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Coastal Protection and Restoration Authority

2016 Operations, Maintenance, and Monitoring Report

for

Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration (BA-35)

State Project Number BA-35
Priority Project List 11

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Table of Contents

Preface

The Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration (BA-35) project was funded through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) on the 11th Project Priority List with the National Marine Fisheries Service (NMFS) as the federal sponsor. The 2016 Operations, Maintenance, & Monitoring (OM&M) report for BA-35 will be the 1st in a series of reports to summarize monitoring and O&M activities conducted during the life of the project. This report includes monitoring data and Annual Maintenance Inspections available through 2016. Additional documents pertaining to the BA-35 project may be accessed on the CPRA website at https://cims.coastal.louisiana.gov/outreach/ProjectView.aspx?projID=BA-0035 or on the CWPPRA website at https://www.lacoast.gov/new/Projects/Info.aspx?num=ba-35.

I. Introduction

The Barataria/Plaquemines barrier shoreline system is about 30 miles long, reaching from Grand Terre Island to Sandy Point, Louisiana. The Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration (BA-35) project is located within this barrier shoreline system between Chaland Pass and Grand Bayou Pass in Plaquemines Parish, Louisiana (Figure 1). This project was developed as part of the comprehensive Barataria Shoreline Complex Project with the goal of restoring the entire Barataria barrier island and headland chain. The Barataria shoreline is an important coastal barrier in protecting the residential communities, infrastructure, and interior marshes of Barataria Bay. This barrier shoreline provides unique habitat for coastal fisheries and wildlife and helps protect natural and human resources from tidal inundation, storm surge, and wave action. The Barataria barrier chain, like all of Louisiana's barrier islands, is experiencing accelerated land loss through a complex interaction of global sea level rise, compactual subsidence, frequent and intense storm impacts, inadequate sediment supply, and human disturbance (Penland et al. 1988; McBride et al. 1989).

Barrier shoreline change analyses conducted through the Barrier Island Comprehensive Monitoring Program (BICM) have demonstrated accelerated shoreline loss rates along the Barataria island chain (Table 1; Martinez et al. 2009). The recent shoreline change rate for the Modern Delta region, which includes the BA-35 project area, was estimated to be -118.3 ft/yr (1996-2005), as compared to a historic change rate of +15.2 ft/yr (1855-2005). The Chaland Headland Region, which contains BA-35, showed an increase in the shoreline loss rate from the historic average of -22.4 (1855-2005) to -33.3 ft/yr (1996-2005). The pre-Hurricane Katrina land loss rate since 1988 was estimated to be over 73 acres/yr, resulting in a predicted short-term year of disappearance of 2014 (CRL 2000). In 1998, the width of the barrier headland separating Bay Joe Wise from the Gulf of Mexico measured only 60-100 ft from bay to gulf at its narrowest points (Figure 2) and by 2004 breaching of the island had begun to occur. The passage of Hurricane Katrina only 6 miles to the east in August 2005 caused extensive breaching in the shore face directly exposing Bay Joe Wise to the Gulf. Construction of the BA-35 project in 2009 directly restored the continuity of the barrier headland, thereby protecting the fragile marshes that rim Bay Joe Wise.

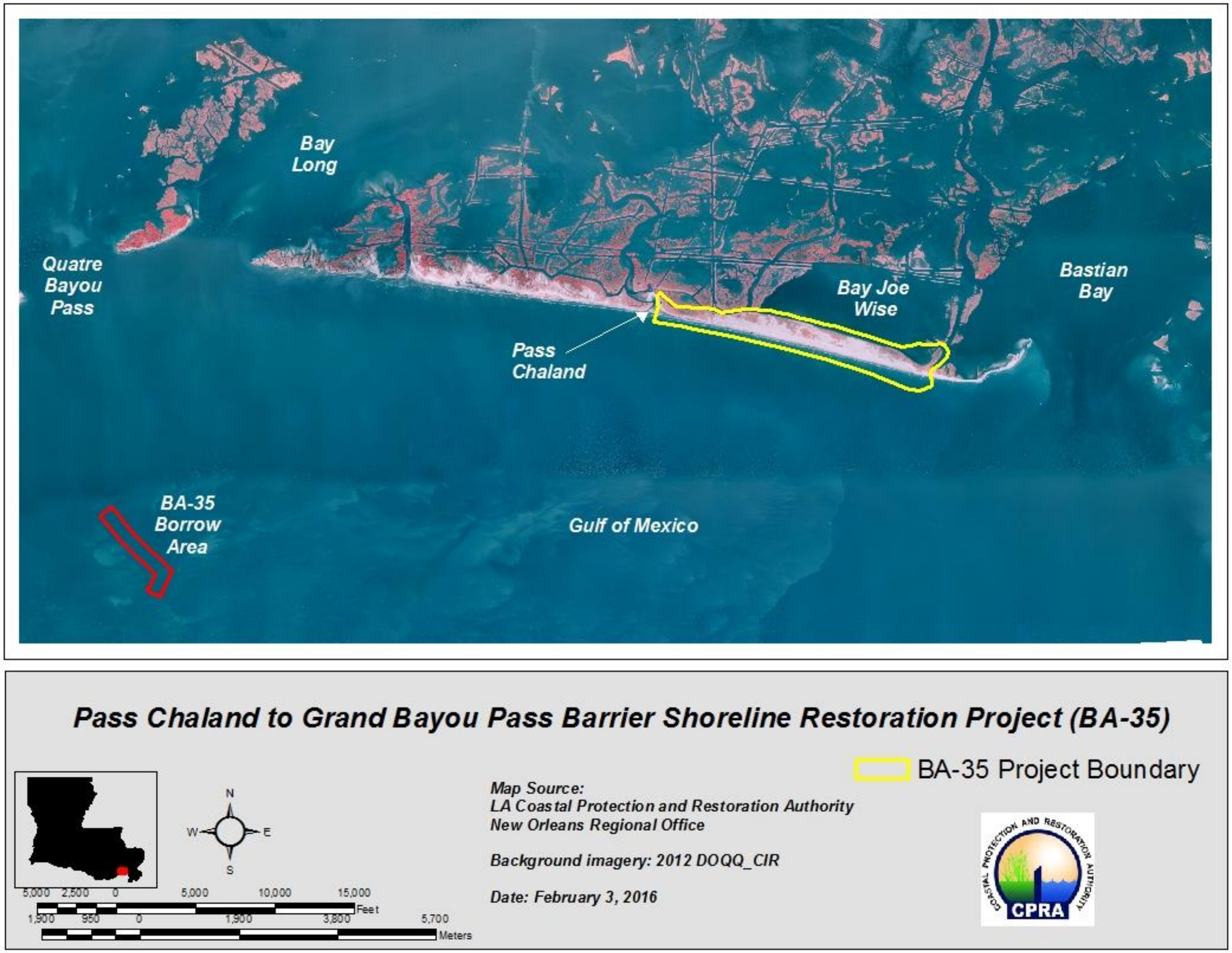


Figure 1. Pass Chaland to Grand Bayou Pass Barrier Restoration (BA-35) project location.

Figure 2. Aerial view of the Pass Chaland to Grand Bayou Pass barrier headland in 1998, 2005 (post-Hurricane Katrina), and 2012 (post-construction).

Table 1. BICM shoreline change analyses of regions containing the BA-35 project area (Martinez et al. 2009).

	Historic Change (1855-2005) Avg. ft/yr	Long-Term Change (1904-2005) Avg. ft/yr	Short-Term Change (1996-2005) Avg. ft/yr	Near-Term Change (2004-2005) Avg. ft/yr
Modern Delta	15.2	-30.2	-118.3	-528.5
Chaland Headland Region	-22.4	-20.2	-33.3	-79.9

The creation and restoration of dune, beach, and back-barrier marsh through the use of dedicated dredging is consistent with Louisiana's Comprehensive Master Plan for a Sustainable Coast (CPRA 2017), specifically, the Barrier Island/Headland Restoration Component. Generally, barrier island restoration involves increasing beach/dune cross-sections and improving the bayside marsh platform. The enhancement of the beach and dune will provide increased protection from storm-related surge and wave erosion through the reduction of island breaching or loss of major portions of the islands. Restoration of the marsh platform behind the barrier islands will reinforce the long-term stability of the headland system against major storm events. Prevention of island breaching (inlet cutting) and limitations on overtopping (washover) during storms are the primary mechanisms by which the project will provide storm protection (CPE 2003).

The purpose of the Pass Chaland to Grand Bayou Pass Barrier Restoration (BA-35) project was to rebuild and nourish the degraded barrier shoreline using the following strategies:

1) Create a marsh platform, beach berm, and gulfward beach fill using dredged material to increase island width and average height, thus prolonging the integrity of the island.
2) Install sand fences and vegetation plantings to stabilize placed dredged material.
3) Restore the tidal connection through post-construction excavation of placed material and breaching of containment dikes to create tidal creeks and ponds.

Extensive modeling of cross-shore sediment transport, circulation and water levels, and inlet stability was conducted to evaluate design alternatives in terms of performance, constructability, and environmental impacts and enhancements. Results were evaluated to ensure the project design did not greatly reduce flow, significantly alter water velocities, or cause significant changes to water elevations through the bay system. Results indicated that significant changes to the flow through the bay system were not anticipated provided the primary flow-way leading from the bay's west side to Pass Chaland was maintained. A water exchange channel through approximately eight acres of existing healthy marsh was designed and permitted to provide this essential flow-way. After extensive regional surveys, the borrow area was identified offshore in a relic distributary channel seaward of the Quatre Bayou Pass ebb shoal complex (Figure 1).

The BA-35 project area was impacted by storm events during both design and construction phases (Figure 3). In August 2005, Hurricane Katrina made landfall approximately six miles to the east of Bay Joe Wise directly affecting project design which had been recently completed in early 2005. An existing small breach enlarged significantly becoming the primary tidal exchange between the gulf and bay and transporting hundreds of thousands of cubic yards of sand from the beach and dune into the bay. Due to sediment infilling within Grand Bayou Pass, Pass Chaland became the sole construction access into the bay, which significantly increased the difficulty and related costs of construction. Three months after the notice to proceed was issued to begin construction, Hurricane Gustav passed to the west of the project area in September 2008 and again the project had to be resurveyed and redesigned. In total, material losses due to these hurricanes were measured at over 1 million cubic yards since the original design plan was completed in early 2005. The only major storm to impact the project area in the post-construction period as of the time of this report was Hurricane Isaac in 2012.

Construction of the BA-35 project was completed in June 2009 for a total cost of $35,047,527. The project created over 420 acres of beach, dune, and marsh platform through the placement of approximately 2.95 million yd^3 of fill (CEC 2010). A channel was incorporated at the western end of the project area to facilitate flushing of Bay Joe Wise through Pass Chaland. The beach and dune elements were constructed to elevations of +4.0 and +6.0 feet NAVD88, respectively. The marsh platform was constructed in three cells. The two easterly cells were constructed to the target marsh elevation of +2.6 feet NAVD88. The westerly cell, which included the breach, was constructed to an elevation of +2.9 feet NAVD88 to account for the primary consolidation settlement of the underlying soils due to the weight of the additional material placed in this cell to close the breach. Approximately 14,360 ft of sand fencing was installed along the dune to aid in sand retention. Planting of the beach/dune platform and the back perimeter of the marsh platform along the containment dike occurred in August 2009 and included the planting of sea oats (*Uniola paniculata*), bitter panicgrass (*Panicum amarum*), saltmeadow cordgrass (*Spartina patens*), gulf cordgrass (*Spartina spartinae*), gulf bluestem (*Schizachyrium maritimum*), seashore dropseed (*Sporobolus virginicus*) and smooth cordgrass (*Spartina alterniflora*).

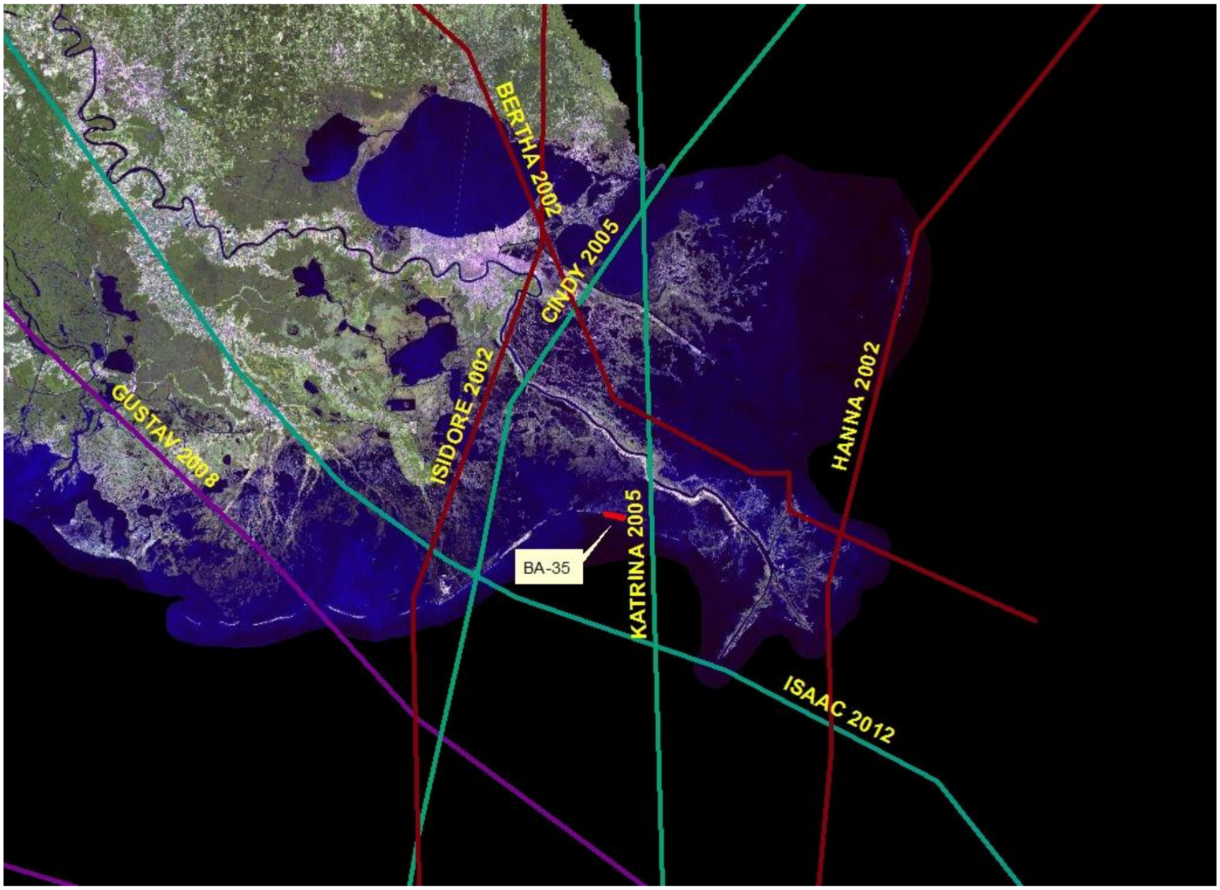


Figure 3. Tracks of major storms events impacting the BA-35 project area from design to post-construction (2002 through 2015).

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration (BA-35) project is to evaluate the constructed project features, to identify any deficiencies, and to prepare a report detailing recommended corrective actions, as needed. Should it be determined that corrective actions are needed, the CPRA shall provide a detailed cost estimate for engineering, design, supervision, inspection, and construction contingencies, and an assessment of the urgency of such repairs (OCPR 2009). The annual inspection report also contains a summary of maintenance projects and an estimated projected budget for the upcoming three (3) years for operation, maintenance and rehabilitation. The three (3) year projected operation and maintenance budget is shown in Appendix A.

An inspection of the Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration (BA-35) was held on May 28, 2015 by members of NOAA and CPRA. Inspection photographs and Field Inspection Notes are included in Appendix B and Appendix C, respectively.

b. Inspection Results

Sand Fence

Approximately 14,360 linear feet of sand fencing was installed during project construction. Hurricane Isaac caused significant damage to the sand fencing in 2012 and there are only remnants remaining; however, the significant vegetation coverage along the beach/dune platform is now performing the same function as the fencing, so there is no need to replace the fencing at this time.

Containment Dike

Due to poor access this feature was not inspected at this time; however, based on recent aerial photography it appears this structure has almost completely degraded. As a result, the hydrologic exchange between Bay Joe Wise and the marsh platform has been naturally established.

Settlement Plates

The settlement plates were not inspected on this site visit.

Vegetative Plantings

The vegetative plantings were successful in retaining sand and stimulating colonization immediately following construction. Natural colonization is successfully occurring as detailed in Section IV of this report.

c. Maintenance Recommendations

No maintenance is recommended at this time.

i. Immediate/ Emergency Repairs

- None at this time.

ii. Programmatic/ Routine Repairs

- No Programmed Maintenance is recommended at this time.

d. Maintenance History

N/A

III. Operation Activity

N/A

IV. Monitoring Activity

Project-specific data collection for the BA-35 project will be supplemented by data collected through the Barrier Island Comprehensive Monitoring program (BICM) as outlined in the BA-35 Monitoring Plan (Hymel 2015). To more effectively identify the magnitude, rates, and processes of barrier shoreline change, BICM was developed by the CPRA as a framework for a coast-wide monitoring effort (Troutman et al. 2003). A significant component of this effort includes documenting the historically dynamic morphology of the Louisiana nearshore, shoreline, and backshore zones. An advantage of BICM is that it will provide long-term morphological datasets on all of Louisiana's barrier islands and shorelines, rather than just those islands and areas that are slated for coastal engineering projects or have had construction previously completed. BICM will provide unified, long-term datasets that will be available to evaluate constructed projects, plan and design future barrier island projects, develop operation and maintenance activities, and assess the range of impacts created by past and future tropical storms. Initial BICM datasets collected include: 1) post-storm damage assessment photos and video, 2) shoreline positions, 3) habitat composition, 4) land/water analysis, 5) topography, 6) bathymetry, and 7) sediment characteristics. The project-specific monitoring for the BA-35 project will follow procedures used to collect BICM data. In addition to the BICM program, the Coast-wide Reference Monitoring System (CRMS) - *Wetlands* program (Folse et al. 2012) will provide supplemental aerial photography for the BA-35 project, when possible. In the event that BICM/CRMS data collection does not occur as scheduled, additional project-specific data collection will occur as outlined in the BA-35 monitoring plan.

a. Monitoring Goals

The goals of the BA-35 project (NMFS 2005) were to:

1) Nourish the Gulf shoreline and create, after initial equilibrium and settlement, 30 ac dune and 123 ac supratidal habitat by Year 3.
2) Create 226 acres of back-barrier marsh platform settled to intertidal elevation with unrestricted tidal exchange by Year 3.
3) To establish marsh vegetation (both planted and natural colonization).
4) Fill tidal inlets and overwash breaches, restore and create dune and marsh to increase island longevity, and maintain shoreline integrity.
5) Prevent breaching defined as failure of the beach/dune resulting in an opening of the island to tidal exchange between the Gulf and the bay.

Due to multiple project re-designs following Hurricanes Katrina and Gustav, the project footprint used to calculate acreage targets in the WVA (NMFS 2005) and Final Design Report (SJB and CEC 2005) differed from the actual as-built footprint. Therefore, some acreage targets listed in the WVA goal statements are not achievable. For example, the goal of creating 226 acres of back-barrier marsh is not possible because the as-built marsh fill area was reduced to 201 acres.

The following general monitoring goals will be used to evaluate the effectiveness of the project:

1) Monitor changes in elevation over time. Achieve an elevation of the back-barrier marsh platform such that by Year 3 the marsh elevation is within the intertidal zone, and remains within this zone through Year 20.
2) Monitor changes in the vegetation community (species composition and abundance) over time. On the dune and supratidal portions of the project, there should be 40% vegetation coverage at Year 3 and 60% coverage at Year 5. On the created marsh platform, there should be 37% vegetation coverage at Year 3 and 75% coverage at Year 5 (NMFS 2005).
3) Determine changes in habitat classes over time. The design objective was to protect or create 161 acres of barrier island habitat by Year 20.

b. Monitoring Elements

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

Aerial Photography

To determine changes in habitat types within the project area, near-vertical, geo-rectified photography was acquired in the pre- and post-construction periods. All photography was geo-rectified, mosaicked, and classified using BICM standard operating procedures (Troutman et al. 2003, Fearnley et al. 2009). The habitat classification follows Penland et al. (2003) and includes eight categories: Water, Intertidal, Marsh, Barrier Vegetation, Beach, Bare Land, Structure, and Rip-Rap. Pre-construction photography (Oct/Nov 2008) of the BA-35 project area was acquired and analyzed through CRMS/BICM and as-built photography (12/19/09) was acquired and analyzed using BA-35 project-specific monitoring funds. Additional post-construction aerial photographs of the project area will be acquired through CRMS and analyzed through BICM approximately every six years. The most recent photography was acquired in late 2016; however, the habitat analysis of the 2016 photography was not completed at the time of this report. A final habitat analysis will be conducted using project monitoring funds near the end of the 20-year project life (2028).

Vegetation

In October 2013, 50 vegetation sampling plots were established along 10 transects corresponding to the Barrier Island Comprehensive Monitoring (BICM) survey lines spaced approximately 1,500 ft apart (Figure 4). Using ESRI® ArcGIS 10.1, points were generated every 3 meters along each of the transect lines to generate a pool of prospective plots. In order to accurately characterize the vegetative composition of the different habitats of the island, plot selection was based on three habitat zones along each transect: 1) the upslope area, beginning at the backshore area and rising in elevation to the top of the dune (or highest elevation point) before sloping downward to a flat elevation, 2) the swale or platform which is relatively wide and uniform in elevation, and 3) the downslope or marsh zone often present along the back side of the island. Before going into the field, five potential plots were selected along each transect using 2012 post-Isaac imagery. The range of plot numbers falling into each habitat zone along each transect was determined, and random plot numbers were then selected from within each range. The number of plots randomly selected within each zone was dependent on the relative length of each zone. Coordinates for the 5 plots selected per transect, as well as the full set of potential plots, were then loaded onto a Trimble GeoXT unit to be used in the field.

When in the field, habitat zones were verified to ensure that the five selected plots were an accurate representation of the transect. Because habitat zones could not be predetermined with 100% accuracy using imagery, plots were reselected as needed.

Plots were reselected if they were located in ponds or channels, but plots containing only bare ground or dead vegetation were retained. All three habitat zones were not always present along each transect. Ten plots were established in the upslope/dune region, 23 plots were established in the platform (swale) region, and 17 plots were established in the marsh. At each sampling plot, species composition, percent cover, and relative abundance were evaluated within 4-m^2 plots using a modified Braun-Blanquet sampling method (Mueller-Dombois and Ellenberg 1974). A second vegetation survey of the same plots was conducted in October 2016, and future surveys will be conducted in 2019, 2023, and 2028.

Figure 4. Vegetation plots established within the Pass Chaland to Grand Bayou Pass Barrier Restoration (BA-35) project area.

Bathymetry and Topography

A combination of bathymetric and topographic surveys is being used to monitor changes in the cross-shore profile of the BA-35 fill areas. Surveys conducted through BICM are being used, when possible, to monitor project performance, but some project-funded surveys are being conducted in desired years where BICM data is not collected. LiDAR (Light Detection and Ranging) topographic surveys conducted through BICM cover the entire subaerial extent of the island. The resulting data provide a density of approximately 1 elevation point per square meter. BICM bathymetry data are being collected using single beam data acquisition and real time kinematic (RTK) survey methods along transects every 1,500 ft (457.2 m) on the gulf and bay sides of the island extending to 2 km offshore. Data are also being collected along transects 4,500 ft (1371.6 m) apart from 2 to 4 km offshore.

A summary of the available topographic and bathymetric datasets can be found in Table 2. Pre-construction bathymetric/topographic surveys were conducted in 2003 (BA-35 project design), 2006 (BICM) and 2008 (BA-35 pre-construction, post-Hurricane Gustav). Post-construction bathymetric/topographic surveys were conducted in 2009 (as-built) and 2010 (Year 1) using BA-35 project funds. The BA-35-funded surveys were conducted using RTK survey methods along cross-sectional transects spaced approximately 250 ft apart in 2008 and 2009 and 1,500 ft apart in 2010. Additionally, Year 4 LiDAR topography (2013) obtained by the USGS (DAS 2013) and Year 7 bathymetry (Jan 2016) obtained through BICM were merged to provide a Year 4/Year 7 dataset. Although there is a significant time gap between these two datasets due to unexpected delays in bathymetry data collection, there were no major storms during this period and the transition between the merged datasets produced acceptable results. Remaining post-construction surveys will be conducted approximately every 5 years through BICM.

Table 2. Summary of topographic and bathymetric datasets collected within the BA-35 project area.

Date	Source	Survey Type	Method	Geoid
2003	BA-35 Design	Topography/Bathymetry	RTK/Sonar	99
7/2006	BICM	Bathymetry	RTK/Sonar	03
12/2006	BICM	Topography	LiDAR	03
9/2008	BA-35 Pre-Construction	Topography/Bathymetry	RTK/Sonar	99
5/2009	BA-35 Post-Construction	Topography/Bathymetry	RTK/Sonar	99
9/2010	BA-35 Monitoring	Topography/Bathymetry	RTK/Sonar	03
3/2013	USGS	Topography	LiDAR	09
1/2016	BICM	Bathymetry	RTK/Sonar	03

Vertical elevations for the BA-35 design, pre-construction, and as-built surveys were referenced to NAVD88, GEOID99 (ft). All other surveys were adjusted to GEOID99 for comparison to these surveys. Each survey dataset was re-projected horizontally and vertically to the UTM NAD83 coordinate system and the NAVD88 vertical datum in meters using Corpscon® software. The re-projected data were imported into ESRI ArcGIS® 10.2.1 software for surface interpolation. When necessary, LiDAR and bathymetry point datasets were merged using the Merge tool in ArcGIS®. Triangulated irregular network (TIN) models were then produced from the point data sets. Next, the TIN models were converted to grid models [1.0 m^2 (3.3 ft^2) cell size], and the spatial distribution of elevations were mapped in one foot (0.31-m) elevation classes. The grid models were then clipped to polygons for the marsh and beach/dune creation areas to estimate elevation and volume changes within the project area.

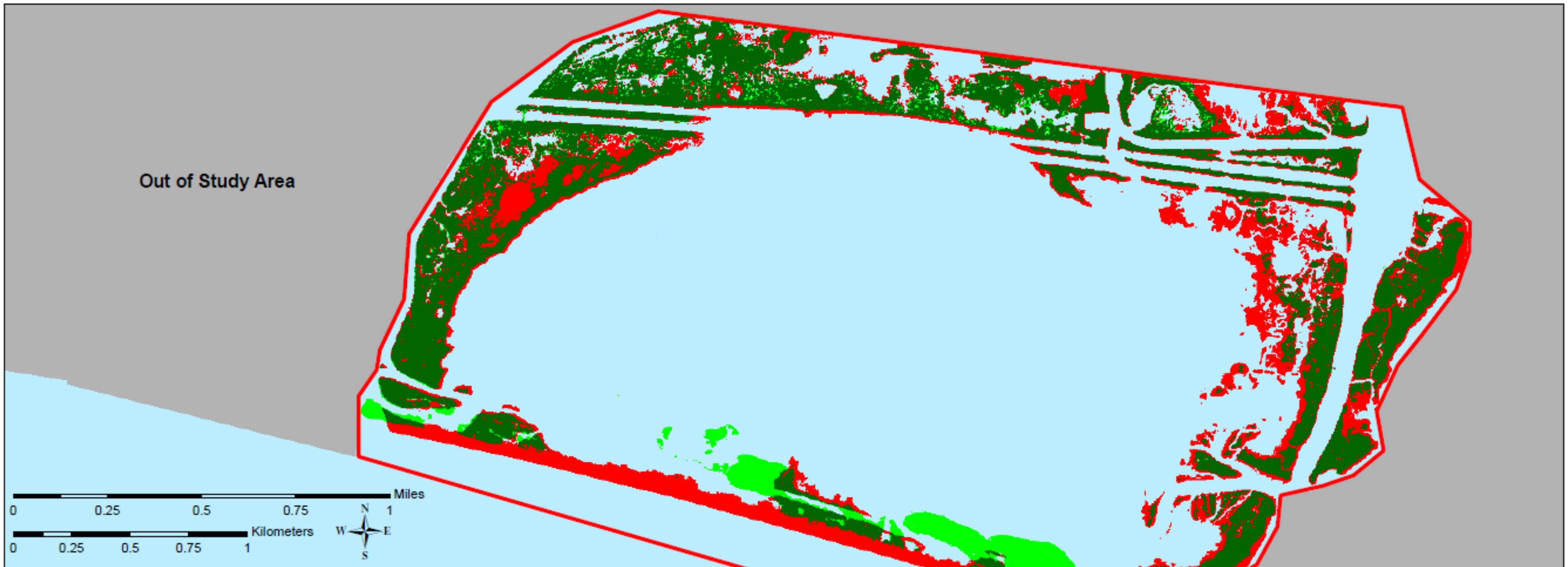
Elevation change grids were created by subtracting the corresponding grid models using the Spatial Analyst>Math>Minus tool. After the elevation change grid models were generated, the spatial distribution of elevation changes in the BA-35 fill area were mapped in one foot (0.31-m) elevation classes. Lastly, volume changes were calculated in cubic meters (m^3) using the 3D Analyst>Raster Surface>Cut/Fill function within ArcGIS®.

c. Monitoring Results and Discussion

i. <u>Aerial Photography</u>

From 1998 to 2005, the continuity of the barrier shoreline separating Bay Joe Wise from the Gulf of Mexico was compromised leaving Bay Joe Wise exposed to the increased wave activity of the Gulf. During this period, there was a net loss of 173 acres of land in the area of Bay Joe Wise (Fearnley et al. 2009, Figure 5), a loss rate of 25 acres per year. The purpose of the BA-35 project was to rebuild and nourish this degraded shoreline and to reinforce the island with a vegetated marsh platform. Habitat analyses of photography obtained of the BA-35 project area in 2008 (pre-construction) and 2009 (as-built) are presented in Figures 6 and 7. It should be noted that dredging of the water exchange channel had begun before the acquisition of the pre-construction photo in fall of 2008, as indicated by the presence of 22 acres of spoil. Although these impacts were relatively small, the resulting habitat analysis is slightly altered from true pre-construction conditions. The analyses show a gain of approximately 244 acres of land within the BA-35 project area immediately following construction (Table 3). The project area consisted of approximately 30% land and 70% water before construction and 58% land and 42% water following construction. The bare land category increased from 8.2% to 48.9% of the total acreage following construction. All other land categories showed a decrease in acreage following construction due to the homogeneous nature of the post-construction landscape, which resulted in an overall net land increase of 27.1%. The 43 acres of marsh habitat observed in 2009 (post-construction) occurred mainly in pre-existing marsh areas outside of the BA-35 marsh creation platform. Subsequent post-construction aerial photography of the project acquired through CRMS in 2016 indicates substantial growth of vegetation on the beach/dune and marsh creation platform; however, the BICM habitat analysis of this photography was not yet conducted as of the time of this report.

BICM Habitat Analysis: Bay Jo Wise, Modern delta Land Loss/Land Gain - 2005 from 1998



Legend

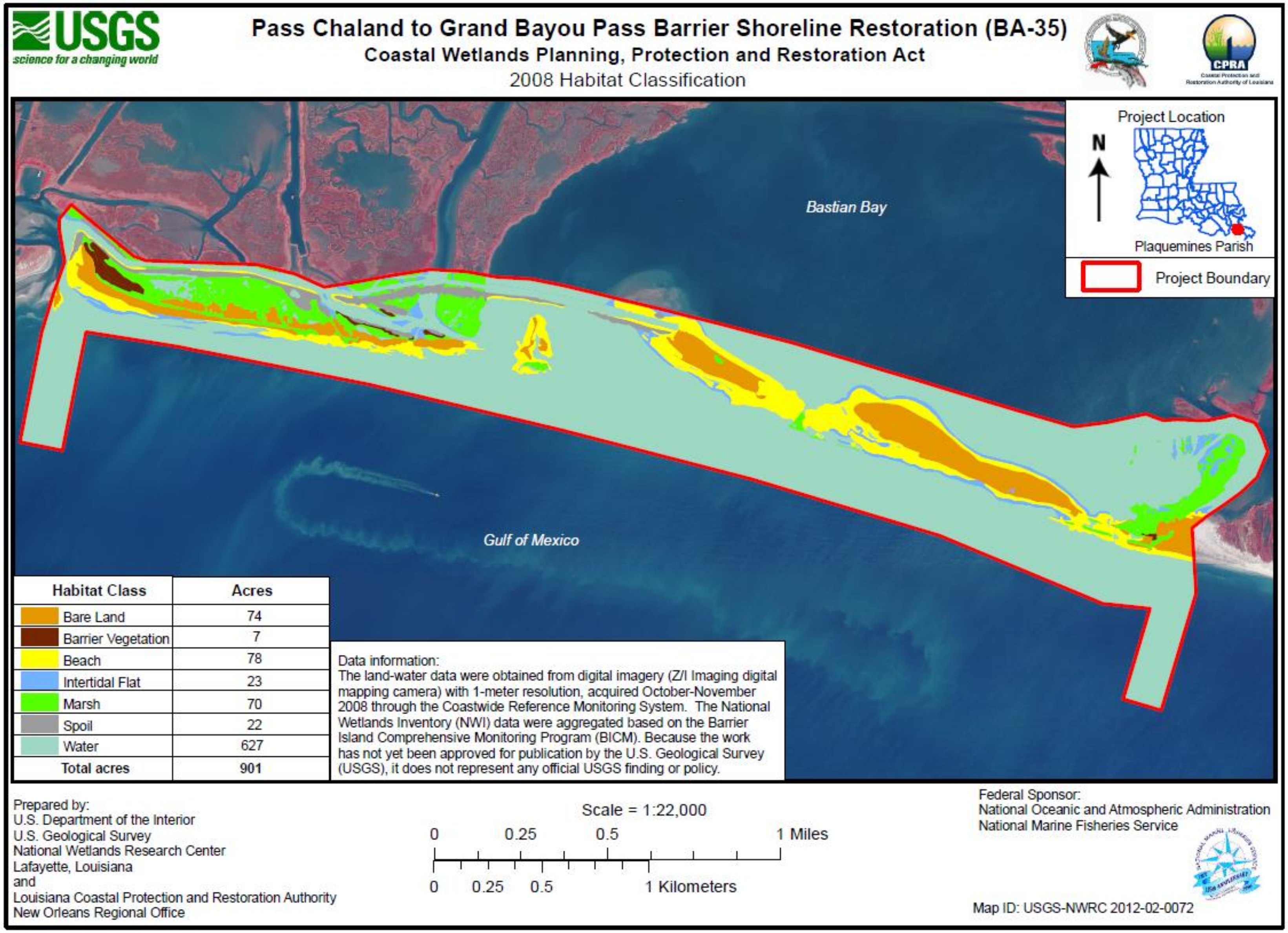
- water
- land gain
- land loss
- land unchanged
- analysis area

Habitat Classes	2005 from 1998	
	Acres	Hectares
Water	1682	681
Land Gain	52	21
Land Loss	225	91
Land Unchanged	357	144
Analysis Area	2315	937

The goal of the Habitat Analysis portion of the Barrier Island Comprehensive Monitoring (BICM) program is to classify the habitat types present along five delta regions in Louisiana for the time periods 1996/98, 2001/02, 2004, and 2005 and make comparisons between each time period. The western Chenier Plain extends extend from Sabine Pass to the Lower Mud Lake Entrance in western Louisiana; the Teche delta extends from Raccoon Point to Wine Island Pass; the Lafourche delta extends from Cat Island Pass to Quatre Bayou Pass; the Modern delta extends from Quatre Bayou Pass to Sandy Point; and the Chandeleur Islands extend from Breton Island to Hewes Point.

Funding for this project was provided by the LCA Science and Technology Program, a partnership between the Louisiana Department of Natural Resources (LDNR) and the US Army Corps of Engineers (USACE), through LDNR Interagency Agreement No. 2512-06-06. All work was completed by staff at the University of New Orleans - Pontchartrain Institute for Environmental Sciences.

Figure 5. Land change analysis from 1998 to 2005 of the area surrounding Bay Joe Wise.



Habitat Class	Acres
Bare Land	74
Barrier Vegetation	7
Beach	78
Intertidal Flat	23
Marsh	70
Spoil	22
Water	627
Total acres	901

Figure 6. 2008 habitat analysis (pre-construction) of the Pass Chaland to Grand Bayou Pass Restoration (BA-35) project area.

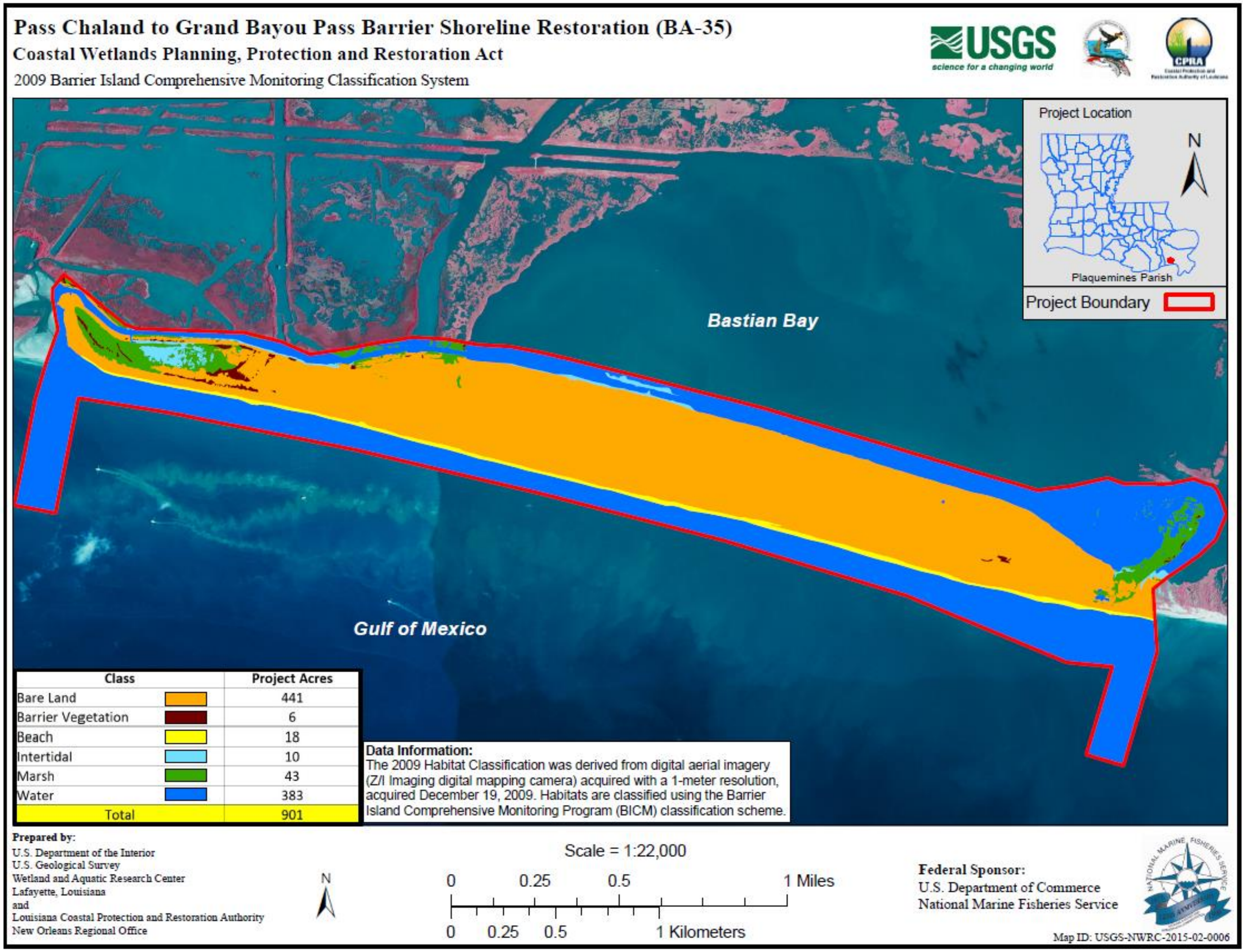


Figure 7. 2009 habitat analysis (as-built) of the Pass Chaland to Grand Bayou Pass Restoration (BA-35) project area.

Table 3. Summary of habitat changes within the Pass Chaland to Grand Bayou Pass Restoration (BA-35) project area from 2008 (pre-construction) to 2009 (as-built).

Habitat Class	BA-35 Project Area				
	2008	% of Total Acreage	2009	% of Total Acreage	Change in % of Total Acreage
Bare Land	74	8.2%	441	48.9%	+40.7%
Barrier Vegetation	7	0.8%	6	0.7%	-0.1%
Beach	78	8.7%	18	2.0%	-6.7%
Intertidal	23	2.6%	10	1.1%	-1.5%
Marsh	70	7.8%	43	4.8%	-3.0%
Spoil	22	2.4%	0	0%	-2.4%
Total Land Classes	274	30.4%	518	57.5%	+27.1%
Water	627	69.6%	383	42.5%	-27.1%
Total Acreage	901	--	901	--	--

ii. Vegetation

The establishment of vegetation through natural colonization and artificial plantings on the restored island is a primary goal of the BA-35 project. Plants were installed in August 2009 and included *Schizachyrium maritimum* (gulf bluestem), *Panicum amarum* (bitter panicgrass), *Uniola paniculata* (sea oats), *Sporobolus virginicus* (seashore dropseed), *Spartina patens* (saltmeadow cordgrass) and *Spartina spartinae* (gulf cordgrass) along the beach/dune platform, and *Spartina alterniflora* (smooth cordgrass) along the northern perimeter of the marsh platform. To monitor the establishment and success of vegetation on the island over time, 50 vegetation plots were established and sampled in October 2013, Year 4 post-construction, as described in the Monitoring Elements section. Ten plots were established in upslope/dune habitat, 23 plots were established in swale habitat, and 17 plots were established in marsh habitat (Figure 8). The habitat type assigned to each plot was based on habitat at the time of establishment as described in Hester et al. 2005, and should not be confused with their relative location in the marsh and beach/dune creation areas. Out of the fifty plots, 24 plots were located within the marsh creation area, 19 of the plots were located in the beach/dune creation area, and 7 were located outside of the creation areas (Figure 8). The beach/dune creation area contained 9 upslope and 10 swale plots, and the marsh creation area contained 11 swale and 13 marsh plots. As such, the vegetation community can be analyzed by habitat type as well as creation area (Figure 8). The same 50 plots were sampled again in 2016, Year 7 post-construction, and at that time two of the plots located in the marsh creation area had transitioned from swale to marsh habitat.

Elevation is one of the primary determinants of habitat zonation within Louisiana's barrier island plant communities (Courtemanche et al. 1999). Approximate elevations of the vegetation plots (ft NAVD_Geoid99) were obtained from USGS LiDAR data collected in March 2013. These data reveal a distinct elevation gradient between habitat types with mean elevations of +4.5 ft NAVD in the upslope plots, +3.2 ft in the platform plots, and +2.3 ft in the marsh plots (Figure 9). These mean elevations were above intertidal range, which was calculated during project design (CPE 2003) to range from +0.48 ft NAVD Mean Low Water to +1.53 ft NAVD Mean High Water (SJB and CEC 2004) and adjusted by +0.30 ft to account for 10 years of sea level rise (NOAA: +9.05mm/yr, Grand Isle, LA Station 8761724) (Figure 8). Similarly, the mean elevation in 2013 was +4.3 ft for plots within the beach/dune creation area (n=19) and +2.4 ft for plots within the marsh creation area (n=24) (Figure 10). Although the sample size is small (n=4), mean elevation calculated for the marsh plots outside the creation area was nearly identical to MHW at +1.9 ft (Figure 10). The change in elevation of the vegetation plots from 2009 (as-built) to 2013 shows the progression toward intertidal range (Figure 10), although the goal was for the marsh platform to be intertidal by Year 3 (2012). Six out of the 24 plots within the marsh creation area were within intertidal range in 2013 and we would expect more plots to fall within this range as settlement continues. The transition of two plots from swale to marsh habitat by 2016 within the marsh creation area demonstrates that this is occurring.

A total of 36 species were identified in or within 15-ft of the sample plots during the 2013 vegetation sampling event, increasing to 43 species in 2016 (Table 4). Total number of species increased by 8 and 4 species in the swale and marsh habitats, respectively, but did not increase in the upslope habitat. Species richness was lowest in the marsh habitat in both sampling years. Total of mean percent cover of live vegetation in 2013 was 84% within the marsh plots, which was twice as high as the upslope plots and five times higher than the swale plots (Figure 11). Total percent cover increased in all habitats by 2016 with the largest increases observed in the upslope and swale habitats. The marsh plots were dominated by *S. alterniflora* in both years with 72% mean cover in 2013 and 81% mean cover in 2016. The swale habitat was dominated by *D. spicata*, *S. alterniflora*, and *S. patens*, although a large increase in *Phragmites australis* (common reed) was observed in three of the swale plots in 2016. The upslope/dune habitat was dominated by *P. repens*, *S. patens*, and *P. australis* in 2010 and by *S. patens*, *P. australis*, *Schizachyrium maritimum* (gulf bluestem) and *Hydrocotyle bonariensis* (largeleaf pennywort) in 2016.

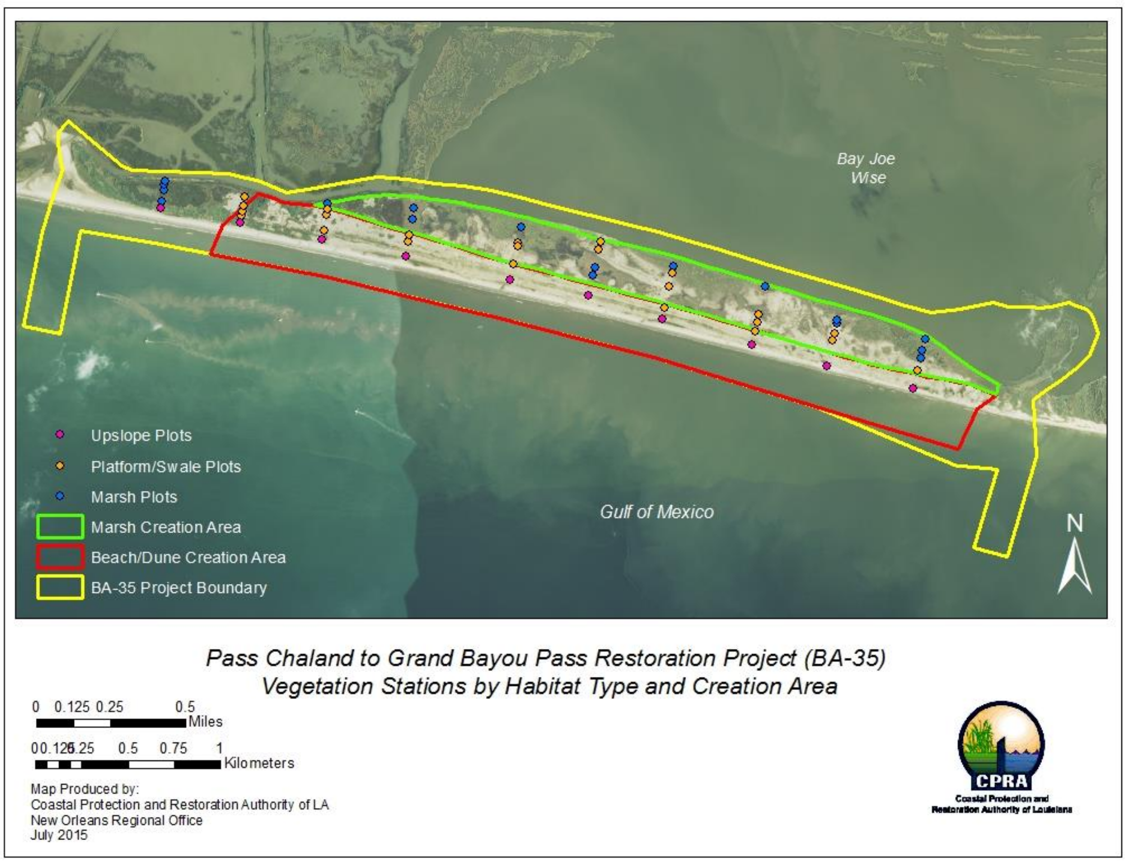


Figure 8. Location of BA-35 vegetation plots by habitat type and creation area as established in October 2013.

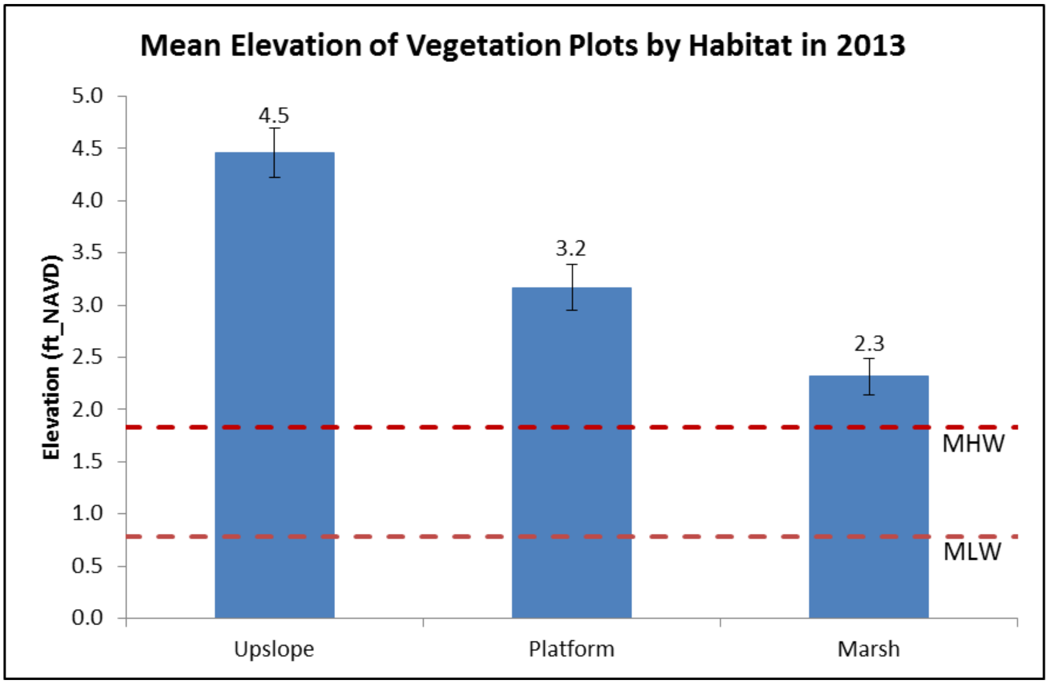


Figure 9. Mean elevation (ft NAVD, Geoid99) of BA-35 vegetation plots by habitat type in March 2013.

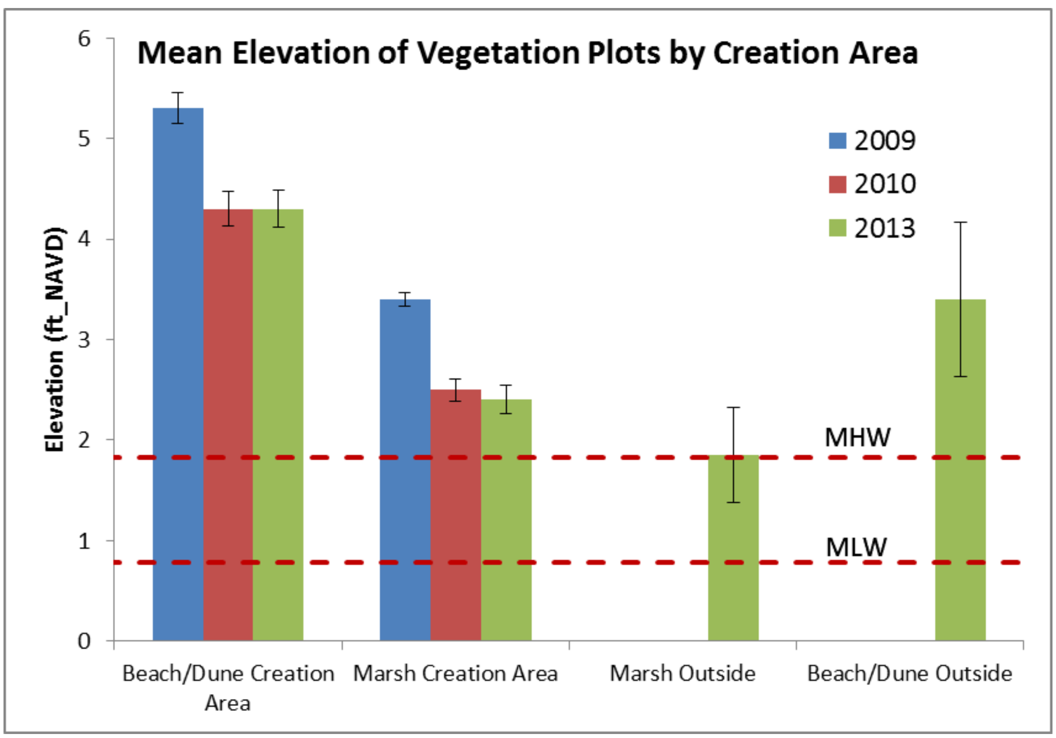


Figure 10. Mean elevation (ft NAVD, Geoid99) of BA-35 vegetation plots within Beach/Dune and Marsh creation areas from 2009 to 2013. Mean elevations of marsh and beach/dune plots located outside of the fill areas (Transects 1 and 2) are shown for reference.

Table 4. Percent occurrence of species by habitat within the BA-35 vegetation plots (or within 15-ft of plots*) in October of 2013 and 2016.

Species Name	% Occurrence of Plots by Habitat					
	Upslope/Dune		Platform/Swale		Marsh	
	2013	2016	2013	2016	2013	2016
Agalinis maritima				*		
Amaranthus australis		10				
Ammannia coccinea		10				
Avicennia germinans					18	11
Baccharis halimifolia	*	10	9	29	6	5
Batis maritima					*	*
Bolboschoenus robustus					*	5
Borrichia frutescens	*	10	4	14	*	5
Cissus trifoliata	*		*			
Conyza spp	*	10		10		
Croton punctatus	*	*		*		
Cynanchum angustifolium						5
Cyperus spp	10	50	13	*	*	
Desmanthus illinoensis				5		
Distichlis spicata	20	20	17	29	6	11
Echinochloa walteri			*			
Eclipta prostrata			4			
Eupatorium sp	*					
Eustachys petraea				5		
Eustoma exaltatum				5		
Fimbristylis castanea	*	20	4	24	*	11
Heliotropium curassavicum			*	19		*
Hydrocotyle bonariensis		50		5		
Ipomoea pes-caprae	*	10			6	5
Iva frutescens	*					*
Leptochloa fusca	20		13	5		*
Panicum amarum	10	20		10		
Panicum repens	20		*		6	
Panicum virgatum	10					
Paspalum vaginatum		50		14		
Phragmites australis	40	60	*	14		
Phyla nodiflora	10	20		14		
Pluchea odorata			4			
Rhynchospora colorata		10				
Sabatia stellaris	10	20		10		
Salicornia bigelovii			13	29	6	*
Schizachyrium maritimum	20	40	4	14		
Sesbania drummondii		10	*	*	*	5
Sesbania herbacea	*	*	*			
Sesuvium portulacastrum	*	*	9	14	6	
Solidago sempervirens	*	40	9	38	6	5
Spartina alterniflora			26	10	88	95
Spartina patens	20	50	4	14	*	11
Spartina spartinae			*	10		
Strophostyles helvola	*	20	*	10	*	5
Suaeda linearis				33		*
Symphyotrichum divaricatum				*		*
Symphyotrichum subulatum				14		
Typha latifolia						*
Vigna luteola	*	40	4	10	*	*
TOTAL SPECIES	25	25	24	32	18	22

[2013: n=10 (upslope), 23 (platform), 17 (marsh)] [2016: n=10 (upslope), 21 (platform), 19 (marsh)]

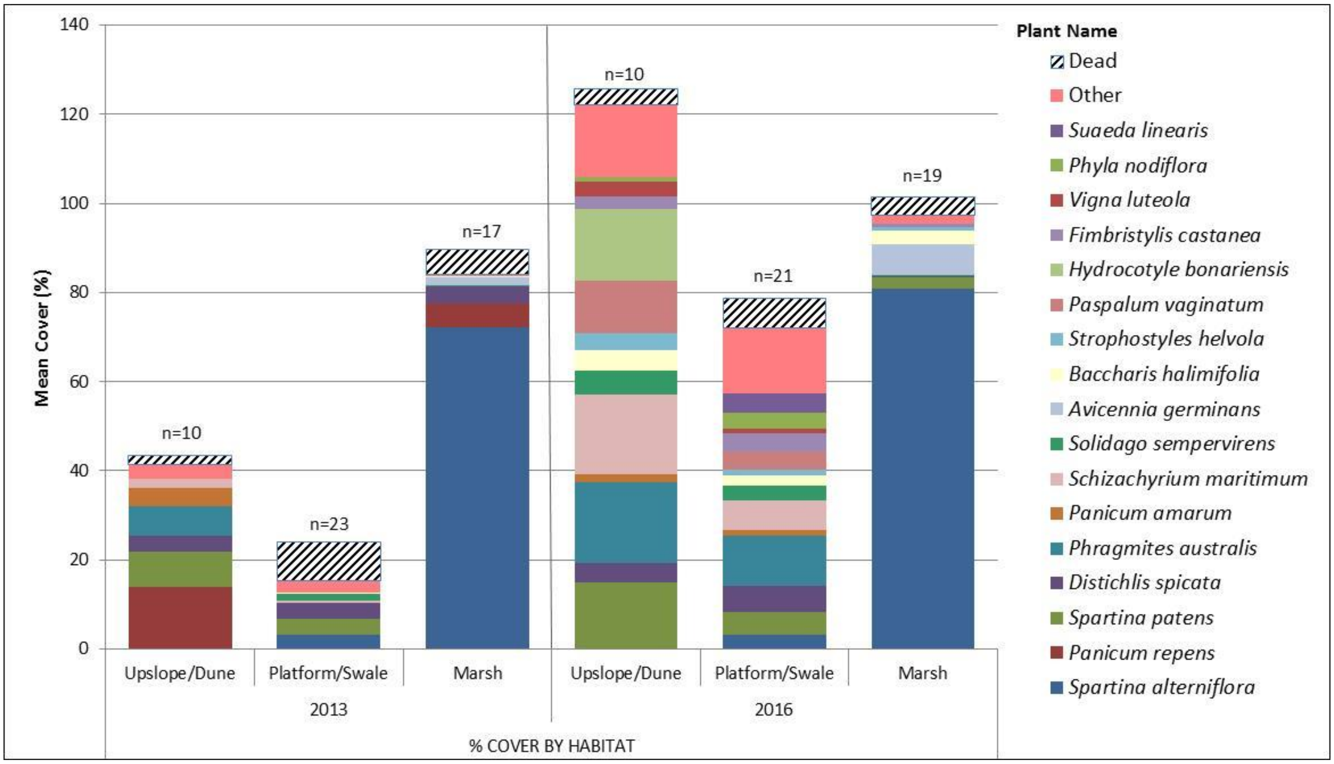


Figure 11. Mean percent cover of species within the BA-35 project area by habitat type in 2013 and 2016.

One of the goals of the BA-35 project was to achieve 40% coverage at Year 3 (2012) and 60% coverage at Year 5 (2014) on the dune and supratidal (swale) portions of the project, and to achieve 37% coverage at Year 3 and 75% coverage at Year 5 on the created marsh platform (NMFS 2005). Analysis of the vegetation plots by creation area shows that mean percent cover in the beach/dune area increased from 20% in Year 4 (2013) to 79% in Year 7 (2016), which surpasses the Year 5 goal of 60% (Figure 12). In the marsh creation area, mean percent cover at Year 4 was 50%, which surpassed the Year 3 goal of 37%; however, the mean cover of 71% at Year 7 was slightly lower than the Year 5 goal of 75%. As the created marsh platform continues to settle within intertidal range, we expect that the flooding regime will be more conducive to outgrowth of the existing patches of marsh. The marsh creation area was dominated by *S. alterniflora* at 43% in 2013 and 55% in 2016, which was planted on the marsh platform following construction (Figure 13). The three species with the highest cover in the beach/dune area in 2013 were *P. repens*, *S. patens*, and *P. australis* (Figure 13), with *S. patens* being the only planted species. Between 2013 and 2016, *P. australis* and the planted species, *S. maritimum*, both showed high increases in cover in the beach/dune creation area. Monotypic stands of *P. australis* are expanding in the beach/dune creation area with two plots containing 100% coverage of this species in 2016. By 2016, total mean coverage was three times higher in the beach/dune creation area and almost twice as high in the marsh creation area than it was in 2013 (Figure 13).

In summary, although settlement of the marsh platform to intertidal range is taking longer than predicted, the island has benefitted from a period of relatively low storm activity which has allowed significant colonization to occur. Plant colonization of the beach/dune creation area is meeting project goals, and colonization of the marsh platform at Year 7 is only 4% short of the Year 5 goal. The next vegetation sampling event for the BA-35 project is scheduled to occur in 2019 (project Year 10).

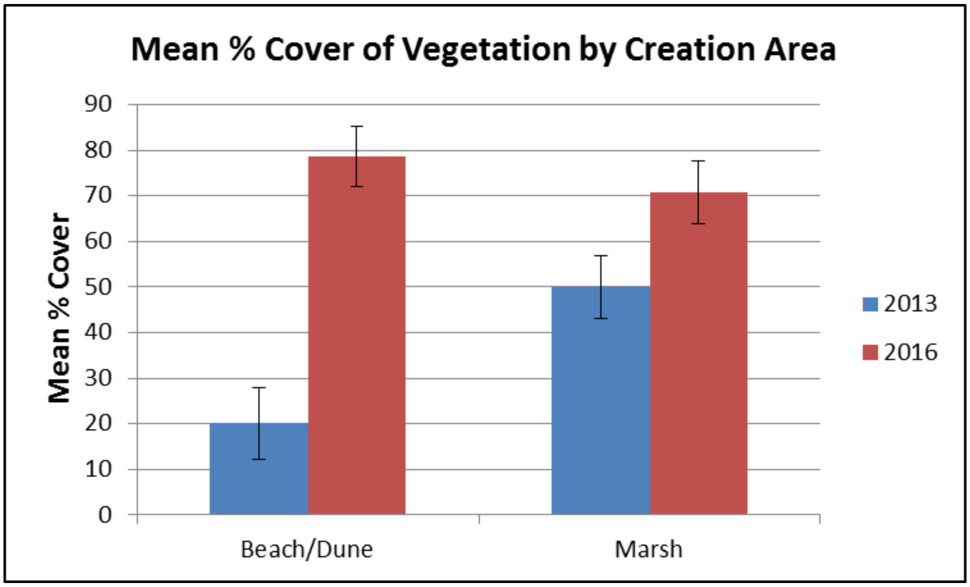


Figure 12. Mean percent cover within the BA-35 Beach/Dune and Marsh creation areas in 2013 and 2016.

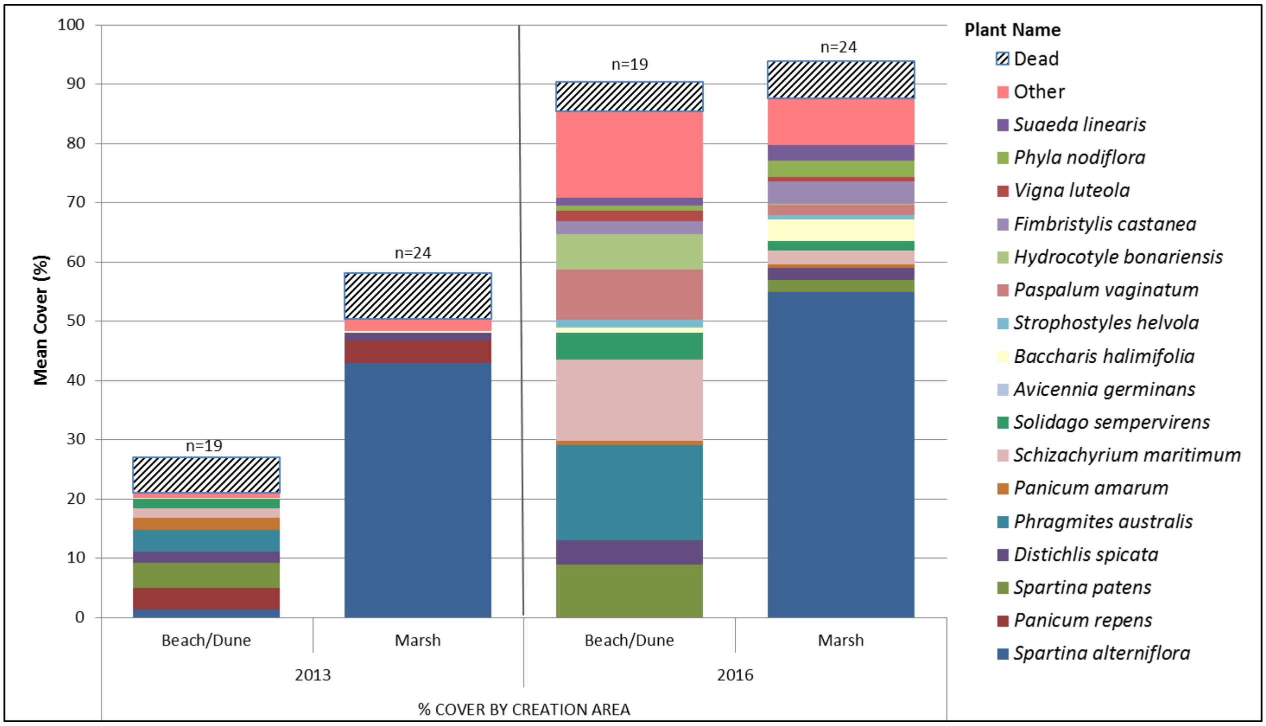


Figure 13. Mean percent cover of species within the BA-35 project area within the Beach/Dune and Marsh creation areas in 2013 and 2016.

iii. Bathymetry and Topography

Changes in volume and elevation in the BA-35 beach/dune and marsh fill areas from 2003 to 2013 are summarized in Figure 14. Time periods presented are Year -6 Pre-construction (2003), Year -3 Pre-construction (2006), Year -1 Preconstruction (2008), Year 0 As-Built (2009), Year +1 Post-construction (2010), and Year +4 Post-construction topography merged with Year +7 Post-construction bathymetry (2013/2016). For ease of discussion, the merged Year 4/Year 7 dataset will hereafter be considered an approximation of Year 5 conditions. Elevation grid models for all survey years are presented in Appendix D and elevation change models are presented in Appendix E. The pre-construction elevation models (2003, 2006, and 2008) showed that sediment was being lost over time in the future beach/dune fill area and gained in the future marsh fill area as sediment was overwashed and redistributed during the extreme storm events which occurred during this period, most significantly Hurricanes Katrina in 2005 and Gustav in 2008 (Appendix D1-D3, Appendix E1-E2). Proportionally, volume losses in the beach/dune area were greater than the gains in the marsh fill area with a net loss of 881,121 yd^3 (673,665 m^3) from the system from 2003 to 2008. Mean elevation within the future beach/dune area dropped by 2.5 ft (0.8 m) during the pre-construction period (2003 to 2008), while mean elevation within the marsh area increased by 1.3 ft (0.4 m).

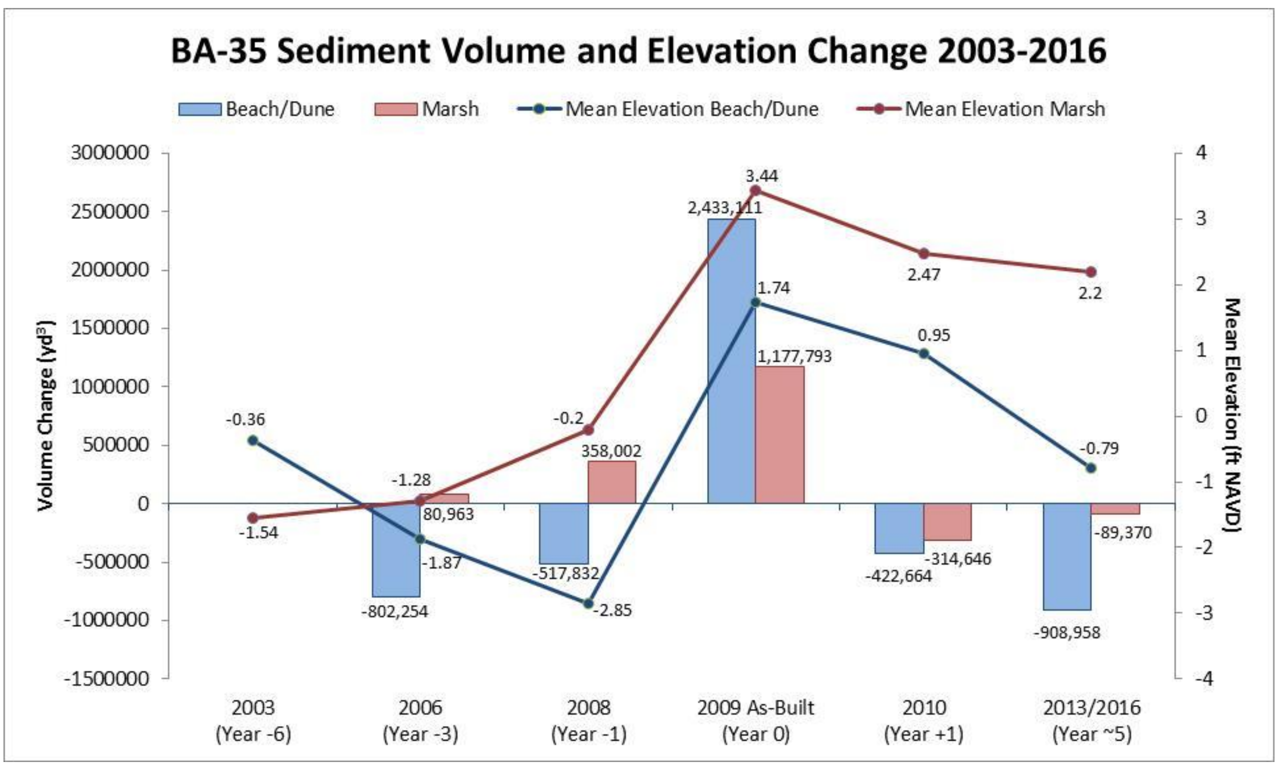


Figure 14. Summary of sediment volume (yd^3) and mean elevation (ft NAVD88) changes in the BA-35 beach/dune and marsh fill areas from 2003 to 2016.

The 2009 as-built grid model (Appendix D4) and the 2008-2009 elevation change model (Appendix E3) show significant sediment gains resulting from BA-35 project construction. From 2008 to 2009, sediment volume increased by 2,433,111 yd^3 (1,860,247 m^3) in the beach/dune area and by 1,177,793 yd^3 (900,487 m^3) in the marsh area. As-built in-place quantities reported in the BA-35 project completion report (CEC 2010) were 6% higher within the beach/dune fill area [2,585,809 yd^3 (1,976,993 m^3)] and 8% lower with the marsh fill area [1,083,723 yd^3 (828,566 m^3)] presumably due to difference in calculation methods. Sediment losses were observed in both fill areas in the years following construction. One year following construction (Appendix D5, Appendix E3), sediment volume was reduced by a total of 737,310 yd^3 (563,714 m^3), with the loss in the beach/dune area [422,664 yd^3 (323,150 m^3)] only slightly higher than the loss in the marsh area [314,646 yd^3 (240,564 m^3)]. It should be noted that the 2010 Year 1 grid model did not cover 13 ac (5 ha) of the fill areas due to the limits of the survey extent, which introduces slight error in volume change measurements involving that year. Between Year 1 and 5, there was a much higher loss in the beach/dune area of 908,958 yd^3 (694,948 m^3) than the marsh area [89,370 yd^3 (68,328 m^3)], which was mainly due to scarping along the beach face as shown in dark blue in the 2010 to 2013/2016 change model (Appendix E5). Effects from Hurricane Isaac, which passed to the west of the project area in 2012 (Figure 3), would be reflected during this period. No major washovers or breaching occurred during Hurricane Isaac and shoreline integrity was maintained, which was one of the goals of the BA-35 project; however, significant wave action over the beach/dune area washed out some areas of the plantings and caused significant damage to the sand fence. Total volume loss from construction to Year 5 is estimated at 1,746,116 yd^3 (1,335,001 m^3), which corresponds to 52% of the in-place volume remaining from construction.

Some eroded material from the beach face has likely contributed to the complete in-filling of Pass Chaland through longshore transport (Figure 15), which is generally in the westward direction along this segment of Louisiana's coast (Georgiou et al. 2005). Much of this material was deposited during Hurricane Isaac in 2012. In addition, several other barrier restoration projects have recently been constructed to the east [Shell Island West (BA-0111), Shell Island East (BA-0110), Pelican Island (BA-0038), Scofield Island (BA-0040)], which have also introduced substantial amounts of sediment into the barrier system. The result of infilling of Pass Chaland is that the water exchange channel constructed for the BA-35 project to maintain the flow-way and circulation patterns between the Gulf of Mexico and Bay Joe Wise through Pass Chaland is no longer functioning as designed. It does appear that water exchange is still occurring between Bay Joe Wise and Bayou Chaland through the BA-35 water exchange channel. Water exchange between Bay Joe Wise and the Gulf of Mexico is now primarily occurring to the east through the remnants of Grand Bayou and Bastian Bay.

During project design, elevation zones were defined as dune (≥5 ft NAVD), supratidal (≥2 to ≤ 4.9 ft NAVD), intertidal/marsh (≥0 to ≤ 1.9 ft NAVD), and subtidal/open water (<0 ft NAVD), which were used to make projections of project performance

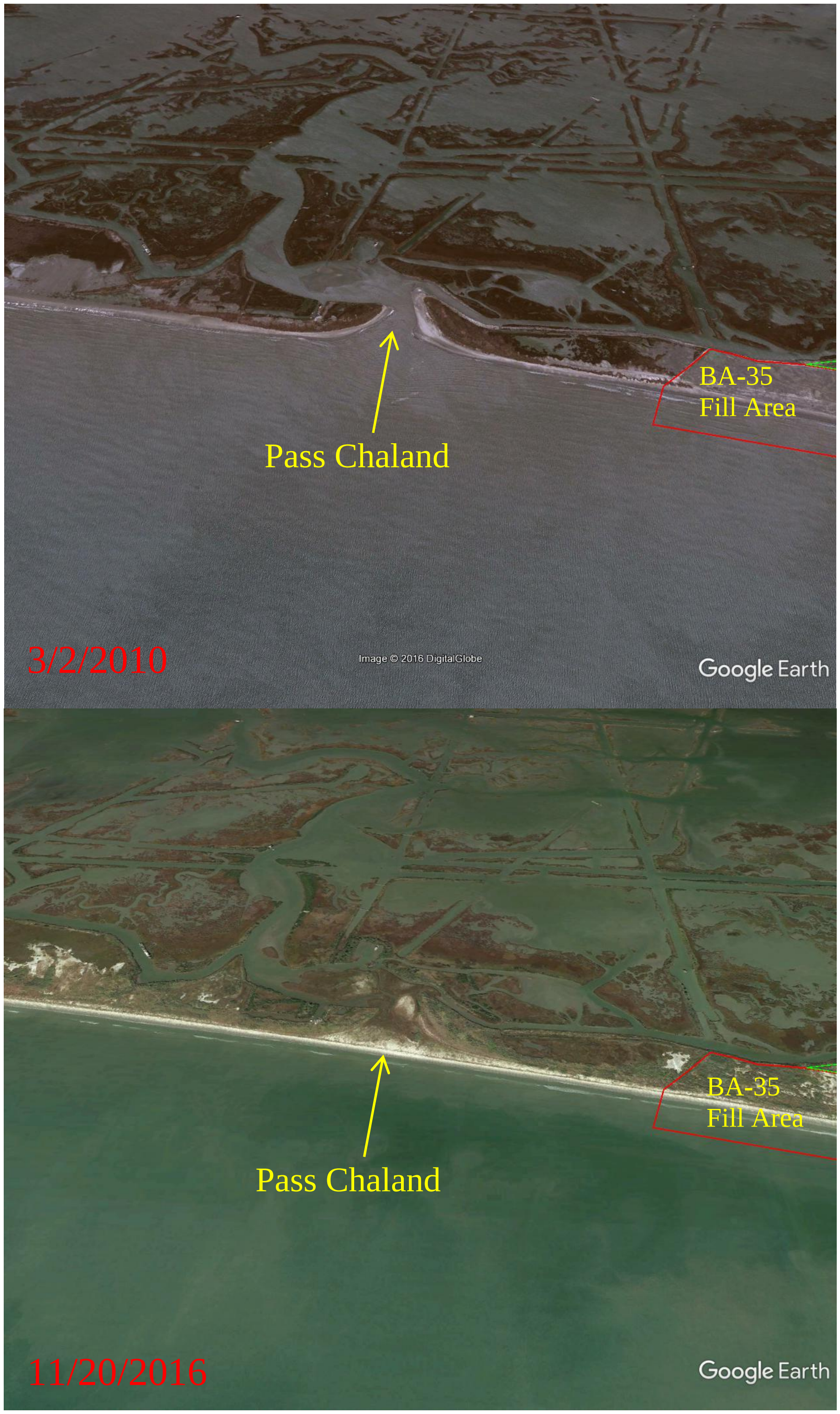


Figure 15. In-filling of Pass Chaland between 2010 and 2016.

(CEC 2005). Following these definitions, elevation zone acreages were calculated from the grid models (Appendix D) and summarized in Table 5. One design goal of the project was that the marsh platform would be settled to intertidal elevation by Year 3. The target fill height of the constructed marsh platform was +2.6 ft (max fill grade of +3.1 ft); however the target height was increased to +2.9 ft in the westerly fill cell that had been heavily breached during the pre-construction storms. The 2009 as-built grid model (Appendix D4) indicates that the mean elevation of the marsh fill area immediately following construction was +3.44 ft, slightly higher than the max fill grade. As would be expected, the marsh fill area was nearly 100% supratidal immediately following construction (Figure 16a). By Year 1 post-construction, mean elevation within the marsh fill area settled by approximately 1 foot and settled an additional 0.3 ft by Year 5 (Figure 14). By Year 5 (Appendix D6), there was a total of 87 intertidal acres within the total fill area, and 71 of those acres were within the 202-ac marsh fill area (Table 5, Figure 16a). Therefore, only 35% of the constructed marsh platform had settled to within intertidal range by Year 5. Comparison with the BA-35 predicted settlement curve shows that the actual marsh fill elevation at Year 5 is 0.6 ft higher than was predicted (Figure 17). Although it was previously reported that marsh settlement at Year 1 (2010) was in agreement with the BA-35 design curve (CEC 2012), that conclusion was determined to be invalid because the 2010 survey data used in the comparison was in Geoid 03. Therefore, the data required adjustment to Geoid 99 before it could be compared to the as-built survey data.

Table 5. Acreage of dune, supratidal, intertidal, and subtidal zones within the BA-35 fill area (beach, dune, and marsh combined) in three pre-construction years (2003, 2006, and 2008) and three post-construction years (2009, 2010, and 2013/16).

Elevation Zone	Elevation Range (ft NAVD)	TY-6	TY-3	TY-1	TY0	TY1	~TY5
		2003	2006	2008	2009	2010	2013/2016
Dune	≥ 5	0.4	1	0	70	18	14
Supratidal (Swale)	≥ 2 to ≤ 4.9	59	35	47	305	327	266
Intertidal (Marsh)	≥ 0 to ≤ 1.9	118	99	103	33	47	87
Subtidal (Open Water)	< 0	352	394	380	121	125	162

The target fill heights of the beach and dune platforms during construction were +4.0 and +6.0 ft NAVD, respectively. Mean elevation within the entire beach/dune fill area increased from -2.85 ft before construction to +1.74 ft following construction (Appendix D4); however, the mean elevation of the as-built beach platform (excluding offshore and dune areas) was higher than the target elevation at +4.9 ft. By Year 5, the beach platform area had settled 1.1 ft to a mean elevation of 3.8 ft. Elevation within the dune fill area increased from -1.8 ft before construction to +6.1 ft after construction (Figure 18). Although the dune fill template was 28 acres, there was a total of 70 constructed acres above dune height (+5) in the beach/dune fill area (Table 5). By Year 5, the dune crest did not appear to migrate significantly outside of the as-built template, although significant flattening of the dune had occurred. Elevations within the dune fill template by Year 5 showed 1.5 ft of settlement to below dune height of 4.6 ft. The Year 5 grid model (Appendix D6, 2013/2016) showed 14 acres remaining above dune height (+5 ft) and 138 supratidal acres within the beach/dune fill area (Figure 16b).

The Future Without Project conditions calculated during BA-35 project design (SJB and CEC 2005) estimated that there would be only 17 intertidal acres, 5 supratidal acres, and 0 dune acres remaining within the project design template by 2016 (~Year 7). By comparison, the approximated acreages of these elevation zones at ~Year 5 post-construction are 87 intertidal, 266 supratidal, and 14 dune acres (Table 5). This equates to a net increase of +345 acres (intertidal or greater) at Year 5 compared to what was expected without the BA-35 project.

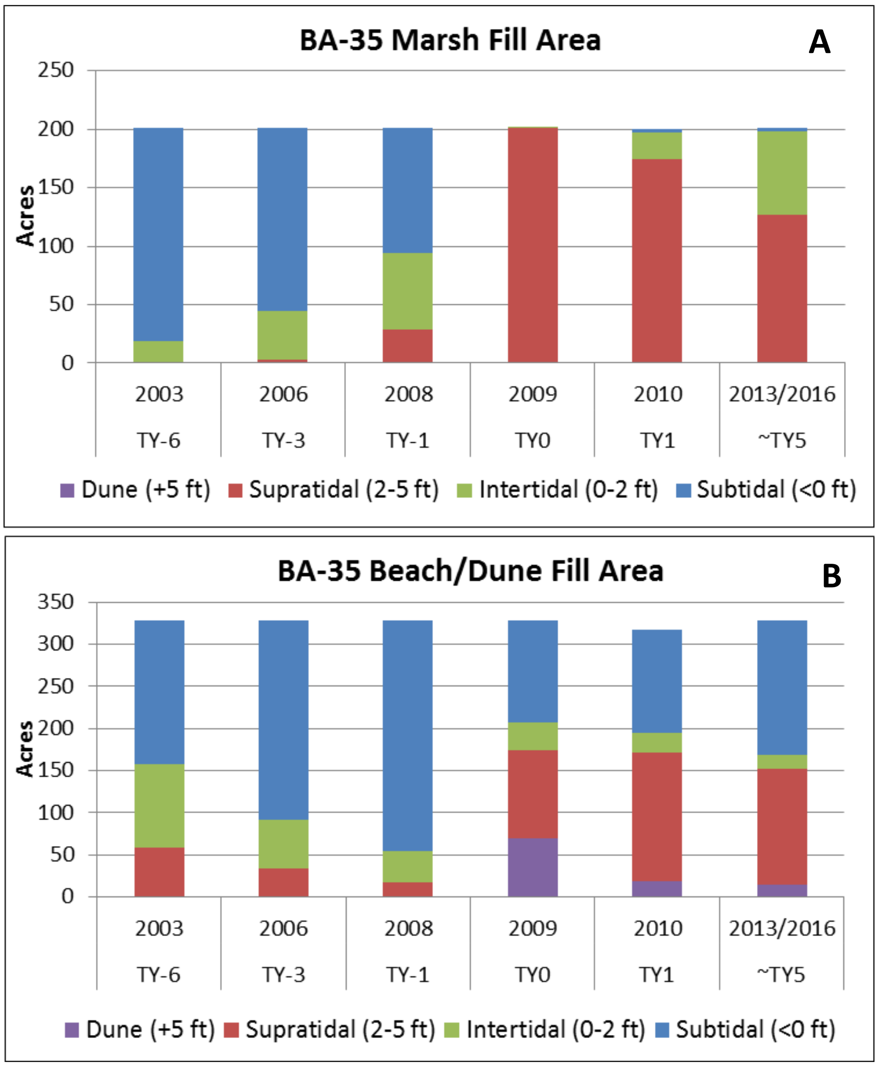


Figure 16. Changes in acreage over time within the subtidal, intertidal, supratidal and dune zones within the BA-35 marsh fill **(A)** and beach/dune fill **(B)** areas from 2003 through 2016.

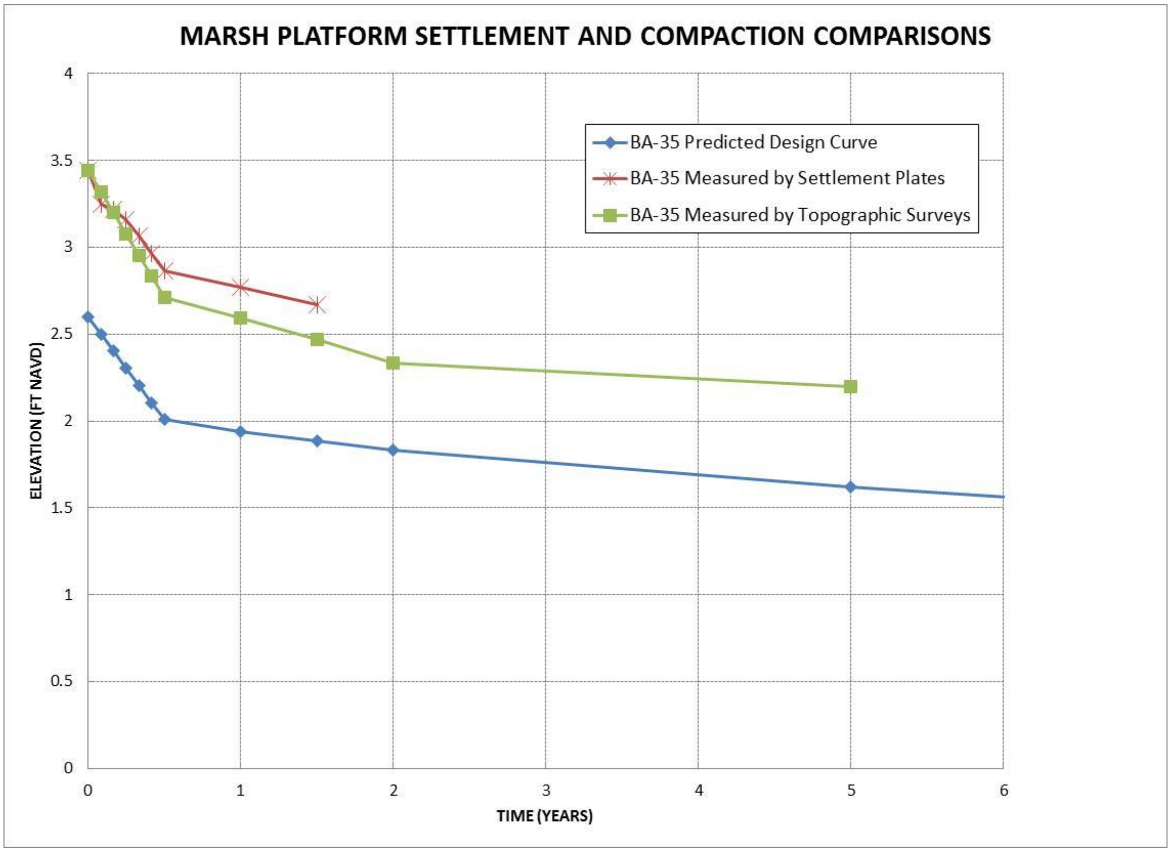


Figure 17. Actual and predicted settlement of the BA-35 marsh platform through Year 5 post-construction.

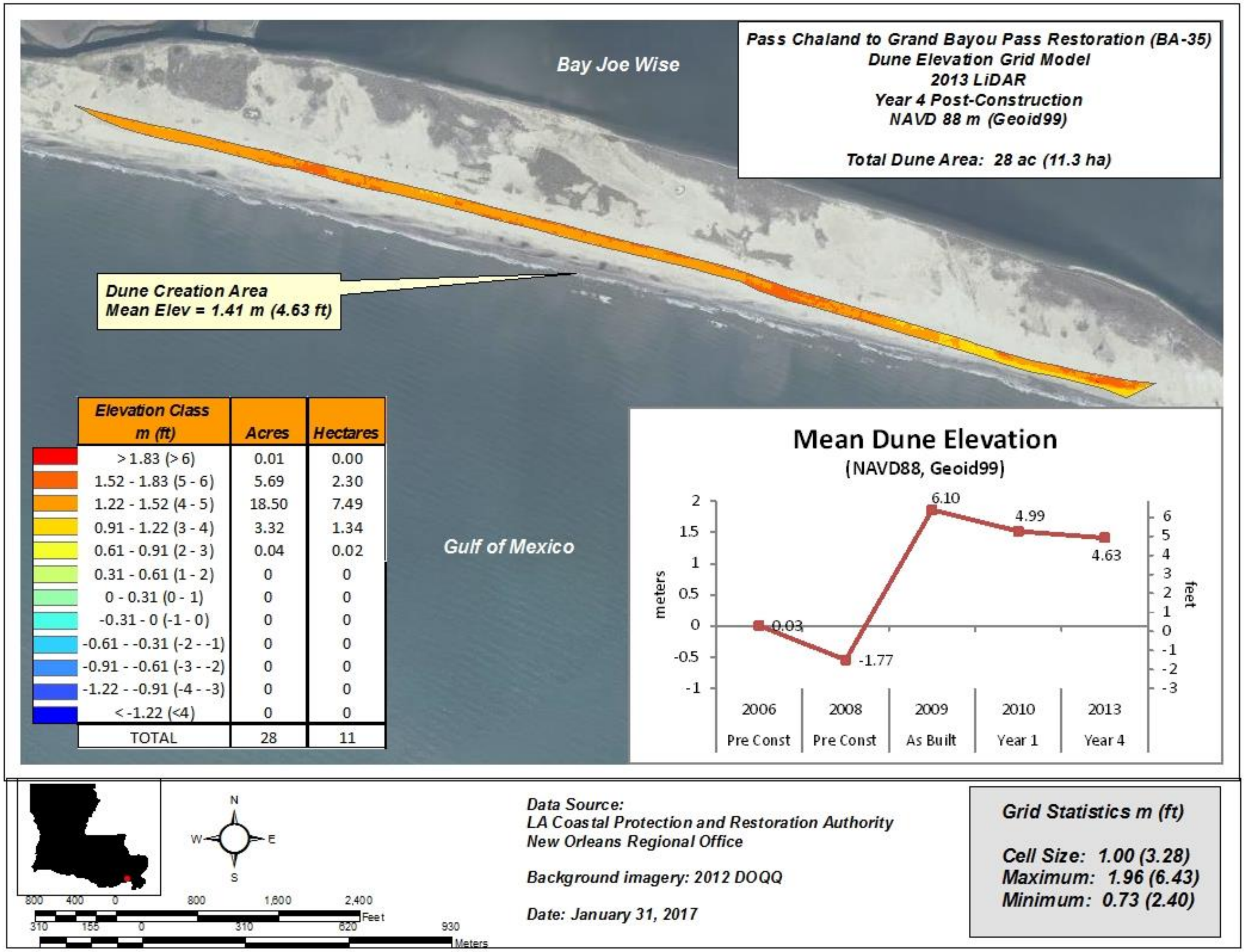


Figure 18. 2013 grid model for the BA-35 dune fill area. Graph inset shows changes in the mean dune elevation (ft NAVD88) over time.

V. Conclusions

a. Project Effectiveness

By Year 7 of the project life, the BA-35 project has succeeded in the overall goal of restoring and preserving the structural integrity of the barrier shoreline along the Gulf of Mexico. Multiple breaches were closed during construction and the continuous shoreline now provides a barrier between the Gulf of Mexico and the fragile interior marshes surrounding Bay Joe Wise. Island design was tested during the passage of Hurricane Isaac in 2012, during which no breaching or major washover occurred. Main impacts during Hurricane Isaac were erosion of the beach face, scouring of the beach/dune plantings, and damage to the sand fencing.

Analysis of aerial photography showed a direct increase of 244 acres of land due to construction within the BA-35 project area. Settlement has occurred in both fill areas, but the goal of achieving a marsh elevation within intertidal range by Year 3 was not fully met. Topography analyses show that only 35% of the marsh platform acreage had settled to intertidal range by Year 5 and mean marsh fill elevation is 0.6 ft higher than was predicted. Settlement will continue to be monitored through periodic BICM surveys.

The goal of establishing vegetation on the island through planted and natural colonization is being met, and the heavily vegetated beach/dune area is serving the purpose of trapping and retaining sediment. Mean percent cover of vegetation in the beach/dune fill area at Year 7 was 79% which surpassed the Year 5 target of 60%. Mean percent cover of 71% in the marsh fill area was slightly lower than the Year 5 target of 75%.

Overall, the BA-35 project has been successful in restoring and maintaining the barrier shoreline and providing valuable barrier island habitat within the marsh and beach/fill areas. By Year 5, there were 345 more acres (intertidal or greater) than the estimated remaining acreage by 2016 if the project had not been constructed.

b. Recommended Improvements

There are no recommendations at this time.

c. Lessons Learned

Leaving the containment dike in place post-construction allowed for additional time for the marsh platform to consolidate and vegetate before being subjected to the erosive energies of Bay Joe Wise, thus improving the chance that the marsh platform will remain intact and functional over the 20-year project life.

The dune on this project was built to a higher elevation (+6 ft) than preceding barrier projects to combat erosion from overwash events throughout the project life. Hurricane Isaac (2012) was the most significant potential overwash event since construction was completed, and the project shows minimal effects from this event. Dunes are now being built higher than the final elevation on this project for similar reasons.

There are very limited sediment resources to provide appropriate material for beach and dune restoration in this area of Louisiana. The quality of material utilized for this project was at the low end of the spectrum of material quality necessary for this purpose. While this project is performing as designed, it is still necessary to improve upon the current designs based on the latest scientific information available. The Mississippi River is being mined to provide material for barrier island restoration at this time. The projects utilizing this material have not been tested with any high energy events, but it will be useful to see how they perform for the planning and design of future projects.

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Appendix A
(Three Year O&M Budget Projection)

Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration (BA-35)

Federal Sponsor: NMFS

Construction Completed : June 11, 2009

PPL #11

Current Approved O&M Budget	Year 0 FY10	Year - 1 FY11	Year -2 FY12	Year -3 FY13	Year -4 FY14	Year -5 FY15	Year -6 FY16	Year -7 FY17	Year -8 FY18	Year -9 FY19	Year -10 FY20	Year -11 FY21	Year -12 FY22	Year -13 FY23	Year -14 FY24	Year -15 FY25	Year -16 FY26	Year - 17 FY27	Year -18 FY28	Year -19 FY29	Project Life Budget	Currently Funded
State O&M	$854,975	$535,594	$1,010,438	$4,561	$4,656	$4,754	$4,854	$224,790	$5,060	$5,166	$5,275	$5,386	$5,499	$5,614	$259,991	$5,852	$5,975	$6,101	$6,229	$6,360	$2,967,130	$2,410,224
Corps Admin	$2,356	$819	$836	$853	$871	$890	$908	$927	$947	$967	$987	$1,008	$1,029	$1,050	$1,072	$1,095	$1,118	$1,141	$0	$0	$18,874	$5,735
Federal S&A	$17,365	$11,548	$19,166	$1,169	$4,277	$1,219	$1,245	$4,178	$1,297	$4,487	$1,352	$1,381	$1,410	$1,440	$4,832	$1,501	$1,532	$1,564	$1,597	$5,768	$88,328	$53,525
Total																					$3,074,332	$2,469,484

Projected O&M Expenditures	Year 0 FY10	Year - 1 FY11	Year -2 FY12	Year -3 FY13	Year -4 FY14	Year -5 FY15	Year -6 FY16	Year -7 FY17	Year -8 FY18	Year -9 FY19	Year -10 FY20	Year -11 FY21	Year -12 FY22	Year -13 FY23	Year -14 FY24	Year -15 FY25	Year -16 FY26	Year - 17 FY27	Year -18 FY28	Year -19 FY29	Remaining Project Life	Current 3 year Request
Maintenance Inspection			$4,208	$4,296	$4,380	$4,468	$4,556	$4,648	$4,742	$4,837	$4,934	$5,032	$5,133	$5,236	$5,340	$5,447	$5,556	$5,667	$5,780	$6,257	$90,516	$13,672
General Maintenance																					$0	$0
Structure Operations																					$0	$0
Corps Admin			$836	$853	$871	$890	$908	$927	$947	$967	$987	$1,008	$1,029	$1,050	$1,072	$1,095	$1,118	$1,141	$0	$0	$15,699	$2,725
Federal S&A			$19,166	$1,169	$4,277	$1,219	$1,245	$4,178	$1,297	$4,487	$1,352	$1,381	$1,410	$1,440	$4,832	$1,501	$1,532	$1,564	$1,597	$5,768	$59,415	$6,642
State S&A			$195,959					$75,846							$87,138						$358,943	$75,846
Construction:			$481,790					$161,230							$161,230						$804,250	$161,230
Professional Services:																					$0	$0
E&D																					$0	$0
Surveying			$4,218																		$4,218	$0
Construction Administration																					$0	$0
Inspection																					$0	$0
Total	$0	$0	$706,177	$6,318	$9,528	$6,577	$6,709	$246,829	$6,986	$10,291	$7,273	$7,421	$7,572	$7,726	$259,612	$8,043	$8,206	$8,372	$7,377	$12,025	$1,333,041	$260,115

O&M Expenditures from COE Report	$470,305	Current O&M Budget less COE Admin	$2,463,749	Current Project Life Budget less COE Admin	$3,055,458
State O&M Expenditures not submitted for in-kind credit	$0	Remaining Available O&M Budget	$1,993,444	Total Projected Project Life Budget	$1,803,346
Total Estimated O&M Expenditures (as of August 2010)	$470,305	**Incremental Funding Request Amount FY12-FY14**	**-$1,733,329**	**Project Life Budget Request Amount**	**-$1,252,112**

Appendix B
(Inspection Photographs)

Photo #1 – West End Beach Looking East.

Photo #2 – West End Shoreline Looking East.

Photo #3 – Tidal Creek on Beach, Looking North.

Appendix C
(Field Inspection Notes)

Structure No. n/a

Structure Description: n/a

Type of Inspection: Annual

Inspector(s): CPRA and NOAA

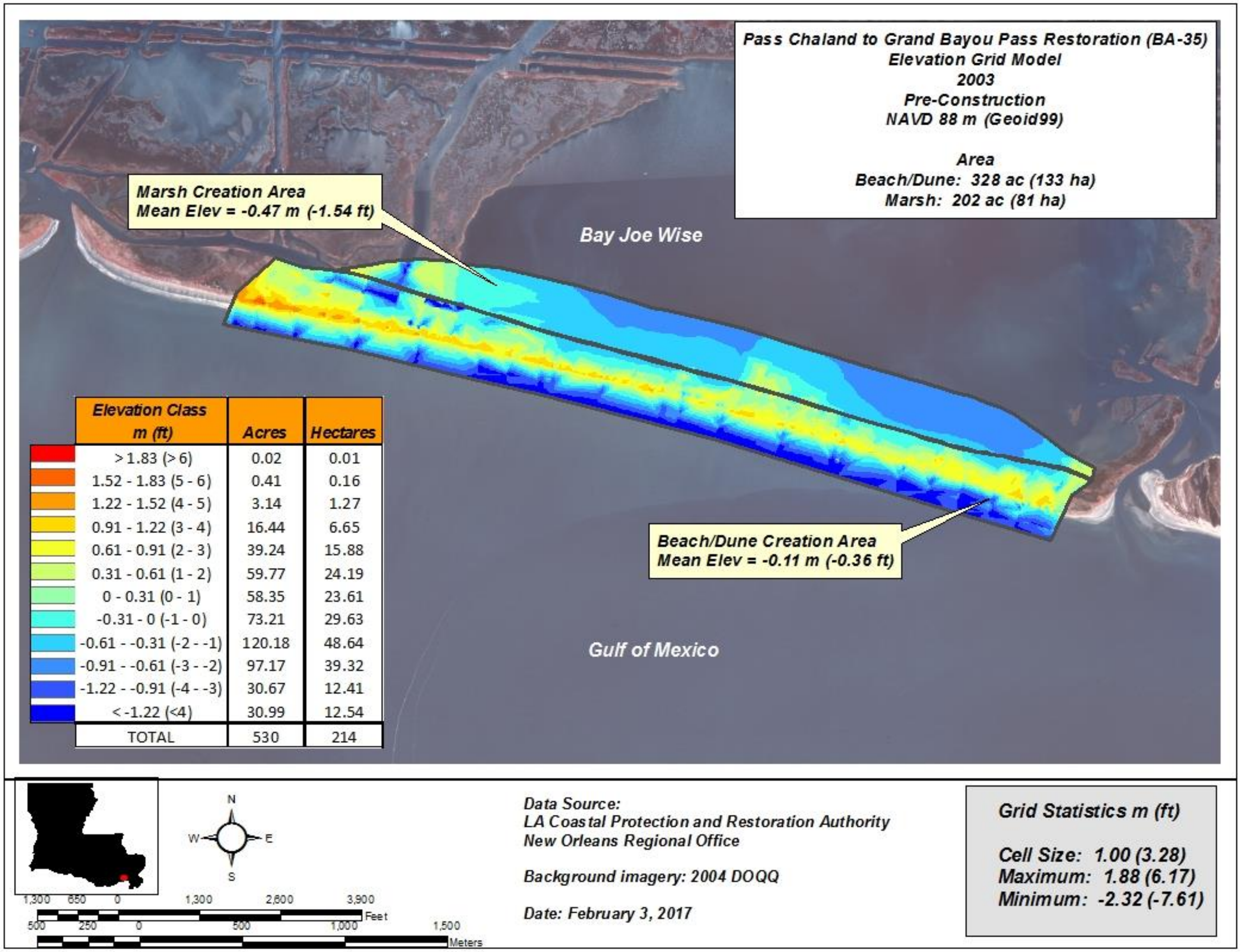
Water Level N/A

Weather Conditions: Clear and Breezy

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Sand Fencing	Poor				No sign of any fencing remaining.
Containment Dike	Poor				No access, did not inspect.
Settlement Plates	Fair				Did not inspect on this visit.
Plantings	Good			1, 2, 3	Appear to be doing well.

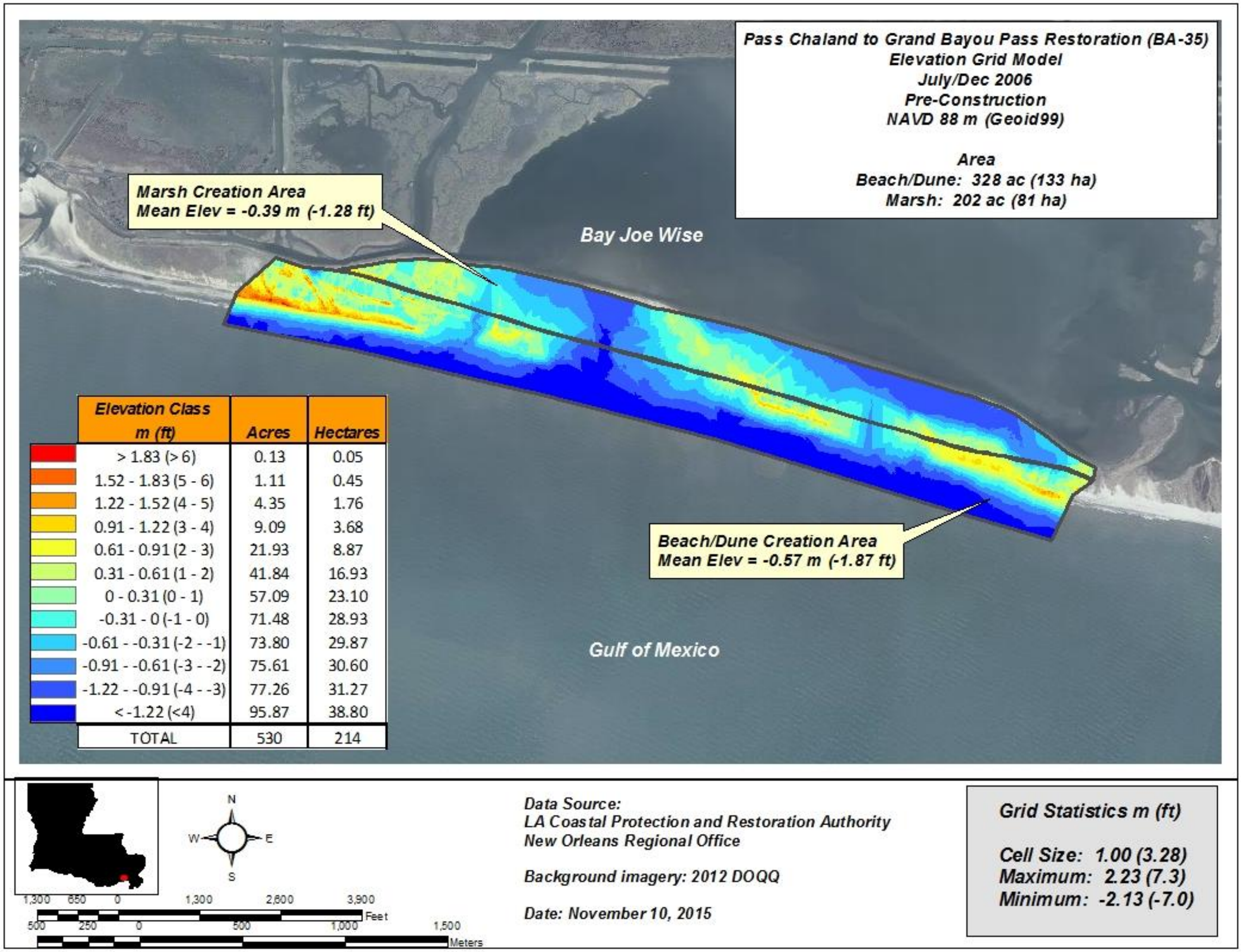
What are the conditions of the existing levees?
Are there any noticable breaches?

Appendix D
(Elevation Grid Models)

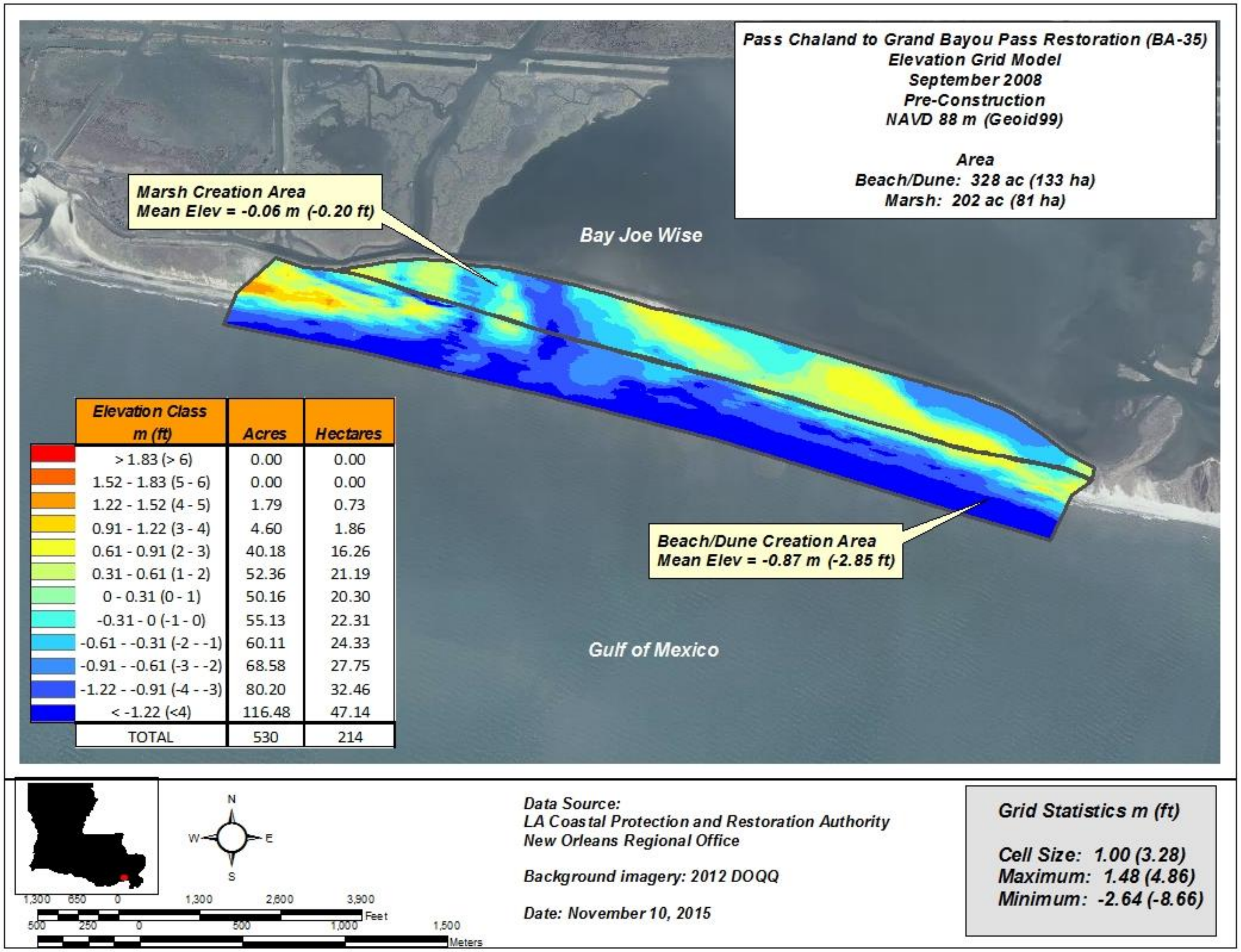


Elevation Class m (ft)	Acres	Hectares
> 1.83 (> 6)	0.02	0.01
1.52 - 1.83 (5 - 6)	0.41	0.16
1.22 - 1.52 (4 - 5)	3.14	1.27
0.91 - 1.22 (3 - 4)	16.44	6.65
0.61 - 0.91 (2 - 3)	39.24	15.88
0.31 - 0.61 (1 - 2)	59.77	24.19
0 - 0.31 (0 - 1)	58.35	23.61
-0.31 - 0 (-1 - 0)	73.21	29.63
-0.61 - -0.31 (-2 - -1)	120.18	48.64
-0.91 - -0.61 (-3 - -2)	97.17	39.32
-1.22 - -0.91 (-4 - -3)	30.67	12.41
< -1.22 (<4)	30.99	12.54
TOTAL	530	214

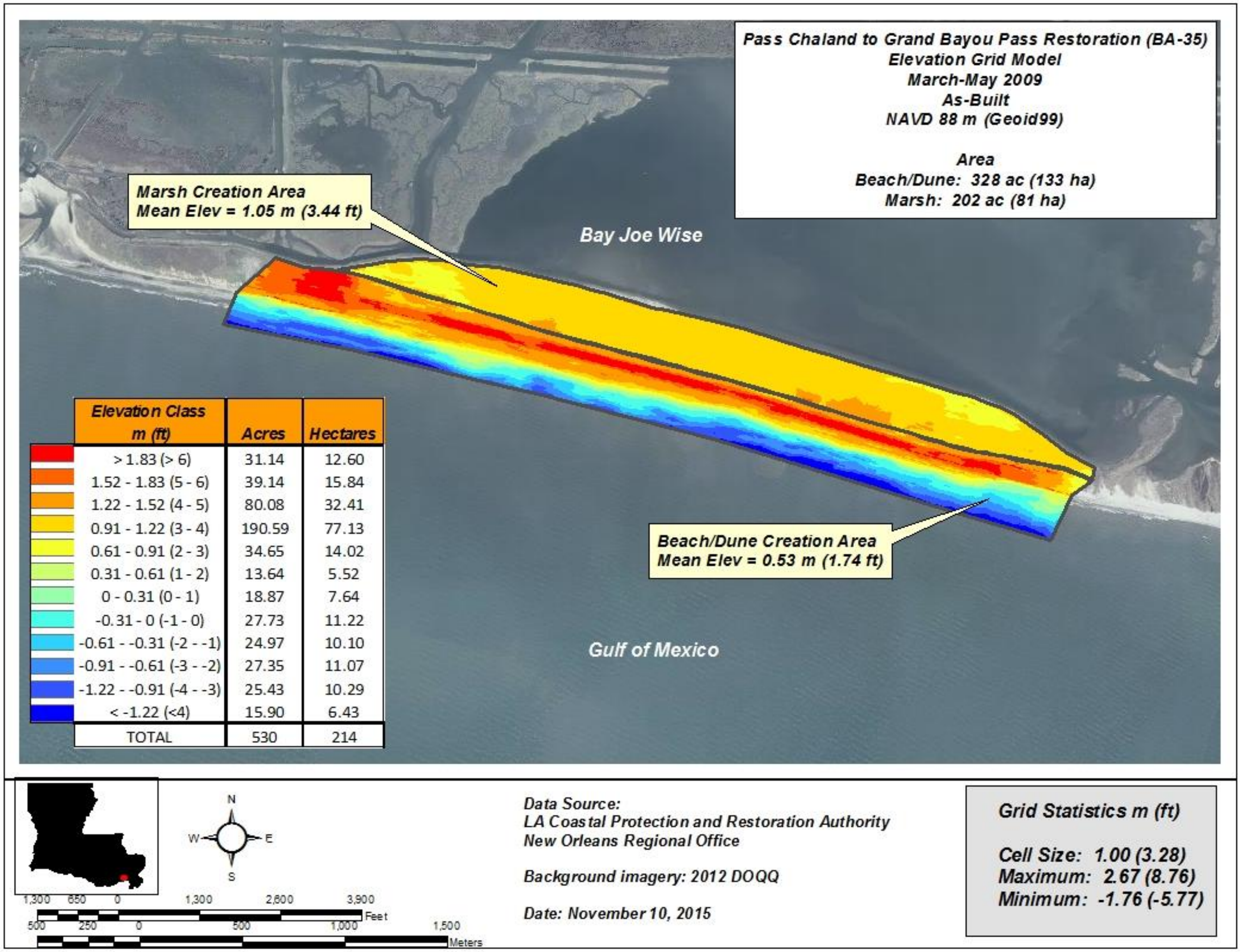
Appendix D1. 2003 elevation grid model for the Pass Chaland to Grand Bayou Pass Restoration (BA-35) project (pre-construction).



Appendix D2. 2006 elevation grid model for the Pass Chaland to Grand Bayou Pass Restoration (BA-35) project (pre-construction).

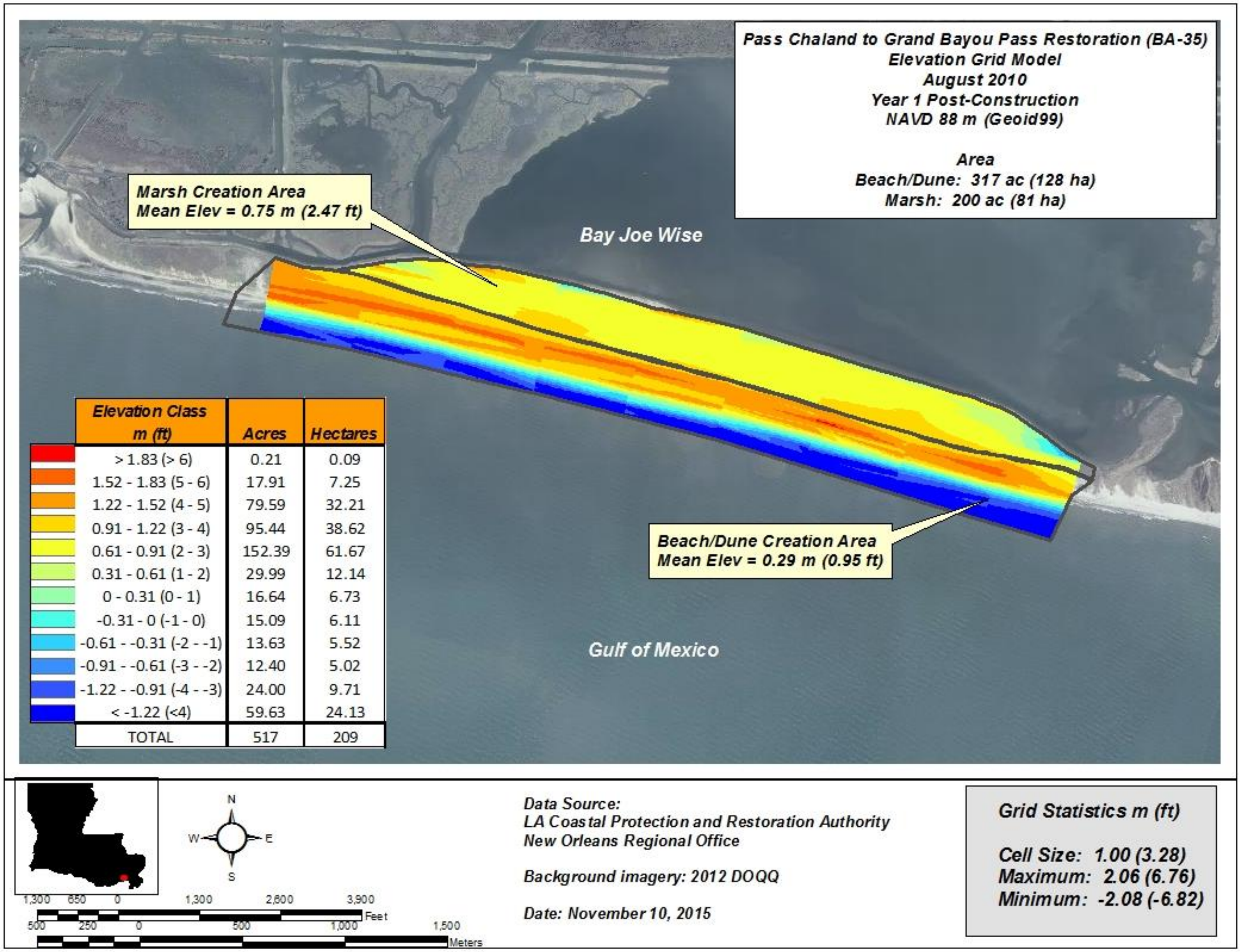


Appendix D3. 2008 elevation grid model for the Pass Chaland to Grand Bayou Pass Restoration (BA-35) project (pre-construction).



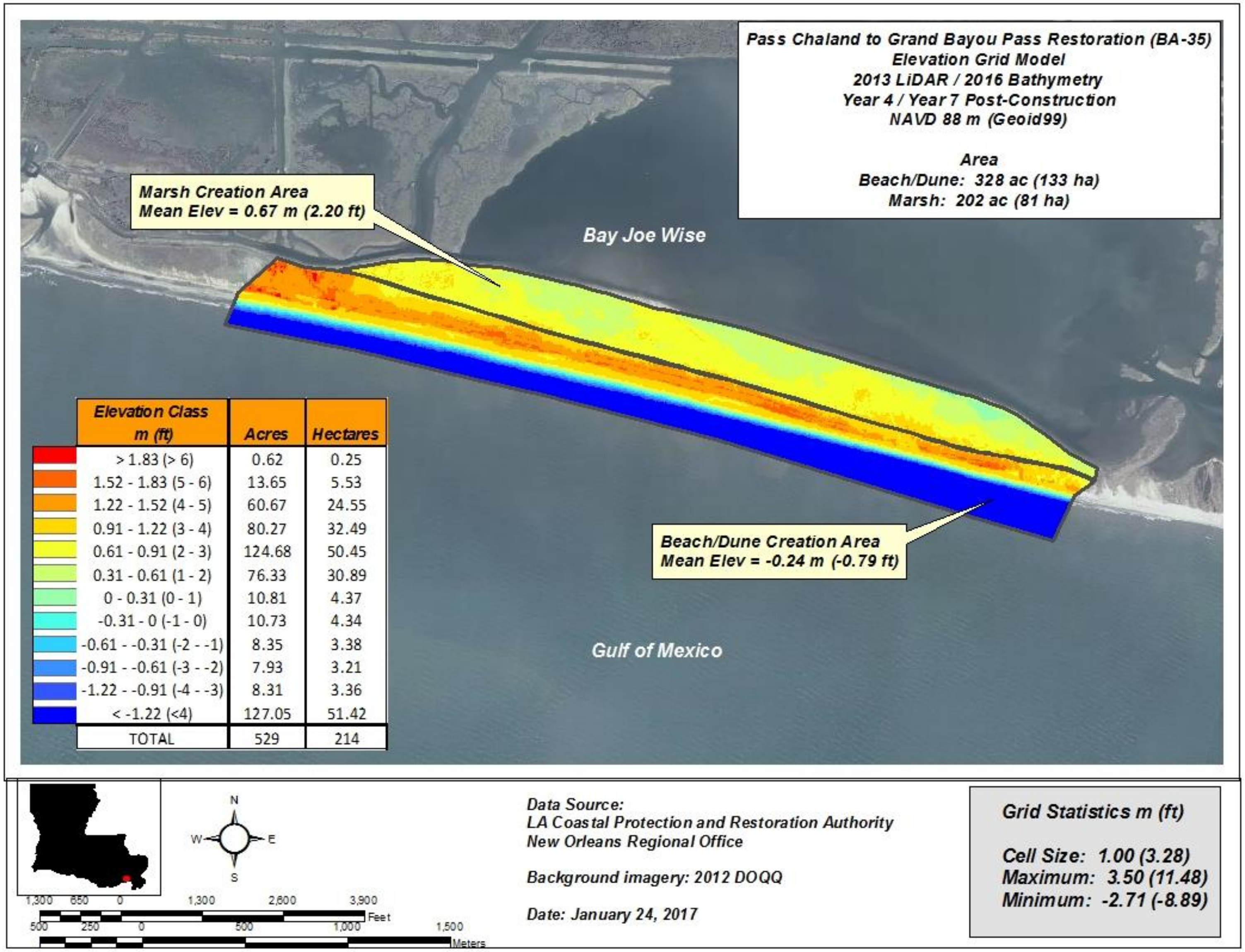
Elevation Class m (ft)	Acres	Hectares
> 1.83 (> 6)	31.14	12.60
1.52 - 1.83 (5 - 6)	39.14	15.84
1.22 - 1.52 (4 - 5)	80.08	32.41
0.91 - 1.22 (3 - 4)	190.59	77.13
0.61 - 0.91 (2 - 3)	34.65	14.02
0.31 - 0.61 (1 - 2)	13.64	5.52
0 - 0.31 (0 - 1)	18.87	7.64
-0.31 - 0 (-1 - 0)	27.73	11.22
-0.61 - -0.31 (-2 - -1)	24.97	10.10
-0.91 - -0.61 (-3 - -2)	27.35	11.07
-1.22 - -0.91 (-4 - -3)	25.43	10.29
< -1.22 (<4)	15.90	6.43
TOTAL	530	214

Appendix D4. 2009 elevation grid model for the Pass Chaland to Grand Bayou Pass Restoration (BA-35) project (as-built).



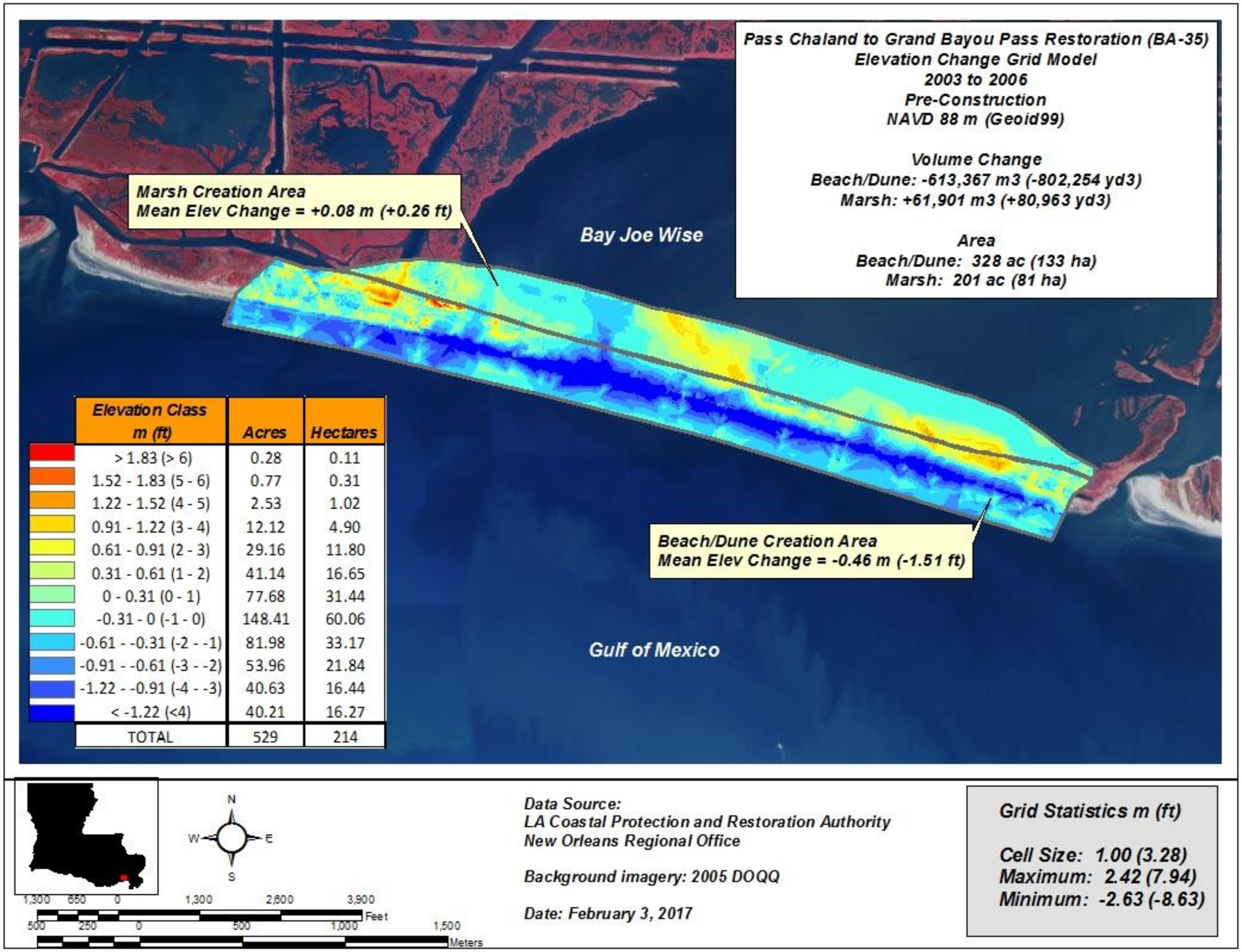
Elevation Class m (ft)	Acres	Hectares
> 1.83 (> 6)	0.21	0.09
1.52 - 1.83 (5 - 6)	17.91	7.25
1.22 - 1.52 (4 - 5)	79.59	32.21
0.91 - 1.22 (3 - 4)	95.44	38.62
0.61 - 0.91 (2 - 3)	152.39	61.67
0.31 - 0.61 (1 - 2)	29.99	12.14
0 - 0.31 (0 - 1)	16.64	6.73
-0.31 - 0 (-1 - 0)	15.09	6.11
-0.61 - -0.31 (-2 - -1)	13.63	5.52
-0.91 - -0.61 (-3 - -2)	12.40	5.02
-1.22 - -0.91 (-4 - -3)	24.00	9.71
< -1.22 (<4)	59.63	24.13
TOTAL	517	209

Appendix D5. 2010 elevation grid model for the Pass Chaland to Grand Bayou Pass Restoration (BA-35) project (Year 1 post-construction).

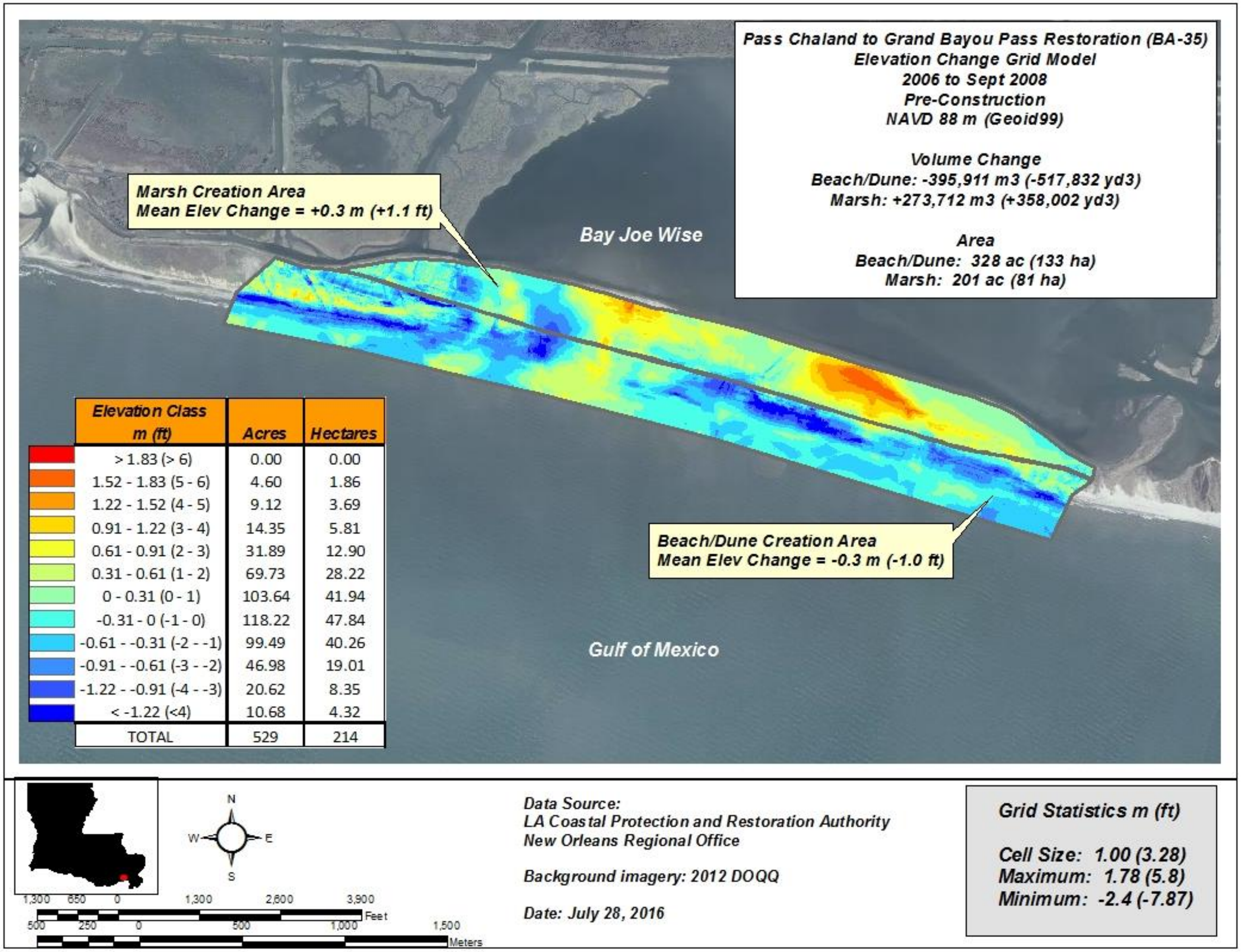


Appendix D6. 2013 LiDAR/2016 bathymetry merged elevation grid model for the Pass Chaland to Grand Bayou Pass Restoration (BA-35) project (Year 4/Year 7 post-construction).

Appendix E
(Elevation Change Models)

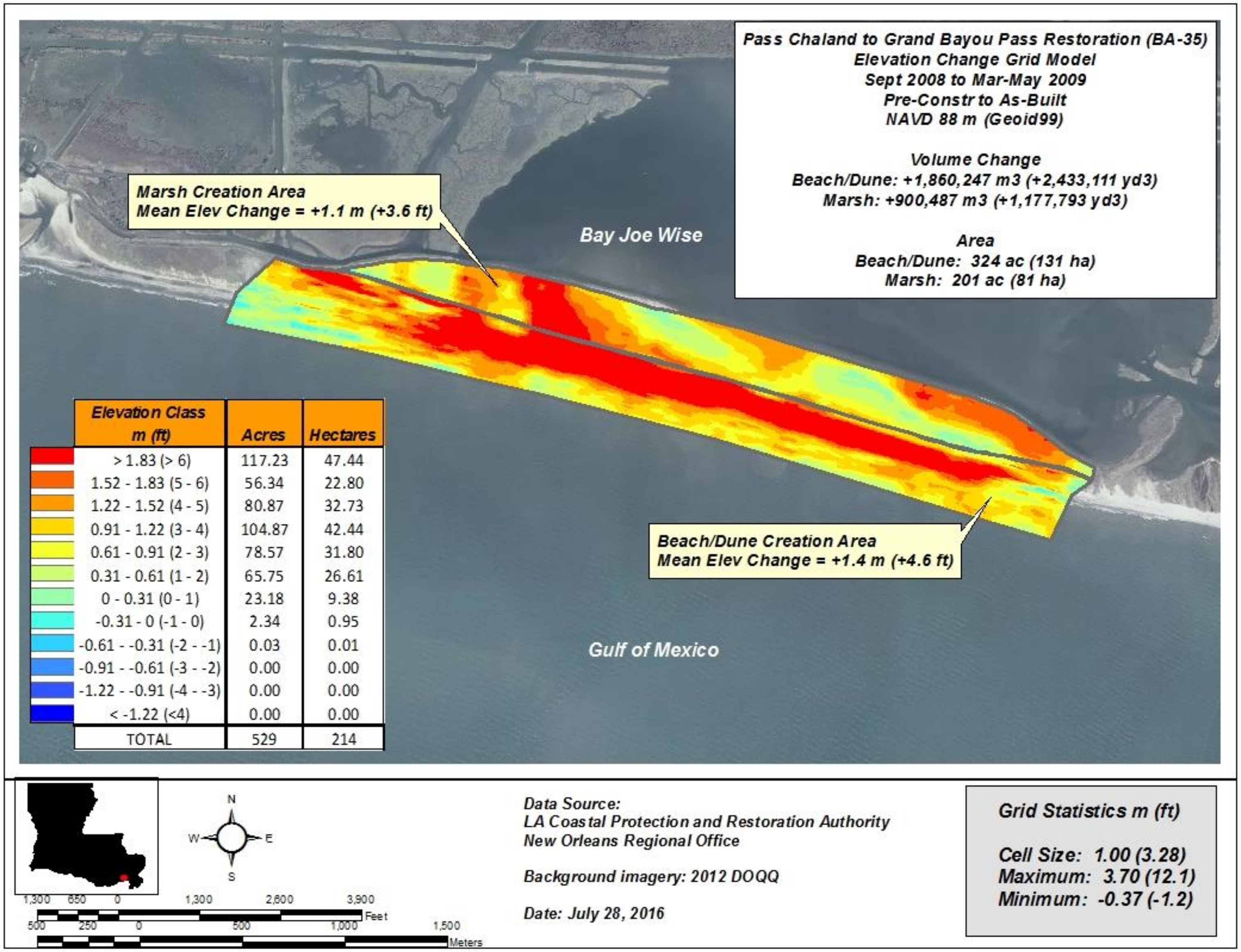


Appendix E1. Elevation and volume change grid model for the BA-35 beach/dune and marsh creation areas from 2003 to 2006.



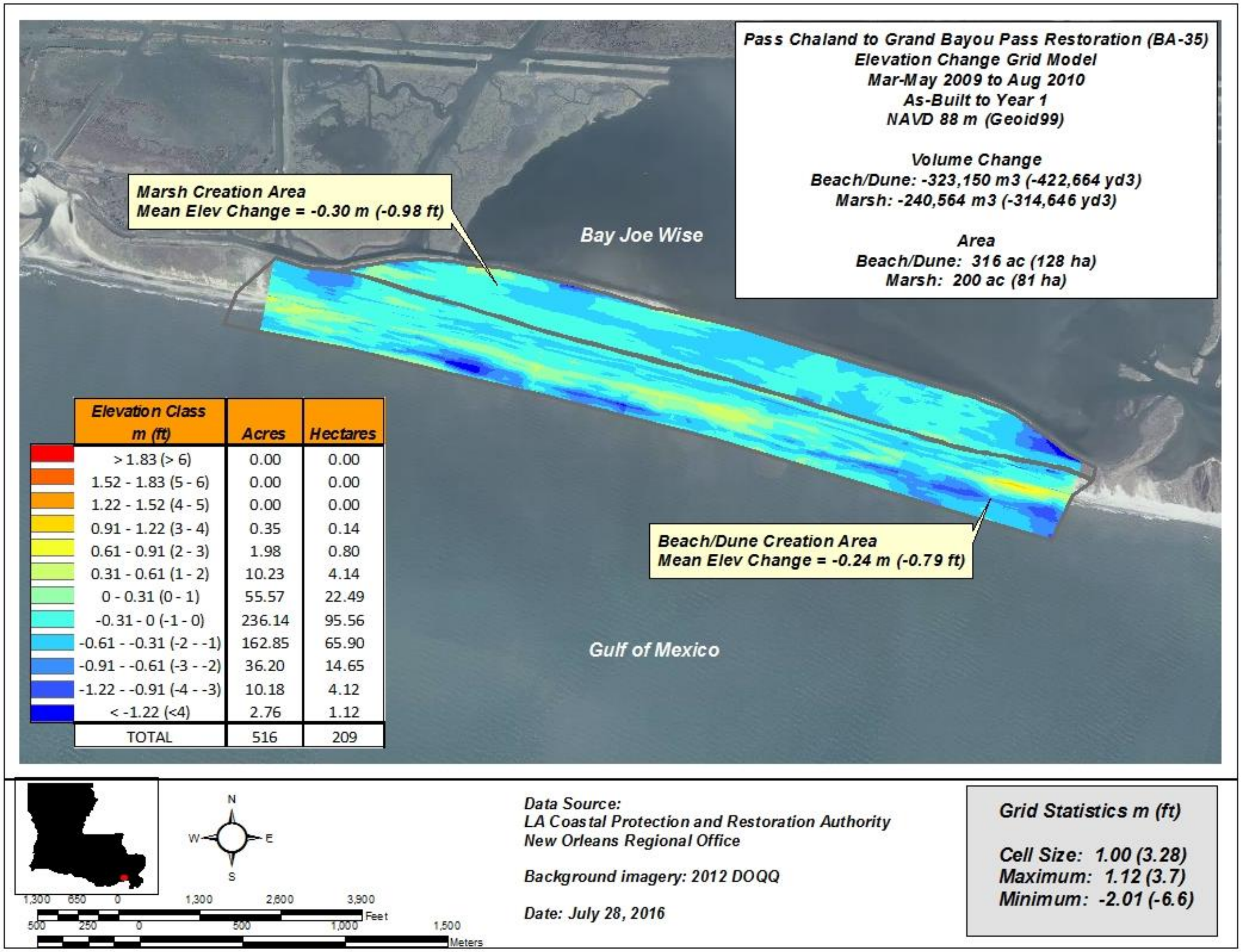
Elevation Class m (ft)	Acres	Hectares
> 1.83 (> 6)	0.00	0.00
1.52 - 1.83 (5 - 6)	4.60	1.86
1.22 - 1.52 (4 - 5)	9.12	3.69
0.91 - 1.22 (3 - 4)	14.35	5.81
0.61 - 0.91 (2 - 3)	31.89	12.90
0.31 - 0.61 (1 - 2)	69.73	28.22
0 - 0.31 (0 - 1)	103.64	41.94
-0.31 - 0 (-1 - 0)	118.22	47.84
-0.61 - -0.31 (-2 - -1)	99.49	40.26
-0.91 - -0.61 (-3 - -2)	46.98	19.01
-1.22 - -0.91 (-4 - -3)	20.62	8.35
< -1.22 (<4)	10.68	4.32
TOTAL	529	214

Appendix E2. Elevation and volume change grid model for the BA-35 beach/dune and marsh creation areas from 2006 to 2008.



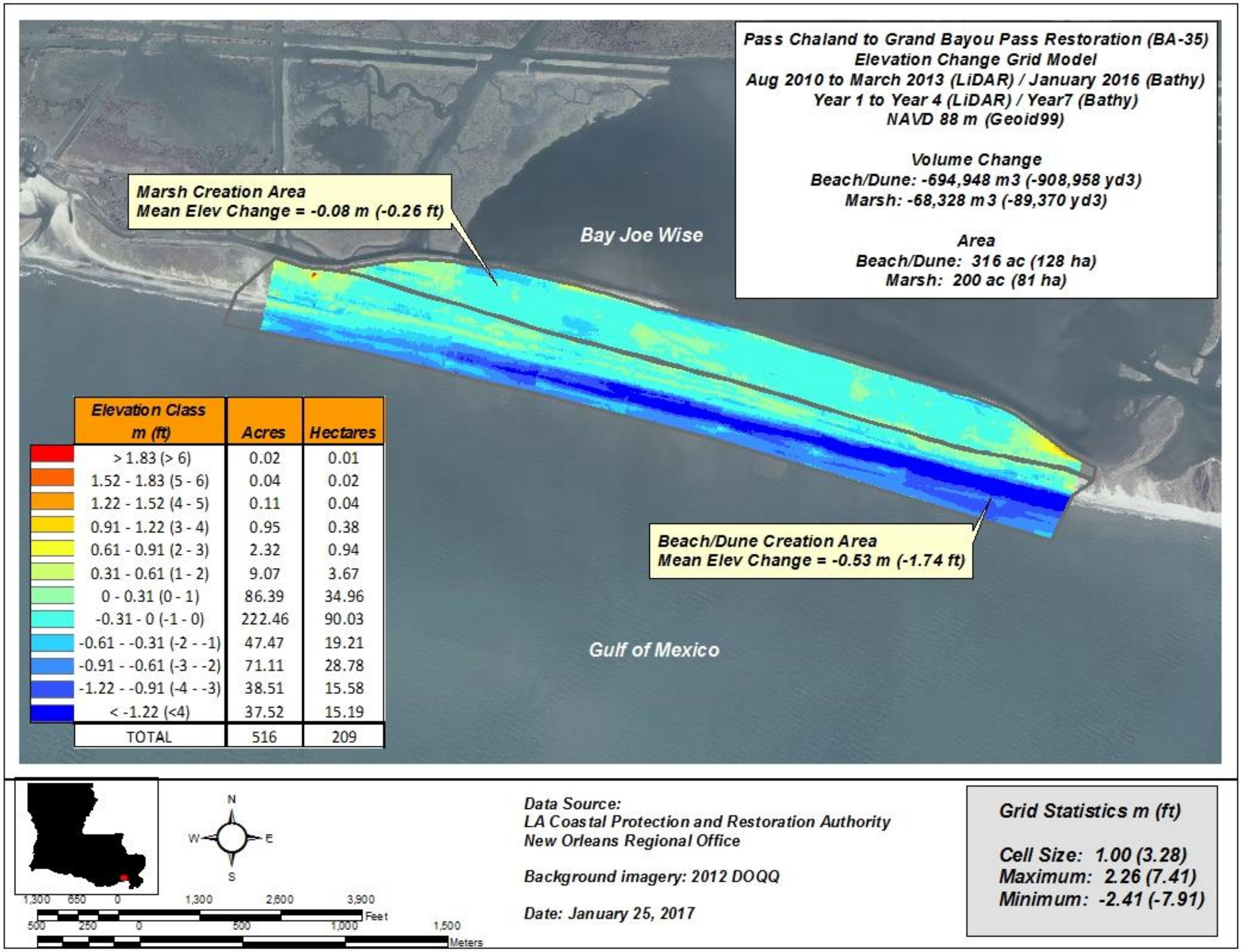
Elevation Class m (ft)	Acres	Hectares
> 1.83 (> 6)	117.23	47.44
1.52 - 1.83 (5 - 6)	56.34	22.80
1.22 - 1.52 (4 - 5)	80.87	32.73
0.91 - 1.22 (3 - 4)	104.87	42.44
0.61 - 0.91 (2 - 3)	78.57	31.80
0.31 - 0.61 (1 - 2)	65.75	26.61
0 - 0.31 (0 - 1)	23.18	9.38
-0.31 - 0 (-1 - 0)	2.34	0.95
-0.61 - -0.31 (-2 - -1)	0.03	0.01
-0.91 - -0.61 (-3 - -2)	0.00	0.00
-1.22 - -0.91 (-4 - -3)	0.00	0.00
< -1.22 (<4)	0.00	0.00
TOTAL	529	214

Appendix E3. Elevation and volume change grid model for the BA-35 beach/dune and marsh creation areas from 2008 to 2009.



Elevation Class m (ft)	Acres	Hectares
> 1.83 (> 6)	0.00	0.00
1.52 - 1.83 (5 - 6)	0.00	0.00
1.22 - 1.52 (4 - 5)	0.00	0.00
0.91 - 1.22 (3 - 4)	0.35	0.14
0.61 - 0.91 (2 - 3)	1.98	0.80
0.31 - 0.61 (1 - 2)	10.23	4.14
0 - 0.31 (0 - 1)	55.57	22.49
-0.31 - 0 (-1 - 0)	236.14	95.56
-0.61 - -0.31 (-2 - -1)	162.85	65.90
-0.91 - -0.61 (-3 - -2)	36.20	14.65
-1.22 - -0.91 (-4 - -3)	10.18	4.12
< -1.22 (<4)	2.76	1.12
TOTAL	516	209

Appendix E4. Elevation and volume change grid model for the BA-35 beach/dune and marsh creation areas from 2009 to 2010.



Appendix E5. Elevation and volume change grid model for the BA-35 beach/dune and marsh creation areas from 2010 to a merged 2013 (LiDAR topography) and 2016 (bathymetry) dataset.