State of Louisiana
Department of Natural Resources
Coastal Restoration Division

Monitoring Plan

for

Plowed Terraces Demonstration

State Project Number CS-25
Priority Project List 4

August 2003
Cameron Parish

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MONITORING PLAN

PROJECT NO. CS-25
PLOWED TERRACE DEMONSTRATION PROJECT

ORIGINAL DATE: June 8, 1998
REVISED DATE: August 14, 2003

Preface

Pursuant to a CWPPRA Task Force decision on August 14, 2003 to adopt the Coastwide Reference Monitoring System (CRMS-*Wetlands*) for CWPPRA, updates were made to this Monitoring Plan to merge it with CRMS to provide more useful information for modeling efforts and future project planning while maintaining the monitoring mandates of the Breaux Act. The implementation plan included review of monitoring efforts on currently constructed projects for opportunities to 1) determine if current monitoring stations could be replaced by CRMS stations, 2) determine if monitoring could be reduced to evaluate only the primary objectives of each project and 3) determine whether monitoring should be reduced or stopped because project success had been demonstrated or unresolved issues compromised our ability to actually evaluate project effectiveness. As a the result of a joint meeting with DNR, USGS, and the federal sponsor, the recommendations for this Monitoring Plan were to maintain it in its current form. Consequently, no changes were made as a result of the CRMS review.

Project Description

The plowed terrace project area is located in northwestern Cameron Parish and southwestern Calcasieu Parish, Louisiana. It is approximately 24 mi (38.6 km) southwest of Lake Charles, Louisiana (Figure 1) within Unit NO-13 of the Calcasieu-Sabine Cooperative River Basin Study (USDA 1993). The marsh in and adjacent to the project area has experienced deterioration of its substrate and conversion from a solid fresh marsh to mostly open water with remnants of fresh and intermediate marsh (NRCS 1997).

The project area includes approximately 3,252 ac (1316 ha), of which 2,774 ac (1123 ha) are open water and 478 ac (193 ha) are fragmented marsh. Currently, most of the project area is open water. Severely eroded marsh areas have resulted from excessive water level fluctuations, saltwater intrusion, and wind generated wave action. The marsh is predominately vegetated with *Spartina patens* (wiregrass), *Typha* spp. (cattail), and *Scirpus californicus* (bullwhip). The open water areas are typically 2 ft (0.6 m) deep or less, are turbid, and have little or no aquatic vegetation. Average salinity levels in the area range from 2 to 5 parts per thousand (ppt), but have been recorded as high as 15 ppt under drought conditions. Furbearers, alligators (*Alligator mississippiensis*), large and small game, waterfowl, and commercial and recreational fisheries in and near the project area contribute to the local economy, both directly and indirectly, and are essential elements to the local ecosystem (NRCS 1997).

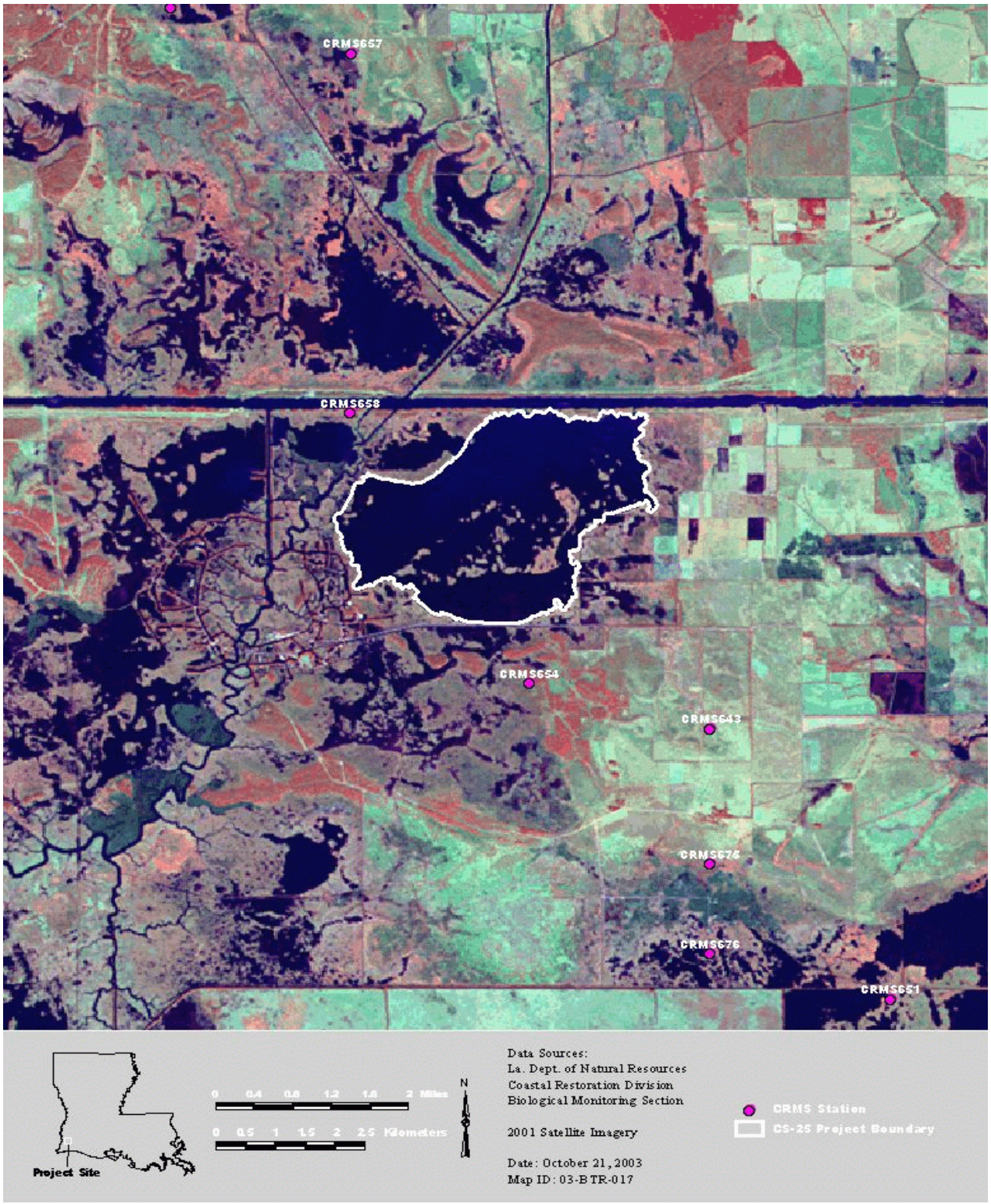

Figure 1. Plowed Terrace Demonstration (CS-25) project area and features.

The project area is in the West Gulf Coastal Plain geomorphic province. Most of the surface sediments are Holocene (recent) age with small remnants of Pleistocene age deposits. The soils of the marsh are fragile; that is, they are easily broken or dispersed and subsequently washed away. Soil associations in the project area are Clovelly-Ged. Clovelly soils are formed in moderately thick accumulations of herbaceous plant remains and in clayey alluvium. While similar to Clovelly soils in most respects, Ged soils generally have higher mineral content. Eroded wetlands in the project area have become shallow, turbid, open water areas and have soil types suitable for plow-constructed earthen terraces (NRCS 1997).

Between 1956 and 1978, approximately 2,800 ac (1133 ha) of fresh marsh were lost in the project area; nearly 350 ac (142 ha) by conversion to intermediate marsh and approximately 2,450 ac (992 ha) by conversion to open water. From 1978 to 1990, approximately 150 additional ac (61 ha) of fresh and intermediate marsh were lost through conversion to open water (NRCS 1997). Many factors, both natural and human-induced, have contributed to this drastic loss of marsh. These factors include relative sea level rise, saltwater intrusion, increased water level fluctuations, shoreline erosion, rapid freshwater removal, ponding, and erosion of interior marshes. Many of the natural occurrences contributing to marsh loss have been exacerbated by human-induced changes to hydrology (NRCS 1997).

Soils of the open water areas appear suitable for plow-constructed earthen terraces and provide an excellent opportunity to develop and demonstrate a non-traditional procedure for constructing earthen terraces in shallow water areas. The plowed terrace project is a 3-yr demonstration and is expected to serve as a wave-stilling, sediment-trapping structure and provide a base for the establishment of emergent vegetation, while protecting adjacent existing marsh (figure 2). Project implementation should help reduce net wetland loss in coastal Louisiana (NRCS 1997).

Success of the plow is dependent upon long term sustainability of the terrace at a height favorable for establishment and growth of *Spartina alterniflora* (smooth cordgrass). Substrate waterlogging causes soil reduction, increases in soil sulphate concentrations, and root oxygen deficiencies in *S. alterniflora* reducing its growth and productivity and possibly causing vegetative diebacks (Mendelssohn and McKee 1988, Mendelssohn et al. 1981). To insure the success of vegetative plantings (and the terrace), the terrace should maintain a height greater than the mean water level at low tide.

Using a plow for terrace construction has been demonstrated on Rockefeller Wildlife Refuge in Cameron Parish, Louisiana. For this project, a plow was used to borrow earthen material on either side of a terrace and compact materials by "squeezing" them in a pre-formed finishing box on the back of the implement. The total length of terraces is approximately 10,000 ft (3048 m) and they are constructed in water depths of 6 - 24 inches (15 - 61.0 cm). The terraces were planted with *S. alterniflora* and were designed to have a settled height of about 1.5 feet (0.46 m) above marsh elevation. As stated in the Rockefeller Wildlife Refuge Plowed Terrace Demonstration Fact Sheet, using this method of terrace construction should be more cost effective with less impact to the environment than traditional terrace construction with draglines. After recent inspection (April 1998) by LDNR/CRD personnel nearly 1 year after construction, it was concluded that the terraces

were still persisting at a height suitable for habitation by *S. alterniflora.* Terraces sustaining vegetation were at or above water level at the time of the inspection. Terraces which had not been planted were 3 - 6 inches (8 - 15 cm) beneath the surface of the water.

The principle project features include:

1. 54,000 linear ft (16459 m)of terraces including a minimum total of 6,000 linear ft (1829 m) of gaps for a total length of 60,000 linear ft (18288 m). Each terrace will be a maximum of 500 linear ft (152 m) with minimum gaps of 50 linear ft (15.2 m) between terraces. Each will be a minimum of 3 ft (0.9 m) above the existing pond bottom with a 3-ft top (0.9-m) width and a 10-ft (3.0 m) bottom width (figure 2).

2. Vegetative plugs of *S. alterniflora* planted at 3-ft (0.9-m) centers on both sides of the terrace at approximate mean water level.

Project Objectives

1. To demonstrate the cost effectiveness of using a plow versus other methods (e.g. drag line and bucket dredge) to create sediment terraces.

2. To encourage colonization by emergent vegetation.

Specific Goals

The following goals will contribute to the evaluation of the above objectives:

1. To establish a viable terrace within the project area by non-traditional means.

2. Create emergent marsh on the terrace through plantings.

Additional Monitoring Needs

1. CRD engineers will provide a cost assessment including price per linear foot of terrace construction by plow and other methods.

Reference Area

The importance of using appropriate reference areas cannot be overemphasized. Monitoring on both project and reference areas provides a means to achieve statistically valid comparisons, and is therefore the most effective means of evaluating project success. However, for the purpose of this project, a reference area is not required. The effectiveness of the plow and its ability to establish a

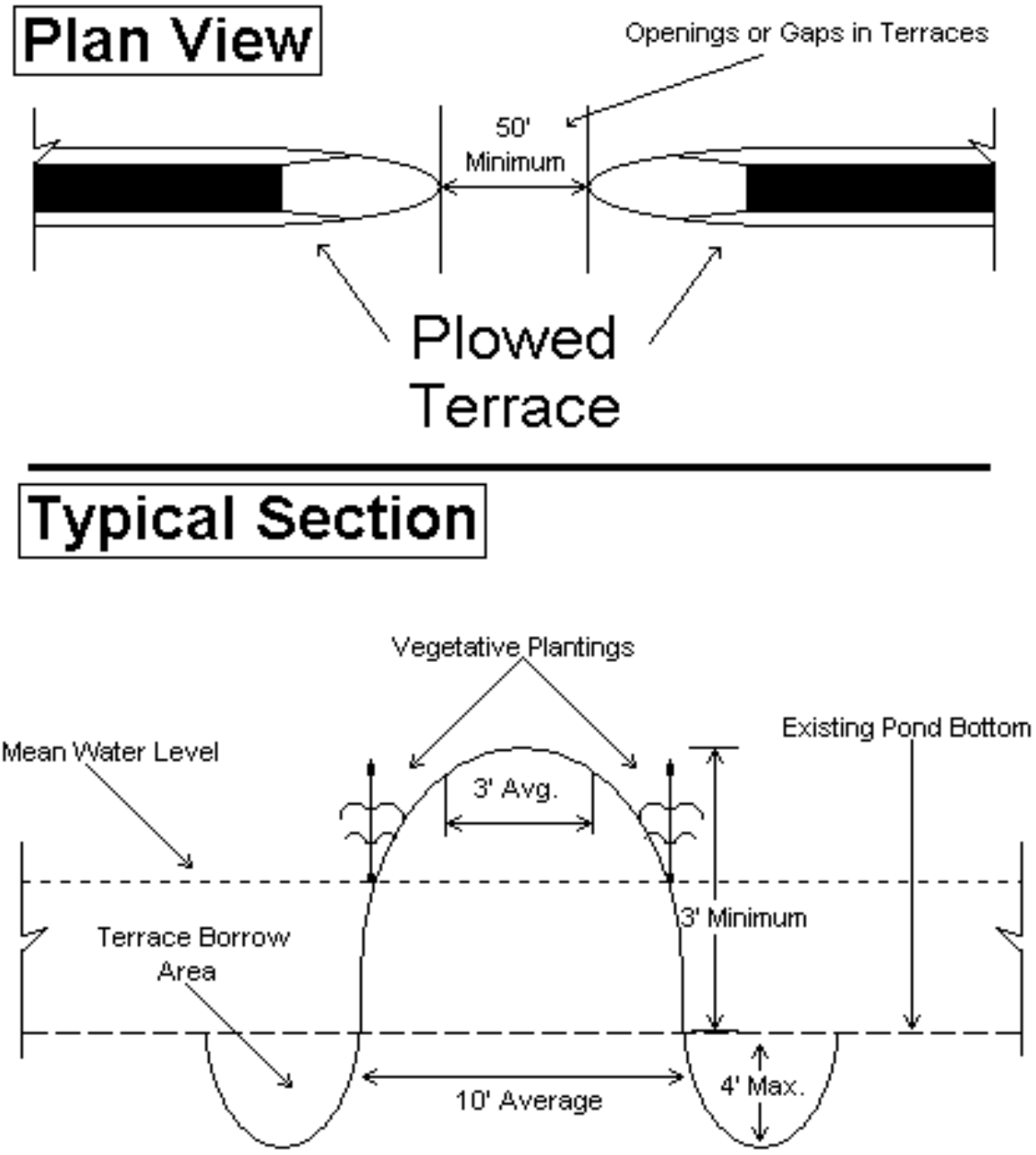

Figure 2. Partial plan view and typical cross-section of the plowed terrace.

viable and lasting terrace are our main objectives. No valid comparisons with a reference area can be made for testing plow performance.

CRMS will provide a pool of reference sites within the same basin and across the coast to evaluate project effects. At a minimum, every project will benefit from basin-level satellite imagery and land:water analysis every 3 years, and supplemental vegetation data collected through the periodic Chabreck and Linscombe surveys. Other CRMS parameters which may serve as reference include Surface Elevation Table (SET) data, accretion (measured with feldspar), hourly water level and salinity, and vegetation sampling. A number of CRMS stations are available for each habitat type within each hydrologic basin to supplement project-specific reference area limitations.

Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Terraces/Wetland Formation- The total area of wetlands created with the construction of terraces will be determined for 20 randomly selected terraces. A tape measure will be used to determine the width and length of each selected terrace. Measurements will be made from vegetated edge to vegetated edge, with widths being sampled 3 times per terrace and lengths being sampled once per terrace. Monitoring will take place in 1999 (1 month after construction) and in 2002.

2. Vegetative Plantings To assess the vegetative coverage of wetland species established on the terraces, the Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974) will be used. These ocular estimates will involve sampling 3 segments on each of the 20 selected terraces. Each sample area will originate at the middle of a 'width determination line' and extend 10 ft (3 m) perpendicular to it on each side for a total segment/plot length of 20 ft (6.1 m). Monitoring will take place in 2002.

Anticipated Statistical Analyses and Hypotheses

Due to small numbers of sampling periods (1 or 2) and to the absence of a valid control area, the following calculations and statistics will be used in analyzing data sets:

1. Twenty terraces will be randomly selected for area measurements.

2. To calculate the area and standard deviation for each terrace 1 length measurement and the average of 3 width measurements will be used.

$$\text{AREA TERRACE}_i = {}_{avg}W_i \text{. x } L_i$$

$$SD_{area1} = L_i \text{ x } (F_i \text{ / / } 3)$$

$$F_i = \text{standard deviation of width}_i = \text{ / } \frac{(W_1 - {}_{avg}W)^2 + (W_2 - {}_{avg}W)^2 + (W_3 - {}_{avg}W)^2}{(3\text{-}1)}$$

3. To calculate the total area and standard deviations of the 20 selected terraces the following formulas will be used.

$$\text{AREA OF SAMPLED TERRACES} = \text{ j } (\text{AREA}_i)$$
where i = 1-20

$$SD_{area20} = L_1 \text{ / } {}^1/_{3n} \text{ } 3F_i^2$$
where i = 1-20

4. To calculate the total area and standard deviations of all terraces the following formulas will be used.

$$\text{TOTAL AREA OF TERRACES} = {}^N/_n \text{ } 3 \text{ } (\text{AREA}_i)$$
where i = 1-20, N=108, and n=20.

$$SD_{area108} = {}^N/_n \text{ x } \left(\text{ / } {}^1/_{3n} \text{ } 3F_i^2 \right) \text{ x } \left(\text{ / } 3L_i^2 \right)$$

NOTE: Available ecological data, including both descriptive and quantitative data, will be evaluated in concert with the statistical analysis to aid in determination of overall project success. This includes ancillary data collected in the monitoring project but not used directly in statistical analysis, as well as data available from other sources (USACE, USFWS, DNR, LSU, etc.).

Notes

1.	Implementation:	Start construction:	May 1, 1999
		End construction:	August 1, 1999
2.	NRCS Point of Contact:	Marty Floyd	(318) 473-7690
3.	DNR Project Manager:	Herb Juneau	(337) 482-0684
	DNR Monitoring Manager:	David Castellanos	(337) 482-0665

4. The twenty year monitoring plan development and implementation budget for this project is $41,453. A progress report will be available in 2000. Periodic comprehensive reports on coastal restoration efforts in the Calcasieu-Sabine hydrologic basin will describe the status and effectiveness of the project as well as cumulative effects of restoration projects in the basin.

5. References:

Mendelssohn, I.A., and K.L. McKee 1988. *Spartina alterniflora* die-back in Louisiana: Time- course investigations of soil waterlogging effects. J.Ecol. 76: 509-521.

Mendelssohn, I. A., K. L. McKee, and W. H. Patrick, Jr. 1981. Oxygen deficiency in *Spartina alterniflora* roots: Metabolic adaptation to anoxia. Science 214: 439-441.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York. Pp 45-66.

NRCS. 1997. Final Project Plan and Environmental Assessment for Plowed Terrace Demonstration Project (XCS-56) Cameron and Calcasieu Parishes, Louisiana. United States Department of Agriculture (USDA), Natural Resources Conservation Service. 13 pp plus appendices.

USDA. 1993. Calcasieu-Sabine Cooperative River Basin Study Report. United States Department of Agriculture (USDA), Soil Conservation Service. 152 pp plus appendices and maps.