MONITORING PLAN

PROJECT NO. BS-11 DELTA MANAGEMENT AT FORT ST. PHILIP

DATE: August 20, 2003

Project Description

The Delta Management at Fort St. Philip project, which was approved on the 10th priority list of the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), is located on the east bank of the Mississippi River in Plaquemines Parish, Louisiana (figure 1). The features of this project, which include the construction of artificial crevasses and earthen terraces, have been proposed to stimulate the building of new marsh in the area, where extremely high rates of land loss have occurred in recent decades.

The project area is situated at the southern end of the Breton Sound Basin, which is a remnant of the St. Bernard Delta, an abandoned Mississippi River delta lobe. Subsidence and sediment deprivation are natural characteristics of abandoned deltas (Neill and Deegan 1986, Coleman and Gagliano 1964, Kolb and Van Lopik 1966, Coleman 1988, Wells and Coleman 1987, Penland et al. 1990), and are processes that may be significantly accelerated by human activities such as leveeing. Historically, the basin received fresh water and sediment inputs from the Mississippi River and its distributaries during overbank flooding events and through crevasses scoured through the channel bank (Baumann et al. 1984, Cahoon 1991, Penland et al. 1990, Coleman 1988). This project aims to utilize the land-building potential of crevasses to counteract the extensive loss of marsh that has occurred in the area.

Crevasse formation along the lower Mississippi River and its distributaries is the major process that supplies sediment, fresh water, and nutrients to surrounding marsh usually during high river stages. Once a crevasse occurs, a ‘splay’ develops within the receiving bay as sediments accrete near the mouth of the crevasse (Boyer et al. 1997). This newly formed land provides the substrate for rapid colonization of emergent vegetation, which in turn stabilizes the sediment and increases the rate of accretion (White 1993). Growth of the splay occurs through a series of bifurcations of the main channels, eventually forming a ‘subdelta’. The main channel eventually becomes inefficient at sediment delivery and begins to fill with sediment. Artificial crevasses have been utilized as a marsh-management tool in the Mississippi River delta in recent decades in an attempt to recreate this marsh-building process (Kelley 1996, Boyer et al. 1997, Marin 1996, Troutman and MacInnes 1999, Louisiana Department of Natural Resources [LDNR] 1993, LDNR 1999a, Trepagnier 1994). This process is recognized as a successful and cost-effective way to combat land loss.

Marsh terracing is a newer restoration technique being used to build marsh and reduce erosion rates. This involves the creation of terraces or ridges using existing bottom sediments and the arrangement of these ridges in some pattern as to maximize intertidal edge and minimize wave fetch (Rozas and Minello 2001). The terraces may then be planted or seeded with marsh vegetation. The main goal of terrace-field construction is to increase sedimentation, marsh-edge habitat, and marsh productivity. In many cases, they also reduce erosion rates in adjacent marshes. Terraces have been

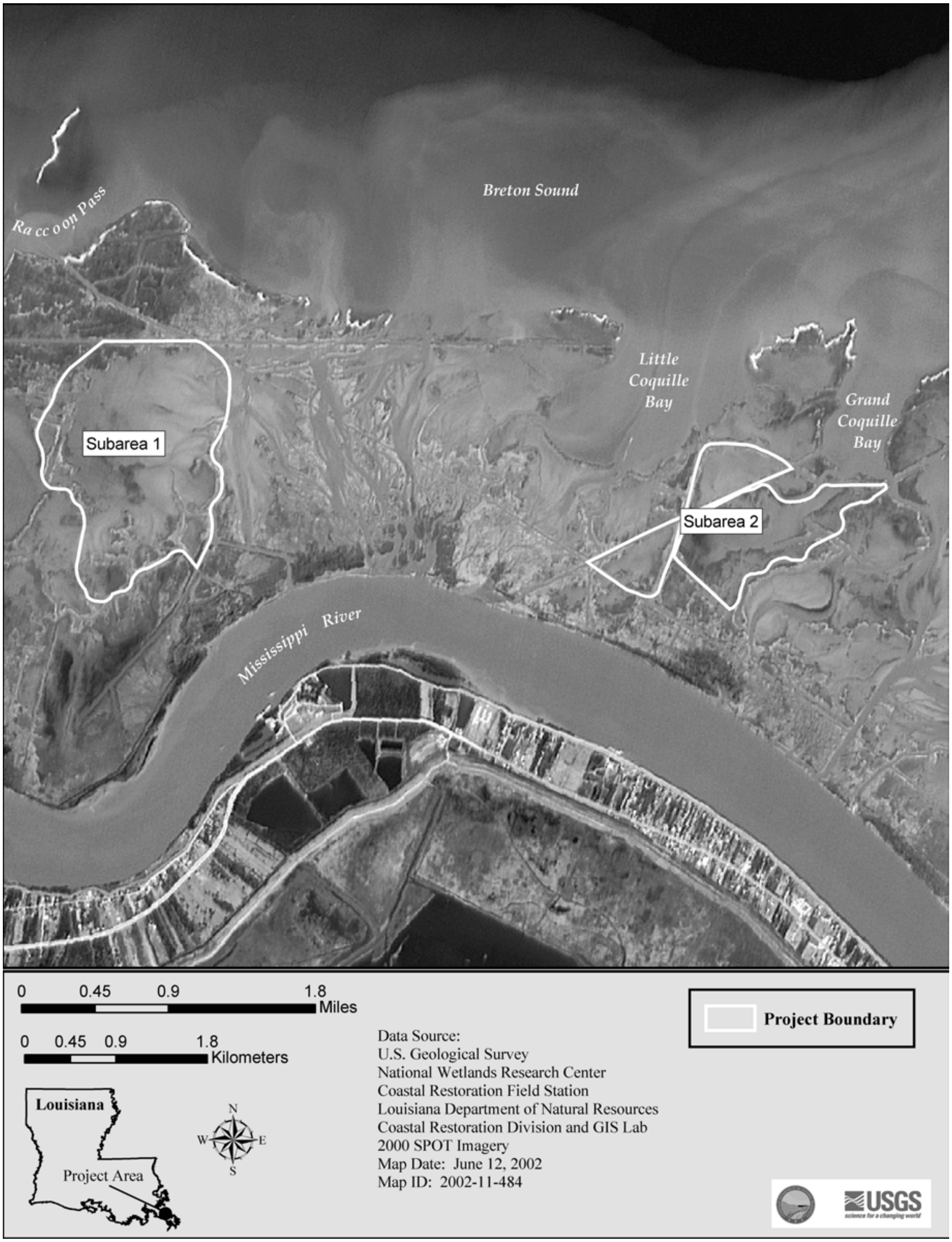

Figure 1. Subarea 1 and 2 of the Delta Management at Fort St. Philip (BS-11) Project Area.

shown to provide habitat for fishery species, with habitat value increasing proportionally with the area of created marsh within the terrace field (Rozas and Minello 2001). Marsh terracing was used successfully in a state-funded project constructed in 1990 at Sabine National Wildlife Refuge, Louisiana (LDNR 1999b). Early monitoring results are also promising from other recently constructed CWPPRA-funded terracing projects, including the Little Vermilion Bay Sediment Trapping project (LDNR 1998).

Marshes within and surrounding the BS-11 project area have experienced a rapid transition from a nearly unbroken expanse of marsh in 1956 to a highly fragmented marsh by 1990 (Roy 2002). In the American Bay mapping unit, in which the BS-11 project area is contained, more than 12% of the total marsh acreage was lost between 1932 and 1974, primarily due to dredging, wind/wave erosion, and subsidence (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority [LCWCRTF and WCRA] 1999). After the formation of a natural crevasse during the flood of 1973, the rate of marsh loss dropped to 10.7% between 1974 and 1990. Although the crevasse directly caused some marsh loss due to the scouring of sediments in the immediate outfall area, aerial photography of the area has indicated that marsh loss in the area has decreased considerably and that many areas which had converted to open water are now infilling with sediment (Roy 2002). Shorelines exposed to high wave energies, however, continue to erode, subsidence continues to occur, and a loss of almost 14,000 acres (5,600 hectares) is projected by the year 2050 if no action is taken (LCWCRTF and WCRA 1999). This project will enhance the natural marsh-building processes already occurring in the area through the construction of seven artificial crevasses and initiate marsh growth in open water habitat through the use of an earthen terrace field.

The Delta Management at Fort St. Philip project area is divided into two subareas. Subarea 1 consists of 174-acres (0.7-km^2) of emergent marsh and 678-acres (2.7-km^2) of open water (figure 1). Subarea 2 consists of 126-acres (0.5-km^2) of emergent marsh and 327-acres (1.3-km^2) of open water. In 1949 and 1968, the marshes surrounding these subareas were classified as brackish adjacent to the river and saline near Breton Sound (LCWCRTF and WCRA 1999). By 1978, an area of intermediate marsh had formed between Subarea 1 and 2 as a result of the crevasse which had formed in 1973 (Chabreck and Linscombe 1978). By 1988, a band of fresh and intermediate marsh had formed adjacent to the river, with the remainder of the area classified as brackish and saline (Chabreck and Linscombe 1988).

In 1997 the entire area was classified as fresh and intermediate marsh, with the two project subareas being entirely intermediate marsh (Chabreck and Linscombe 1997). The marshes within and around the project area support a diverse assemblage of vegetative species representing a broad salinity gradient due to the influences of both the Mississippi River and Breton Sound. Species present in the project area include elephant-ear *(Colocasia esculenta)*, common reed *(Phragmites communis)*, bulltongue arrowhead *(Sagittaria lancifolia)*, delta arrowhead *(Sagittaria platyphylla)*, alligatorweed *(Alternanthera philoxeroides)*, common rush *(Juncus effusus)*, needlegrass rush *(Juncus roemerianus)*, smartweed *(Polygonum sp.)*, Walter's millet *(Echinochloa walteri)*, saltmeadow cordgrass *(Spartina patens)*, smooth cordgrass *(Spartina alterniflora)*, Olney's threesquare *(Schoenoplectus americanus)*, common threesquare *(Schoenoplectus pungens)*, saltmarsh bulrush

(Schoenoplectus maritimus), torpedo grass *(Panicum repens)*, giant cutgrass *(Zizaniopsis miliacea)*, hairypod cowpea *(Vigna luteola)*, cattail *(Typha sp.)*, and poisonbean *(Sesbania drummondii)* (Roy 2002). Submerged and floating aquatic species in the project area include spike watermilfoil *(Myriophyllum spicatum)*, southern waternymph *(Najas guadalupensis)*, sago pondweed *(Stuckenia pectinatus)*, curly pondweed *(Potamogeton crispus)*, and water stargrass *(Heteranthera dubia)* (Roy 2002).

Project Goals and Strategies/Coast 2050 Strategies Addressed

CWPPRA projects are reviewed prior to authorization of construction funds for compatibility of project goals with those in Coast 2050 (LCWCRTF and WCRA 1998), and for the probability that proposed restoration strategies will accomplish those goals (Banks 2001). Project goals and strategies are provided to the LDNR by the sponsoring federal agency through the Environmental Assessment (EA) and/or Wetland Value Assessment (WVA) for the project. The following goals and strategies for the Delta Management at Fort St. Philip project were provided by the U.S. Fish and Wildlife Service in the Environmental Assessment (Roy 2002) and the Ecological Review (Banks 2001).

Project Goals:

1) Create 244 additional acres (1-km^2) of emergent marsh through the construction of crevasses by the end of the 20 year project life. It should be noted that 174 acres (0.7-km^2) of emergent marsh are projected to accrete naturally without the proposed project, thus a net gain of 418 acres (1.7-km^2) is expected within the project area by the end of the 20 year project life.

2) Create 25-acres (0.1-km^2) of emergent marsh through terrace construction. Terrace building will directly account for 16.5 acres (0.07-km^2) of emergent marsh, and the projected expansion of the vegetated terraces over the 20 year project life will account for the remaining 8.5 acres (0.03-km^2).

Project Strategies:

1) Reintroduction of alluvial sediments through seven constructed crevasses.

2) Marsh creation and sediment trapping through the construction of earthen terraces with vegetative plantings.

These project goals are consistent with the Coast 2050 Region 2 ecosystem strategy to restore and sustain marshes by building and maintaining delta splays, as well as the coastwide common strategy to create marsh habitat through terracing (LCWCRTF and WCRA 1998). The introduction and retention of sediments through the use of constructed crevasses and earthen terraces should "assure vertical accumulation to achieve sustainability", which is one of the strategic goals of Coast 2050. The introduction of freshwater through the artificial crevasses will also enhance the estuarine gradient in the project area, which is another important strategic goal of the Coast 2050 plan.

Project Features

Artificial crevasses Three artificial crevasses will be constructed in Subarea 1 (figure 2) and four artificial crevasses will be constructed in Subarea 2 (figure 3). The crevasse dimensions will be as follows:

Crevasse ID	Length, ft (m)	Width, ft (m)	Depth, ft (m)
1A	2,000 (609.6)	75 (22.9)	8 (2.4)
1B	450 (137.2)	75 (22.9)	6 (1.8)
1C	700 (213.4)	75 (22.9)	6 (1.8)
Alt. 2A	625 (190.5)	75 (22.9)	8 (2.4)
2B	900 (274.3)	75 (22.9)	8 (2.4)
2C	1,500 (457.2)	75 (22.9)	8 (2.4)
2D	500 (152.4)	75 (22.9)	8 (2.4)

All crevasses except 1B will be constructed at a 60-degree angle from the parent pass using a barge-mounted, bucket dredge. Crevasse 1B will be constructed at a 120-degree angle from the parent pass. Dredge material from crevasse construction will be used beneficially to create new marsh. All crevasses will be maintained at years 5 and 15 so that they will continue to provide sediment to the receiving bays.

Marsh terraces A total of 164 terraces (32,800-linear ft / 9,997-m) will be constructed in the receiving bay area for crevasse 1A in Subarea 1 (figure 2). The terraces will be arranged in eleven staggered rows oriented northeast-southwest. Each terrace will be 200-ft (61-m) long with a 50-ft (15-m) gap length between the terraces. The terraces will be constructed with a top width of 10-ft (3-m), 6:1 side slopes, and an elevation of 3.5-ft NAVD 88 (1.07-m). The terrace rows will be 200-ft (61-m) apart with a borrow area parallel to each row. Two rows of seashore paspalum (*Paspalum vaginatum*) will be planted on 8-ft (2.4-m) centers along the top of the terraces, and two rows of smooth cordgrass (*Spartina alterniflora*) will be planted on 5-ft (1.5-m) centers on each side of the terraces in order to stabilize the sediments and facilitate vegetative colonization. Due to shallow water depths (1.5 to 2.0-ft) and reduced fetch, significant erosion of the terraces is not expected to occur. Therefore, no maintenance of the terraces is proposed.

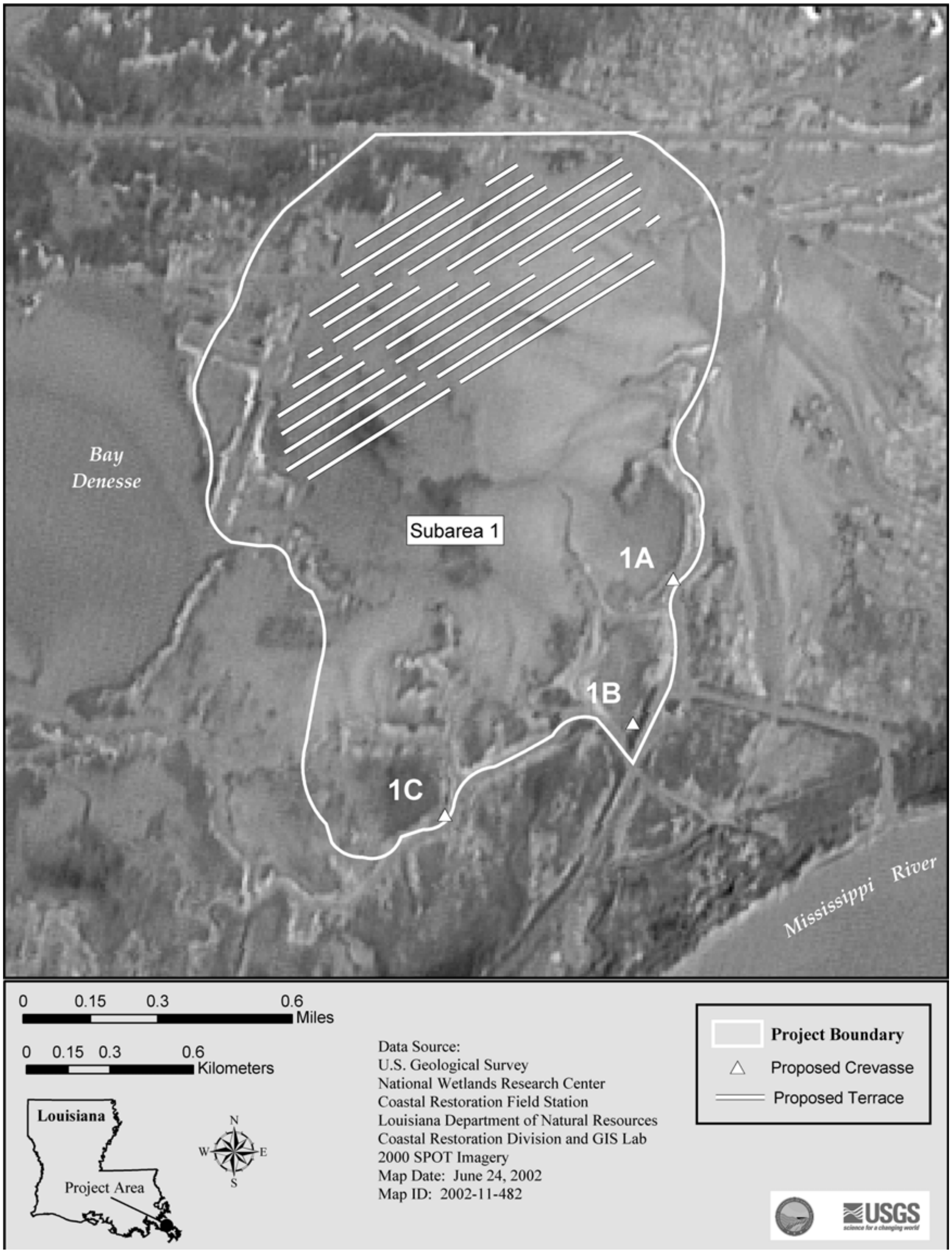

Figure 2. Subarea 1 of Delta Management at Fort St. Philip (BS-11) project area showing the proposed locations of the three artificial crevasses and the terrace field.

Figure 3. Subarea 2 of the Delta Management at Fort St. Philip (BS-11) project area showing the locations of the four proposed artificial crevasses.

Monitoring Goals

Priorities:

Monitoring strategies for the Delta Management at Fort St. Philip project will address both the sediment diversion and the sediment trapping features of this project and will focus on evaluating project effects on land/water ratios, bathymetry/topography and emergent vegetation. Analysis of land/water ratios in the project and reference areas will be used to determine the effects of the constructed crevasses and terraces on the acreage of subaerial land. Periodic elevation surveys of the crevasse receiving bays and of the terrace field will be performed in conjunction with Operations and Maintenance to monitor project effects on the vertical accretion of the marsh. Surveys of emergent vegetation within the crevasse receiving bays and terrace field will determine if the project is effectively creating marsh substrate for colonizing vegetation.

Specific Monitoring Goals:

1) Determine the effects of the project on land/water ratios in the project area.
2) Determine the changes in the mean elevation within the crevasse receiving bays and the terrace field as a result of the creation of subaerial land.
3) Determine the changes in emergent vegetation within the crevasse receiving bays and the terrace field.

Reference Areas:

Two reference areas will be monitored in order to compare project-induced changes in the crevasse receiving bays with natural changes in areas of similar size and hydrologic influence (figure 4). Both reference areas are located downriver from the project area. The larger reference area is 228 acres (0.92-km^2) and receives some riverine input. The smaller area is 67 acres (0.27-km^2) and is mostly isolated by low spoil banks. Aerial photography will be obtained for both the project and reference areas and land/water ratios will be compared. Vegetation and elevation surveys will not be conducted in the reference areas.

Figure 4. The reference areas to be used for monitoring of the Delta Management at Fort St. Philip (BS-11) project.

Monitoring Strategies

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

1. Aerial Photography — In order to evaluate land/water ratios in the receiving bays and within the terrace field, near-vertical, color-infrared aerial photography (1:12,000 scale) of the project and reference areas will be obtained prior to construction in 2002, and in post-construction years 2008, 2018, and 2023. The photography will be georectified using standard operating procedures described in Steyer et al. (1995, revised 2000), and land/water ratios will be determined.

2. Elevation — *Artificial crevasses*: To document changes in the mean elevation within the receiving bays related to the creation of subaerial land, elevational transect lines will be established across the receiving bays of two selected crevasses. One of the 60-degree angle crevasses will be selected from each subarea. One survey baseline will be established along the centerline of each crevasse from the centerline of the existing distributary channel to the open water in the receiving bay. Evenly spaced cross-sectional transects will be established perpendicular to the baseline at 500-ft (152.4-m) intervals in the receiving bays, as well as three cross-sectional profiles of the crevasse-splay channel. Elevation data will be recorded at 100-ft (30.5-m) intervals along the cross-sectional transects and at any abrupt changes in elevation between these intervals.

   Marsh terraces: A grid of surveyed points will be established in the area of the proposed terrace field. Grid lines will run perpendicular to the terraces in the northwest to southeast direction and parallel to the terraces in the northeast to southwest direction. The grid lines will be spaced 500-ft (152.4-m) apart. Elevations will be recorded at points every 100-ft (30.5-m) along each grid line and at several points along the profile of each intercepted terrace. Because the most southeastern rows of terraces may experience greater sedimentation rates due to their close proximity to crevasses 1A, 1B, and 1C, changes in the mean elevation within the southeastern half of the terrace field will be compared to changes in the mean elevation within the northwestern half of the terrace field.

   Surveys of the crevasse channels will be conducted in 2003 (as-built) through the construction contract and in 2008 and 2018 through Operations and Maintenance. Monitoring funds will be used to extend these surveys to include the two selected receiving bays and the terrace field.

3. Vegetation

Artificial crevasses: Plant species composition, percent cover, and relative abundance will be evaluated to document vegetation on newly created land in the receiving bays. Due to sampling time and budgetary limitations, one crevasse within each subarea will be chosen for vegetative sampling. Vegetation surveys will follow the Braun-Blanquet method as described in Steyer et al. (1995, revised 2000). Transects will be established once the splay islands become subaerial, and will match the transects laid out for the elevation surveys. Sample stations (duplicate 4-m^2 [2-m x 2-m] plots) along each transect will be established to represent the major plant communities of interest, with at least five stations in each community. Additional transects and sample stations may be established over time as new land is created. Post-construction vegetation surveys will be conducted in conjunction with elevation surveys during late summer (mid-July to August) in years 2008, 2013, and 2018.

Marsh terraces: Plant species composition, percent cover, and relative abundance will be evaluated to document vegetation on the constructed terraces. Vegetation surveys will follow the Braun-Blanquet method as described in Steyer et al. (1995, revised 2000). Eighteen terraces will be chosen among the terraces intercepted by the elevation survey grid, so that elevation and vegetation data may be associated. Because the most southeastern rows of terraces may experience greater sedimentation rates due to their close proximity to crevasses 1A, 1B, and 1C, nine of the terraces will be selected from the southeastern half of the terrace field (near) and nine of the terraces will be selected from the northwestern half of the terrace field (far). Three 4-m^2 plots will be established along a transect across each selected terrace, so that the southeastern slope, the northwestern slope, and the top of the terrace will be sampled. Post-construction vegetation surveys of the terraces will be conducted during late summer in years 2003 (as built), 2008, 2013, and 2018.

Anticipated Statistical Analyses and Hypotheses

The following describes hypotheses and associated statistical tests, if applicable, used to evaluate each of the specific goals and thus the effectiveness of the project. The numbers to the left correspond to the monitoring elements described above. These are followed by statements of the project goals, and the hypotheses that will be used in the evaluation.

1. Aerial Photography: Descriptive and summary statistics from color-infrared aerial photography collected pre- and post-construction will be used to 1) evaluate land/water ratios and changes in the rate of marsh loss/gain in the project area over time, and 2) compare with the selected reference areas that have not been influenced by crevasse splays.

   Goals: 1) Determine the effects of the project on land/water ratios in the project area.

2. Elevation: Elevation data will be evaluated through repeated measures analyses of variance (ANOVA). These tests will allow for the analysis and documentation of elevational changes within the selected receiving bays and terrace field over time.

   Goal: 2) Determine the changes in the mean elevation within the crevasse receiving bays and the terrace field as a result of the creation of subaerial land.

   Hypothesis[1]:

   H_o: Mean elevation in the crevasse receiving bays at time *i* will not be significantly greater than mean elevation at time *i*-1.

   H_a: Mean elevation in the crevasse receiving bays at time *i* will be significantly greater than mean elevation at time *i*-1.

   Hypothesis[2]:

   H_o: Mean elevation within the terrace field at time *i* will not be significantly greater than mean elevation at time *i*-1.

   H_a: Mean elevation within the terrace field at time *i* will be significantly greater than mean elevation at time *i*-1.

   Hypothesis[3]:

   H_o: Post-construction mean elevation within the southeastern half of the terrace field (nearest to artificial crevasses 1A, 1B, and 1C) will not be significantly greater than post-construction mean elevation within the northwestern half of the terrace field (farthest from the crevasses).

H_a: Post-construction mean elevation within the southeastern half of the terrace field (nearest to artificial crevasses 1A, 1B, and 1C) will be significantly greater than post-construction mean elevation within the northwestern half of the terrace field (farthest from the crevasses).

3. Vegetation: Vegetation data from the crevasse splays will be evaluated through paired t-tests or ANOVA. These tests will allow for the analysis and documentation of vegetation changes within the receiving bays over time.

Goal: 3) Determine the changes in emergent vegetation within the crevasse receiving bays and the terrace field.

Hypothesis[1]:

H_o: Mean % cover of emergent vegetation within the receiving bay at time *i* will not be significantly greater than vegetative cover at time *i*-1.

H_a: Mean % cover of emergent vegetation within the receiving bay at time *i* will be significantly greater than vegetative cover at time *i*-1.

Hypothesis[2]:

H_o: Mean % cover of emergent vegetation on the constructed terraces at time *i* will not be significantly greater than vegetative cover at time *i*-1.

H_a: Mean % cover of emergent vegetation on the constructed terraces at time *i* will be significantly greater than vegetative cover at time *i*-1.

Hypothesis[3]:

H_o: Post-construction mean % cover of emergent vegetation on the terraces nearest to artificial crevasses 1A, 1B, and 1C will not be significantly greater than post-construction mean % cover on the terraces farthest from the crevasses.

H_a: Post-construction mean % cover of emergent vegetation on the terraces nearest to artificial crevasses 1A, 1B, and 1C will be significantly greater than post-construction mean % cover on the terraces farthest from the crevasses.

Notes

1. Proposed Implementation: Start Construction: January 2004
   End Construction: April 2004

2. USFWS Point of Contact: Kevin Roy (337) 291-3120

3. LDNR Project Manager: Ralph Libersat (225) 342-6884
   LDNR Monitoring Manager: Melissa Kay Hymel (504) 280-4074
   LDNR RTS Manager: Kyle Balkum (225) 342-9429

4. The twenty year monitoring plan development and implementation budget for this project is $364,159. Project effectiveness will be reported in the basin-level comprehensive reports.

5. During a CRMS review of projects in 2003, it was also recommended that the Chabreck and Linscombe data for Vegetation/habitat type be used as ancillary data to assist in project evaluation and that O&M be solicited to possibly expand elevation surveys into the crevasse area.

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