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Coast 2050 Region 3

ATCHAFALAYA SEDIMENT DELIVERY
AT-02

Second Priority List Sediment Delivery Project
of the Coastal Wetlands Planning, Protection, and Restoration Act
(Public Law 101-646)

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INTRODUCTION

The Atchafalaya Sediment Delivery (AT-02) restoration project is a distributary channel maintenance and delta-lobe island creation project located in the northwestern region of the Atchafalaya Delta in St. Mary Parish, Louisiana (Figure 1). The project was federally sponsored by the National Marine Fisheries Service (NMFS) and locally sponsored by the Louisiana Department of Natural Resources, Coastal Restoration Division (LDNR/CRD) under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA, Public Law 101-646, Title III). The project area consists of 2,182 acres (883 ha) of freshwater wetlands and shallow open water within the Louisiana Department of Wildlife and Fisheries (LDWF) Atchafalaya Delta Wildlife Management Area (WMA), and is bounded on the north by Mile Island, the west by East Pass and by Atchafalaya Bay to the east and south (Figure 2).

The Atchafalaya River has been a distributary of the Mississippi River for several hundred years. Presently, approximately thirty percent of the flow of the Mississippi River is captured by the Atchafalaya River and this level is maintained by the U.S. Army Corps of Engineers (USACE) Old River control structures at the Mississippi River and the Old River Diversion Channel. The Atchafalaya River Floodway, created to relieve floodwaters from the Mississippi River, had reached its capacity for holding sediments and subsequent to a large flood in 1973 there has been the development of subaerial islands in the Atchafalaya Delta (Van Heerden *et al.* 1991, Roberts 1998). These crevasse-splays represent one, if not the only, occurrence of land growth in Louisiana (Van Heerden *et al.* 1991, Boesch *et al.* 1994). However, dredging activities by the USACE along the Atchafalaya River Navigation Channel have created dredge-material islands that focus river sediments into the main channel and beyond the Point au Fer shell reef (Roberts 1998). These sediments are largely unable to contribute to delta building in the Atchafalaya Bay, but may contribute to mudflat progradation on the Louisiana chenier plain via the Atchafalaya mud stream (Wells and Kemp 1981).

In an effort to again retain sediment, and therefore increase wetland area within the Atchafalaya Delta, the Atchafalaya Sediment Delivery (AT-02) restoration project was designed. The project dredged two historical distributary channels of East Pass and deposited the dredged material on and behind the subaerial islands (Figure 3). The newly dredged channels should promote the deposition of river sediments consistent with natural processes. These processes include the deposition of flocculated silts and clays when these materials encounter higher salinity and low energy systems (i.e. low water velocity). Additionally, sand should be deposited during higher energy events such as spring floods when sediment laden water reaches the lower energy system behind the splays (Roberts 1998).

Sediment deposition increases the island elevation at varying rates depending on sediment particle size, and creates mudflats that are rapidly colonized by vegetation. Emergent marsh vegetation is important for the stability of wetlands and may even facilitate their progradation by trapping sediment during floods (Benner *et al.* 1982). During these periods of flooding, the vegetation not only traps sediment, but promotes the stabilization of the existing substrate by slowing passing water, therefore reducing surface friction and surface erosion. Moreover, it has been posited that decaying wetland plants also add biomass to islands and a lack of plant productivity may be partially

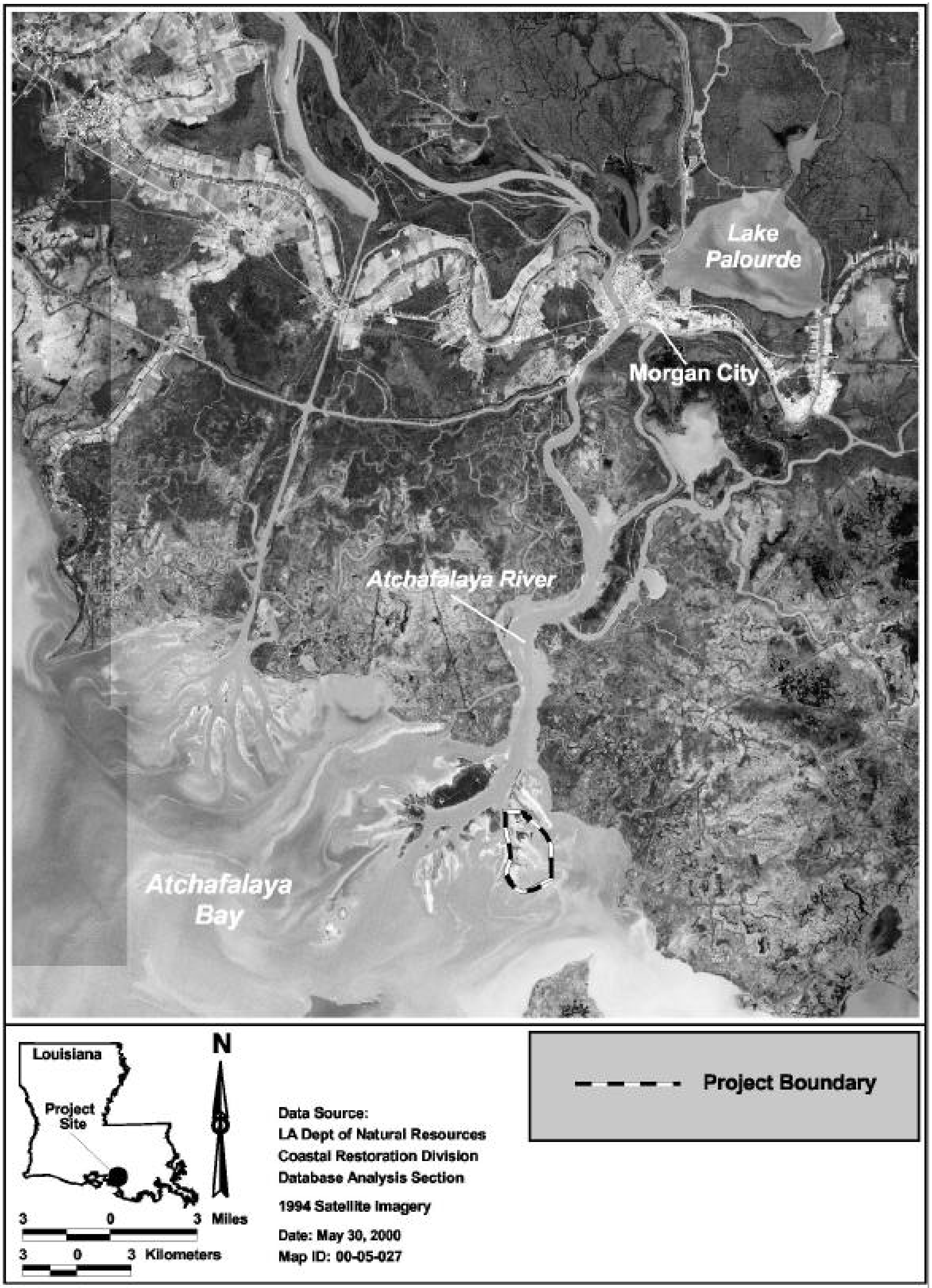

Figure 1. Location and the vicinity of the Atchafalaya Sediment Delivery (AT-02) restoration project.

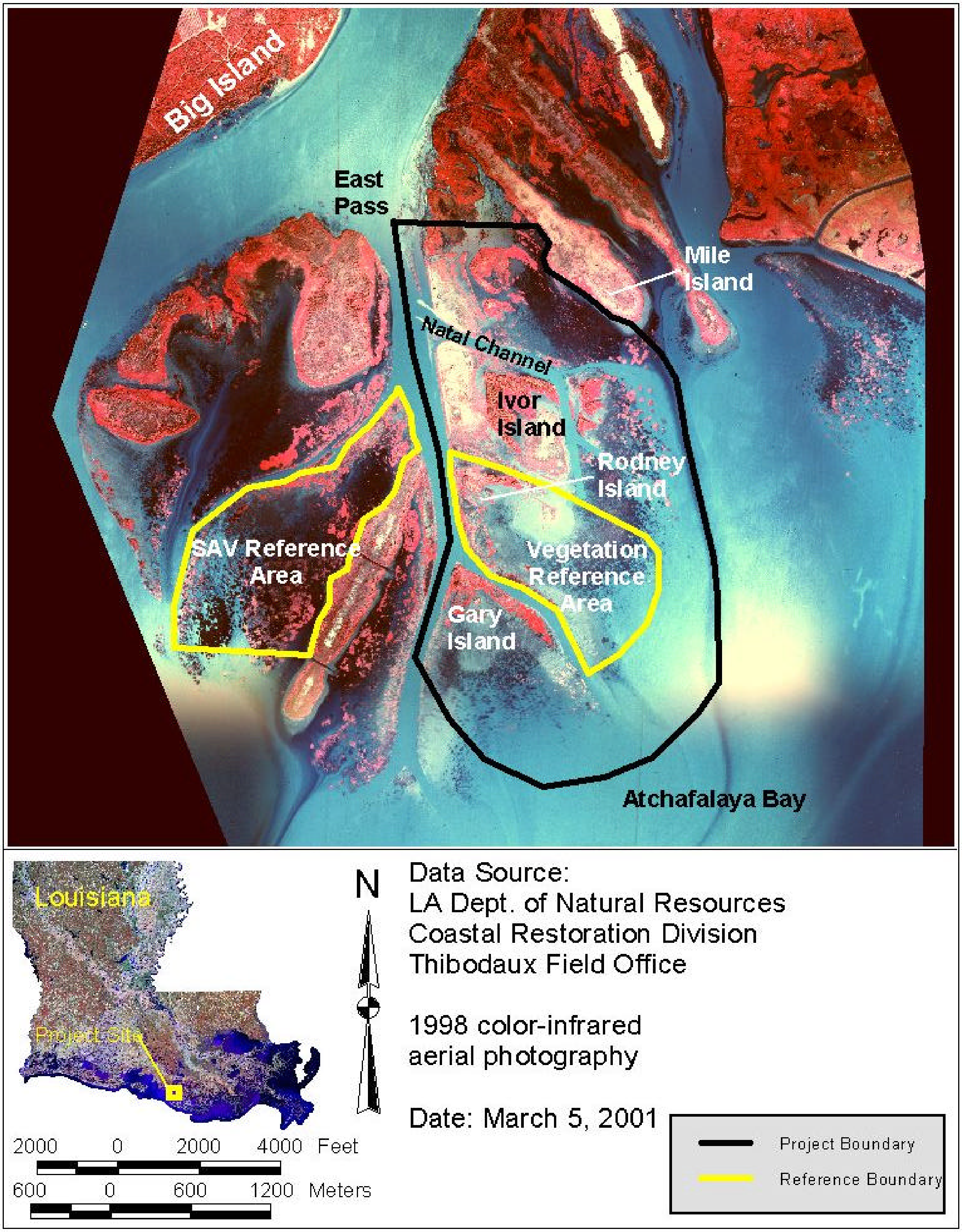

Figure 2. Atchafalaya Sediment Delivery (AT-02) restoration project and reference area boundaries.

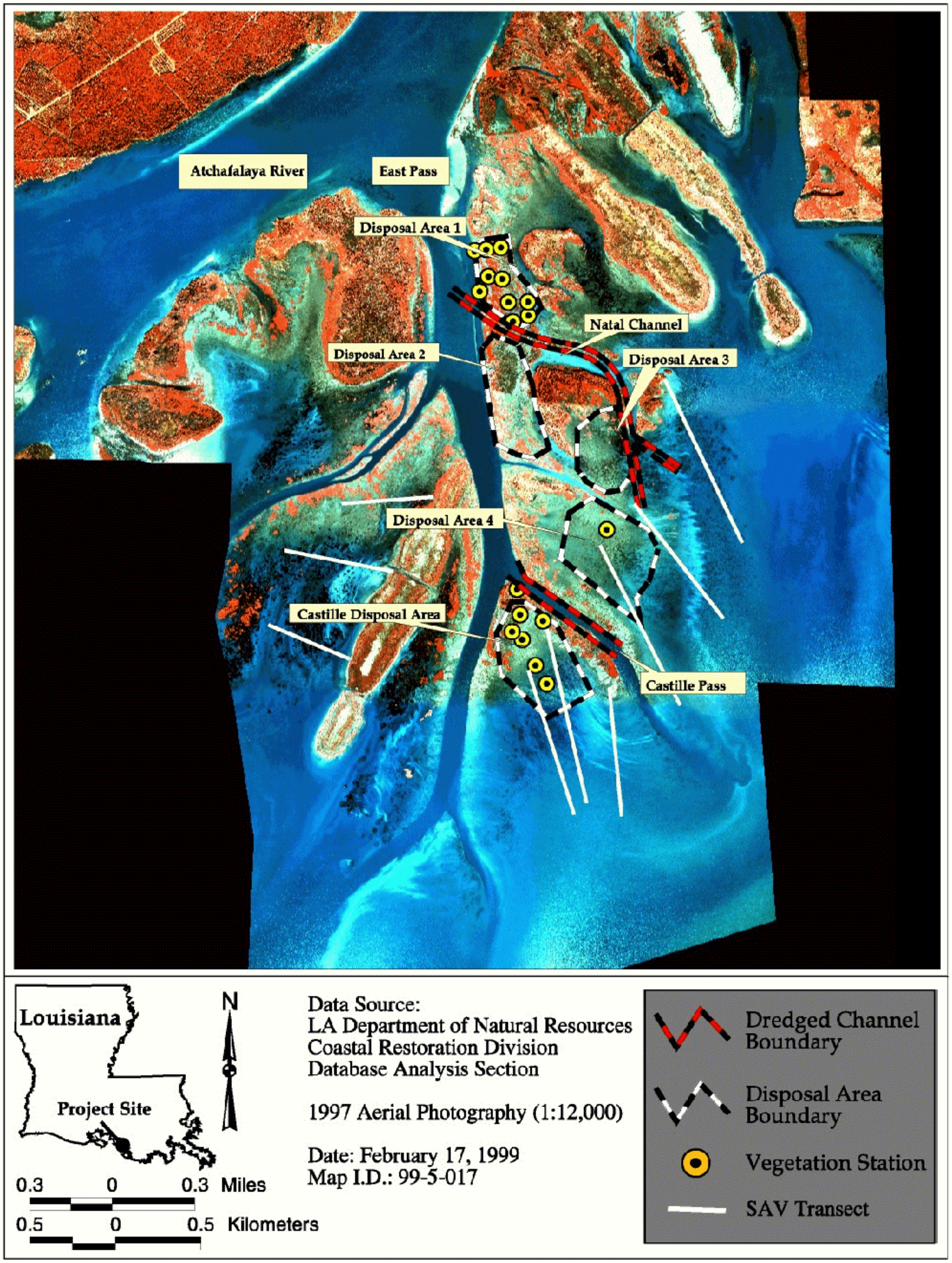

Figure 3. Atchafalaya Sediment Delivery (AT-02) restoration project features.

responsible for wetland loss in other habitats (Nyman *et al*. 1993). Freshwater wetlands support submerged aquatic vegetation (SAV) that may also be important in the continued development of wetlands by reducing bottom scouring and water velocity, therefore, promoting sediment deposition (Wetzel 1975, Carpenter 1981). Additionally, their own biomass may create habitat suitable for emergent vegetation (Carpenter 1981). In aquatic environments, submerged aquatic vegetation is an important component of nutrient cycling and provides organic and inorganic nutrients for other organisms (Carpenter 1981). These plants provide forage for waterfowl (Paulus 1982) and may also be important in fish production by providing a foraging substrate and refuge from predators (Rozas and Odum 1988, Duffy and Baltz 1998).

The project objectives are to restore Natal Channel and Castille Pass to functioning tertiary distributary channels, thereby enhancing the systems natural delta-building potential and utilizing the dredge-material with the intent to create delta lobe islands suitable for the establishment of emergent marsh.

The specific goals established to evaluate the effectiveness of the project are:

1) Increase the distributary potential of Natal Channel and Castille Pass by increasing their cross-sectional area and length.

2) Create approximately 230 ac (92 ha) of delta-lobe islands through the beneficial use of dredged material at elevations suitable for emergent marsh vegetation.

3) Increase the rate of subaerial delta growth in the project area to that measured from historical photographs since 1956.

4) Increase the frequency of occurrence of submerged aquatic vegetation.

METHODS

Project Features

The project re-opened two tertiary channels, Natal Channel and Castille Pass, from their confluences along East Pass (Figure 3). Prior to project construction, Natal Channel's elevation was 0.0 ft (0.0 m) NGVD at its juncture with East Pass and -1.0 ft (-0.3 m) NGVD near Teal Island. Natal Channel was dredged 8,800 ft long by 200 ft wide (2,682.2 m long by 61.0 m wide) to a depth of -10.0 ft (-3.0 m) NGVD with a branch channel 1,500 ft long by 150 ft wide (457.2 m long by 45.7 m wide) to a depth of -10.0 ft (-3.0 m) NGVD southeast of Teal Island (Figure 3). Castille Pass had a subaqueous bar at its head restricting flow. However, beyond the bar was a well defined channel 6 ft (1.8 m) deep and 120 ft (36.6 m) wide. Castille Pass was dredged at it's mouth a distance of approximately 2,000 ft by 125 ft wide (609.6 m long by 38.1 m wide) to a depth of -10.0 ft (-3.0 m) NGVD (Mayer 1999).

The channels were dredged using two 20-in. (50.8 cm) hydraulic cutterhead dredges. The dredged material was pumped through 20-in. (50 cm) pipes to the disposal areas where it was deposited and spread out with marsh backhoes (Mayer 1999). Disposal Area 2 developed a breach in the east side of the containment dike which allowed dredged material to flow out before it was closed. This increased the size of the disposal area by nearly 20 ac (8 ha) from the original design (V. Cook, LA DNR Project Engineer, pers. comm.).

Natal Channel had 668,683 yd^3 (511,244.8 m^3) of sediment dredged and placed in four designated disposal areas to create four dredge-material islands. Castille Pass had 32,242 yd^3 (24,650.8 m^3) of sediment dredged and placed in a single disposal area. Disposal Areas 1, 2, and 3 at Natal Channel were constructed with perimeter containment dikes using an 8.0 yd^3 (6.1 m^3) bucket dredge. Disposal Area 4 at Natal Channel and the disposal area at Castille Pass were constructed without containment dikes since these two disposal areas were considered far enough away from the dredged channels that material would not refill them (Mayer 1999). The project was completed on March 28, 1998.

Monitoring Design

A detailed description of the monitoring design over the entire project life is outlined by Bourgeois (1998). Measurable variables chosen to evaluate project effectiveness were habitat mapping, vegetation, SAV, elevation and bathymetry.

Habitat mapping: The U.S. Geological Survey's National Wetlands Research Center (NWRC) obtained 1:12,000 scale color infrared aerial photography. It was classified and photo-interpreted to measure land to open water ratios and map habitat type changes in the project area. Pre-construction photography was obtained December 19, 1994 and again November 24, 1997 (Figure 4). Post-construction photography was obtained on November 3, 1998 by the LDWF (Figure 4). The aerial photographs were scanned at 300 pixels per inch and georectified using ground control data collected with a global positioning system (GPS) capable of sub-meter accuracy. These individually georectified frames were assembled to produce a mosaic of the project area. Water level

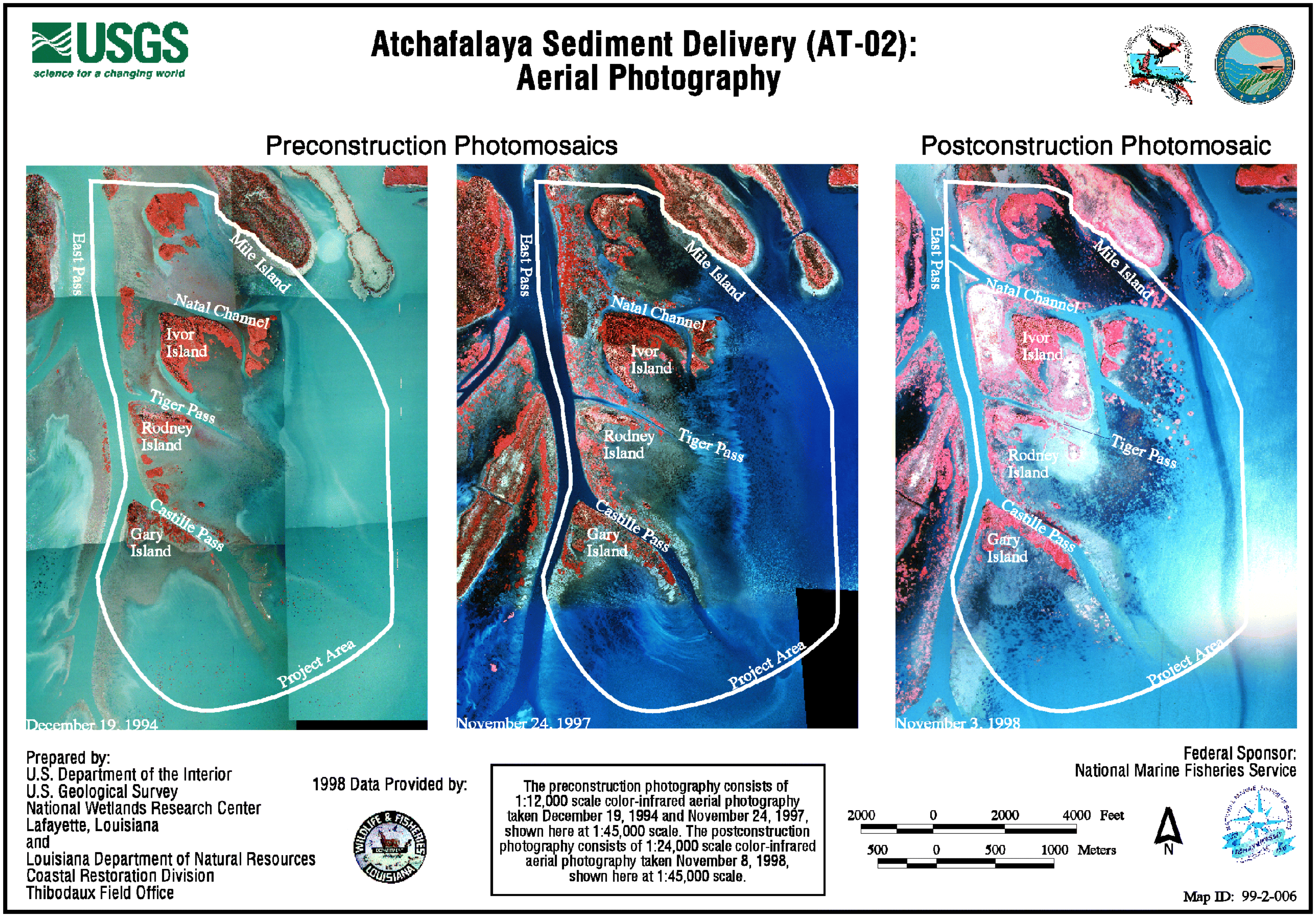

Figure 4. **Atchafalaya Sediment Delivery (AT-02) restoration project 1994 and 1997 pre-construction and 1998 immediate post-construction aerial photography.**

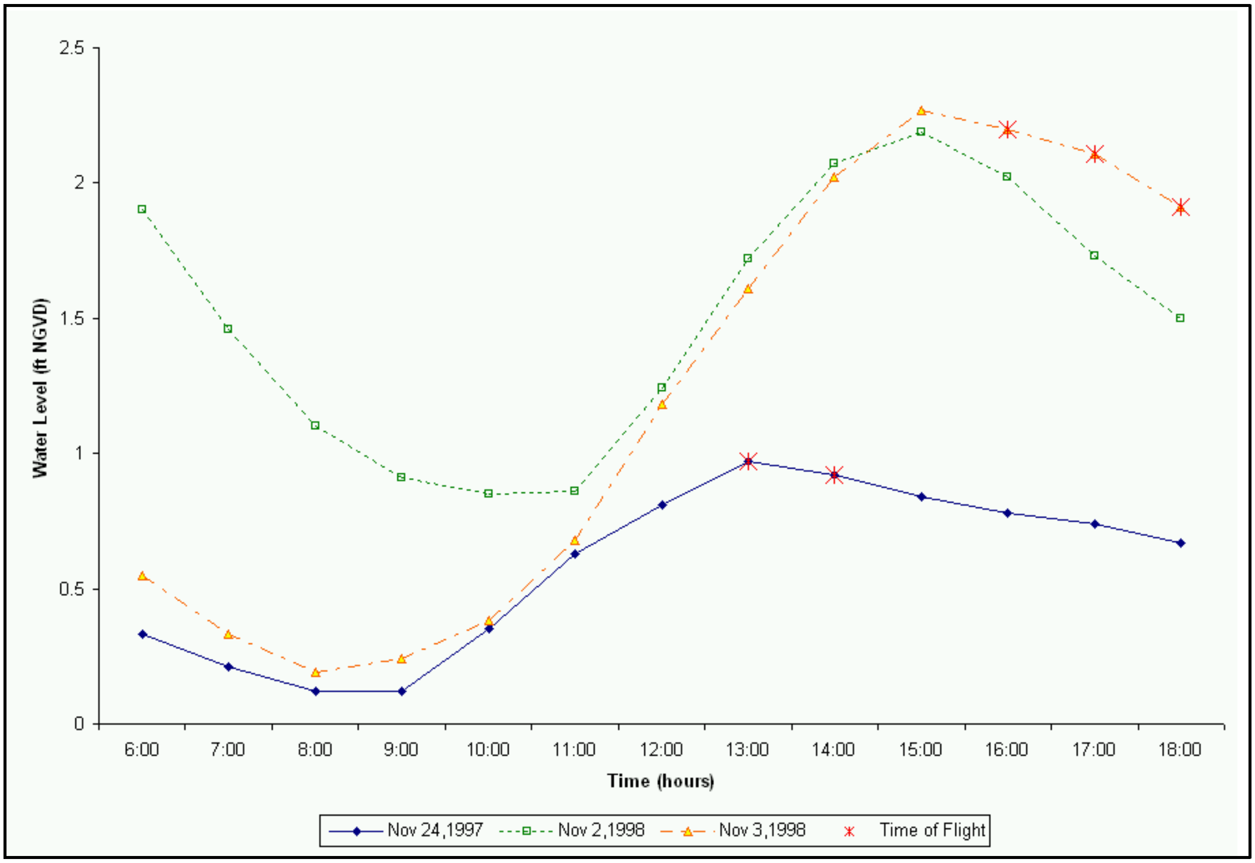

Figure 5. Tide level data for U.S. Army Corps of Engineers hydrologic monitoring station in Atchafalaya Bay at Eugene Island. Aerial surveys were conducted on November 24, 1997 and November 3, 1998. SAV sampling was conducted on November 2, 1998.

was obtained from the USACE Atchafalaya Bay/Eugene Island gauge to evaluate the effects of water levels on habitat interpretations (Figure 5). Water levels were available during the 1997 and 1998 flights, but not during the 1994 flight.

Using the National Wetlands Inventory (NWI) Classification System, the 1994, 1997 and 1998 photography was photo-interpreted by NWRC personnel and classified to the subclass level (Cowardin *et al*. 1979). Classification of photography to the NWI subclass level yielded distinct habitat types in the project area. The habitat delineations were transferred to 1:6,000 scale Mylar base maps and digitized. After being checked for quality and accuracy, the resulting digital data were analyzed using GIS to determine habitat change over time in the project area. The habitat types were aggregated into habitat classes for the purpose of mapping change (Appendix A). Habitat classes were combined further, to assess land/water ratio changes. Land was considered to be a combination of fresh marsh, wetland forested, and upland barren. All other habitat classes were considered water.

Vegetation: In order to sample a range of elevations and different vegetated areas, a total of eighteen 1 m^2 vegetation stations were established on two disposal areas at Natal Channel and on the disposal area at Castille Pass. Plots were delineated every 600 ft (182.88 m) along the surveyed elevation baselines and transects on the disposal areas in October 1998 and were marked with a PVC pipe (Figure 3). The stations were located starting at the northern end of the survey baseline until either the end of the island was reached or no vegetation was apparent. The transects were done similarly with the starting point at the side nearer the dredged channel. Station locations were determined using a differential global positioning system (DGPS), and the coordinates were recorded. Additional vegetation stations will be established as vegetative cover increases.

The 1 m^2 plot is a variation of the standard relevé, or Braun-Blanquet, method (Mueller-Dombois and Ellenberg 1974). This method is rarely used in North America (Barbour *et al.* 1999), however, it has been used in southern Louisiana to characterize marsh vegetation types with a fairly high degree of success (Shaffer *et al.* 1992, Visser *et al.* 1996). Plant species at each station were identified, and cover values were ocularly estimated using Braun-Blanquet units (Mueller-Dombois and Ellenberg 1974) as described in Steyer et al. (1995). The cover classes used were: solitary, <1%, 1-5%, 6-25%, 26-50%, 51-75%, and 76-100%. After sampling the 1 m^2 plot, the residuals were inventoried. Residuals are those species not in the plot, but within 15 meters of the plot edge and were recorded only as present with no assigned cover class. We used Thomas and Allen (1993, 1996, 1998) nomenclature for our species list.

A reference area was chosen to provide statistical comparisons of vegetative communities and elevation between newly created crevasse-splays and naturally formed crevasse-splays in order to determine project effectiveness. The choice was based on its proximity, elevation, plant communities, possible future use as a dredged material disposal area, and historic vegetation data. Rodney Island (Figure 2) was chosen because it was not designated as a future disposal area, it was expected to experience the least impact due to the project, and had historic vegetation data sets collected by Louisiana State University/Coastal Ecology Institute (LSU/CEI). Elevation and vegetative communities on the island were typical of crevasse-splays in the Atchafalaya delta and it experienced the same tidal influences as the project area. However, it is inside the projects predicted area of influence and was partially covered by dredge material during construction. Therefore, only the historical data (1978 - 1998) will be used as a reference for comparison of the created crevasse splays vegetation communities.

In 1979, following the sub-aerial emergence of Rodney Island, the LSU/CEI established twenty-four 1 m^2 vegetation plots along its longitudinal transect; the transect originates at the head of the island and extends southeast. LSU/CEI personnel returned to Rodney Island nearly every year after 1979 to repeat sampling on the established plots, and add plots as island progradation continued. In 1980, 10 vegetation plots were established along the transverse transect, which originates along the southwest edge of Rodney Island and extends northeast. Due to rapid delta growth, and subsequent growth of Rodney Island, new vegetation plots along both transects were/are established nearly every sampling period. The total number of plots sampled in 1980, 1982, and 1998 were 34, 34, and 55, respectively. The method of inventory was the same as mentioned above.

Rodney Island vegetation cover data from 1979, 1980, 1982, and 1998 were compared to the Atchafalaya Sediment Delivery (AT-02) vegetation cover data from 1998 to detect differences in vegetation type between natural and created crevasse-splay communities. Using PC-ORD© version 4 (McCune and Mefford 1999), we used non-metric multidimensional scaling (NMS) (Kruskal 1964, Mather 1976, McCune and Mefford 1999) to search for differences in vegetation communities between islands, potentially identify environmental gradients, and test the effects of elevation on species distribution for those years that surveys were conducted (Rodney 1980, 1982, and AT-02 1998). Using the elevation data, we created classes for use as a categorical overlay against the species data in PC-ORD. We found no previous work suggesting definitive elevation ranges for delta vegetation, so we created 5 classes with the 1st and 5th classes being larger to encompass outliers. The classes are (1) < 0.5 ft, (2) 0.5 to 0.75 ft, (3) 0.76 to 1.00 ft, (4) 1.01 to 1.25 ft, and (5) > 1.25 ft. We ran a total of 10 ordinations using the median of the Braun-Blanquet range assigned to each species within each vegetation plot. The overstory (woody vegetation $1.4 m in height) was solely occupied by *Salix nigra* (black willow), and was grouped with the understory (all herbaceous vegetation and woody vegetation # 1.4 m in height) for analyses. The combination of strata was not due to the exclusive occurrence of *S. nigra*. Instead, it was the limitations of the Braun-Blanquet method, used by both LDNR and LSU/CEI, when used to sample an area with an overstory component. The limitations are a small plot size and the absence of diameter measurements; which, in this case, do not allow for the adequate characterization and analysis of species for overstory community structure.

<u>Submerged Aquatic Vegetation</u>: Submerged aquatic vegetation (SAV) was sampled 1 growing season post-construction in November 1998 to determine species composition and relative frequency of occurrence on two mudflats in the project area and a reference mudflat (Figure 3). Mudflats were sampled for presence or absence of SAV along transects using the rake method (Chabreck and Hoffpauir 1962; Nyman and Chabreck 1996). Three transects were sampled south of Castille Pass, three near Natal Channel, and three west of East Pass in the SAV reference area. A reference area was also chosen to provide statistical comparisons of submerged aquatic vegetation (SAV) between the project area and a similar area outside the project area. The choice was based on proximity, use as a dredged material area, depth, and inflow from a natural channel. The back-bar algal flat, west of East Pass, between Vise Grip Channel and East Pass (Figure 2), was chosen as the reference area. Specifically, because it was opposite the project area along East Pass, was not recently used as a dredge disposal site, appeared to be at a similar elevation and tidal regime, and receives freshwater input from East Pass and Vise Grip Channel. There were no pre-construction data collected because the SAV component was added to the monitoring plan after project construction was completed in March 1998. Comparisons of relative frequency of occurrence, species richness and average depth among species and areas were made.

<u>Topography/Bathymetry</u>: Disposal area topography transects and channel bathymetry cross sections were established by the construction contractor utilizing GPS real-time kinematic survey equipment. Pre-construction surveys occurred in February and March 1998. Post-construction surveys were conducted in March and April 1998 along the same transects. Channel cross-sections were surveyed approximately every 100 ft (30 m). Surveys were conducted in the Louisiana State Plane Coordinate

System (South Zone), North American Datum of 1927 (NAD27), and vertical measurements were referenced to the National Geodetic Vertical Datum of 1929 (NGVD).

Survey data were re-projected horizontally to a Universal Transverse Mercator (UTM) NAD27 coordinate system and imported into GIS software for surface interpolation. A triangulation-based terrain model (TIN) was generated from each data set and grids (1 m^2 cell size) were generated from each TIN model in order to calculate elevation and volume changes. Elevation changes were computed using the Map Calculator routine of the Spatial Analyst® extension of ArcView® GIS software, and a tool was customized to calculate area and volume of Natal Channel and the five disposal areas. Natal Channel A and Castille Pass post-construction surveys were not provided to LDNR/CRD monitoring section for analysis in this report.

A tool was customized in ArcView® to calculate volumes of individual survey cross-sections/areas. The -25 foot (-7.6 m) NGVD contour was selected as a base elevation for all calculations. This elevation was below the minimum elevation (-13 ft) in Natal Channel. Since the pre- and post-construction surveys for each area varied in size, only the intersection of the pre- and post-construction surveys could be used to calculate elevation and volume changes. After the elevation-change maps were generated, volume changes at each site were calculated to quantify the amount of sediment dredged from Natal Channel and deposited in the disposal areas.