effectiveness of wave damping devices of various designs in stabilizing vegetational plantings and reducing shoreline erosion could not be evaluated due to confounding factors with experimental design discussed earlier, such as treatment interactions, spatial and temporal variability, and lack of replication.

Vegetative plantings of *S. alterniflora* quite clearly failed, as they did in the earlier planting project conducted along Falgout Canal (Steyer 2000). The plantings along the shoreline appear to be located along a cutbank. Analysis of hourly water level readings indicated that the plantings could have been flooded excessively (figure 12). While, *S. alterniflora* is known to grow over a wide range of tidal conditions (McKee and Patrick 1988) and can tolerate anaerobic soil conditions (DeLaune et al. 1984), Webb and Dodd (1989) did report lower survival and density of plantings in areas inundated 100% of the time. Also, Eleuterius and Eleuterius (1979) recorded 1 year of inundation time within the lowest elevation zone of *S. alterniflora* in Mississippi at 87%, which was less inundation time than in this case.

Secondly, nutria *(Myocastor coypus)* herbivory could play an integral part in establishment of plantings. Steyer (2000) stated that herbivory impacted the earlier plantings along Falgout Canal, and we noted herbivory on the plantings during the May 26, 1998 sampling. Studies have shown nutria impacts on coastal vegetation (Kinler et al. 1987, Shaffer et al. 1992, Nyman et al. 1993, Linscombe and Kinler 1994, Evers et al. 1998, Ford and Grace 1998) and planted vegetation (Mendelssohn and Hester 1988, Myers et al. 1995) to be significant.

The wave damping structures have held up well, except for the geo-mesh fabric (figure 7). The geo-mesh fabric was displaced shoreward and eventually ended up on the shoreline. Minor damage has occurred on some support posts on the uniaxial geo-grid fence designs, and the damage appears to be from an impact, either a log or boat striking the structure (figure 15).

Unfortunately, the lasting structural integrity of the treatments may result from their apparently poor energy-absorbing capabilities. We observed little reduction in wave energy when boat wakes impacted the wave-damping structures even when multiple structures were impacted by the same wave. Structures at Lake Salvador Shoreline Protection Demonstration (BA-15) project that absorbed the most wave energy had the worst structural integrity (Lee, et al. 2000). Consequently altering the structures at Falgout Canal to increase wave-energy absorption and presumably shoreline protection, may reduce the structural integrity.

Figure 15. Damage on Shore-perpendicular, four section uniaxial geo-grid fence (design D; treatment 4) at Falgout Canal - Vegetative Plantings Demonstration Project (TE-17) (Photo taken March 13, 2000).

CONCLUSIONS

Results indicate that the vegetative plantings and wave damping devices installed along the northern bank of Falgout Canal have not reduced shoreline erosion rates by establishment of *S. alterniflora*. While treatment interactions, lack of replication, and other confounding effects mentioned previously, allow no definitive conclusions to be made about differences in treatments, it is fairly clear that the project as a whole has not achieved the desired results. Even if establishment of vegetative plantings is disregarded, the wave damping devices themselves cannot be shown to reduce shoreline erosion when compared to the reference area. However, it should be noted that the reference area is considered to be a very poor shoreline for comparison and the experimental design problems affect interpretation of results. Also, it should be noted that the structures themselves tended to hold up well in the current conditions, however, their affects on wave energies are undetermined.

Future investigations should include better experimental designs. Due to the nature of demonstration projects, experimental designs should be well conceived and implemented. Demonstration projects, by their nature are implemented to test a technique over a short duration, and should be set up as such. In this case, an appropriate design should have included replicates of each treatment with and without plantings, separation of treatments to prevent interaction, randomization of treatment placements, and better reference areas with and without plantings.

Also, better investigation of planting site conditions for selected species in relation to flooding and salinity should be conducted prior to project implementation. The Houma Navigation Canal DCP has collected water levels and salinities since May 1992 and information on depth and duration of flooding could have been investigated. This information may have lead to modifications of the project with regards to planting location or species utilized.

LDNR/CRD has determined that additional monitoring of this project would provide limited value in further interpreting project effectiveness. A recommendation will be made to the federal sponsor to discontinue monitoring of this project.

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

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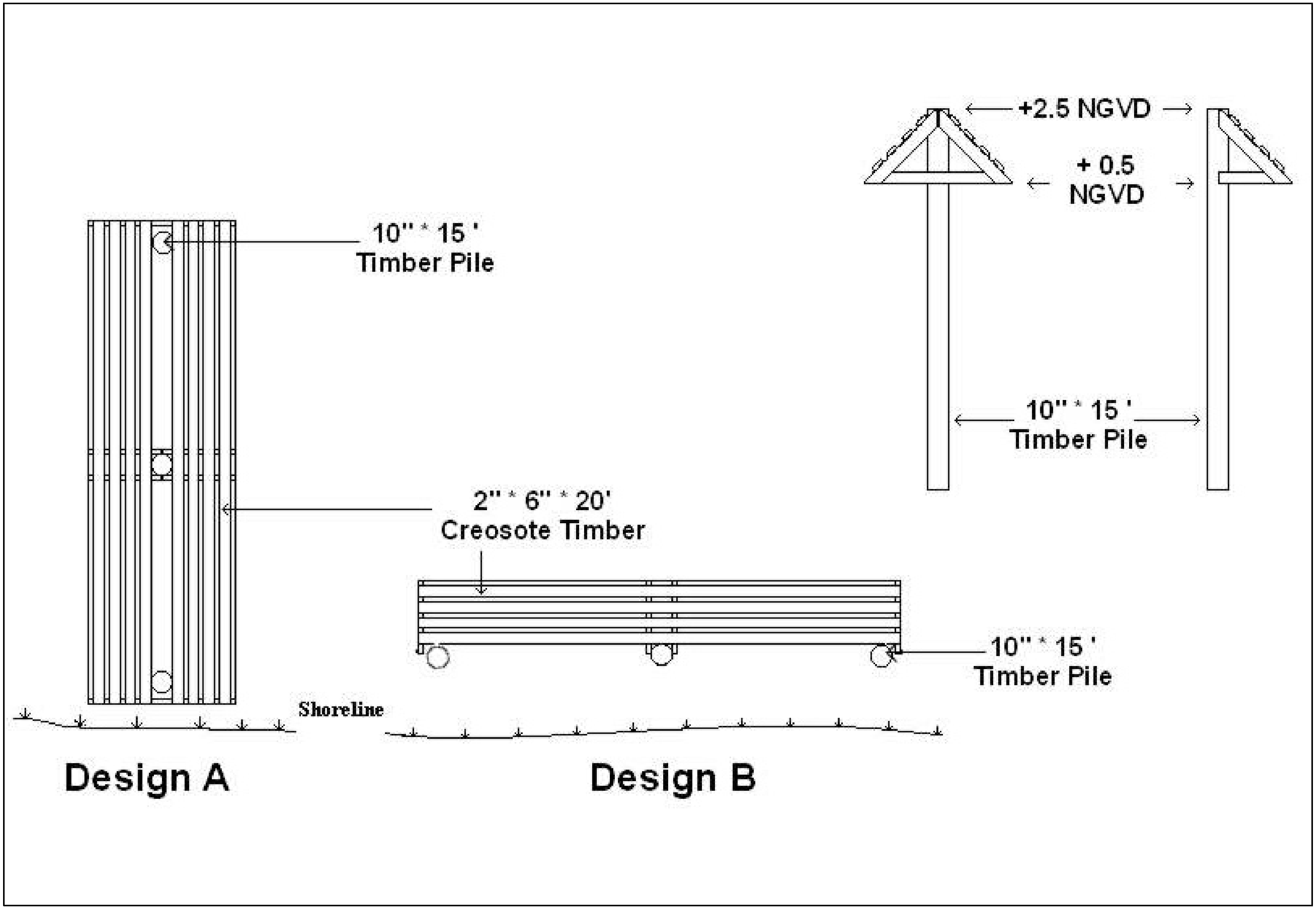
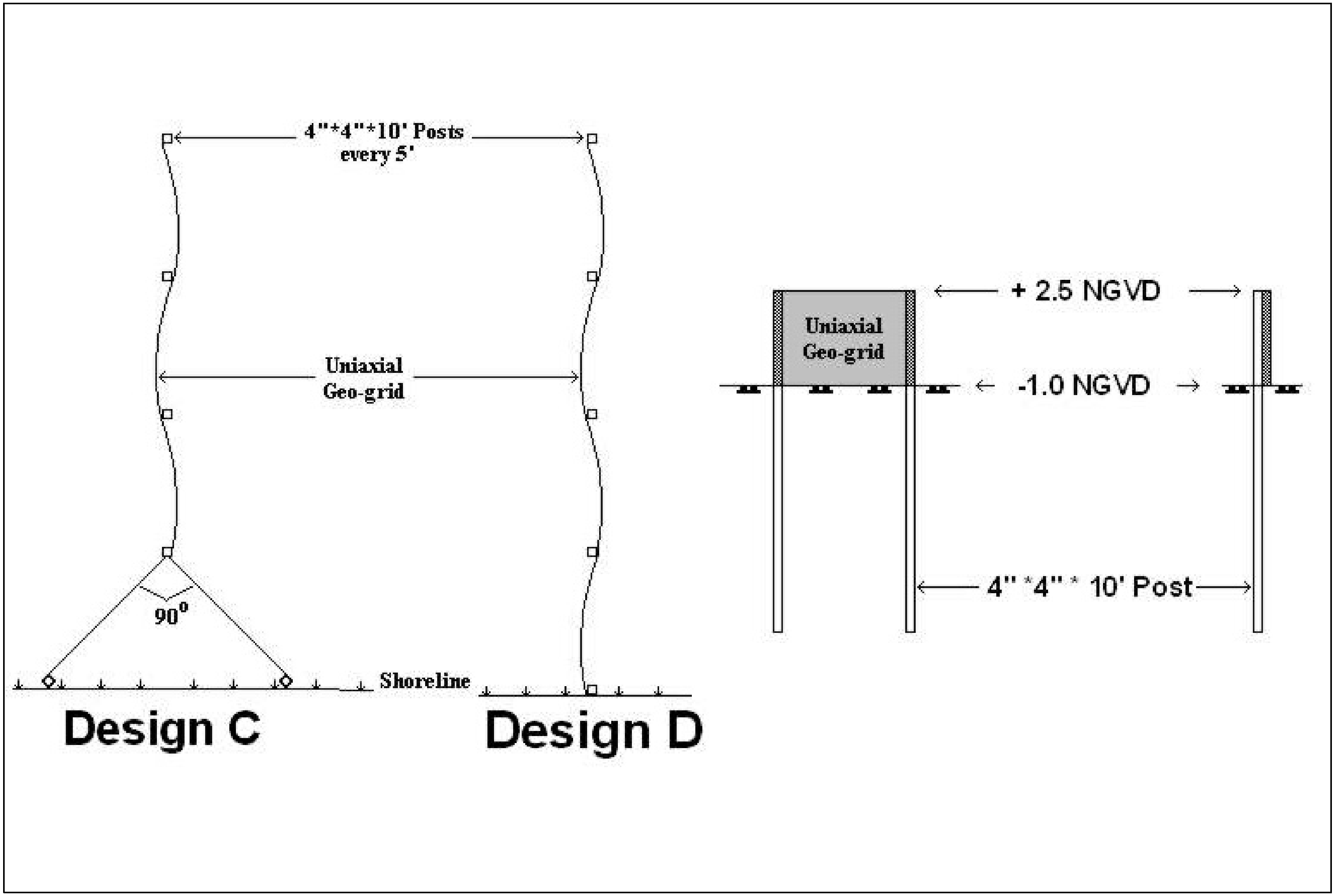
For further information on this report, please contact Todd Hubbell at (504) 447-0991 or the LDNR and CWPPRA homepages at http://www.savelawetlands.org and http://www.lacoast.gov respectively.

Appendix A

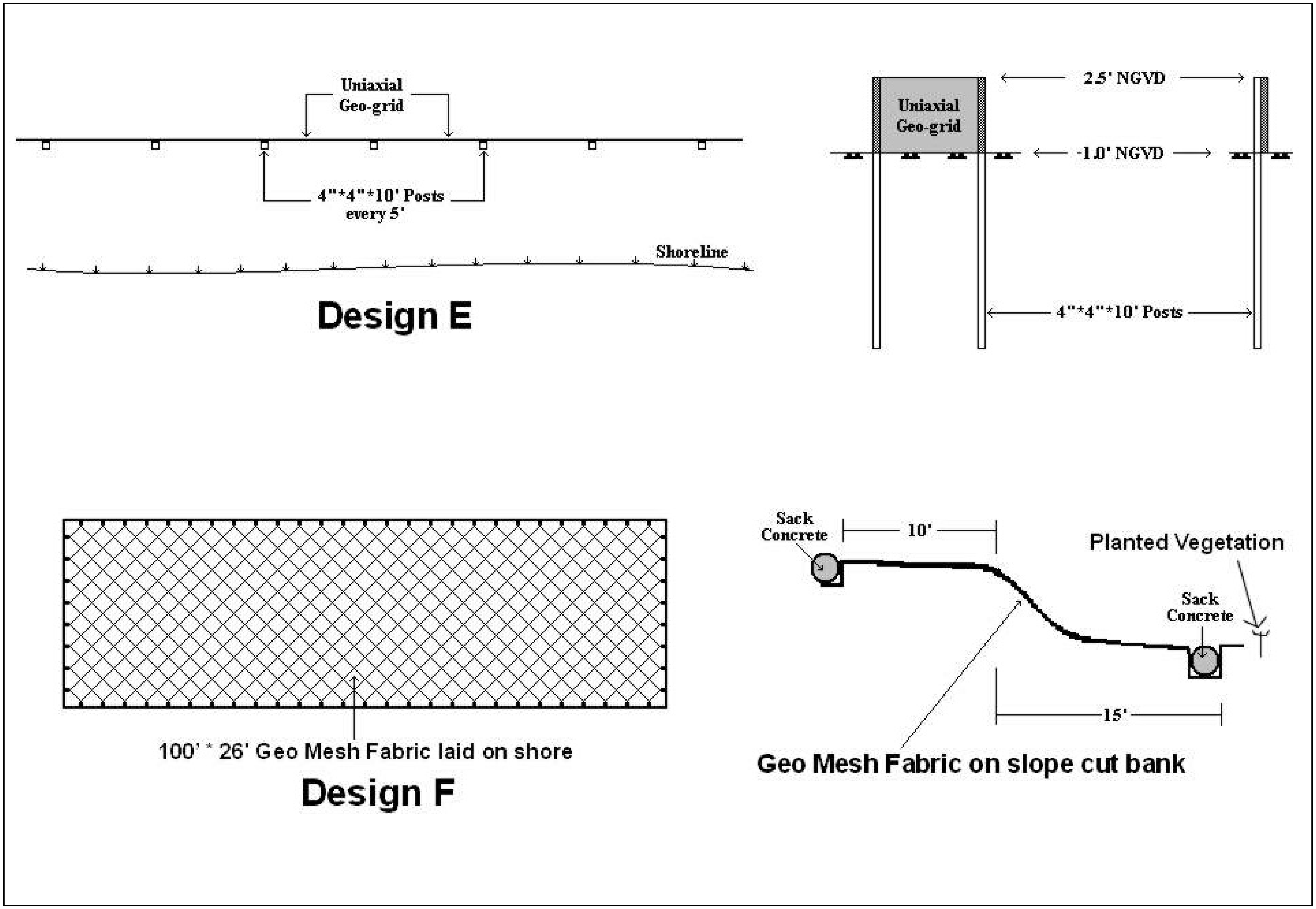
Structure Designs



Layout of Shore perpendicular, four section and five section double sided wooden A-frame (treatments 1 and 8) structure. Layout of shore-parallel, single sided wooded A-frame (treatment 7) structure for the Falgout Canal - Vegetative Planting Demonstration Project (TE-17).



Layout of Shore-perpendicular, four and five section uniaxial geo-grid fence with flared end (treatments 2 and 6) structures and Shore-perpendicular, four and five section uniaxial geo-grid fence (treatments 4 and 9) structures for the Falgout Canal - Vegetative Planting Demonstration Project (TE-17).



Layout of Shore-parallel, uniaxial geo-grid fence (treatment 5) structure and Geo mesh Fabric laid on shore (treatment 3) structure for the Falgout Canal - Vegetative Planting Demonstration Project (TE-17).