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For the period October 15, 1997 to December 14, 1999

Coast 2050 Region 2

CHANNEL ARMOR GAP CREVASSE
MR-06 (XMR-10)

Third Priority List Beneficial Use of Dredged Material Project of the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) (Public Law 101-646)

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Introduction

Human alterations to the Mississippi River (MR) have had negative impacts on the hydrography of the river and its wetland-building processes. Prolonged maintenance of the river in its present course through artificial levees has caused rapid sedimentation onto the continental shelf and seaward progradation of the river mouth at rates up to 91.4 yds/yr (100 m/yr) within the past several decades. In addition, an abundance of small, bifurcating distributaries throughout the Mississippi River Delta (MRD) has caused a loss in stream gradient, which is critical to efficient sediment transport. Growth of the MRD has therefore not been limited by the size of the receiving basin, but by inefficient sediment delivery. Moreover, the MR currently delivers 50 to 60 percent less sediment to the Gulf of Mexico than it did in the early 1900's (Wells and Coleman 1987). Much of this sediment loss has been due to trapping of coarse sediment material, which is essential in building subaerial land, by upstream dams and reservoirs in the Arkansas, Missouri, and Ohio river basins.

Rapid wetland deterioration in the MRD is likely due to a combination of the above factors in conjunction with eustatic sea-level rise, which is estimated to be 0.37 in/yr (0.94 cm/yr) (Penland and Ramsey 1990). In addition, the subsidence rate for the entire MRD is approximately 0.43 in/yr (1.1 cm/yr) (Day and Templet 1989), and is exacerbated by frequent canal dredging for navigation purposes and by fluid and gas withdrawals during mining of mineral resources. The most recent land loss rate estimate for the MRD is 5.37 mi^2/yr (13.91 km^2/yr), which is 21% of the total annual land loss occurring in the Louisiana coastal zone (Dunbar et al. 1992).

The MR levee, below Venice, Louisiana, was reinforced with stone over the last few decades, but a few shallow gaps were left in this river-bank armor to allow overflow of freshwater into adjacent marshes and to promote levee breaches (crevasses) during periods of high river stages. Crevasses promote infilling of shallow interdistributary ponds with sediment-laden river water and eventually create subaerial land (or deltaic splays) that becomes colonized with marsh vegetation. A natural crevasse splay typically has a life of 20 to 175 years, depending on the size of the crevasse and adjacent parent pass, water discharge, sediment volume, and wind and tidal influences (Wells and Coleman 1987). Between 1750 and 1927, regularly occurring crevasse splays were responsible for building more than 80% of the MRD wetlands (Davis 1993).

Since the early 1980s, artificial crevasses have been used as a management tool to combat wetland loss in the MRD. By breeching levees and digging crevasses, the natural processes of crevasse splay formation are enhanced. The Louisiana Department of Natural Resources, Coastal Restoration Division (LDNR/CRD) constructed three crevasses in 1986 that produced over 657 ac (266 ha) of emergent marsh from 1986 to 1991, and four crevasses in 1990 that produced over 400 ac (162 ha) of emergent marsh in three years (LDNR 1993; Trepagnier 1994). Results from the LDNR Small Sediment Diversions project show that land gains from 1986 to 1993 from thirteen artificial crevasses ranged from 28 to 103 ac (11.3 to 41.7 ha) for older crevasses (4 to 10 years old) and 0.5 to 12 ac (0.2 to 4.9 ha) for younger crevasses (0 to 2 years old) (LDNR 1996).

Crevasse creation is recognized as both cost-effective and highly successful at creating new wetlands. The average cost per crevasse constructed by LDNR in 1990 was approximately $48,800, or $433/acre of wetland created. Boyer et al. (1997) reported that the average cost per area of land gain for 24 constructed crevasses in Delta National Wildlife Refuge declines with age as new land builds and may be only $19/acre if all the receiving bays revert to marsh.

The Channel Armor Gap Crevasse project area is located in the MRD, south of Venice in Plaquemines Parish, Louisiana, and is within the boundary of the Delta National Wildlife Refuge between the main stem Mississippi River and Main Pass (figure 1). The crevasse is located on the left descending bank of the MR at mile 4.7 above Head of Passes. The project receiving bay, Mary Bowers Pond, comprises 70% of the total 1567 ac (634 ha) in the project area. The objective is to promote formation of emergent freshwater marsh in place of the shallow, open water area of Mary Bowers Pond by increasing the flow of sediment-laden river water into the receiving bay . The specific goals are to increase elevation and cover of emergent wetland vegetation in the project area. The crevasse was dug in October 1997 from an existing gap in the MR levee, and over the 20-yr life of the project, it is expected to create approximately 1,000 ac (405 ha) of emergent marsh.

Methods

Water discharge and suspended sediments were measured to determine changes in discharge over time and to determine the relationship of these two variables within the crevasse channel. Both variables were measured along transects at the mouth (at MR) and end (at Mary Bowers Pond) of the crevasse channel on seven dates. The first sample was taken in October 1997, just after the crevasse was constructed, whereas the remaining six were taken between February and October 1998. Velocity (used to calculate discharge) was measured with a hand-held velocity meter at numerous intervals along each transect and depth-integrated to establish a ratings curve. Suspended sediment concentration (used to calculate sediment load) was measured with a point sampler at five even intervals along each transect and at five depths along a vertical profile for each sample location.

Pursuant to a CWPPRA Task Force decision on April 14, 1998, the original monitoring plan was reduced in scope due to budgetary constraints. Discharge and suspended sediment sampling, scheduled for monitoring from 1999-2008, was changed to only include 1999-2003. Furthermore, the revised monitoring plan called for only two samples per year for the remaining years, one during high river stage and one during low river stage. Because of these changes, it was determined that relatively little useful information would be derived from future monitoring of these two variables and that funds could be better used to address the vegetation and elevation goals of this project. Thus, monitoring of suspended sediment and discharge was dropped, and the monitoring plan was revised to include vegetation sampling on a yearly basis for ten consecutive years with concurrent

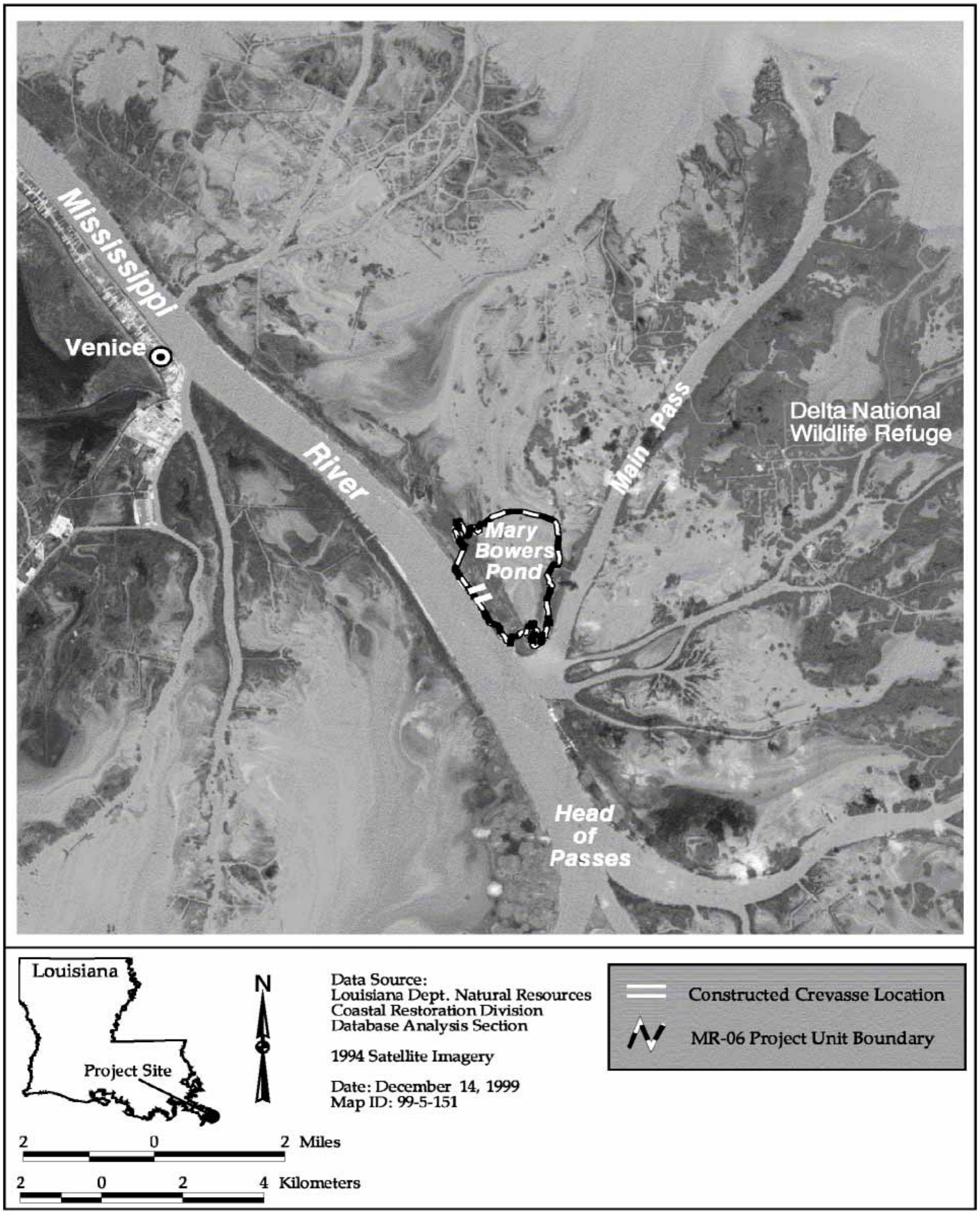

Figure 1. Channel Armor Gap Crevasse (MR-06) project location.

elevation surveys conducted by LDNR/CRD personnel. This monitoring will begin after the first subaerial crevasse splay is formed.

Elevation, reported in North American Vertical Datum of 1988 (NAVD), was surveyed in the receiving bay on November 25, 1997 to determine preconstruction elevation in the project area. Eleven transect lines were established perpendicular to the crevasse channel, 500 ft (152 m) apart, and extended the entire length of the open water areas in the receiving bay (figure 2). Elevations were recorded at 500-ft intervals along each transect and at any significant change in elevation within those intervals.

Distribution of habitat types and the land to open water ratio were determined from preconstruction aerial photography (near-vertical, color-infrared, 1:12,000 scale) that was taken of the project area on January 9, 1996. At the U.S. Geological Survey's National Wetlands Research Center (NWRC), the aerial photographs were scanned at 300 pixels per inch and georectified with ground control data collected with a differential global positioning system (DGPS) capable of sub-meter accuracy. Individual georectified frames were then mosaicked to produce a single image of the project area. To determine habitat types and their distributions, the photomosaic was photointerpreted by NWRC personnel and classified to the subclass level using the National Wetlands Inventory (NWI) classification system (Anderson et al. 1976). Habitat classifications were then transferred to 1:12,000 scale Mylar base maps, digitized, and checked for quality and accuracy. In addition, the photomosaic was classified according to pixel value and analyzed to calculate the land to water ratio of the project area. All areas characterized by emergent vegetation, wetland forest, or scrub-shrub were classified as land, while open water, aquatic beds, and non-vegetated mud flats were classified as water.

Results

Water discharge through the crevasse peaked in May, then decreased through the summer and early fall of 1998 (figure 3). Except for October 1998, suspended sediment load followed a similar trend as water discharge. Over all sample dates, average discharge and suspended sediment load were higher at the mouth (2,151 ± 509 cfs [61 ± 14 cms] and 965 ± 212 metric tons/day) than at the end (1,337 ± 327 cfs [38 ± 9 cms] and 547 metric tons/day) of the crevasse.

Average elevation of the entire receiving bay was -3.48 ± 0.06 ft (-1.06 ± 0.02 m) NAVD and ranged from -1.85 ft (-0.56 m) to -6.75 ft (-2.06 m) NAVD. The deepest sections of the bay were near the northern boundary of the project area, whereas the southern-most end of the receiving bay was shallowest (figure 4).

Habitat analysis of the preconstruction aerial photographs yielded eight habitat classes (table 1). Over half of the project area consisted of mud flats, whereas fresh marsh made up the majority of the remaining acreage. Most fresh marsh was located on the western side of the project area, as was nearly all of the wetland forest and scrub-shrub habitats (figure 5). Except for a few small channels, the larger open water habitats were confined to the northern portion of the area.

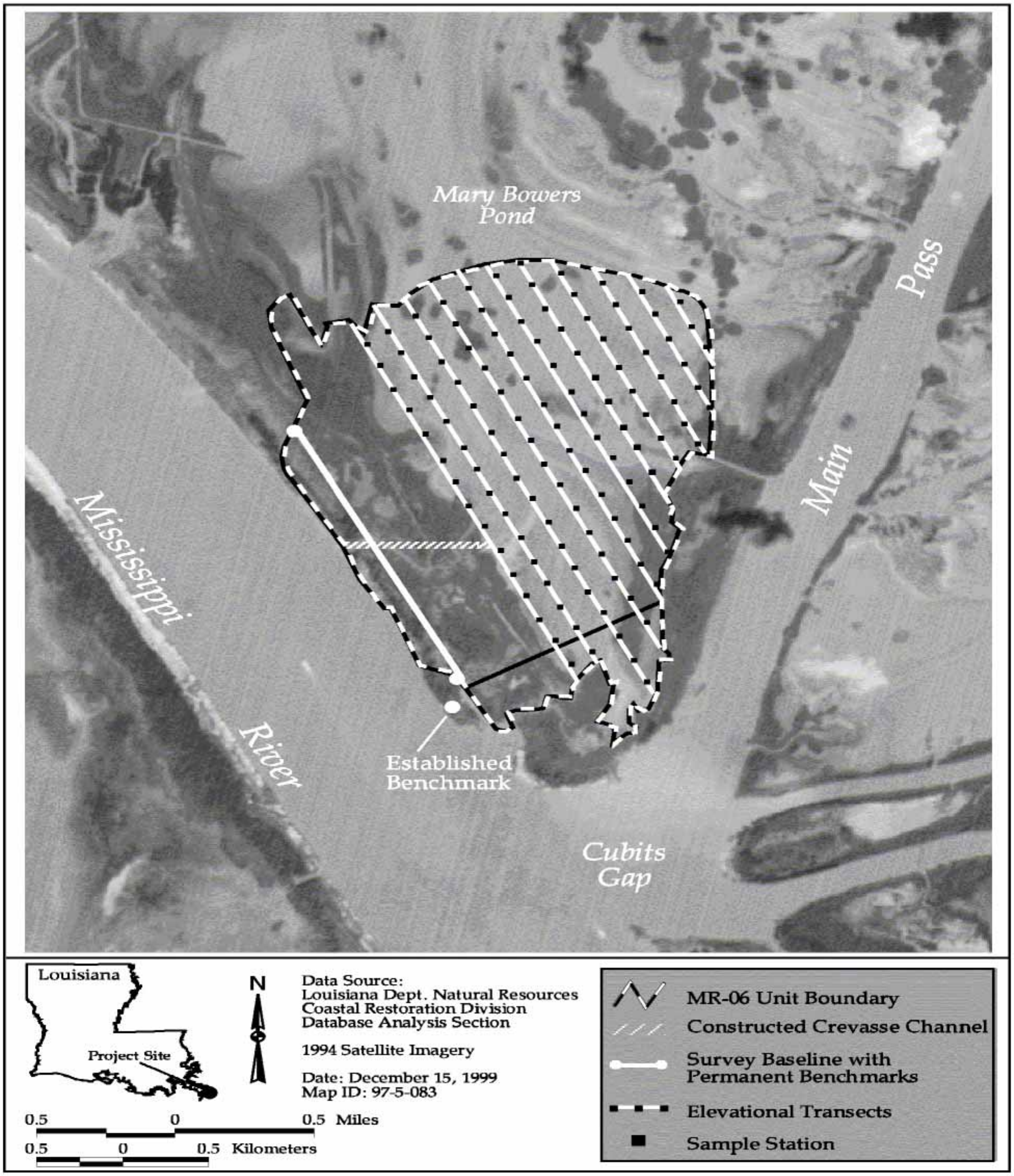

Figure 2. Schematic diagram of elevation transects and sampling station locations in the Channel Armor Gap Crevasse (MR-06) project area.

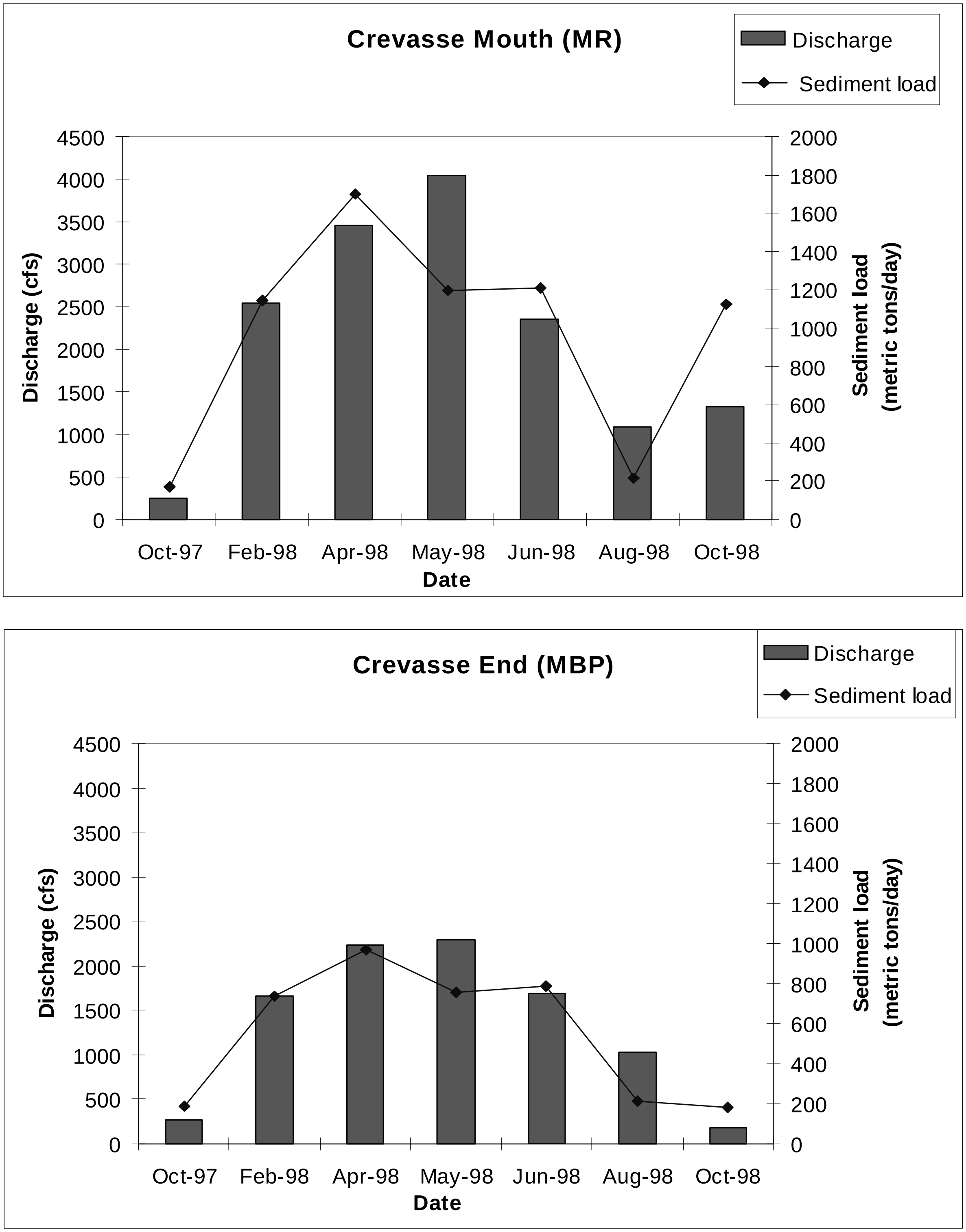

Figure 3. Water discharge and suspended sediment load at the mouth and end of the MR-06 project crevasse from October 1997 to October 1998. Abbreviations are as follows: MR = Mississippi River and MBP = Mary Bowers Pond.

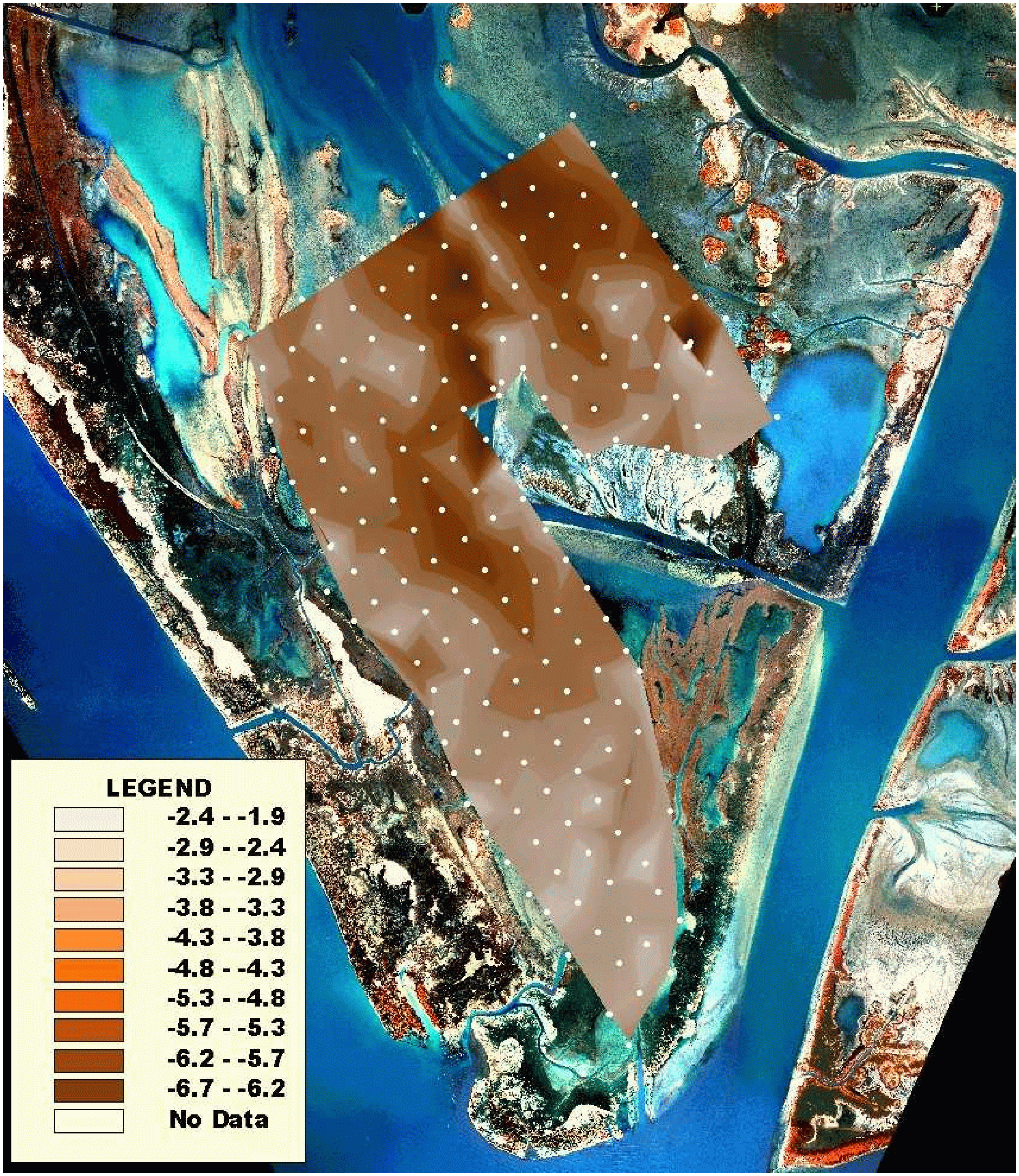

Figure 4. Elevation within the receiving bay (Mary Bowers Pond) of the Channel Armor Gap Crevasse (MR-06) project area. White dots represent elevation survey stations. Although it is shown as open water on this aerial photo (taken in 1996), the area south of the large crevasse within the project area (right) was actually land when the elevation survey was conducted in 1998, thus this area was not surveyed.

Table 1. Habitat classes and number of acres of each habitat in the Channel Armor Gap Crevasse (MR-06) project area for 1996 (preconstruction).

Habitat Class	**Acres**
Open water - fresh	138.4
Submerged aquatics	0.3
Fresh marsh	415.6
Wetland forest - fresh	35.3
Mud flats - fresh	953.1
Wetland scrub-shrub	18.9
Rocky shore	0.5
Upland barren spoil	3.7
Total	1,565.8

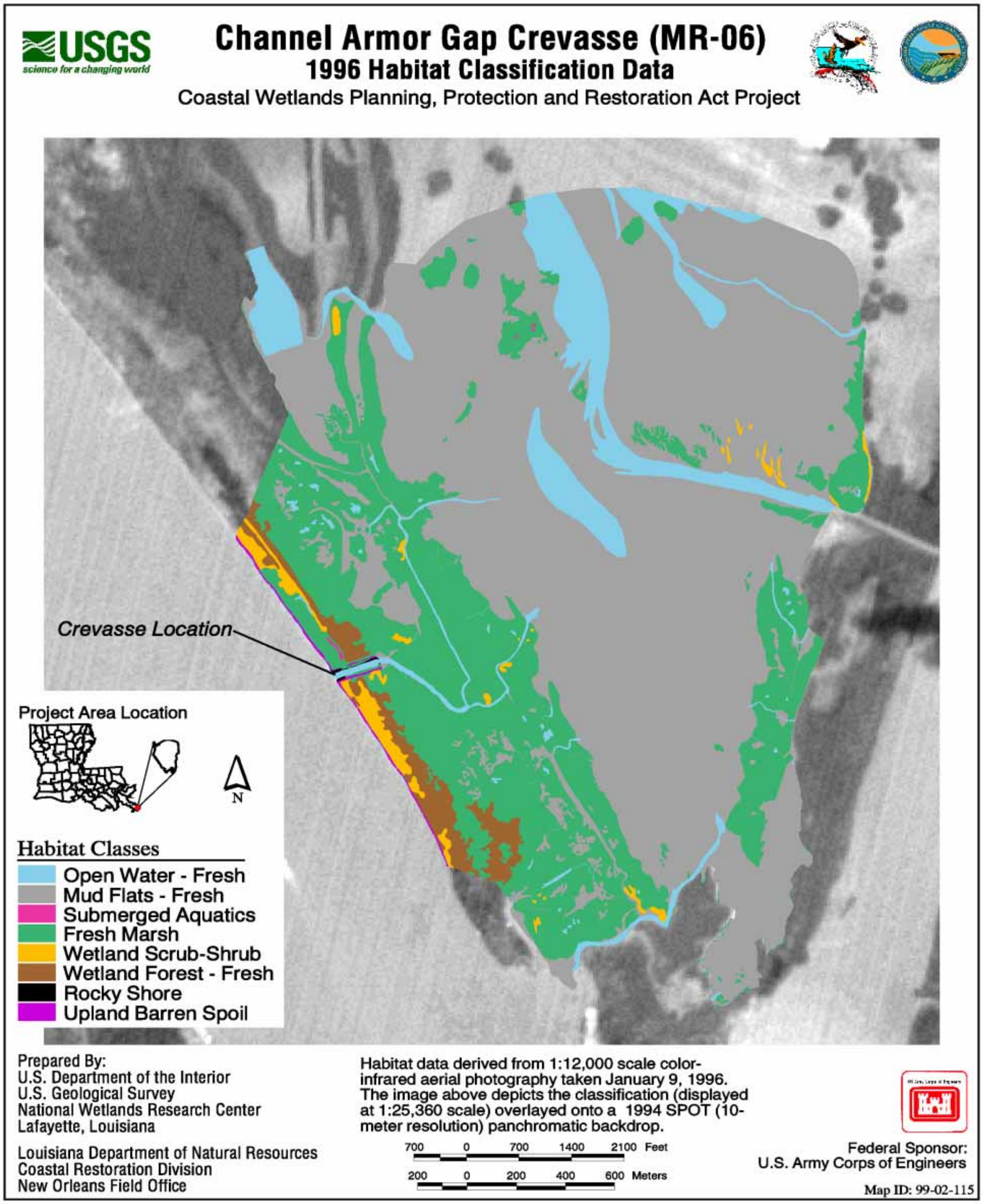

Figure 5. Preconstruction habitat analysis of the Channel Armor Gap (MR-06) project area.

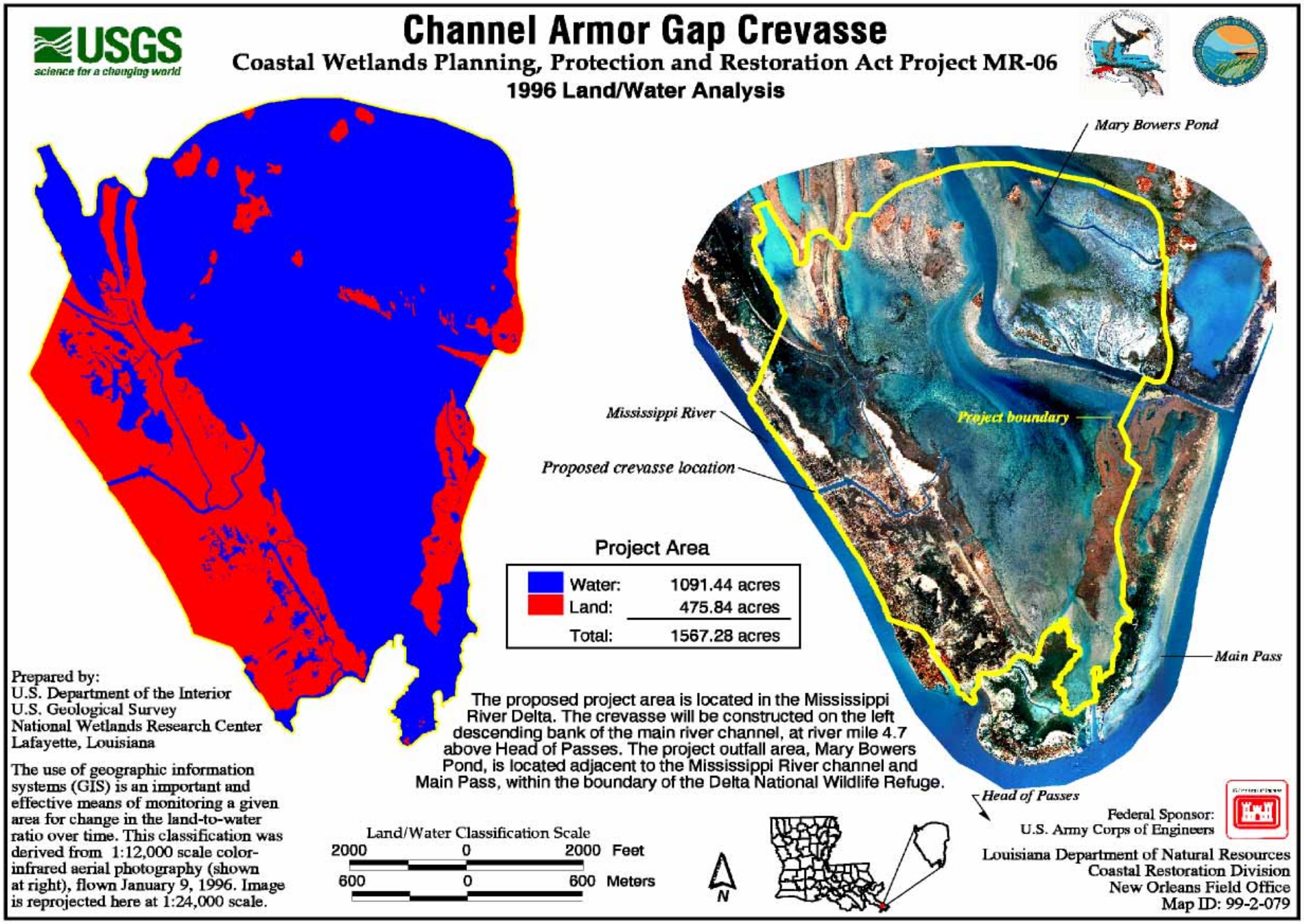

Figure 6. Preconstruction aerial photography and land/water analysis of the Channel Armor Gap Crevasse (MR-06) project area.

Results from the land/water analysis indicated that 476 ac (193 ha) of the project area were land, and 1091 ac (442 ha) were open water, a ratio of 30% land to 70% open water (figure 6). As was seen from the distribution of habitat types, most of the land was located adjacent to the MR and Main Pass levees, except for land associated with the crevasse on the east side of the receiving bay and the islands of fresh marsh in the northern portion of the bay.

Discussion

Differences in discharge and suspended sediment load between the mouth and end of the crevasse are most likely due to the manner in which the crevasse was constructed. During excavation, spoil was not piled continuously along the channel near the end of the crevasse, leaving openings in the crevasse levee near the receiving bay. Furthermore, a small canal that bisects the crevasse channel was left open. As a result, some of the water that enters the mouth of the channel is dispersed through these openings before reaching the end of the channel.

Discharge for the MR is markedly seasonal, with highest flows from February through May and lowest flows from September through November (Mossa 1988, Reed 1995). Suspended sediment concentration generally follows a similar pattern, with highest concentrations occurring during high flow periods and lowest during low flow months (Mossa 1988, Reed 1995). Hence, our discharge and suspended sediment load data from the crevasse were generally expected, except for the October 1998 sample. The high sediment load relative to discharge resulted from a comparatively high suspended sediment concentration in the crevasse channel, which was likely due to high winds reported in the area when the sample was taken. High winds associated with weather events resuspend sediments in coastal lakes and bays (Cahoon and Turner 1987; Reed 1989), and resuspension of sediments in the receiving bay, coupled with wind-driven tides and a reversal of flow in the crevasse, would account for the high suspended sediment concentration in the crevasse channel during a low discharge period for the MR. This scenario was also documented on October 20, 1999, during a field trip to the project area. Although the pattern of flow in the area is generally from south to north, strong northerly winds associated with a passing cold front increased tides and suspended sediments (as evidenced by water color) in the receiving bay, and the pattern of flow was reversed in the area. Consequently, sediment-laden water from the bay flowed out of the crevasse and into the MR. At the same time, MR water was relatively clear (green), indicating that the source of the sediments was the disturbed receiving bay and not the river. Arndorfer (1973) described a similar reversal of flows through crevasses and attributed the process to tidal action.

Elevation, habitat and land/water data are baseline information that describe preconstruction conditions in the project area. However, another feature of the project area that needs to be noted is the two additional crevasses that flow into the receiving bay. One crevasse, located at the southern tip of the project boundary above Cubits Gap (figure 2), was constructed by the U.S. Army Corps of Engineers in 1995. The second larger crevasse, which was constructed by the Superior and Mobile Oil Company in 1985 and re-dredged by USFWS in 1995, is located on the eastern side of the receiving bay, off of Main Pass. Effects from these crevasses are evident in the preconstruction data and will persist throughout the project’s life. The most obvious effect is on habitat data and the land to water ratio of the project area. The land created by both of these crevasses, particularly the larger one, is evident on both the habitat and land/water maps. Moreover, the elevation survey revealed that the most shallow locations in the receiving bay were nearest the two crevasses, whereas the deepest open water habitats were associated with a major flow channel of the larger crevasse. These additional crevasses will accelerate land-building in the receiving bay and help achieve the objective of this project. However, it may be difficult to isolate the direct effects of the project crevasse from the relative effects of the other two crevasses, especially in areas intermediate between the crevasses.

Although visible splay growth has been reported to occur in two or three years after an artificial crevasse is constructed (Boyer et al 1997), no subaerial land has formed in the project area after two years. Nonetheless, shoals were evident in areas of the receiving bay nearest the project crevasse. This crevasse is still in the beginning of the progradational phase of development, which is characterized by subaqueous infilling of the receiving bay and establishment of major flow channels (Wells and Coleman 1987). Only after a well defined channel pattern develops, thus creating an efficient sediment delivery system, will subaerial growth of the crevasse splay begin to increase (Wells and Coleman 1987).

Conclusions

Data in this report provide a description of the preconstruction conditions of the Channel Armor Gap Crevasse (MR-06) project area. Except for discharge and suspended sediment data, which were dropped from monitoring, no postconstruction data were collected. Therefore, conclusions regarding the objectives of this project cannot be made at this time.

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