WEST HACKBERRY PLANTINGS AND SEDIMENT ENHANCEMENT (C/S-19)
C/S-19-MSPR-0696-2
PROGRESS REPORT NO. 2
for the period
June 29, 1994 to June 17, 1996

Project Status

The following data collection and analysis activities have been conducted since the previous progress report.

Vegetative Plantings: No new vegetative planting data have been collected since the previous progress report (LDNR 1995). However, several statistical analyses have been performed on the data presented in progress report no.1, indicating a significant decrease in mortality of California bullwhip (*Scirpus californicus*) plantings between 6 and 12 mo, as compared with the mortality rate between 0 and 1 mo.

The original monitoring design (LDNR 1995) indicated that estimates of percent cover of the plantings would be made from a 1 m^2 subsample plot centered around a corner plant within each 16-plant sampling plot. Because the selected corner plants for sampling plots B2–4, C1–3, C2–1, and C2–2 were absent by 6 mo postplanting, future data sets will be collected using a revised method that involves estimating percent cover for each entire 16-plant sampling plot.

Project Description

The project, located about 6 mi west of Hackberry, Louisiana, was designed to evaluate the ability of vegetative plantings and hay-bale fences to abate wind-driven erosion along various shorelines in a deteriorated marsh. In April 1994, installation of 6,000 linear ft of hay-bale fencing was completed. In June 1994, approximately 4,750 trade-gallon-size plantings of California bullwhip were installed. The fences and plantings were installed in three groups (A, B, and C) along the eastern, western, and southern shorelines of a large, shallow, interior marsh pond, using different configurations of fences and plantings (figure 1). The fences are either straight or "V-shaped" segments constructed parallel to shorelines. The California bullwhip transplants were planted in two parallel rows on 5-ft centers, with the rows running parallel to adjacent shorelines.

The specific project objectives are to restore, protect, and enhance about 300 acres of inland wetlands by using vegetation plantings to minimize wetland erosion, and hay-bale fences to encourage sediment deposition. The specific goals are to reduce wind-driven wave erosion of marsh shorelines using California bullwhip plantings, increase sediment deposition adjacent to hay-bale fences, and increase the amount of emergent and submersed aquatic vegetation.

Monitoring Design

Color-infrared aerial photography was taken once preconstruction in November 1993, and will be taken at year 3 postconstruction, for use in documenting shoreline movement and determining ratios of vegetated-to-nonvegetated areas. Shoreline markers were installed at 100-ft intervals along shorelines west of Group A, fences 5 and 6, and in a reference area just to the south of Group A. The positions of these shoreline segments were surveyed in August 1994, and they will be resurveyed at years 3, 5, and 10 postconstruction to evaluate shoreline movement.

A 5% sample of the vegetation plantings, consisting of 16 randomly selected plots of 16 plants (8 plants on each of 2 rows) were monitored for survivorship (percent survival), species composition, and percent cover at 1, 6, and 12 mo postplanting. Monitoring of these variables in the sampling plots will be repeated at years 3, 5, and 10.

In August 1994, sediment deposition along the hay-bale fences was monitored along 18 transects established across and perpendicular to a subsample of 6 of the fences, and in a reference area away from the fences. Subsequent surveys are planned for postconstruction years 3, 5, and 10.

In addition, the effect of salinity levels on planting success is being evaluated using salinity data collected from an adjacent restoration project at Rycade Canal.

A two-way analysis of variance (ANOVA) with repeated measures was performed on the vegetation planting data. The mortality rate during the three consecutive time intervals (0 to 1 mo, 1 to 6 mo, and 6 to 12 mo postplanting, respectively) was analyzed to measure the changes in mortality rate among the three monitoring periods and among four sampling groups. Since the values of the original data ranged from 0 to 1 and did not conform to a normal distribution, all data were transformed by logistic transformation using the formula $\log_e[(1+X)/X]$, where X = original data + 0.000001.

Results/Discussion

Hay-bale fences: In May and June 1994, hay-bale fences were selected and tagged for elevational transect surveys, the reference sites were located and marked, and the shoreline markers were deployed along the sections of shoreline to be surveyed. In July 1994, elevation transects were surveyed across selected hay-bale fences and the reference site (figure 2). Typical elevation profiles

are provided in figures 3 and 4. In addition, two sections of shoreline were surveyed to record the current position.

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 1994, an attempt was made to remedy this problem when 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 Natural Resource Conservation Service and Cameron Parish installed discarded Christmas trees in fences A3-A6. As of 26 July 1995, about 73% of the Christmas trees had remained intact in the enclosures. The next elevational transect survey is scheduled for July 1997.

The results to date suggest that hay-bale fences are ineffective at abating wave energy as designed and deployed in this environment, because the wave action causes the hay bales to break apart. The use of hay bales consisting of longer lengths of straw, in combination with a wrapping of smaller mesh geogrid fabric may have been effective in more protected locations, such as the Group B and C fences.

Vegetative Plantings Survival: In July 1994, sixteen 16-plant sampling plots were randomly selected and delineated for use in monitoring. Planting survival was evaluated in terms of survivorship, which is the number of live transplants in the plots at time point *x* divided by the number of transplants in the plots, and mortality rate, which is the percentage of deaths in proportion to the number of live transplants remaining in the plots (Harper 1977). The surveys conducted at 1, 6, and 12 mo postplanting indicate that survivorship decreased during the first 12 months postplanting. Survivorship at 1, 6, and 12 mo postplanting was 77.2%, 59.1%, and 55.6%, respectively (figure 5, tables 1 and 2). However, the mortality rate also decreased over the same time period. The results of a two-way ANOVA indicate a significant decrease ($P<0.05$) in the mortality rate over time, from 0.228 between 0 and 1 mo postplanting, to 0.059 from 6 to 12 mo postplanting (figure 5, tables 2, 3). No significant difference in mortality rate was found among planting groups A, B, and C (table 3).

Vegetative Plantings Cover: In the monitoring design for vegetative plantings (LDNR 1995), the percent cover of vegetation in a 1 m^2 subsample plot centered around one corner plant within each 16-plant sampling plot, was to be used as a measure of the percent cover in each 16-plant plot. Using this method, the mean percent cover of bullwhips in a 1 m^2 plot associated with each 16-plant sampling plot was 5% at 1 mo, 9% at 6 mo, and 45.2% at 12 mo postplanting (table 1).

By 6 mo postplanting, the selected corner plants for vegetation sampling plots B2−4, C1−3, C2−1, and C2−2 were absent, resulting in percent cover estimates of 0% for each of the 4 plots at 6 mo and 12 mo postplanting, at which time the survivorship in these plots ranged from 19% to 75% (table 1). Therefore, the percent cover estimates from the associated 1 m^2 subsample plots are not representative of the canopy cover in these four 16-plant plots at 6 mo and 12 mo postplanting. It

is not possible to make meaningful comparisons of the 1 mo postplanting percent cover data for these plots with subsequent data sets using this methodology.

To solve this problem, it was decided that for future data sets, percent cover will be recorded for each entire 16-plant sampling plot, rather than for only the 1 m^2 subsample plots. The 1 mo postplanting monitoring data was extrapolated to estimate percent cover data for each entire 16-plant sampling plot by assuming 5% cover for each live plant in a plot at 1 mo postplanting (table 4). This data will be compared to the next percent cover data set, to be collected at the end of year 3 in July 1997.

At the same time, the data collected to date does allow for further evaluation of the percent cover observed in 12 of the 16 sampling plots, where the corner plant used to estimate percent cover remained alive through 12 mo postplanting. The results of a two-way ANOVA indicate a significant increase ($P<0.05$) in percent canopy cover over 12 mo postplanting (figure 6, table 3). The overall averages of percent cover for 1, 6 and 12 mo postplanting were 5%, 12%, and 60.2%, respectively (figure 6, table 1). Significant difference ($P<0.05$) in percent cover was also found among planting groups A, B, and C (table 3).

From the preliminary data, it can be concluded that California bullwhip plantings can be established in this environment in a relatively short time period. After an initial period of establishment, there was a significant decrease in mortality rate and a significant increase in percent cover during the first year postplanting (figures 5, 6). The effectiveness of California bullwhip at minimizing wetland erosion will be evaluated after subsequent shoreline surveys are conducted.

Salinity: Analysis of pre- (September 1993 to June 1994) and postconstruction (July 1994 to September 1995) salinity data from the Rycade Canal (C/S-02) project, which influences salinity levels in the West Hackberry Plantings project area, indicates that salinity averaged 4.0 ppt in the West Hackberry Plantings project area during the period of record (LDNR 1996). This level of salinity falls within the known range of tolerance for California bullwhip.

References

Harper, J. L. 1977. *Population Biology of Plants*. New York: Academic Press.

Louisiana Department of Natural Resources (LDNR) 1995. West Hackberry Plantings and Sediment Enhancement (C/S-19) Monitoring Plan. Unpublished monitoring plan. Abbeville: Coastal Restoration Division (CRD).

_____ 1996. Rycade Canal (C/S-2) Progress Report No. 1. Unpublished monitoring report. Abbeville: CRD.

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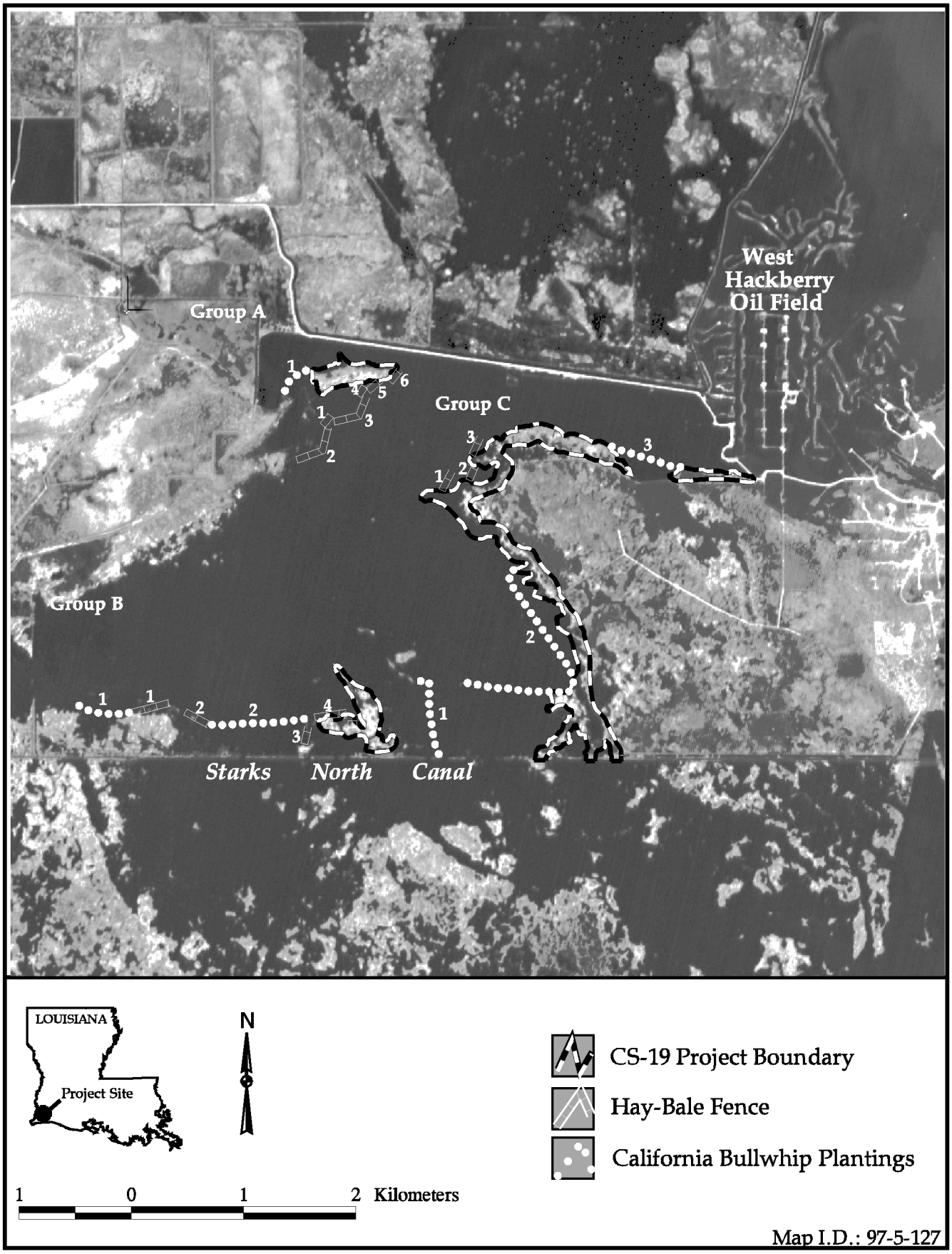


Figure 1. West Hackberry Plantings and Sediment Enhancement (CS-19) project area showing locations of restoration features.

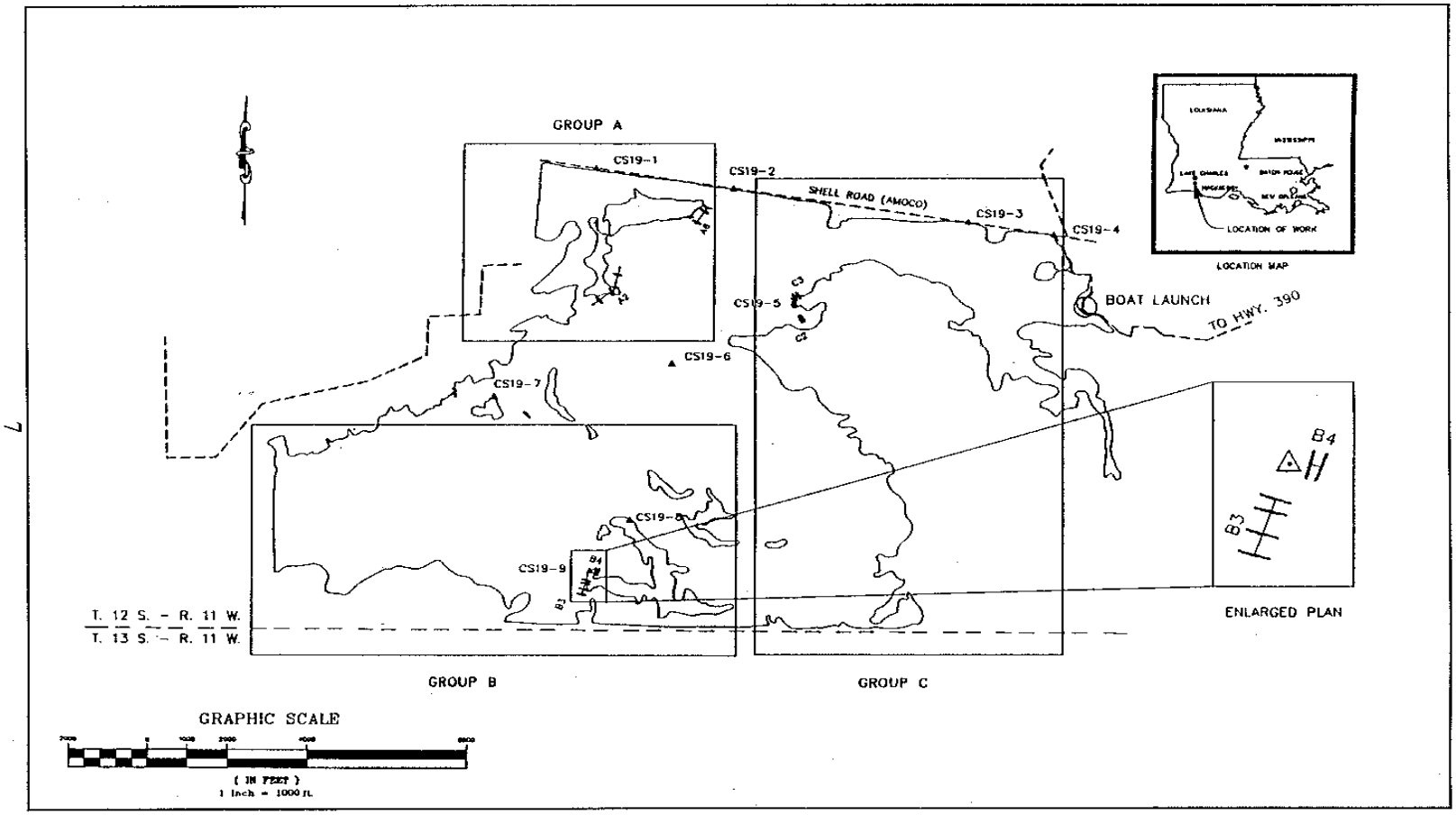
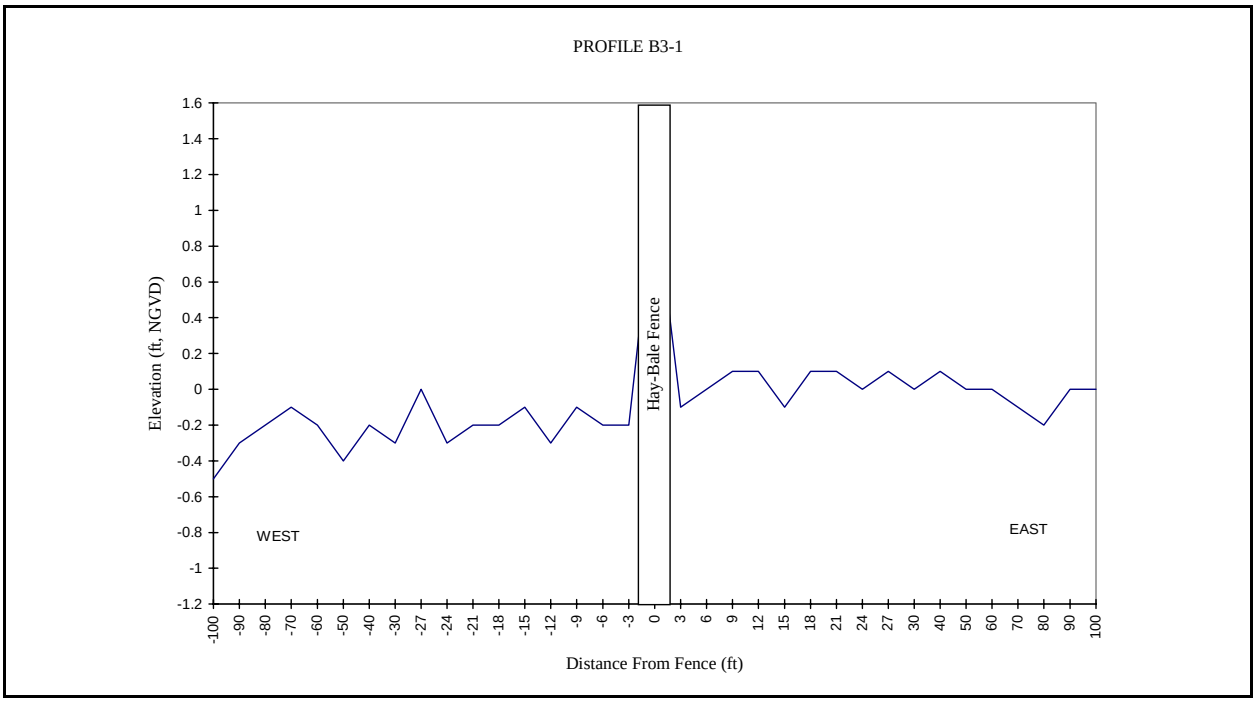


Figure 2. West Hackberry Plantings and Sediment Enhancement (C/S-19) project area map showing locations of hay-bale fences and shorelines selected for surveying.



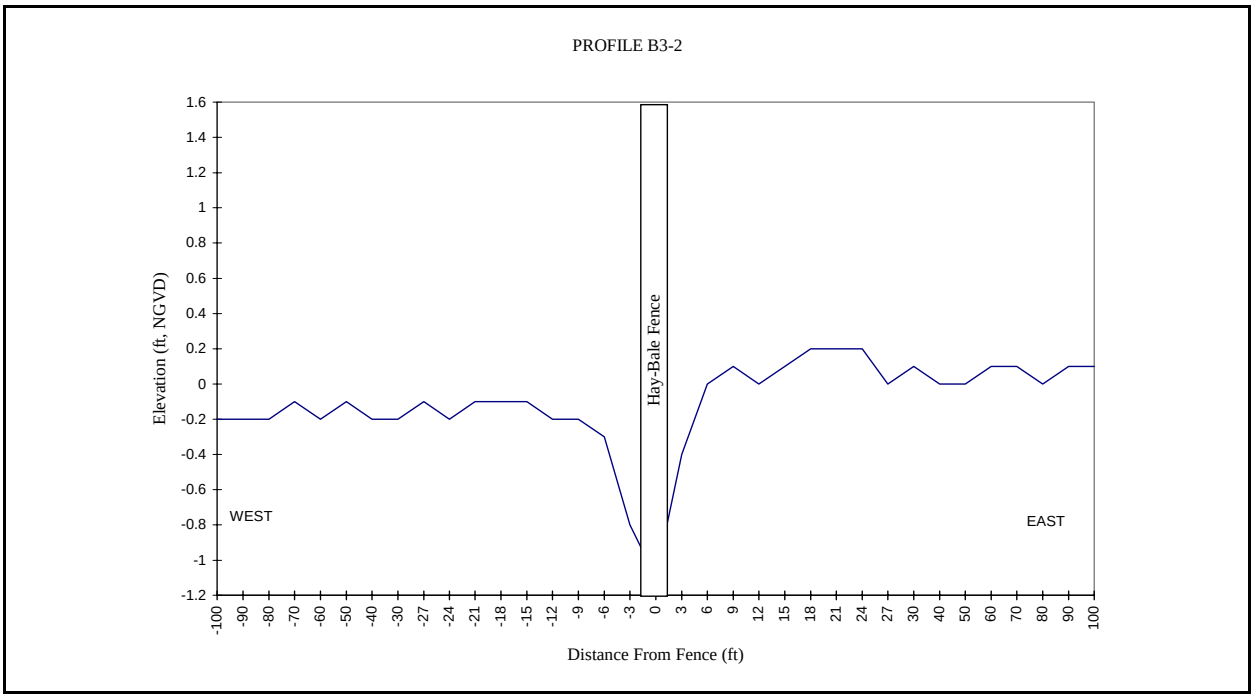
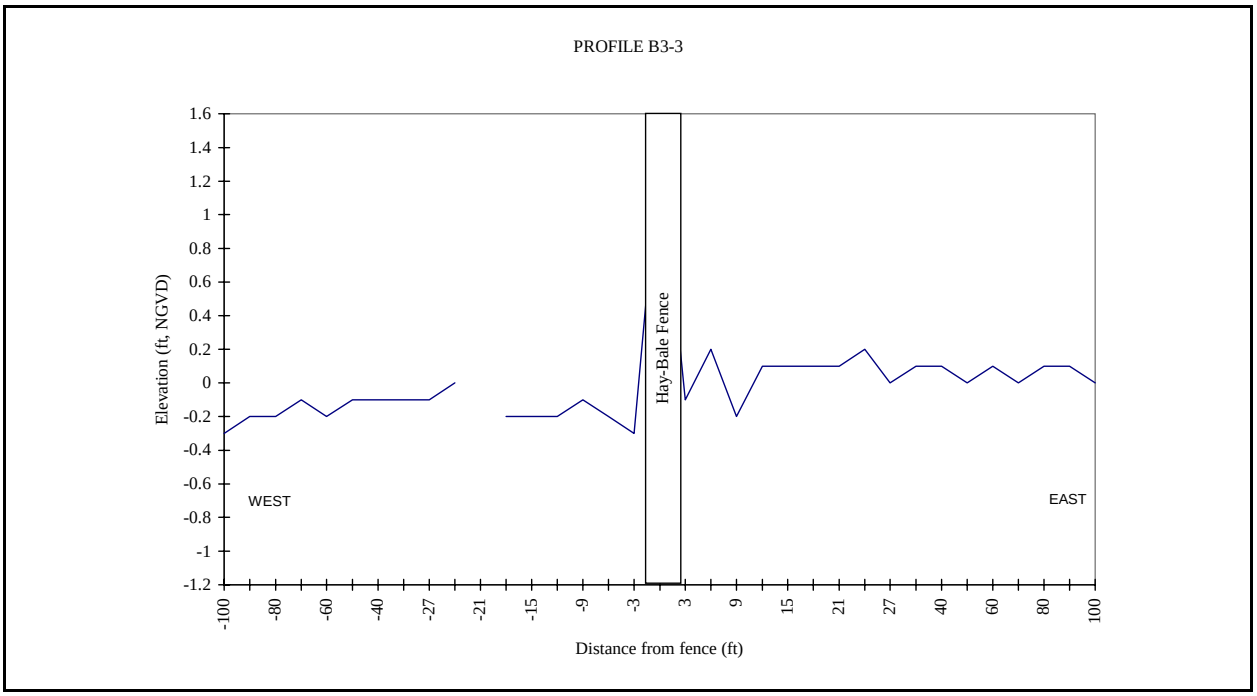


Figure 3. Elevational profile transects 1 and 2 across hay-bale fence Be in the West Hackberry Plantings and Sediment Enhancement project area, Cameron Parish, Louisiana, surveyed July 1994. (See figure 2 for locations of fence and transects).



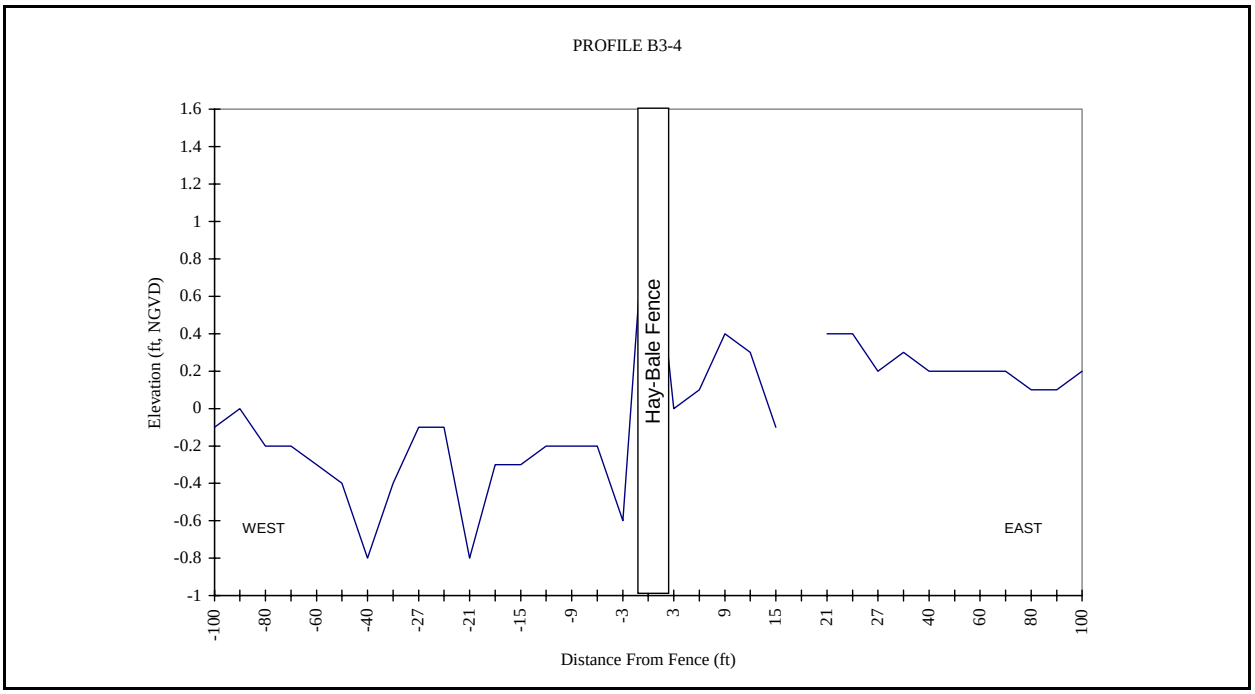
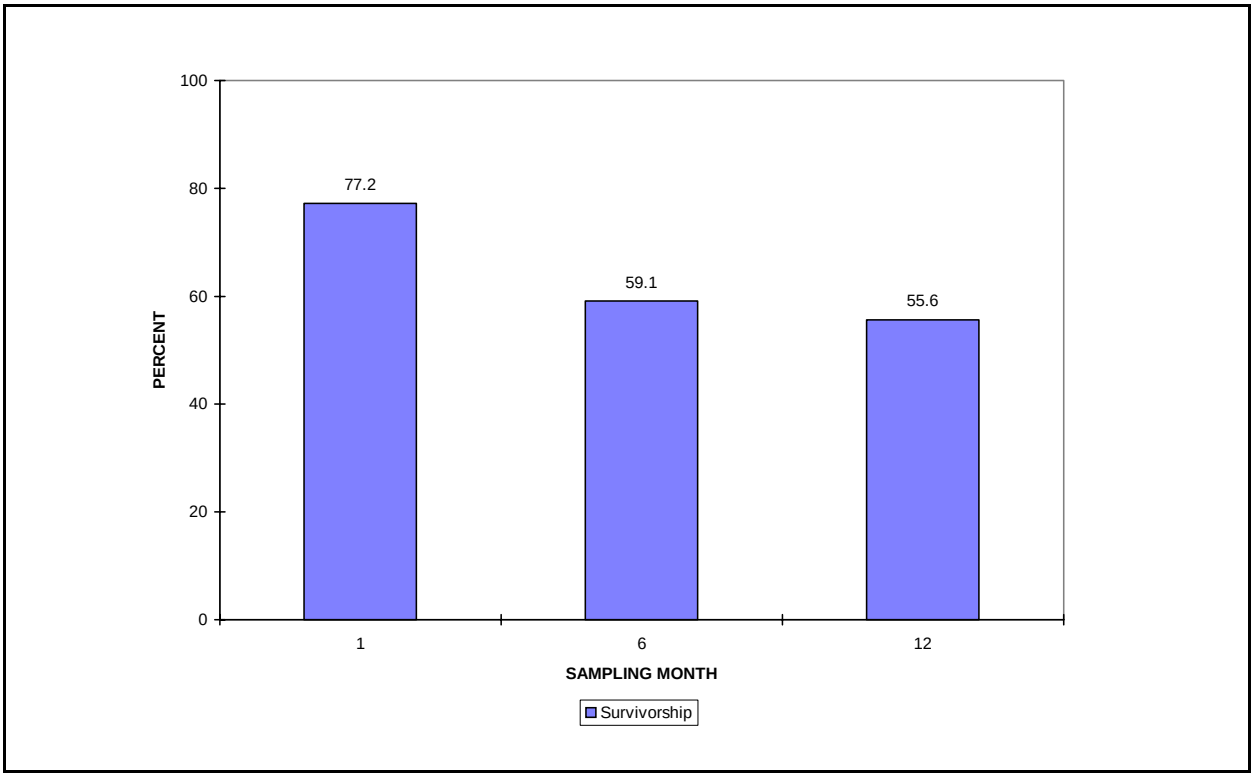


Figure 4. Elevational profile transects 3 and 4 across hay-bale fence B3 in the West Hackberry Plantings and Sediment Enhancement project area, Cameron Parish, Louisiana, surveyed July 1994. (See figure 2 for locations of fence and transects).



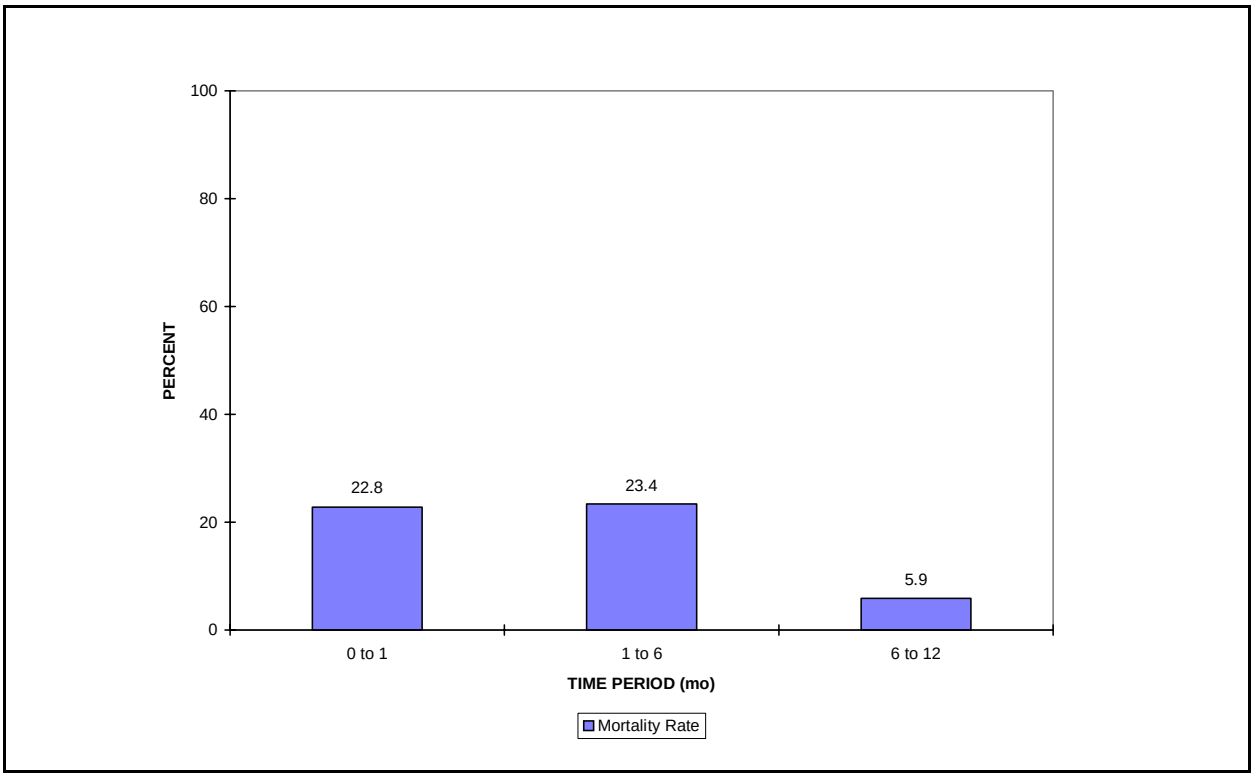


Figure 5. Mean survivorship and mortality rate of California bullwhip plantings in 16 random sampling plots, from August 1994 to July 1995, as observed at 1, 6, and 12 mo postplanting. The mortality rate, determined for consecutive time periods 0 to 1, 1 to 6, and 6 to 12 mo postplanting, decreased significantly ($P<0.05$) from 6 to 12 mo postplanting.

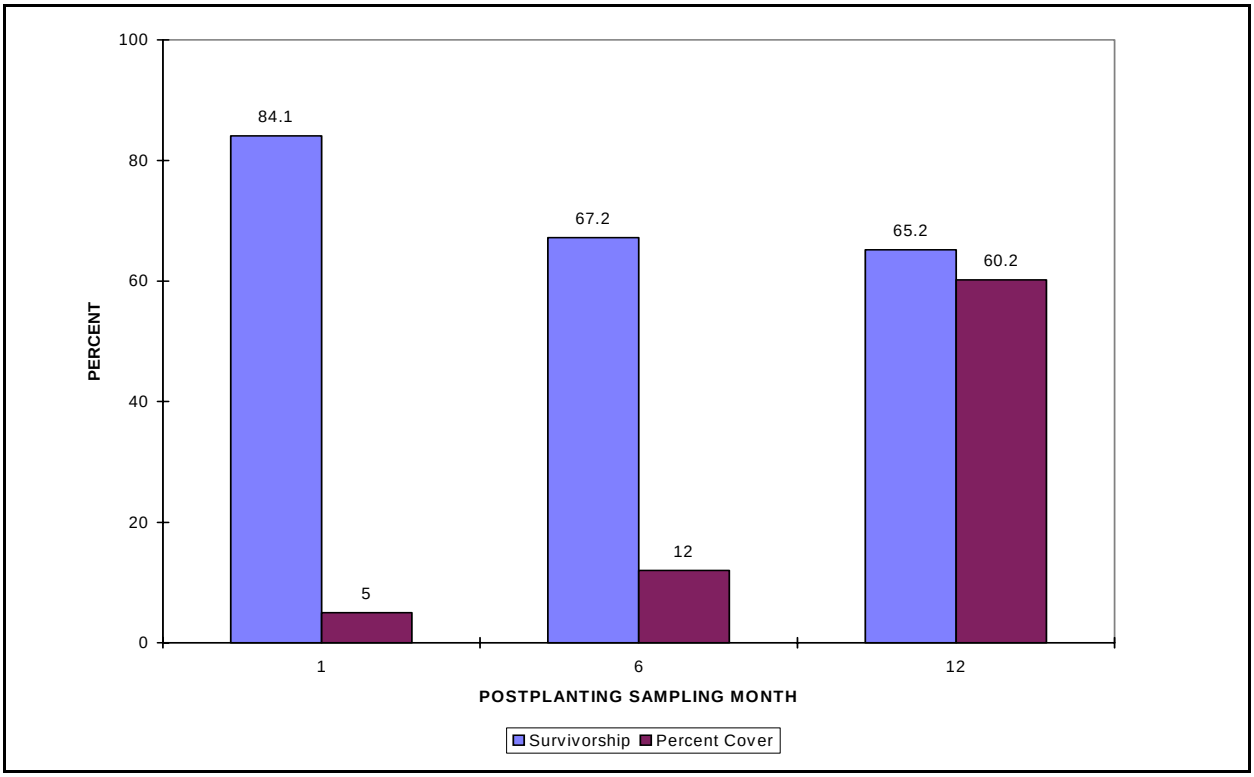


Figure 6. Mean survivorship and percent cover of California bullwhip plantings in 12 random sampling plots, from August 1994 to July 1995, as observed at 1, 6, and 12 mo postplanting. (Note: only the 12 plots for which percent cover data was available at 6 and 12 mo postplanting are included in this graph.)

Table 1. Survivorship (percent survival) of California bullwhip plantings in sixteen 16-plant sampling plots, and percent cover in associated 1 m^2 subsample plots, as observed at 1 mo (August 1994), 6 mo (February 1995), and 12 mo (July 1995) postplanting. Mean values provided for all sampling plots (n=16) and for the plots in which the corner plants used to estimate canopy cover for the plot survived through 12 mo postplanting (n=12).

PLOT	1 Month		6 Months		12 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)
A1–1	88	5	50	5	50	2
B1–1	75	5	69	20	69	100
B2–1	75	5	75	18	75	100
B2–2	94	5	94	15	94	100
B2–3	100	5	94	5	94	100
B2–4	94	5	75	0	63	0
C1–1	75	5	31	3	19	3
C1–2	94	5	69	3	63	3
C1–3	38	5	38	0	25	0
C2–1	38	5	0	0	0	0
C2–2	56	5	25	0	19	0
C2–3	63	5	50	10	44	50
C2–4	94	5	81	10	81	100
C2–5	94	5	75	40	75	100
C3–1	69	5	50	5	50	25
C3–2	88	5	69	10	69	40
Mean (n=16)	77.2	5	59.1	9	55.6	45.2
Mean (n=12)	84.1	5	67.2	12	65.2	60.2

Table 2. Partial life table of California bullwhip (*Scirpus californicus*) plantings in the West Hackberry Vegetative Planting project area, based on means of data collected from sixteen 16-plant sampling plots, from August 1994 to July 1995, at 1, 6, and 12 mo postplanting.

Age (mo)	Survival Frequency (n)	Survivorship	Mortality	Mortality Rate
0	16	1	0.228	0.228
1	12.3	0.772	0.181	0.234
6	9.3	0.591	0.035	0.059
12	8.8	0.556	-	-

Table 3. The results of two-way ANOVA on mortality rate 9 (n=16) and percent cover (n=12) of California bullwhip plantings, from August 1994 to July 1995, as observed at 1, 6, and 12 mo postplanting. The data were transformed by logistic transformation using the formula $\log_e[(1+X/X]$, where X = original data + 0.000001.

		Mortality Rate	**Percent Cover**
SOURCE	**DF**	**F-VALUE**	**F-VALUE**
Group	2	1.39 ns	8.06 *
Row(group)	3	0.26 ns	0.06 ns
Month	2	7.04 *	3.51 *
Group × Month	4	0.33 ns	2.4 ns
Row(group) × Month	6	1.14 ns	0.33 ns

ns = not significant; * = significant (P<0.05).

Table 4. Estimates of percent cover for California bullwhip plantings within each entire 16-plant sampling plot, as observed in August 1995, at 1 mo postplanting.

GROUP	ROW	PLOT NO.	NO. LIVE PLANTS AT 1 Month	% COVER FOR PLOT AT 1 Month
A	1	A1–1	14	4.8
B	1	B1–1	12	3.8
B	2	B2–1	12	3.8
B	2	B2–2	15	4.7
B	2	B2–3	16	5.0
B	2	B2–4	15	4.7
C	1	C1–1	12	3.8
C	1	C1–2	15	4.7
C	1	C1–3	6	1.9
C	2	C2–1	6	1.9
C	2	C2–2	9	2.8
C	2	C2–3	10	3.1
C	2	C2–4	15	4.7
C	2	C2–5	15	4.7
C	3	C3–1	11	3.4
C	3	C3–2	14	4.4
		Mean:	12.3	3.9