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For the period April 01, 1994 to December 31, 2000

WEST HACKBERY PLANTINGS AND SEDIMENT ENHANCEMENT
CS-19

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

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ACKNOWLEDGMENTS

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ABSTRACT

The West Hackberry Plantings and Sediment Enhancement project (CS-19) is located within Cameron Parish, about 6 mi (9.7 km) west of Hackberry, Louisiana. The project objectives are to restore, protect, and enhance about 300 ac (120 ha) of inland wetlands by using *Scirpus californicus* (California bulrush) plantings to reduce wind-driven wave erosion of marsh shorelines, and using hay-bale fence enclosures to increase sediment deposition in ponds. Ponds in the project area range approximately one to three ft (0.3-0.9 m) deep. In April 1994, 6,000 linear ft (1,829 m) of hay-bale fencing were installed. In June 1994, approximately 4,750 trade-gallon-size plantings of *S. californicus* were installed along 11,875 linear ft (3,620 m) of shoreline.

Hay bales initially installed in the fences disintegrated within three months; a second set of hay bales installed in the fences disintegrated within two weeks. It was therefore concluded that hay bales could not reduce erosion and increase sediment deposition at this site, therefore measurements were discontinued. Decomposition of the hay and wave energy, appeared to have prevented the hay from remaining in the fence enclosures. This suggests that hay bales are not a suitable material for enhancing sediment deposition in ponds.

Scirpus californicus plantings were initially successful, creating 4.3 ac (1.7 ha) of emergent wetland, but due to droughts in 1996 and 1999/2000 only 1.2 ac (0.5 ha) survived. Water salinity in the area rarely fell below 20 ppt for six weeks during the drought of 1996, and averaged 15 - 20 ppt for one year during the drought of 1999/2000. Prolonged exposure to these extreme conditions probably exceeded the salinity tolerance of *S. californicus*. Plantings that have survived the droughts did show a gain in lateral spread but have become brown in appearance and are beginning to show signs of thinning within the plots. This suggests that once the plantings become established in a new environment they can survive through moderate periods of saline and drought conditions and show an increase in lateral spread even under adverse conditions. Planting *S. californicus* is therefore still considered a viable restoration tool.

INTRODUCTION

Coastal navigation channels have played a major role in wetland loss. The losses resulting from channels are categorized as either primary losses (i.e., those resulting directly from construction) or secondary losses (i.e., those long term losses induced by the presence of channels). Primary losses include the impacts resulting from the excavation of the channel and the placement of the resulting dredge material, while secondary wetland losses are caused by 1) hydrologic modifications resulting from the channel (e.g., saltwater intrusion and disruption of natural sheet flow) and 2) erosion of the channel bank resulting from vessel-generated wave wash (Good et al. 1995).

Navigation channels have caused marsh loss near Hackberry, Louisiana, primarily via secondary mechanisms. Kelso Bayou was historically the only passageway for water exchange between Black Lake and the surrounding marshes. Construction of the Alkali Ditch, Gulf Intracoastal Waterway (GIWW), and the Calcasieu Ship Channel increased the number of passageways to Black Lake. The West Cove Canal, located in the Sabine National Wildlife Refuge, has a direct link to the Calcasieu Ship Channel. This canal, which houses the Hog Island Gully structure, is also a major factor in contributing saltwater into the West Hackberry Plantings project area. This increase in exchange points has resulted in 1) increased salinity, 2) increased water fluctuations, 3) increased opportunities for saltwater intrusion, and 4) increased tidal scouring and erosion (NRCS 1993).

The West Hackberry Plantings and Sediment Enhancement project (CS-19) is located within the Rycade Canal Marsh Management project (CS-02) area (figure 1). Shoreline erosion has created vast expanses of shallow open water which in turn allows wind induced erosion along the remaining shorelines. Land to water ratio was 1:3.8 just prior to construction (figure 2). Ponds within the project area are approximately one to three ft (0.3-0.9m) deep. In order to test and demonstrate their ability to deter further erosion, approximately 4,750 trade-gallon-size plantings of *Scirpus californicus* (California bulrush) were installed in approximately 1.5 - 2.5 feet of water, parallel to 11,875 ft (3,620 m) of shoreline. Hay-bale fencing was constructed in approximately 2.0 - 2.5 feet of water, parallel to another 6,000 ft (1,829 m) of shoreline.

The project objectives are to restore, protect, and enhance about 300 ac (120 ha) of inland wetlands by using vegetation plantings to minimize wetland erosion, and hay-bale fences to encourage sediment deposition.

The following specific goals will contribute to the evaluation of these objectives:

1. Reduce wind-driven wave erosion of marsh shorelines using *S. californicus* plantings.

2. Increase sediment deposition adjacent to hay-bale fences.

3. Increase the amount of emergent and submersed aquatic vegetation.

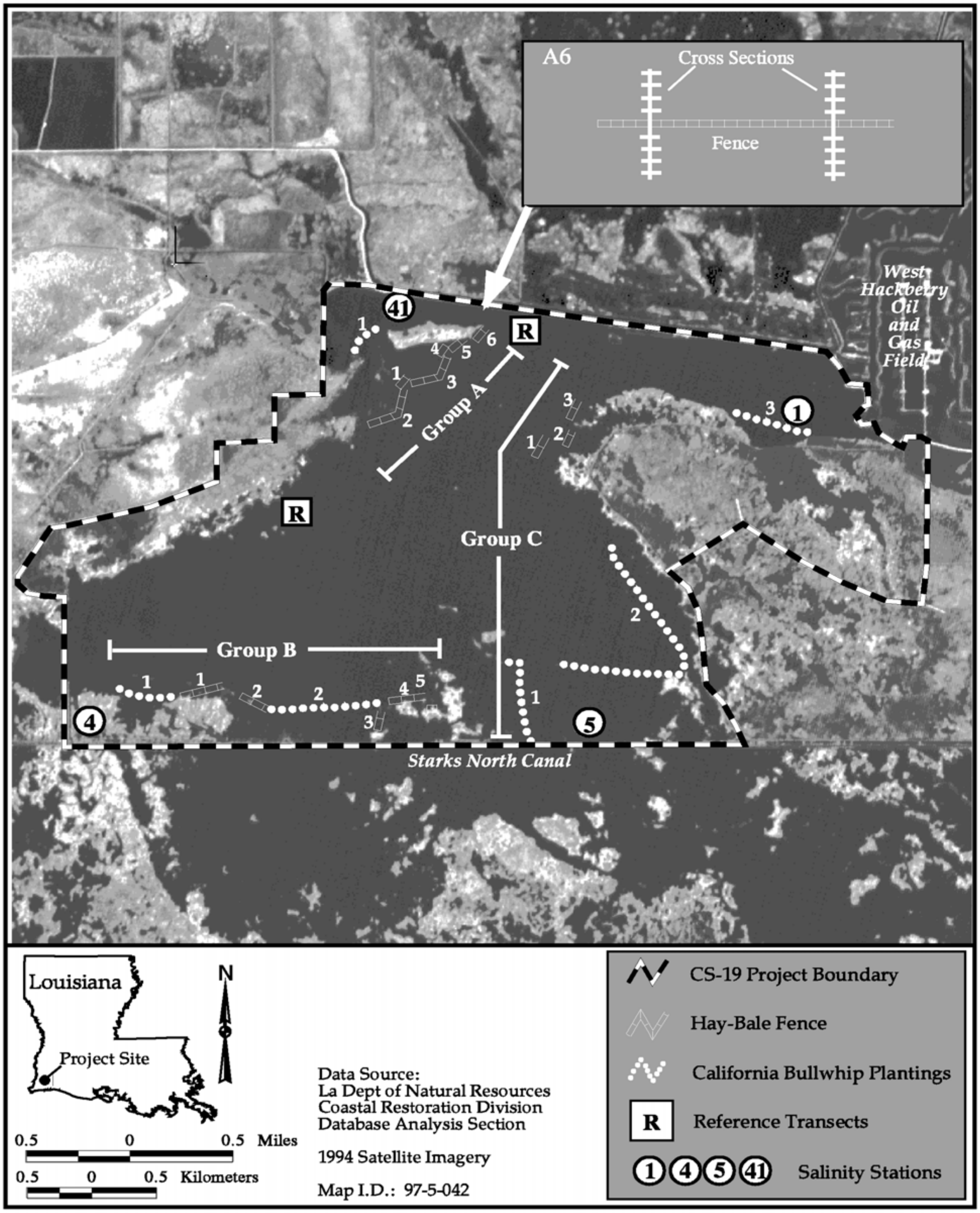

Figure 1. West Hackberry Plantings and Sediment Enhancement (CS-19) project area showing locations of restoration features and a typical cross-section elevation survey within Group A.

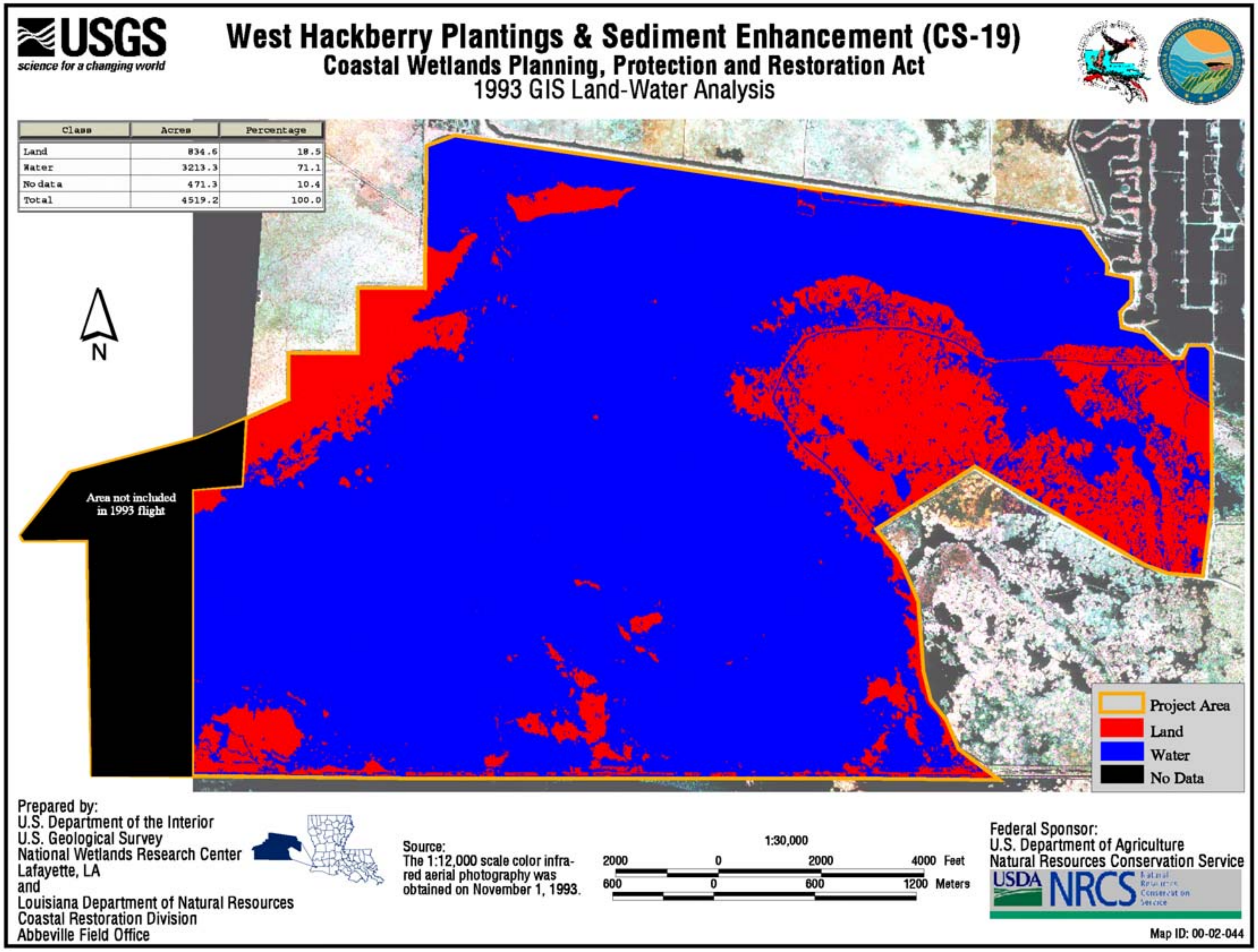

Figure 2. 1:12,000 scale near-vertical color infrared aerial photography depicting 1993 GIS land to water analysis within the (CS-19) West Hackberry Vegetative Plantings project area.

METHODS

A detailed description of the monitoring design over the entire project life can be found in Miller (1998).

Aerial Photography:

The National Wetlands Research Center (NWRC) in Lafayette, Louisiana, obtained 1:12,000 scale near-vertical color infrared aerial photography of the project area on November 1, 1993 (preconstruction), and again on November 23, 1997 (postconstruction). Upon completion of the flight, the photography was checked for flight accuracy, color correctness, and cloudiness. The duplicate photography was prepared for scanning and analysis. The original film was archived at the NWRC.

A digital TIFF file with a resolution of 1.016 m per pixel was created from scanning the photography. Using ERDAS Imagine, a geographic information system (GIS), and optimal global positioning system (GPS) points collected in the field, the photography was georeferenced, mosaicked, and used to generate a base map. The photomosaic was then classified according to pixel value and analyzed to determine land to water ratios in the project area. All areas characterized by emergent vegetation, scrub shrubs, and forests were classified as land, while open water, aquatic beds, and mud flats were classified as water. An accuracy assessment comparing the GIS classification of 100 randomly chosen pixels to aerial photography resulted in overall classification accuracy of 98.5%. Each of these steps was completed according to the standard operating procedure described in Steyer et al. (1995).

Hay-bale Fences:

In May and June 1994, six hay-bale fences were randomly selected and tagged for elevational transect surveys and two reference sites were located and marked. Shoreline markers were deployed along two sections of shoreline to be surveyed, one west of fence A6, and one southwest of the Group A fences (figure 1). In August 1994, a professional cross-sectional survey by Pyburn & Odom Inc. was conducted across selected hay-bale fences and two reference sites. In addition, the two sections of shoreline on which the shoreline markers were installed were surveyed using a Global Positioning System (GPS) to record the current position.

Sediment deposition and the occurrence of submersed aquatic vegetation (SAV) along the hay-bale fences were monitored along 16 transects established across and perpendicular to a sub-sample of 6 fences (A2, A6, B3, B4, C2, and C3). A typical cross section transect at station A6 can be seen in figure 1. For use as a reference, two additional transects were established in open water away from the fences, one north of fence A6 and one south of the Group A fences (figure 1).

Vegetation Planting Survival:

In July 1994, sampling plots were randomly selected and delineated for use in vegetation monitoring. A 5% sample of the vegetation plantings, consisting of 16 randomly selected plots of 16 plants (8 plants on each of 2 rows) was monitored for survivorship (percent survival), species composition, and percent cover in August 1994, February 1995, July 1995, October 1996, July

1997 and August 1999. A list of the monitoring data collected can be found in the appendix (table A1). Monitoring in October 1996 (month 27) was not initially planned (Louisiana Department of Natural Resources [LDNR] 1995), but was conducted to evaluate the effects of drought on planting survival.

Planting survival was evaluated in terms of four variables (Harper 1977), which are defined and calculated as follows:

$$\text{survival frequency} = \text{number of live plants inside plot at timepoint } x$$

$$\text{survivorship } (l_x) = \text{probability (at planting time) of surviving until age } x = \frac{\text{no. live plants inside plot at timepoint } x}{\text{original no. plants inside plot}}$$

$$\text{mortality } (d_x) = \text{probability (at planting time) of dying during age interval } x, x+1 = l_x - l_{x+1}$$

$$\text{mortality rate } (q_x) = \text{probability of a planting at age } x \text{ dying before the age of } x+1 = \frac{l_x - l_{x+1}}{l_x} = \frac{d_x}{l_x}$$

Vegetation Planting Cover:
Cover was initially measured in 1 m^2 sub-plots centered around one corner plant within each 16-plant sampling plot. By 6 mo postplanting, however, the selected corner plants for vegetation sampling plots B2 ! 4, C1 ! 3, and C2 ! 2 were absent. To overcome this problem, percent cover was subsequently recorded for each entire 16-plant sampling plot, rather than for only the 1 m^2 sub-sample plots. The 16-plant sampling plots averaged 40 ft (12.2 m) long and 35 ft (10.7 m) wide.

A two-way analysis of variance (ANOVA) with repeated measures was performed on the percent cover data to evaluate changes in percent cover among the five monitoring periods (0 to 1 mo, 1 to 6 mo, 6 to 12 mo, 12 to 36 mo and 36 to 60 mo postplanting) and among the experimental units. ANOVA was also used to test for differences in survivorship among time periods and planting groups. When the ANOVA was significant, Least Square Means (LSM) multiple comparisons were used to determine between which groups there were significant differences. Test results were considered significant at $p \leq 0.05$.

Salinity:
The effect of water salinity on planting success was evaluated using salinity data collected in the Rycade Canal (CS-02) project area, which surrounds the West Hackberry Plantings site. Pre-construction (September 1993 to June 1994) and postconstruction (July 1994 to September 1995 and September 1999 to October 2000) water salinity data from the Rycade Canal (CS-02) project, were analyzed and compared to the statistical analysis of the CS-19 data to determine its effect on planting success.

RESULTS

Aerial Photography:
When the 1993 (preconstruction) aerial photography was taken, the designated project area consisted of 834.6 acres (337.8 ha) of land and 3,213.3 acres (1,300.4 ha) of open water (figure 2). Because the project area was subsequently enlarged, the 1997 postconstruction photography consisted of 1,059.1 acres (428.6 ha) of land and 3,460.1 acres (1,400.3 ha) of open water (figure 3). In order to perform the 1993 to1997 change analysis only areas common to both dates of photography were used. The GIS land to water analysis indicates a net gain in land of 7.4 acres (2.96 ha) between 1993 and 1997 (figure 4). The gain in land over this period is presumed to be a direct effect of drought conditions throughout the 1996 water period and is not a result of project effects.

Hay-bale Fences:
Hay bales did not remain intact for very long. By July 1994, the Group A and C hay-bale fences were empty, while some hay remained in the Group B fences. In December 1995, group A, fence A3, was modified and refurbished with hay bales, and fence A2 was refurbished with hay bales wrapped in plastic geogrid fabric. Within two weeks, all of the hay was washed out of the enclosures. In March 1995, the USDA Natural Resources Conservation Service (NRCS) and Cameron Parish installed discarded Christmas trees in fences A3-A6. As of October 23, 1996, about 70% of the Christmas trees remained in the enclosures. Subsequent post-construction surveys have been canceled due to the inability of the fences to hold hay.

The results demonstrated that hay-bale fences are ineffective at abating wave energy as designed and deployed in this environment due to the hay deteriorating rapidly after exposure to water. Once this happened, even minimal wave action caused the hay bales to break apart. However, the treated lumber fences have remained intact. The fences may serve somewhat as wave damping devices, since they do apparently diminish some of the wind generated wave energy adjacent to the structures (figures A1 and A2).

Vegetation Plantings Cover:
The mean percent cover at 1, 6, 12, 36 and 60 mo postplanting was 5.0%, 9.0%, 47.0%, 13.0% and 17.0%, respectively (figure 5). The results of the ANOVA indicate a significant difference ($p \leq 0.05$) in percent cover over time (table 1). Significant differences (" < 0.05) in percent cover occurred between 1 - 12 mo ($p = 0.028$), 6 - 12 mo ($p = 0.005$), 12 - 36 mo ($p = 0.003$) and 12 - 60 mo ($p = 0.005$), respectively. The largest decrease in vegetative cover was noticed after month 12 when high salinity water entered into the project area during the drought of 1996 (figure 5).

Data indicate that *S. californicus* plantings established relatively quickly where salinity did not exceed 8 ppt. After an initial period of establishment, there was a significant increase in percent cover during the first year postplanting (figure 5). Observations at plots B1-1, B2-1, B2-2 and B2-3 for the 36 month sampling period suggest that early establishment and rapid growth may also help to buffer the more vigorous transplants from die-back resulting from extreme environmental conditions, such as high salinity (table A1) .

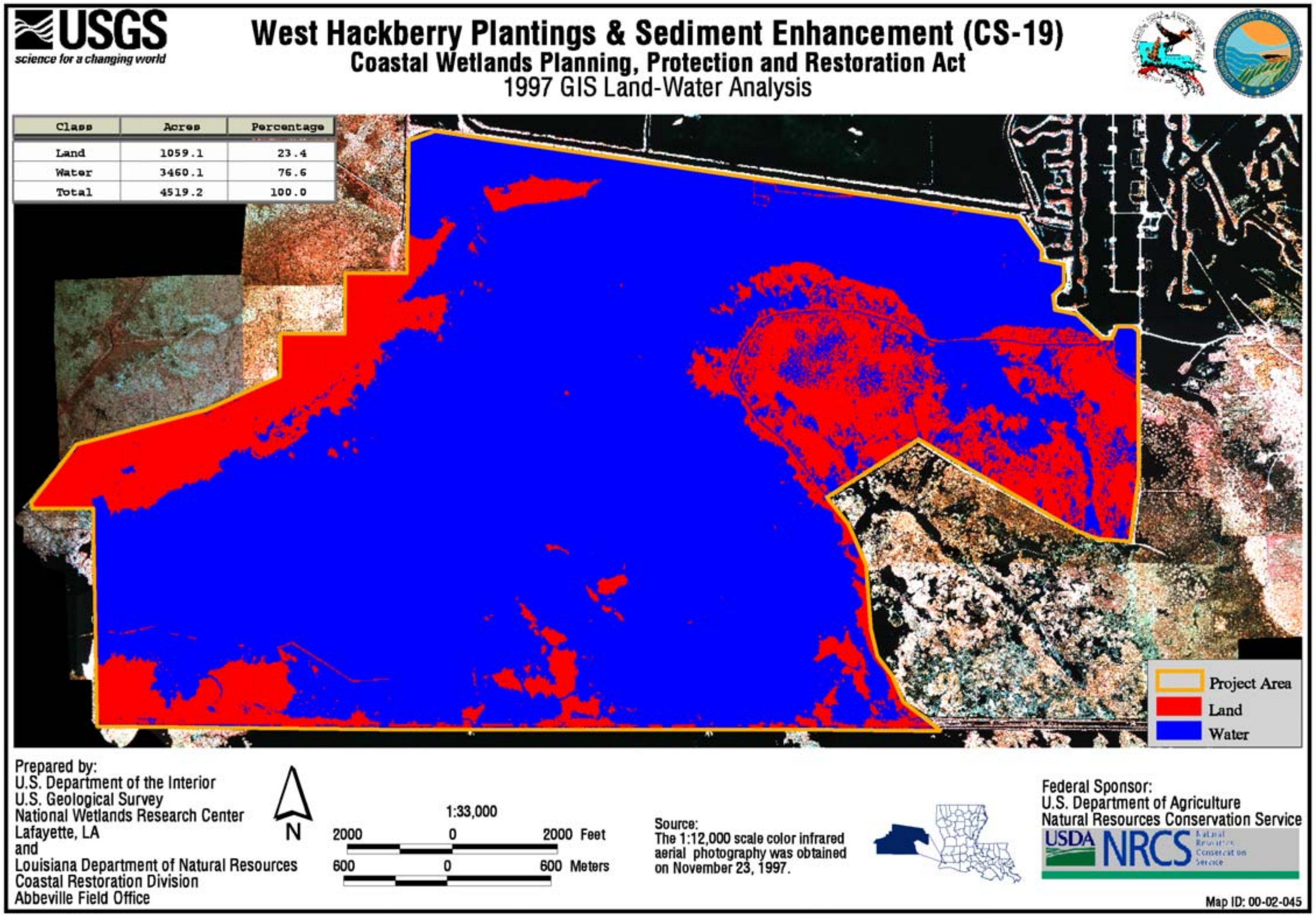

Figure 3. 1:12,000 scale near-vertical color infrared aerial photography depicting 1997 GIS land to water analysis within the (CS-19) West Hackberry Vegetative Plantings project area.

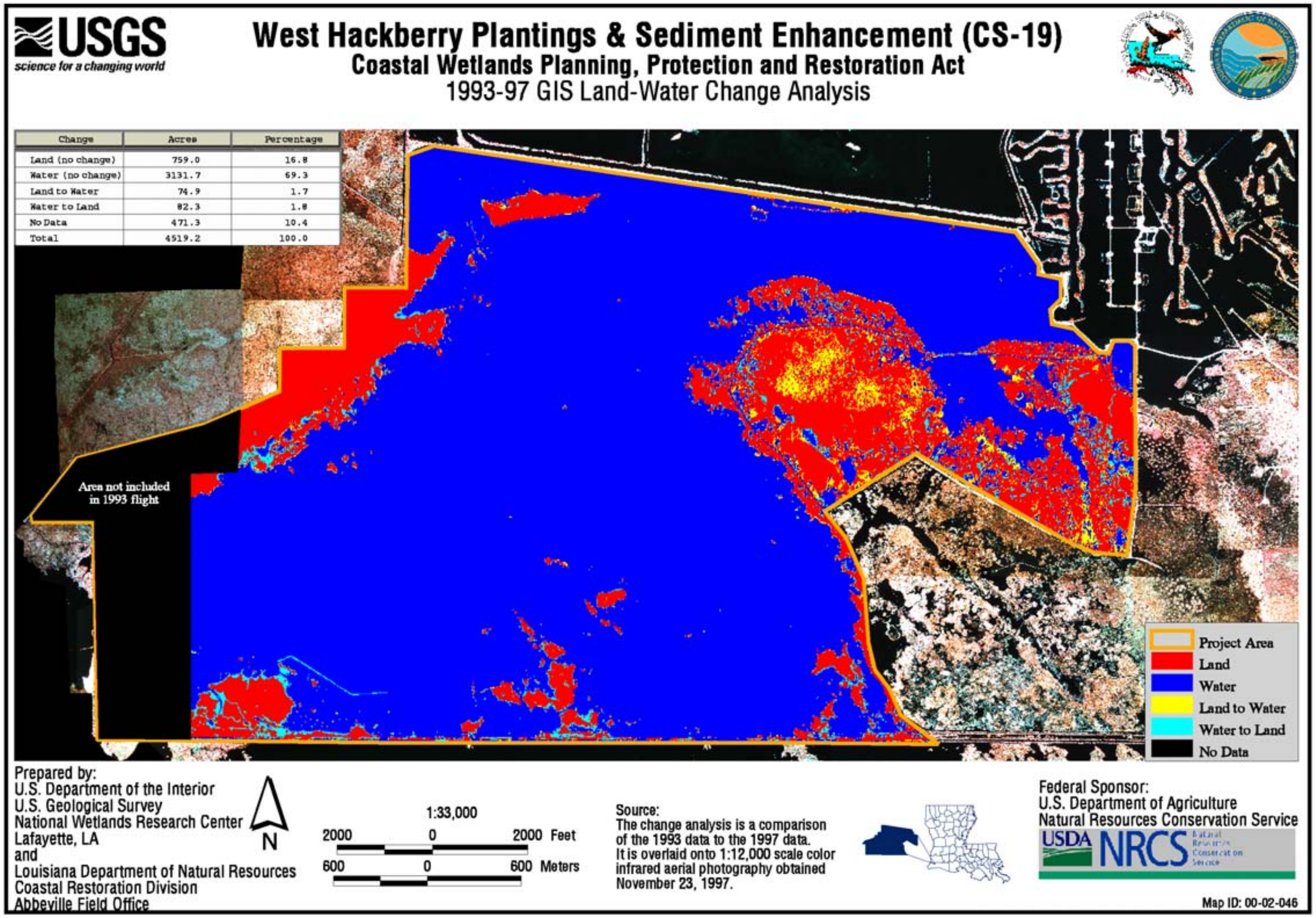

Figure 4. 1:12,000 scale near-vertical color infrared aerial photography depicting 1993 to 1997 land to water changes within the (CS-19) West Hackberry Vegetative Plantings project area.

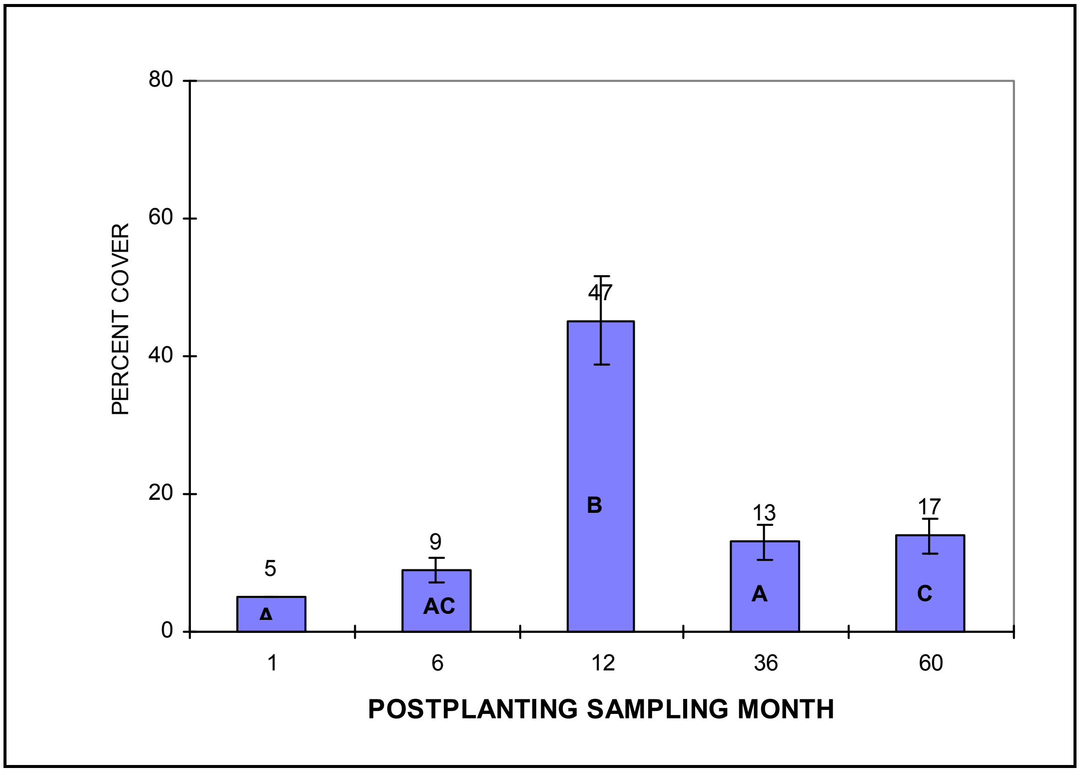

Figure 5. Mean percent cover of *S. californicus* plantings in 16 random sampling plots from August 1994 to August 2000. Plantings observed at 1, 6, 12, 36, and 60 mo postplanting. Similar letters on histogram columns indicate no significant differences among time periods

Table 1. The results of a two-way ANOVA on percent cover of 16 *S. californicus* planting groups, from August 1994 to August 2000, as observed at 1, 6, 12, 36 and 60 mo postplanting.

SOURCE	DF	F-VALUE
Planting Groups	5	2.15 ns
Time	4	14.82 [a]
Planting Groups*Time	20	4.04 ns

ns = not significant; [a] = significant ($p \leq 0.05$).

Vegetation Plantings Survival: Survivorship (percent survival) decreased during the first 36 mo postplanting, averaging 76.0%, 59.0%, 55.0% and 21.0% at 1, 6, 12 and 36 mo postplanting, respectively (figure 6). Survivorship remained at 21.0% through month 60. The results of the ANOVA indicate a significant difference in the survivorship of the planting groups over time (table 2). Least square means multiple comparisons of the survivorship values indicate that there were significant differences between 1 - 6 mo, 1 - 12 mo, 1 - 36 mo, 1 - 60 mo, 6 - 36 mo, 6 - 60 mo, 12 - 36 mo and 12 - 60 mo postplanting (figure 6).

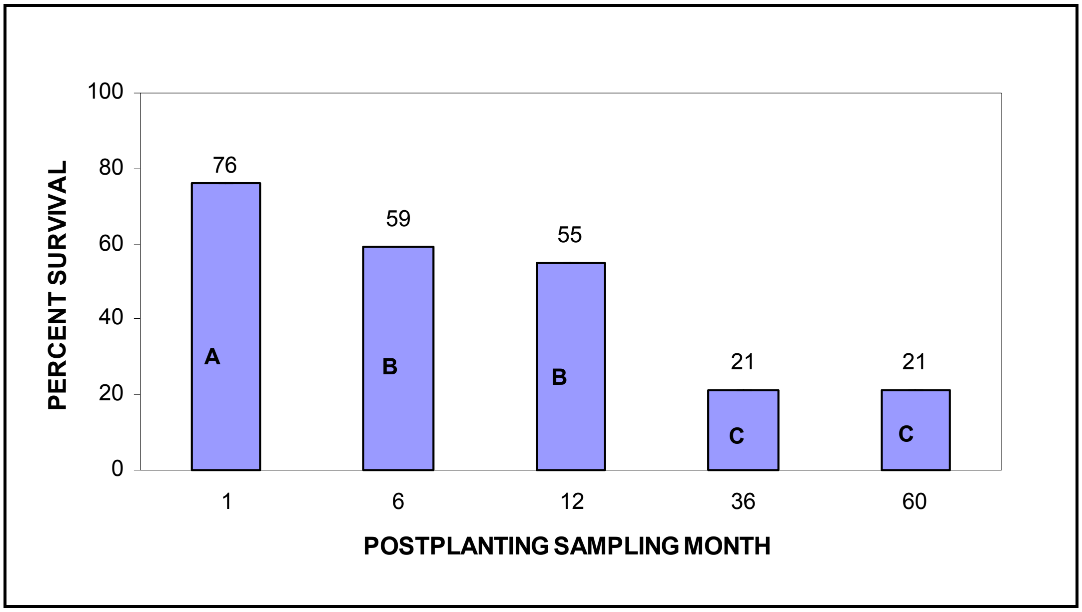

Figure 6. Mean survivorship of *S. californicus* plantings in 16 random sampling plots from August 1994 to August 2000. Plantings observed at 1, 6, 12, 36, and 60 mo postplanting. Similar letters on histogram columns indicate no significant difference among time periods.

Table 2. The results of a two-way ANOVA on survivorship of 16 *S. californicus* planting groups, from August 1994 to August 2000, as observed at 1, 6, 12, 36, and 60 mo postplanting.

SOURCE	DF	F-VALUE
Planting Groups	15	9.64 [a]
Time	4	29.06 [a]

ns = not significant; [a] = significant ($p \leq 0.05$).

Salinity:

Analysis of pre- (September 1993 to June 1994) and postconstruction (July 1994 to August 2000) water salinity data from the Rycade Canal (CS-02) project, which influences salinity in the West Hackberry Plantings project area, indicates that salinity averaged 4.0 ppt in the vicinity of the West Hackberry plantings during that period of record (Weifenbach 1996). *Scirpus californicus* is described as common to intermediate marshes (Chabreck 1972), but the salinity tolerance for *S. californicus* is not documented. Data collected for this project indicate that *S. californicus* plantings can easily tolerate salinity of up to 6.0 ppt for short periods after initially planted, and can tolerate salinity of up to 10.0 ppt after plantings become established. Plantings that survived appear to have been those that were the most vigorous before the 1996 drought, which suggests that larger stands may tolerate higher salinity better than smaller stands. In addition, salinity averaged slightly higher on the eastern half than on the western half of the West Hackberry plantings area for each year, further suggesting that die-back of the plantings was associated with high salinity.

High salinity in the 1996 and 1999-2000 periods resulted from drought conditions in southwest Louisiana from February through July 1996 and September 1999 through June 2000 (Louisiana Office of State Climatology [LOSC] 1996, 1999, 2000). The major factors that influenced these conditions were the below normal precipitation amounts, with the predominant wind direction promoting northward migration of high salinity water for most months (tables 3 and 4). A comparison of discrete monthly salinity for years 1993 through 2000, as recorded at 4 stations in the vicinity of the West Hackberry plantings (figure 1), shows that salinity averaged less than 6 ppt at all four stations for years 1993 through 1995, averaged over 8 ppt at all four stations during 1996 and averaged over 10 ppt from October 1999 to October 2000 (figure 7). Between May and September 1996, salinity averaged 14.4 ppt among the 4 stations within the plantings. Average salinity fails to indicate the extreme salinity that occurred in the project area. Examination of hourly salinity data collected in 1996 and 1999-2000 indicate that salinity rarely fell below 20 ppt for six weeks during the summer of 1996 and ranged from 15 - 27 ppt from October 1999 to November 2000 (figures 8 and 9).

Table 3 Monthly and cumulative climate data from January through September 1996 for the southwestern Louisiana division (Allen, Beauregard, Calcasieu, Cameron, and Jefferson Davis parishes).

Month	Monthly Mean Precipitation (inches)	Cumulative Departure From Normal (inches)	Monthly Palmer Drought Severity Index	Monthly Predominant Wind Directions
Jan	3.33	-1.75	±Normal	S, N, SW, NW
Feb	1.51	-4.41	Mild	SW, S, N, NE
Mar	1.58	-6.97	Mild	S, SW, NW, N
Apr	3.22	-7.54	Mild	S, SW, SE
May	1.38	-11.52[a]	Moderate	S, SW, SE
Jun	6.01	-10.75	Mild	S, SW, SE
Jul	4.98	-11.81	Moderate	SW, SE
Aug	8.77	-8.89	±Normal	NE, E, SE, S
Sep	7.33	-6.77	Moist Spell	NE, E, SE, S, N

Source: Compiled with data from Louisiana Office of State Climatology (1996).
[a] *Indicates highest May departure on record for the southwestern Louisiana division.*

Table 4. Monthly and cumulative climate data from September 1999 through June 2000 for the southwestern Louisiana division (Allen, Beauregard, Calcasieu, Cameron, and Jefferson Davis parishes).

Month	Monthly Mean Precipitation (inches)	Cumulative Departure From Normal (inches)	Monthly Palmer Drought Severity Index	Monthly Predominant Wind Directions
Sep	4.07	-7.54	Mild	NNE, NE, N, SE
Oct	1.99	-9.46	Mild	NNE, NE, N, SE
Nov	1.00	-12.69	Moderate	NNE, SE,
Dec	4.61	-13.75	Moderate	NNW, SSE, S
Jan	1.26	-3.82	Moderate	n/a
Feb	.80	-7.19	Severe	n/a
Mar	2.42	-8.91	Severe	n/a
Apr	3.58	-9.09	Severe	n/a
May	6.58	-8.15	Severe	n/a
Jun	5.44	-8.35	Moderate	n/a

Source: Compiled with data from Louisiana Office of State Climatology (1996).
n/a = No longer available.

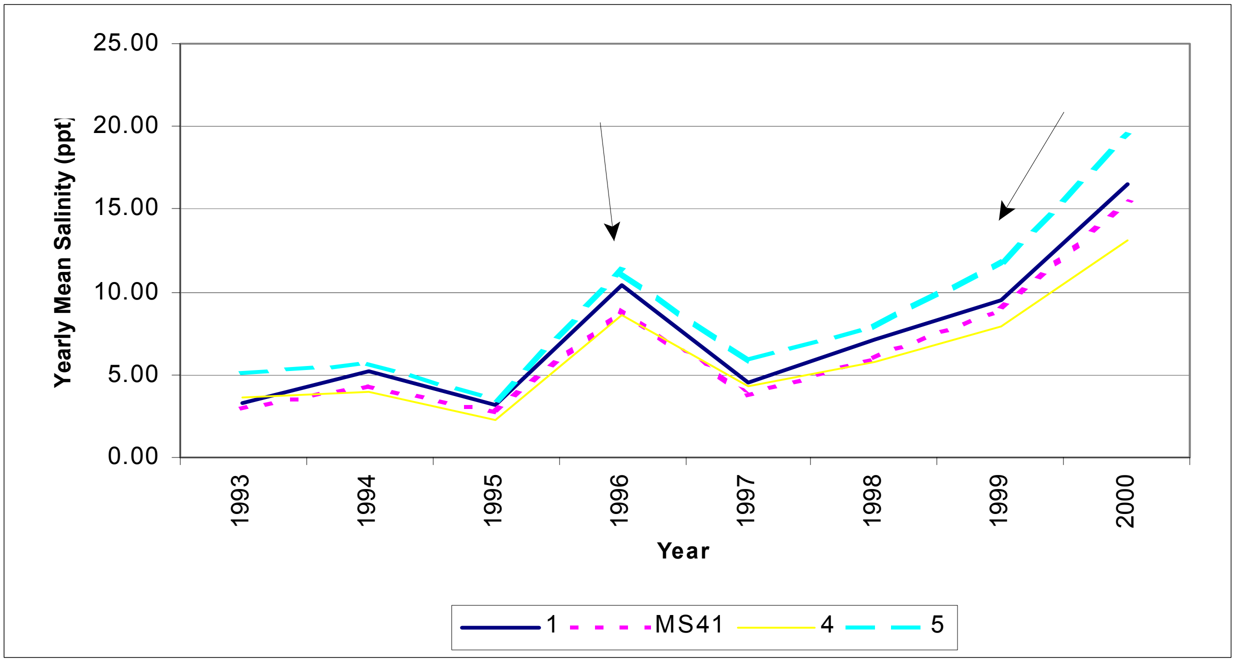

Figure 7. Yearly mean discrete salinity averages in the West Hackberry Planting project area at stations 1, MS41, 4 and 5 depicting salinity ranges for years 1993 to 2000. (Based on monthly and bimonthly discrete data collected by LDNR/CRD personnel for the Rycade Canal [CS-02] project.)

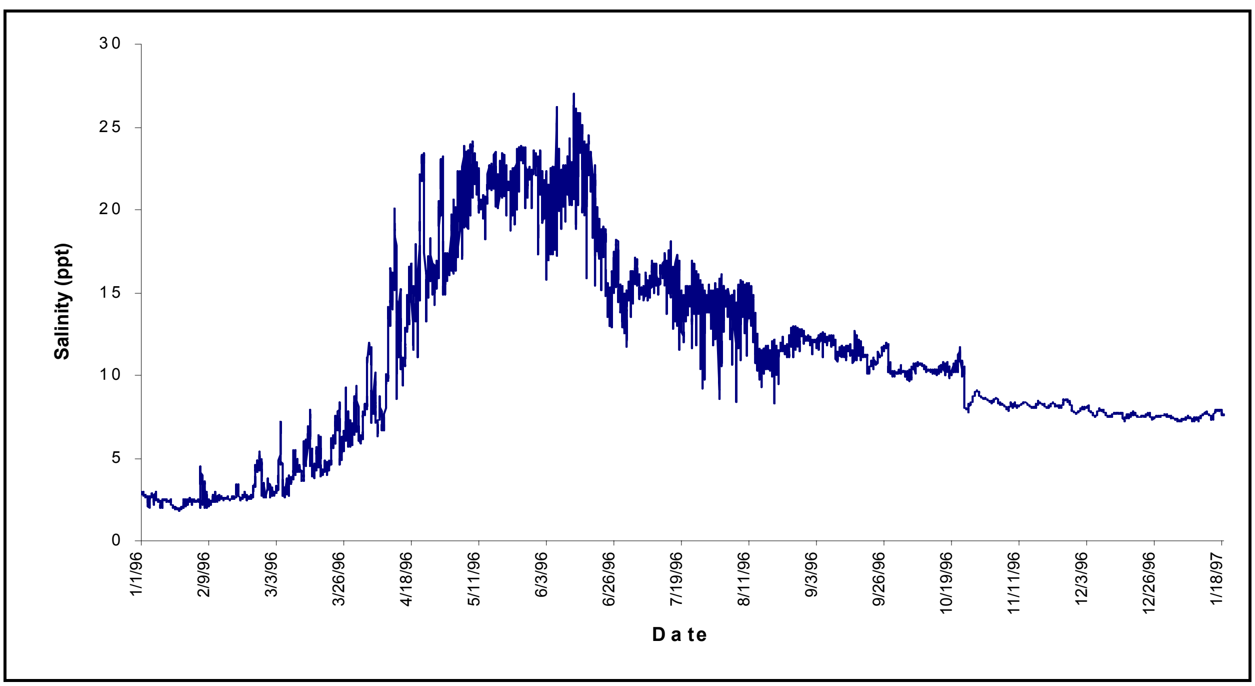

Figure 8. Continuous recorder salinity data collected from station 5 within the West Hackberry Plantings (CS-19) project area from January 1, 1996 to January 14, 1997.

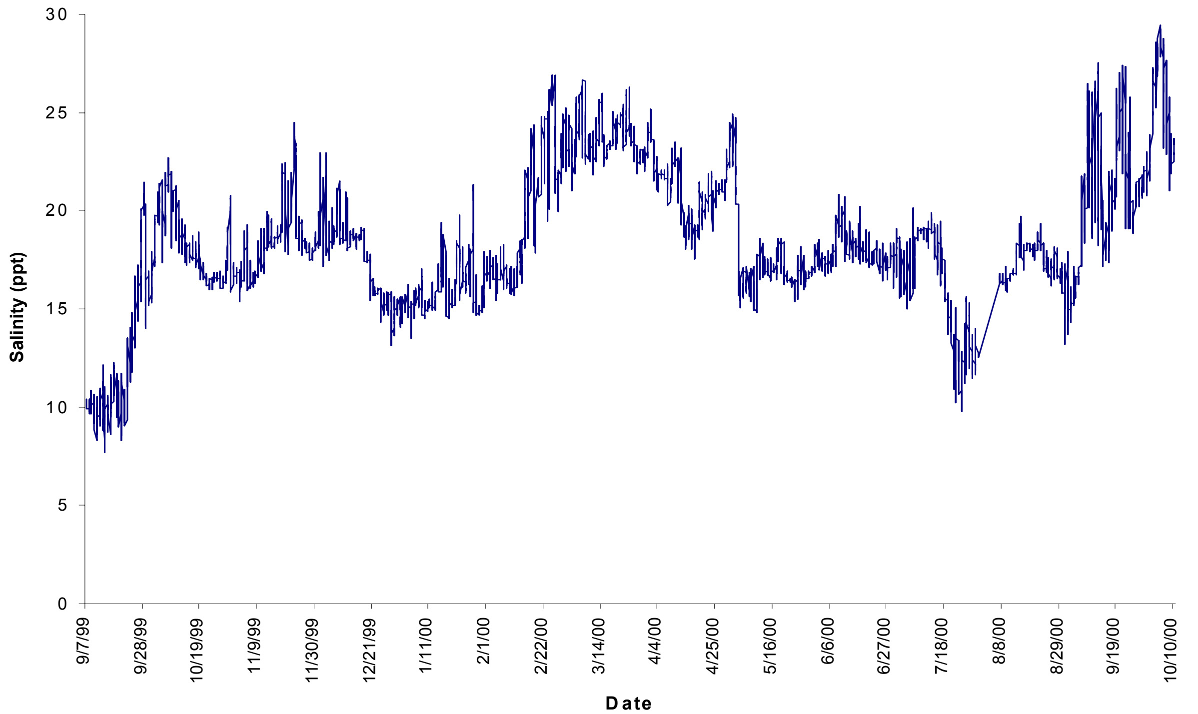

Figure 9. Continuous recorder water salinity data collected from station 5 within the West Hackberry Plantings (CS-19) project area from September 7, 1999 to October 10, 2000.

DISCUSSION

<u>Aerial Photography</u>:
The photo acquisition plans for the 1993 (preconstruction) aerial photography were acquired according to the original monitoring plan and approved by the LDNR. After the 1993 photography had been acquired, a boundary change occurred due to a decision between LDNR and NRCS, which resulted in a westward expansion of the original boundary by 471.3 acres (190.7 ha). As a result, only 4,047.9 acres (1,638.1 ha) of the project area are available for the change analysis between the 1993 and 1997 photography. Figure 4 shows the aerial extent of the available preconstruction photography. Postconstruction photography encompasses the entire project area.

<u>Hay-bale fences</u>:
This project has shown that hay bales will not remain intact for prolonged periods of time while submerged under water. Modifications to the twine used for wrapping the hay were also nullified after the hay bales broke up within weeks after the second attempt. Hay deteriorates rapidly after exposure to water, thus causing the hay bales to break apart regardless of the wrapping techniques used.

While the hay bales proved to be unsuitable, the fences used to accommodate the hay bales remained intact and are still unaltered. Due to large spaces between the boards parallel to the water line and the fences being placed up to 100 ft (30.5 m) from the shoreline, wave erosion still occurs but possibly at a slower rate. No data have been collected to determine shoreline erosion rates behind the fences. Minimal calming has been observed periodically.

Vegetation plantings survival:
Before the 1996 drought, all mature stems on the plantings were noticed to be dark green in appearance and the greatest percent cover was recorded. After the drought, nearly all of the mature stems on the plantings were brown and appeared to be dead, and most of the remaining transplants did not bear obvious young, green shoots. However, the plantings were growing in approximately 2 ft (0.6 m) of turbid water, and it is likely that any additional new growth was submerged and was not apparent. The planting rows on the east side of the planting area showed the greatest impact. Vigorous growth of the transplants has developed only on the south end of planting row A1, and on rows B1 and B2 (figures A3 to A10).

In October 1996, only four of the 16 established sampling plots included growth so vigorous that the individual transplants were indistinguishable. Of the remaining 12 plots, two plots contained only two live plants, three plots were not inspected due to missing corner poles, and all remaining plots were either devoid of vegetation or appeared to be dead. Observations suggest that significant decreases in survivorship occurred during the 12 - 60 mo period (table A1).

In July 1997 and August 1999, nearly all of the plantings within the planting area were missing, except for 4 plots located within group B. The plantings within group B were brown in appearance although individual plantings could not be distinguished. The overall percent cover of the plantings within group B was 45 % and the remaining 12 vegetation plots did not contain any plantings. Overall mean survival within the entire 16 plots was 25.0%. The plots with the highest survival rates are in the western-most part of the project area, which is the least saline part of the planting areas. Recovery of the vegetative plantings from the drought of 1996 to the drought of 1999-2000 has been minimal and future rejuvenation of the plantings is not expected. Vegetative clippings of seed heads from the remaining 25% of the plantings were collected by the NRCS to examine the vigor of those plantings in other brackish environments inside of the coastal zone.

CONCLUSION

The results presented in this report have shown that hay bales cannot be used in a high wave energy system as the bales deteriorate rapidly and wash out of the fence enclosures. Future use of hay bales to control shoreline erosion is not recommended. The fences, constructed of treated lumber, have remained intact and secondarily may serve somewhat as wave damping devices when the fences are within near proximity of the shoreline.

Vegetative plantings of *S. californicus* are not likely to persist in a brackish environment where salinity exceeds 8-10 ppt for extended periods of time. It has been shown that once *S. californicus* plantings become established, at least some individual plantings can withstand salinity higher than once thought possible. This suggests that once the plantings become established in a new environment some can survive through moderate periods of saline and drought conditions. Although *S. californicus* plantings cannot thrive in a brackish environment, at least some individuals can survive under adverse conditions that occur for a limited time period.

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APPENDIX

Vegetation Data
Vegetation Photos

Table A1. Survivorship (percent survival) of *S. californicus* plantings in 16-plant sampling plots, and percent cover in associated 1 m^2 subsample plots, from August 1994 to August 1999, as observed at 1mo, 6 mo, 12 mo, 36 mo and 60 mo postplanting. Mean values are for all sampling plots (n = 16) and associated subsample plots.

Plot	1 Month		6 Months		12 Months		36 months		60 months	
	% Survival (entire plot)	% Cover (1 m^2 plot)	% Survival (entire plot)	% Cover (1 m^2 plot)	% Survival (entire plot)	% Cover (1 m^2 plot)	% Survival (entire plot)	% Cover (1 m^2 plot)	% Survival (entire plot)	%Cover (1 m^2 plot)
A1!1	88	5	50	5	50	2	0	0	0	0
B1!1	75	5	69	20	69	100	100	35	100	60
B2!1	75	5	75	18	75	100	100	70	100	70
B2!2	94	5	94	15	94	100	100	60	100	60
B2!3	100	5	94	5	94	100	100	40	100	35
B2!4	94	5	75	[a]	63	[a]	0	0	0	0
C1!1	75	5	31	3	19	3	0	0	0	0
C1!2	94	5	69	3	63	3	0	0	0	0
C1!3	38	5	38	[a]	25	[a]	0	0	0	0
C2!1	38	5	0	0	0	0	0	0	0	0
C2!2	56	5	25	[a]	19	[a]	0	0	0	0
C2!3	63	5	50	10	44	50	0	0	0	0
C2!4	94	5	81	10	81	100	0	0	0	0
C2!5	94	5	75	40	75	100	6	5	0	0
C3!1	69	5	50	5	50	25	0	0	0	0
C3!2	88	5	69	10	69	40	0	0	0	0
Mean	77.19	5.00	59.06	9.00	55.63	45.19	25.38	13.13	25.00	14.06

[a] Corner plant used to estimate percent cover in this associated 1m^2 plot was dead or absent at 6 and 12 mo postplanting.

Figure A1. Group C hay-bale fence within the CS-19 project area showing wave damping as a secondary benefit once the hay bales deteriorated.

Figure A2. Group B hay bale fencing within the CS-19 project area showing wave damping ability and distance from shoreline the fences were constructed.

Figure A3. Row A1 vegetative plantings within the CS-19 project area for the 1995 monitoring period.

Figure A4. Row A1 vegetative plantings within the CS-19 project area for the 1996 monitoring period.

Figure A5. Row A1 vegetative plantings within the CS-19 project area for the 1997 monitoring period.

Figure A6. Row A1 vegetative plantings within the CS-19 project area for the 1999 monitoring period.

Figure A7. Row B2 vegetative plantings within the CS-19 project area for the 1995 monitoring period.

Figure A8. Row B2 vegetative plantings within the CS-19 project area for the 1996 monitoring period.

Figure A9. Row B2 vegetative plantings within the CS-19 project area for the 1997 monitoring period.

Figure A10. Row B2 vegetative plantings within the CS-19 project area for the 1999 monitoring period.

Figure A11. Row C3 vegetative plantings within the CS-19 project area for the 1995 monitoring period.

Figure A12. Row C3 vegetative plantings within the CS-19 project area for the 1996 monitoring period.

Figure A13. Row C3 vegetative plantings within the CS-19 project area for the 1997 monitoring period.

Figure A14. Row C3 vegetative plantings within the CS-19 project area for the 1999 monitoring period.