Barrier Island Status Report:
Fiscal Year 2025 Annual Plan

Coastal Protection and Restoration Authority of Louisiana

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Contributing Author

Syed M. Khalil compiled this barrier island status report as part of the Annual Plan document, which is submitted annually to each member of the Louisiana Legislature.

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Revision Chronology

Version	Date	Description
1	03/09/2021	Update for Annual Plan 2022
2	01/13/2022	Update for Annual Plan 2023
3.	01/24/2023	Update for Annual Plan 2024
4.	12/29/2023	Update for Annual Plan 2025

Executive Summary

In compliance with Act 297 of the 2006 Regular Legislative Session, the Coastal Protection and Restoration Authority (CPRA) provides this barrier island status report as part of the Annual Plan document, which will be submitted to each member of the Louisiana Legislature. The current Barrier Island Status report is available electronically at the CPRA website. Please visit www.coastal.LA.gov to download and review the full report.

Constructed Projects

The coastlines of the modern Mississippi River Delta Plain (MRDP) are bordered by numerous barrier islands from Raccoon Island in the west to Hewes Point in the northern Chandeleur Islands in the east. These barrier islands could be grouped to represent fragmented remnants of distal extremities of several major delta lobes and headlands. In order to identify these barrier islands with their corresponding delta lobes they have been grouped from west to east as the Early Lafourche Barrier System, Late Lafourche Barrier System, Modern Barrier System, and the St. Bernard Barrier System. The back-barrier lagoons are connected to the Gulf of Mexico by approximately 25 tidal inlets which separate these barrier islands from each other and allow the exchange of diurnal tides.

The restoration of Louisiana's barrier islands and barrier island systems has been a priority over the past several decades. In all 40 barrier island projects have been constructed to date (including 11 in the Early Lafourche Barrier System, 20 in the Late Lafourche Barrier System, 6 in the Modern Barrier System, and 3 in the St. Bernard Barrier System and 2 are in design stage as Future Projects (1 in Early Lafourche and 1 in St. Bernard; see Table 1). Most of these constructed barrier island projects have been monitored, and their performance has been assessed to adaptively improve resilience and longevity of these projects and future barrier island projects.

With several major restoration projects in place, the post-restoration estimated Year of Disappearance (YOD) for several barrier island systems in Louisiana have been extended from years to decades. This increase in island longevity throughout the system is a direct benefit of the restoration projects. Further, with the increase in both frequency and intensity of major hurricanes over the past decade (and similar projections into the future), in the absence of the restoration and protection program, it is expected many of these islands would have disappeared much sooner than original projections.

Monitoring and Maintenance

Louisiana's barrier islands are part of a complex system controlled by many overlapping and interrelated processes. The four primary barrier island systems have been monitored and evaluated by recent efforts, such as the Barrier Island Comprehensive Monitoring (BICM) program, the monitoring of the Emergency Berms, and project specific efforts. These programs have provided information to the CPRA regarding the current condition and stability of Louisiana's barrier islands. To minimize the acceleration of island disintegration that commonly occurs after a breach, a barrier island Breach Management Program was developed to address both breach prevention and response to breaches when they occur. This program was considered to improve the state's ability to restore storm-induced damages and extend the life-expectancy and integrity of Louisiana's barrier shorelines. The basic objective of this program has since being adopted under

the Barrier Island System Management (BISM) program. Finally, to ensure the efficient and effective use of limited sediment resources in Louisiana, a number of programs/projects, including Borrow Area Monitoring and Maintenance (BAMM) and the Louisiana Sand Resources Database (LASARD), have been initiated under the overarching umbrella of the Louisiana Sediment Management Plan (LASMP). In order to monitor the impact of loading of sand to build beach and dune and restore the barrier islands/headlands, a CIAP-funded Caminada Moreau Subsidence Study (CMSS) was undertaken. BAMM evolved into BAMM-2 as mentioned in section 6.6 whereas the CMSS helped CPRA develop the techniques of measuring subsidence rates, which were determined for the entire coastal Louisiana.

A final report entitled "Louisiana Barrier Island Comprehensive Monitoring (BICM) Program Summary Report: Data and Analyses 2006 through 2010: U.S. Geological Survey Open-File Report 2013–1083" was published as a USGS open file and can be accessed online at http://cims.coastal.la.gov/DocLibrary/DocumentSearch.aspx?Root=0&Folder=0 (Kindinger et al 2013). The BICM program used both historical and newly acquired (2006 - 2010) data to assess and monitor changes in the aerial and subaqueous extent of islands, habitat types, sediment texture and geotechnical properties, environmental processes, and vegetation composition. BICM datasets included aerial still and video photography (multiple time series) for shoreline assessment, shoreline position, habitat mapping, and land loss from CIR aerial photography light detection and ranging (Lidar) surveys for topographic elevations; single-beam and swath bathymetry; and sediment grab samples.

The second BICM program data collection cycle was initiated in 2015 with plans to complete analysis and reporting in 2022. Final Reporting for the BICM monitoring data collected during the second BICM cycle (2015-2021) is ongoing and expected to be completed by 2024. Funding for the third BICM cycle has been secured through a NRDA LA TIG grant. Data acquisition for phase three of the BICM program began in late 2022.

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Barrier Island Performance Assessment

Louisiana's barrier shoreline is one of the fastest eroding shorelines in the world. Due to the geologic setting and the predicted changes in sea level during coming decades, these shoreline habitats and the services they provide are some of the most vulnerable features of our coastal landscape. Barrier island stability is affected by a number of factors, including settlement, over-wash, offshore loss of sediment, longshore transport, and island breaching. Each of these factors is discussed in the context of recent high-frequency data collection.

Shoreline erosion data from BICM indicate that most of Louisiana's shoreline is eroding faster than ever before with some short-term (1996 – 2005) erosion rates more than double the historic (1890s – 2005) averages. However, recent information from the post-BICM studies elucidates the benefits of recent restoration projects. The full report includes a presentation of the overall findings from BICM and detailed discussion of recent shoreline change rates by geomorphologic delta complex. Additionally, the BICM program has updated shoreline change rates for the entire Louisiana coast through 2015.

Minimized Design Template

The minimized design template is defined as a design template with minimal barrier island dimensions that restores the barrier shoreline's geomorphic form and ecologic function and retains this form and function after being subjected to the design storm events.

A minimized design template was previously developed for the Terrebonne Basin barrier shorelines extending from East Timbalier Island to Raccoon Island as part of the Louisiana Coastal Area program for the Terrebonne Basin Barrier Shoreline Restoration Project (TBBSR). Efforts related to modeling for the 2017 Master Plan project evaluations led to development of a minimal design template for the coast. Future efforts related to regional project evaluation and prioritizations can utilize this minimal design, allowing valid comparisons and prioritization areas along the coast using an un-biased approach. Table 3 in the detailed report presents the dimensions of the minimized restoration templates.

Future Plans

Louisiana has invested hundreds of millions of dollars over the past two decades restoring its barrier islands and shorelines and plans to continue to invest in rebuilding these features. Khalil and Raynie (2015) suggested a system-wide approach over restoring and maintaining individual barrier islands. They further recommended that an integrated, system-wide approach acknowledges and embraces the interconnected nature of internal marshes, bays, tidal inlets/passes, and barrier islands as they all constitute one system. This approach was partly adopted and recommended by the 2017 Coastal Master Plan (CPRA 2017). CPRA has adopted this approach and currently developing a Louisiana's Barrier Island System Management (BISM) Program. Rather than recommending specific barrier island and shoreline projects and assigning them to a certain implementation period, CPRA intends to and have restored and maintained the Terrebonne, Timbalier, and Barataria barrier islands and shorelines as part of a regular rebuilding program (Khalil, Raynie, and LeBlanc, 2019). CPRA continued system-wide monitoring, exploration and management of compatible sediment via acquisition of geotechnical and geophysical data, and improving overall understanding of sediment management requirements to support the sediment needs and prioritization of the 2017 Coastal Master Plan projects (CPRA 2017). This allow monitoring and assessment of these critical features to help direct project investment and for CPRA to be able to strategically respond when catastrophic events like future hurricanes impact these areas. During 2020-2021 a program with funding from BOEM was implemented under the Louisiana Sediment Management Plan (LASMP) to utilize the existing data from LASARD, SWAMP, and BICM and other sources (e.g. ACRE, 2019; Kindinger et al., 2002; Flocks et al., 2009) to: (1) develop and explore unconventional out-of-system offshore sand resource prospects for barrier island restoration; (2) develop and explore mixed-sediment resource prospects for marsh, ridge, and landbridge restoration and evaluate impacts of using in-system borrow material in Barataria and Terrebonne/Timbalier Bays; and (3) characterize sand sources and sinks in the active barrier island system to refine operational sediment budgets (ACRE, 2019) and inform barrier island sand management and restoration strategies. These sediment sources will help restoration of barrier islands more efficiently and cost effectively. Simultaneously, Borrow Area Management and Monitoring (BAMM) - 2 was initiated. In 2022 CPRA received funding through the Louisiana Trustee Implementation Group (LA TIG) for development of the Barrier Island Restoration Tradeoff Analysis (BIRTA) toolkit, a system of databases and tools that automate implementation of the BISM workflow through data analysis and predictive modeling.

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1.0 Introduction

The Coastal Protection and Restoration Authority (CPRA) provides this barrier island status report as part of the Annual Plan document to be submitted to each member of the Louisiana Legislature in compliance with Act 297 of the 2006 Regular Legislative Session. The Act requires that the report: 1) indicate the condition of all barrier islands; 2) provide the status of all barrier island stabilization and preservation projects under construction; and 3) outline future plans for restoration and maintenance of the barrier islands and coastal passes. Because the Annual Plan provides information about all coastal restoration projects in Louisiana (including location, status, features, acres benefited, cost, and funding source), it is appropriate to include a report on the current status of the barrier islands.

2.0 Overview of Barrier Islands

The coastline of the modern Mississippi River Delta Plain (MRDP) is bordered by numerous barrier islands related to several historic major deltaic headlands. For the sake of convenience these islands and headlands can be organized into four distinct barrier systems, each tied to an abandoned Mississippi River delta complex: from west to east they are the, Early and Late Lafourche, Modern, and St. Bernard Delta/Barrier Systems (Figure 1). The back-barrier bays and lagoons are connected to the Gulf of Mexico by numerous tidal inlets, which allow the exchange of diurnal tides and separates these barrier islands from each other. The morphology of the barrier islands along the Louisiana coast is related to the sediment supply and physical processes acting in the region (Campbell et al., 2005; Georgiou et al., 2005). Because barrier islands migrate and deteriorate over time (McBride and Byrnes, 1997), restoration of these habitats requires periodic replenishment of sediment/sand to compensate for the losses due to erosion and subsidence. Numerous hurricanes and the Deepwater Horizon oil spill have clearly demonstrated the advantage of robust barrier islands and a well-managed coastline in terms of shoreline resilience and hurricane damage reduction. These events have also highlighted the ecological concerns related to the massive loss of coastal wetland and barrier island systems (Ewing and Pope, 2006). Coastal geomorphic features/landscapes created by these barriers can provide a significant and potentially sustainable buffer from wind and wave action as well as storm surges generated by tropical storms and hurricanes. Barrier shorelines are unique habitats that represent the foundation for complex and productive coastal ecosystems. Moreover, numerous native and migrating marine and avian species utilize Louisiana's barrier island and headland environments. A few of the species that frequent these coastal shores are listed as threatened under the provisions of the Endangered Species Act of 1973.

The restoration of Louisiana's barrier islands has been a priority for a number of programs over the past several decades. In the 1990s, barrier island restoration was a priority for the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program, which funded construction of a number of barrier island restoration projects. CPRA has restored almost all the barrier islands and headlands in coastal Louisiana. These constructed projects have been studied and their performance has been assessed to adaptively improve resilience and persistence of new projects. Khalil and Raynie (2015) suggested a system-wide approach over restoring and maintaining individual barrier islands. They further recommended that an integrated, system-wide

approach acknowledges and embraces the interconnected nature of internal marshes, bays, tidal inlets/passes, and barrier islands as they all constitute one system. This approach was partly adopted and recommended by 2017 Coastal Master Plan (CPRA 2017). Consequently, a more programmatic approach has been adopted by CPRA replacing earlier project-specific one with funding from NFWF. CPRA has recently initiated a Barrier Island System Management (BISM) Program[1] which is an integrated programmatic approach to categorizing, prioritizing, selecting, and funding state barrier island maintenance projects, while continuing coordination with existing and future restoration mechanisms. This is further discussed in detail in Section 6.5 of this status report and in Khalil et al., (2019).

In all 40 barrier island projects (which includes 11 in the Early Lafourche Barrier System, 20 in the Late Lafourche Barrier System, 6 in the Modern Barrier System, and 3 in the St. Bernard Barrier System) have been constructed in Louisiana over the past two and a half decades (Table 1). A total of 2 future projects are currently funded for design only 1 in Early Lafourche and 1 in the St. Bernard Barrier System. Many of these projects are described below geographically from west to east, and are grouped by barrier island system.

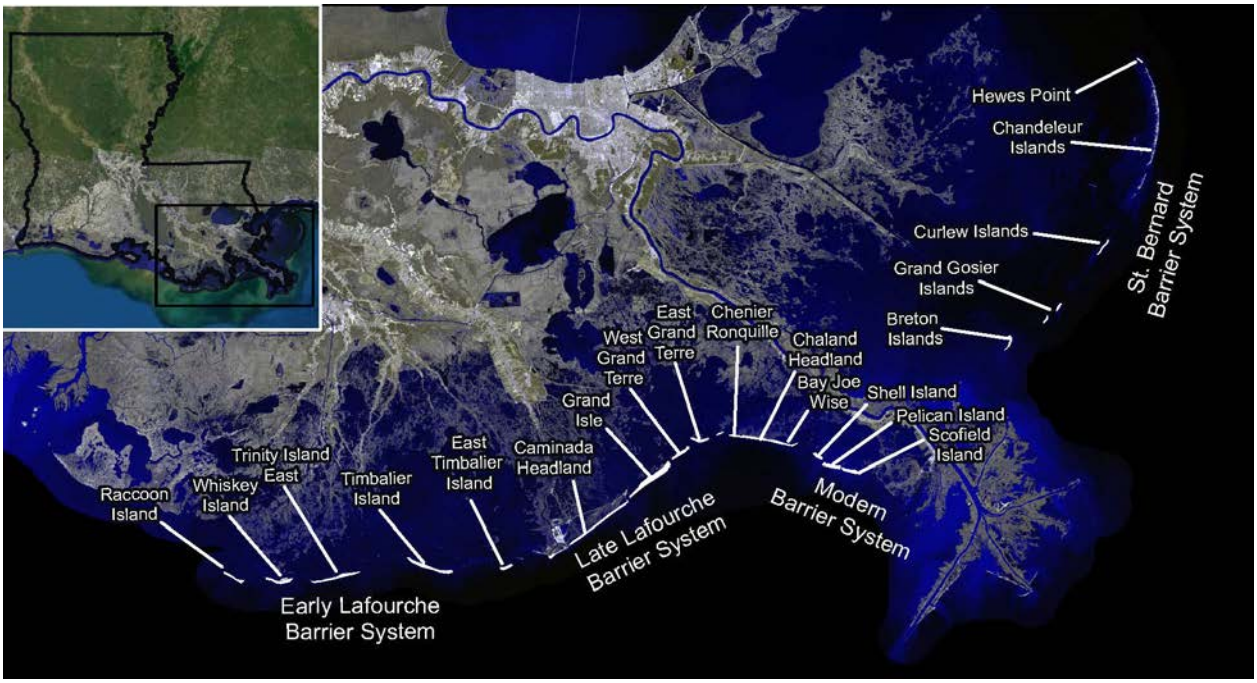


Figure 1: Location of barrier islands belonging to Early Lafourche, Late Lafourche, Modern, and St. Bernard Barrier systems in Louisiana.

1 Barrier Island Re-nourishment Program (BIRP) as reported during AP 2020 has been renamed as Barrier Island System Management (BISM) Program

Table 1: List of Constructed, Funded for Construction, and Future Barrier Island Projects in Louisiana

	Barrier Shoreline Restoration Projects	Funding Program	Construction Year
Early Lafourche Barrier System			
Constructed Projects			
1	Raccoon Island Repair (TE-0106)	Various	1994
2	Raccoon Island Breakwaters (TE-0029)	CWPPRA	1997
3	Raccoon Island Shoreline Protection/ Marsh Creation (TE-0048)	CWPPRA	2007, 2013
4	Whiskey Island Restoration (TE-0027)	CWPPRA	1999
5	Whiskey Island Back Barrier Marsh Creation (TE-0050)	CWPPRA	2009
6	NRDA Caillou Lake Headlands (TE-0100) (includes Whiskey West Flank Restoration (TE-0047))	NRDA	2018
7	Isles Dernieres Restoration Trinity Island (TE-0024)*	CWPPRA	1999
8	New Cut Dune and Marsh Restoration (TE-0037)*	CWPPRA	2007
9	Isles Dernieres Restoration East Island (TE-0020)*	CWPPRA	1999
10	Enhancement of Barrier Island and Salt Marsh Vegetation DEMO (TE-0053)	CWPPRA	2010
11	Wine Island	FEMA	1995
Funded for Construction			
	None		
Future Projects			
	Raccoon Island Restoration (TE-0163)	NRDA	TBD
Late Lafourche Barrier System			
Constructed Projects			
1	Timbalier Island Planting Demonstration (TE-0018)	CWPPRA	1996
2	East Timbalier Island Sediment Restoration, Phase 1 (TE-0025)	CWPPRA	2000
3	East Timbalier Island Sediment Restoration, Phase 2 (TE-0030)	CWPPRA	2000
4	Timbalier Island Dune and Marsh Creation (TE-0040)*	CWPPRA	2004
5	West Belle Pass Barrier Headland Restoration (TE-0052)	CWPPRA	2012
6	Caminada Headland Beach and Dune Restoration (BA-0045)	CIAP/ STATE	2015
7	Caminada Headland Beach and Dune Restoration, Increment 2 (BA-0143)	NFWF	2016
8	Grand Isle and Vicinity Hurricane Protection	WRDA	2010
9	Bayside Segmented Breakwaters at Grand Isle (BA-0050)	CIAP	2012
10	Grand Isle Bay Side Breakwaters (BA-0187)	STATE	2015
11	Grand Isle - Fifi Island Restoration (BA-0155)	CIAP	2015
12	Grand Isle - Fifi Island Breakwater (BA-0168)	State	2015
13	Grand Isle Bayside Segmented Rock Breakwater and Habitat Enhancements (BA-0233)	STATE	2020
14	Grand Isle & Vicinity: West End Beach Nourishment Project (BA-0210)	STATE	2021
15	Vegetative Planting of a Dredged Material Disposal Site on Grand Terre (BA-0028)	CWPPRA	2001
16	Restoration on West Grand Terre Island at Fort Livingston (BA-0186)	NOAA	2003
17	East Grand Terre Island Restoration (BA-0030)	CIAP	2010
18	Caminada Back Barrier Marsh Creation (BA-0171)	CWPPRA	2022
19	West Grand Terre Beach Nourishment and Stabilization Project (BA-0197)	RESTORE	2023
20	Terrebonne Basin Barrier Island and Beach Nourishment (TE-0143)	NFWF	2023
Funded for Construction			
	None		
Future Projects			
	None		
Modern Barrier System			
Constructed Projects			
1	Chenier Ronquile Barrier Island Restoration (BA-0076)	NRDA	2017
2	Barataria Barrier Island Complex Project: Pelican Island & Pass La Mer to Chaland Pass Restoration: (BA-0038, part 1) also known as "Chaland Headland"* (BA-0038, part 2) also knows as "Pelican Island"	 CWPPRA CWPPRA	 2007 2012
3	Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration (BA-0035) also known as "Bay Joe Wise"	 CWPPRA	 2009
4	Shell Island Restoration: Shell Island West NRDA (BA-0111) Shell Island East (BA-0110)	 NRDA Berm Funds	 2017 2013
5	Riverine Sand Mining/Scofield Island Restoration (BA-0040)	CWPPRA/ Berm Funds	2013
6	Western Berm Reaches W8, W9, W10	Berm Funds	2010-2011
Funded for Construction			
	None		
Future Projects			
	None		

Barrier Shoreline Restoration Projects	Funding Program	Construction Year
St. Bernard Delta System		
Constructed Projects		
1 Chandeleur Islands Marsh Restoration (PO-0027)	CWPPRA	2001
2 Emergency Berms E4	Berm Funds	2010
3 Louisiana Outer Coast Restoration: North Breton Island	NRDA	2021
Funded for Construction		
None		
Future Projects		
Chandeleur Island Restoration Project (PO-0199)	NRDA	TBD

* Indicates projects which received additional funding through BIMP (Section 3.4) to install sand fences to trap sand and buffer wind and wave energy after over-wash damages from Hurricanes Gustave and Ike (2008) impacted the Gulf of Mexico shoreline.

2.1 Early Lafourche Barrier System (Raccoon Island to Wine Island)

2.1.1 Constructed Projects

1. Raccoon Island Repair and Restoration Project (TE-106; State; 1994) – The goal of this project was to close breaches formed by Hurricane Andrew and restore the sandy beaches damaged during the storm. The goal was accomplished through the closure of 5 breaches, restoration and elevation of the beach, and construction of back barrier nodes (small sand islands) to provide additional habitat. Approximately 1.5 million cubic yards (MCY) of sand dredged from back barrier borrow sites were placed during restoration. Vegetation was planted to retain sediment and create appropriate habitats.
2. Raccoon Island Breakwaters Demonstration (TE-29; CWPPRA; 1997) – The goal of this project was to reduce shoreline erosion and increase subaerial land area. Eight segmented breakwaters were constructed along the eastern portion of the island to reduce the rate of shoreline retreat, promote sediment accretion along the beach and protect seabird habitat. Project effectiveness was determined by monitoring changes in the shoreline position, wave energy, and elevation along the beach, and by topographic and bathymetric surveys of the Gulf between the shoreline and the breakwaters.
3. Raccoon Island Shoreline Protection/ Marsh Creation (TE-48; CWPPRA; 2007, 2013) – The goal of this project was to protect the Raccoon Island rookery and seabird colonies from a receding shoreline by reducing the rate of erosion along the western end of the island and creating more land along the northern shoreline. This goal was accomplished through the construction of eight additional breakwaters west of the existing (TE-29) breakwaters and a terminal groin at the eastern end of the island (Phase A). In addition, mixed sediment was dredged from an offshore borrow area in federal waters and placed to create 60 acres of back barrier marsh platform with an average elevation of 3.5 feet (Phase B). The shoreline protection (Phase A) component of this project was constructed in 2007; construction of the back barrier marsh platform component (Phase B) was completed in April 2013.
4. Whiskey Island Restoration (TE-27; CWPPRA; 1999) – The objective of this project was to create and restore sandy beaches and a back barrier marsh platform on Whiskey Island. Approximately 4.6 miles of the Gulf-side sandy shoreline with beach/dune component of variable width (700-800 feet) was restored using about 2.9 MCY of sand. The dune height was 4 feet with crest width varying between 300-500 feet. The project created 523 acres of back barrier marsh platform and filled-in the breach at Coupe Nouvelle. The initial vegetation planting of smooth cordgrass (*Spartina alterniflora*) on the bayside shore was completed in July 1998 and additional vegetation seeding and planting were carried out in spring 2000.

5. Whiskey Island Back Barrier Marsh Creation (TE-50; CWPPRA; 2009) – The goal of the TE-50 project was to increase the longevity of the previously restored island by increasing the island's width which helped retain sand volume and elevation. Approximately 316 acres of back barrier intertidal marsh habitat, 5,800 linear feet of tidal creeks, three 1-acre tidal ponds and 13,000 linear feet of protective sand dune were created by semi-confined disposal and placement of dredged sediment. About 2.76 MCY of mixed sediment was dredged from an offshore borrow area in Gulf of Mexico near the island. After removal of the mixed sediment overburden, about 0.36 MCY of underlying sand was used to create the dune fronting the marsh platform. Native marsh vegetation was planted to colonize and protect the newly-placed marsh soil.
6. NRDA Caillou Lake Headlands Restoration Project (TE-100; NRDA; 2018) – This project included the area as envisaged by former CWPPRA project entitled "Ship Shoal: Whiskey West Flank Restoration (TE-47)". The design template of this project was slightly modified from the one that was suggested under the *Louisiana Coastal Area (LCA) - Terrebonne Basin Barrier Shoreline (TBBS) Restoration Project*, which includes the entire island footprint. This project provided a barrier to reduce wave and tidal energy, thereby protecting the mainland shoreline from continued erosion. This was accomplished through the dredging and transport of 10.45 MCY of sand from Ship Shoal Block 88 to create and/or restore approximately 845.8 acres of subtidal, intertidal, supratidal, and dune habitats on Whiskey Island. Sediment was also placed on 107.8 acres that were below the -1.5-ft NAVD88 elevation, resulting in restoration of 953.6 acres in total. Beach and dune were constructed to elevations of +4.7 ft. and +6.9 ft. NAVD88, respectively. The combined beach and dune component was constructed to a minimum width of 880 ft. with a maximum restored width of 1,340. The project was completed in July of 2018.
7. Isles Dernieres Restoration Trinity Island (TE-24; CWPPRA; 1999) – Project objectives included the restoration of the dunes and back barrier marshes of Trinity Island. Approximately 4.85 MCY of sand/sediment were dredged from Lake Pelto to build approximately 4.3 miles of 8-feet high dune with crest width of about 300 feet along with an elevated marsh platform on the bay side of the island. Approximately 353 acres of supratidal and intratidal habitats were created. About 22,500 feet of sand fences were installed along various orientations with vegetative planting to stabilize the sand and minimize wind-driven transport and loss.
8. New Cut Dune and Marsh Restoration Project (TE-37; CWPPRA; 2007) – The purpose of this project was to fill the breach between Trinity and East Islands through the creation of beach, dune, and marsh habitats in order to increase the structural integrity of eastern Isles Dernieres. This also restored sand transport within the littoral zone and added sediment to the nearshore system. New Cut was closed through the construction of about 8,000 feet of dune platform (by placing approximately 0.85 MCY of sand dredged from an offshore borrow area) matching the dune elevations on the east and west, strengthening the connection between East and Trinity Islands. Nine species of native barrier island vegetation were planted and approximately 17,000 linear feet of sand fence was installed.
9. Isles Dernieres Restoration East Island (TE-20; CWPPRA; 1999) – The project restored the coastal dunes and wetlands of the Eastern Isles Dernieres. Approximately 3.9 MCY of sand were dredged from Lake Pelto to build about 353 acres of beach and dune with target elevations of 2 feet and 8 feet, respectively. The dune crest width ranged from 300 to 500 feet. Sand fences were installed and vegetation planted to stabilize the sand and minimize aeolian transport.

10. Enhancement of Barrier Island Vegetation Demonstration (TE-53; CWPPRA; 2010) – The goal of this project was to test several methodologies or products to enhance the establishment and growth of key barrier island and salt marsh vegetation. The project focused specifically on enhancing the establishment and growth of transplants of both dune vegetation (*Panicum amarum* and *Uniola paniculata*) and marsh vegetation (*Spartina alterniflora* and *Avicennia germinans*). Planting took place on Whiskey Island and New Cut in 2010, and monitoring of vegetation treatments was completed in 2011.
11. Wine Island (FEMA; 1995) – Wine Island Restoration created a rock dike surrounding the deteriorated Wine Island and utilized dredged sediment to increase the elevation and subaerial portion of the island. This project was later planted and aerially seeded to create more than 20 acres of wetlands.

2.1.2 Funded for Construction

None.

2.1.3 Future Projects

The Raccoon Island Restoration Engineering and Design (E&D) Project (TE-0163) was approved in 2022 by the Louisiana Trustee Implementation Group to aid in restoring natural resources and services within the Louisiana Restoration Area that were injured by the Deepwater Horizon oil spill. The project is being led by NOAA with the Louisiana Coastal Protection and Restoration Authority and the Louisiana Department of Wildlife and Fisheries as co-implementing Trustees. Collaboration also includes the U.S. Fish and Wildlife Service due to shared trust resources. A notice to proceed was issued in the fall of 2023 by NOAA to their E&D contractor to begin a two to three year effort. A data gap analysis was completed, landrights for E&D were provided by the state, and reconnaissance level surveys are underway. Conceptual alternatives will be evaluated in a design criteria report and tentative designs are scheduled to complete 30% design during 2024.

2.2 Late Lafourche Barrier System (Timbalier Island to East Grand Terre Island)

2.2.1 Constructed Projects

1. Timbalier Island Planting Demonstration (TE-18; CWPPRA; 1996) – For this project, sand fences were installed and vegetation compatible to salinity and the habitat type of Timbalier Island were planted in locations on the island to retain sand and buffer wind and wave energy.
2. East Timbalier Island Sediment Restoration, Phase 1 (TE-25; CWPPRA; 2000) – This project was to strengthened and thus increase the longevity of East Timbalier Island. The project included the placement of dredged sediment in three embayments along the landward shoreline of East Timbalier Island, along with aerial seeding of the dune platform, installation of about 13,000 linear feet of sand fencing, and dune vegetation plantings. About 2.8 MCY of sediment was dredged from an offshore borrow area to create a total of about 217 acres of supratidal and intra-tidal habitats, including a 5-foot high dune with crest width of about 200 feet and a 2-foot high and 500-foot wide marsh platform. This project was funded over two funding cycles of CWPPRA (PPL 3 and 4) during 1999 and 2000, respectively.
3. East Timbalier Island Sediment Restoration, Phase 2 (TE-30; CWPPRA; 2000) – The project goals and objectives were the same as that of Phase 1. While Phase 2 of the project along the western half of the island did not reconnect the western and eastern portions of the island, it did create 99% of the targeted acreage. It has helped to protect thousands of acres of existing

fringing marsh to the north. Funds from this phase of the project were also used for 7,000 feet of rubble mound revetment constructed to protect the newly created habitats.

4. Timbalier Island Dune and Marsh Creation (TE-40; CWPPRA; 2004) – Timbalier Island has been migrating rapidly to the west/northwest; therefore, the western portion of Timbalier Island is undergoing lateral migration by spit-building processes at the expense of erosion along the eastern portion. The objective of this project was to restore the eastern portion of the island by restoring beach, dunes, and marsh. An 8-foot high dune with average crest width of about 400 feet was built using about 4.6 MCY of sand/sediment dredged from offshore borrow area which created a total fill area of about 273 acres, including about 196 acres of marsh platform.
5. West Belle Pass Barrier Headland Restoration (TE-52; CWPPRA; 2012) – This project re-established the eroded West Belle Pass headland via dune and marsh creation, prevented increased erosion along the adjacent bay shoreline and protected the interior marshes in the vicinity of Port Fourchon. The project created a continuous headland approximately 10,660 feet in length, created about 93 acres of dune habitat using nearly 1.74 MCY of dredged sand and created about 227 acres of marsh habitat using 3.05 MCY of dredged mixed sediment. Construction began in May 2011 and was completed in 2012.
6. Caminada Headland Beach and Dune Restoration (BA-45; CIAP, Surplus; 2015) – The Caminada Headland Beach and Dune Restoration project has restored and maintained the headland through the creation of dunes and beach habitat to protect unique coastal habitats, re-established littoral sand transport to Grand Isle and protect Port Fourchon and the only hurricane evacuation route available to the region. This reach of the Barataria shoreline also supports the only land-based access to the barrier shoreline in the MRDP. Construction of portions of the Caminada Headland component of the LCA-BBBS Restoration Project template began in early 2013 using CIAP 2007 and Surplus 2008 funds. Approximately 3.6 MCY of sand from South Pelto Blocks 12 and 13 borrow area (eastern portion of Ship Shoal Complex) were placed to restore approximately 6 miles of shoreline by constructing a 7-foot high and 290-foot wide dune and a 4.5-foot high and 65-foot wide beach totaling 373 acres of restored habitat. It may be noted that for the first time sand from the Ship Shoal complex was dredged for coastal restoration purposes and was transported a distance of approximately 22 miles. Also for the first time, compactional subsidence due to the load of emplaced sand could be quantified by measuring elevation changes in the various subsurface strata. This was accomplished by installing 10 monuments at three different stations. The details are mentioned later in this report under Caminada-Moreau Subsidence Study (CMSS) in Section 3 – Monitoring and Maintenance.
7. Caminada Headland Beach and Dune Restoration Increment II (BA-143; NFWF; 2016) – During the second increment of the Caminada Headland restoration, approximately 5.2 MCY of sand dredged from the South Pelto Block was emplaced. A 7-ft high dune with a 290-ft width and a 4.5-ft high and 65-ft wide beach were constructed over a project length of 39,000 linear feet, thereby restoring the headland with a similar design template as BA-45. Construction of this project began from the central portion of the headland, where the BA-45 project ended and continued eastward toward Caminada Pass, restoring approximately 686 acres of habitat. Construction began in May 2015 and the pumping of sand was complete during October 2016. Native dune vegetation was planted during spring 2017. Between the BA-45 and BA-143 projects, more than 8.8 MCY of sand from Ship Shoal was placed onto the headland, restoring over 13 miles and 1,059 acres of beach and dune habitats.]

8. Grand Isle and Vicinity Hurricane Protection (WRDA; 2010) – The Grand Isle and Vicinity Hurricane Protection Project consists of a 7.5 mile vegetated sand dune extending the length of Grand Isle's gulf shore, a jetty to stabilize the western end of the island at Caminada Pass, and an offshore breakwater system. The construction contract was awarded to Weeks Marine in the amount of $25 million. Notice to Proceed was issued to the contractor on April 15, 2009, and construction began on May 15, 2009. The construction on Grand Isle was delayed slightly due to Tropical Storm Ida which damaged a 1,000 foot section of the "burrito". The main project and the repair project, which will use geotubes, was completed early in 2010.
9. Bayside Segmented Breakwaters at Grand Isle (BA-50; CIAP; 2012) – The purpose of this project was to reduce erosion on the bay side of Grand Isle. Twenty-four 300 foot breakwaters (approximately 1.5 miles) were constructed on the back-bay side of Grand Isle. This project was constructed with Jefferson Parish CIAP funds in September 2012.
10. Grand Isle Bay Side Breakwaters (BA-0187; State; 2015) – The purpose of this project was to reduce erosion on the bay side of Grand Isle. Fifteen 300-foot breakwaters were constructed on the back-bay side of Grand Isle.
11. Grand Isle - Fifi Island Restoration (BA-0155; CIAP; 2015) – This project provides protection for approximately 100 acres of existing island habitat (Grand Isle & Fifi Island) by the installation of approximately 10,000 linear feet of rock shore protection. An additional $999,500 was contributed from the CIAP of 2001 for construction and design of this project.
12. Grand Isle - Fifi Island Breakwater (BA-0168; State; 2015) – The project constructed 1,450 feet of breakwaters and restored 1,450 feet of existing breakwaters along the southwestern portion of Fifi Island in Jefferson Parish to reduce erosion on Fifi Island and the bay side of Grand Isle to protect commercial and residential infrastructure, wetlands, and fisheries.
13. Grand Isle Bayside Segmented Rock Breakwater Project and Habitat Enhancements (BA-0233; Surplus; 2020) – State Surplus ($6.5M) funds were used for the construction of 17 rock breakwaters along the bayside of Grand Isle in Jefferson Parish to reduce wave erosion. Construction began during October 2019 and ended in July 2020. Construction of these seventeen 350-ft. bayside, near-shore segmented breakwaters on the north (bay) side of Grand Isle bridged the gap in bayside breakwaters previously constructed and provide storm surge flood protection for the island. Work included the construction of an access channel, placement of an estimated 62,426 tons of Riprap R1500, placement of an estimated 28,651 square yards of geotextile fabric, and installation of 34 Marine hazard markers.
14. Grand Isle & Vicinity: West End Beach Nourishment Project (BA-0210; State; 2021) – This project constructed five offshore segmented breakwaters and nourished/created approximately 6500 linear feet of beach with sediment from a borrow source near Caminada Pass. The purpose of this project was to nourish the areas of shoreline that have experienced significant erosion from storm events over the past several years. The beach and dune nourishment will work in tandem with the five rock breakwaters to provide resiliency and risk reduction to this area of Grand Isle. This project was completed in 2021 with funds from GOMESA (State funding) and the Bipartisan Budget Act of 2018 (Federal Funding).
15. Vegetative Plantings of a Dredged Material Disposal Site on Grand Terre Island (BA-28; CWPPRA; 2001) – The goal of this project was to stabilize dredged sediment sites on West Grand Terre Island. This was achieved through vegetation plantings and by purchasing grazing rights on the island for the 20-year life of the project.
16. Restoration on West Grand Terre Island at Fort Livingston (BA-0186; NOAA; 2003) – This project consists of a rock dike built to protect the Gulf shoreline of West Grand Terre Island

and Fort Livingston. This project was expedited because erosion rates along West Grand Terre rapidly accelerated due to the impacts of tropical storms in 2002.

17. East Grand Terre Island Restoration (BA-30; CIAP; 2010) – This project stabilized and benefitted 1,575 acres of barrier island habitat and extended the island's life by filling breaches and tidal inlets along the shoreline by emplacement of sand. About 621 acres of land were created by restoring 2.8 miles of barrier shoreline through construction of a 6-foot high dune along with 165 acres of beach habitat and construction of about 456 acres of marsh platform using about 3 MCY of sand and 1.6 MCY of mixed sediment from two offshore borrow areas. Although the CPRA constructed this projects using CIAP 2007 funds, this project was designed, permitted, and received the necessary land rights for construction through the CWPPRA program in partnership with the NOAA Fisheries.
18. Caminada Headlands Back Barrier Marsh Creation Project (BA-171; CWPPRA) – This project created and/or nourished approximately 900 acres of back barrier marsh behind nearly 8 miles of the Caminada Headland beach using sediment dredged from the Gulf of Mexico. The project created a platform upon which the beach and dune could migrate, reducing the likelihood of breaching, increasing the retention of over-washed sediment, improving the longevity of the barrier shoreline, protecting wetlands and infrastructure to the north and west, and slowing the current trend of degradation on the headland. This project works synergistically with the BA-0045 and BA-0143 Caminada Headland Beach and Dune Restoration projects. Assuming that there would be some natural recruitment, vegetative plantings are planned at one year after project construction and 3 years after project construction, if needed. Containment dikes will be degraded or gapped within 3 years following construction completion to allow access for estuarine organisms. Construction started in June 2020, but was delayed by two hurricanes (Hurricane Zeta in October 2020 and Hurricane Ida in August 2021) which made landfall near the project site. Construction was completed in December 2022.
19. West Grand Terre Beach Nourishment and Stabilization Project (BA-0197; NRDA) – The objectives of the West Grand Terre Beach Nourishment and Stabilization (BA-0197) project are to restore and enhance dune and back-barrier marsh habitat to provide storm surge and wave attenuation, thereby addressing the issues of gulf shoreline erosion, diminished storm surge protection, and subsidence of back barrier marshes. The project design goals are to increase the width of the island and maintain shoreline integrity through the introduction of sediment in order to increase island longevity. With the completion of the project, approximately 14,800 linear feet shoreline has been protected, 295 acres of beach and dune have been restored, restoration of 144 acres of back barrier marsh and construction of a rock revetment to protect the restored marsh, as well as fish dips to allow for tidal exchange. Located on the gulf side is a rock revetment spur and extension of the gulfside revetment to the shoreline. The project was advertised on May 12, 2020 with a bid opening on June 17, 2020. Weeks Marine received a Notice to Proceed on August 27, 2020. Contractor mobilized equipment for construction in January 2021. The original completion date was November 2021; however, the completion date was extended to July 2022 to implement recovery efforts Post-Hurricane Ida and construct the beach and dune and marsh habitat features. The project required expansion of the excavation area within the permitted borrow footprint to address losses within the beach and dune and marsh project footprints. Post-Ida Modifications were required to the rock revetment sections to account for the additional scouring within the alignment. The project was designed with the funds from RESTORE grant but construction

was undertaken with NRDA funds. An initial Vegetative Plantings contract, including installation of sand fencing, was awarded post-construction and was completed in May 2023. In addition, interior tidal creeks were planted post-construction in November by Restore or Retreat to address tidal exchange through fish dips on the bayside of the island.

20. Terrebonne Basin Barrier Island and Beach Nourishment (TE-143; NFWF; Formerly East Timbalier (TE-118)) – This project includes restoration areas on Trinity-East Island, Timbalier Island and West Belle Headland. Construction of the project was completed in June 2022, and vegetative planting was completed in Fall 2023. Three borrow areas were utilized for construction; these included two sand borrow areas located in federal waters approximately 10 nautical miles (nm) to the south of Trinity-East Island and one mixed sediment borrow area located in State waters approximately 3.0 nautical miles south of West Belle Headland. The completed project restored 1,080 acres of barrier island habitat, including 8.6 miles of beach, and used approximately 8.8 million cubic yards of sediment. The construction period spanned two active hurricane seasons, and two major hurricanes impacted the project. On Timbalier Island, Hurricane Ida (2021) caused shoreline retreat and breaching, and the project footprint had to be reduced. On West Belle Headland, Hurricane Zeta (2020) partially destroyed recently constructed beach, dune, and marsh for a total loss of approximately 2.8 million cubic yards of sediment. A feeder beach was constructed with remaining project funds, and a FEMA claim is being pursued to repair the headland.

2.2.2 Funded for Construction

None.

2.2.3 Future Projects

None.

2.3 Modern Barrier System (Chenier Ronquille to Scofield Island)

2.3.1 Constructed Projects

1. Chenier Ronquille Barrier Island Restoration (BA-76; NRDA; 2017) – This project has expanded the Chenier Ronquille's gulf shoreline structural integrity by tying into two recently constructed projects to the east and address one of the remaining reaches of the Barataria/ Plaquemines shoreline. The design includes 20 years of advanced fill volume for the beach and dune template as well as fill for marsh creation/nourishment. Approximately 212 acres of beach/dune fill were constructed, and approximately 306 acres of back barrier marsh platform were constructed using sand/sediment from the borrow areas identified for earlier projects. This island provides vital habitat and helps reconnect the barrier island chain that provides defense to inland communities. Dune plantings were conducted by seeding and installing approved nursery stock. Portions of the marsh platform were planted with cordgrass, and portions of the dune, swale, and marsh were planted with appropriate species. This project was funded through the Louisiana Outer Coast Restoration project using NRDA Early Restoration Funds. Construction was contracted by the National Marine Fisheries Services and was completed in 2017.
2. Barataria Barrier Island Complex Project: Pelican Island and Pass La Mer to Chaland Pass Restoration (BA-38; CWPPRA; 2007, 2012) – This project restored barrier island habitat, enhanced storm-related surge and wave protection, prevented overtopping during storms, and increased the volume of sand within the active barrier system. This project includes restoration

of two barrier islands viz. the Chaland Headland portion of this project, which was constructed in 2007, and the Pelican Island segment, which began construction in May 2011 and was completed in 2012. Additionally, in June 2010, the state began construction of a barrier berm in response to the *Deepwater Horizon* oil spill from Shell Island to Scofield Island west of the river to protect its coast from the oil-spill (number 5, below). The construction of the berm introduced a substantial amount of sand into the barrier island system.

a. Pass La Mer to Chaland Pass Restoration (BA-38-1; CWPPRA; 2007) – A total fill area of 484 acres was created which included about 254 acres of back barrier marsh platform with an average elevation of 2.5 feet. The back barrier marsh platform was constructed using about 1.0 MCY of overburden mixed sediment from an offshore borrow area. About 2.4 MCY of sand were placed to build about 230 acres of beach-dune habitat with a dune height of 6 feet and crest width of 400 feet over a project length of 2.7 miles.
b. Pelican Island Restoration Project (BA-38-2; CWPPRA; 2012) – Pelican Island was restored using about 6.4 MCY of mixed sediment and sand from 4 different borrow areas in state and federal waters ranging in distance from 2 to 12 miles. About 2.1 MCY (in-place volume) of sand were utilized to create 192 acres of beach-dune habitats. Average dune elevation was about 7.5 feet extending to a length of 2.5 miles. About 398 acres of marsh platform, with an average elevation of about 2.6 feet, were constructed using 1.6 MCY of sediment. It may be noted that Emergency Berm W9 was built in front of this island using about 1.24 MCY of sand.

3. Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration (BA-35; CWPPRA; 2009) – Also known as Bay Joe Wise, this project includes the emplacement of mixed sediment to create marsh along with tidal creeks and ponds, followed by vegetation plantings. The project's objectives were to: 1) prevent the breaching of the Bay Joe Wise shoreline by increasing barrier shoreline width; 2) increase back-barrier, emergent marsh area by approximately 220 acres to maintain the barrier shoreline; and 3) create emergent marsh suitable for tidal aquatic habitats. These features act as a buffer against wave and tidal energy, thereby protecting the mainland shoreline from breaching and continued erosion. About 350 acres of total fill area were created which included a marsh platform approximately 1,000 feet wide contiguous with the northern side of the gulf shoreline of Bay Joe Wise. The dune was built to an elevation of 6 feet with a dune crest width of about 110 feet. Approximately 3 MCY of sediment were dredged from the Pas la Mer Ebb-Tide Delta, Pass Chaland Ebb-Tide Delta, and Grand Pass Ebb-Tide Delta. The project also included the construction of approximately 10,000 feet of 4-foot wide, 2-foot deep tidal creeks or water exchange channels. In addition, immediate post-construction aerial seeding was conducted with Japanese millet (*Echinochloa frumentacea*) or brown top millet (*Panicum ramosum*) followed by smooth cordgrass (*Spartina alterniflora*) and black mangrove (*Avicennia germinans*) plantings.
4. Shell Island Restoration – Shell Island is a critical component of the Barataria shoreline which has been breached into two islands – east and west. Restoration of these two islands was initially included in the LCA-BBBS Project. The Shell Island Restoration project would restore this barrier island through the creation of dune and marsh habitat. The overall goals of this project are to prevent intrusion of the Gulf of Mexico into interior bays and marshes, restore natural sand transport along this reach of the coast, and protect oil and gas facilities. This segment of the shoreline has been nearly lost. It may be noted that Emergency Berm Reach W8 was built using about 0.777 MCY of sand on the eastern portion of the Shell East Island. This project has been split into two projects: Shell Island East-Berm (BA-110) and Shell Island

West NRDA (BA-111). Both Shell Island East (Berm) and Shell Island West (NRDA funded through the Louisiana Outer Coast Restoration project using NRDA Early Restoration Funds) have been completed (2017). Details of these two projects appear in numbers 7 and 9 below.

a. Shell Island West (BA-111; NRDA; 2017): The Shell Island West NRDA project encompassed the entire Shell West Island and the western portion of the Shell East Island that was not constructed under the Shell East Berm project (BA-110). Sand dredged from the Mississippi River was pumped approximately 19 miles. The Mississippi River borrow area was on the left descending bank; as such, the dredge pipe was laid across the bottom of the river to emerge on the right descending bank. From there, the pipeline crossed the Mississippi River levee, a hurricane protection levee, and two highways (Highway 11 and Highway 23), and then followed the Empire Waterway right-of-way to the eastern end of the project area. Four booster pumps were required to move the sand from the river to the project area. The template of this project included 16,100 feet of shoreline with an 8-foot high and 340-foot wide dune on the western portion of the Shell East Island, and a 380-foot wide dune on the Shell West Island, creating an area of about 319 acres with 4.8 MCY of sand. About 285 acres of barrier marsh platform were constructed using about 1.1 MCY of mixed sediment from an offshore borrow area. Sand fencing was installed along the length of the dune crest to aid in the retention of emplaced sand. Construction of the BA-111 project was completed in July 2017. The marsh and dune platforms were planted in Spring 2018. This project was funded through the Louisiana Outer Coast Restoration project using NRDA Early Restoration Funds.
b. Shell Island East Berm (BA-110; 2013) was constructed between April and August 2013. About 2.29 MCY of sand from a Lower Mississippi River Borrow Area (the same borrow area used for the Scofield Restoration Project [BA-40]) were utilized to construct an 8-foot NAVD 88 dune with a crest width of 340 feet between station 76+79 and station 144+00 creating a dune area of about 87 acres as well as a beach area of approximately 54 acres. About 136 acres of marsh platform were constructed using about 0.286 MCY from the same borrow area as the dune sediment.

5. Riverine Sand Mining/Scofield Island Restoration (BA-40; Berm; 2013) – The goals of this project were to mitigate breaches and tidal inlets in the shoreline, reinforce the existing shoreline with sand, increase the width of the island with back barrier marsh to increase island longevity, and to re-establish a sandy dune along the length of the shoreline to protect the back barrier marsh platform from sea level rise and storm damage. The beach-dune habitats were constructed by the sand dredged from a borrow area in the Lower Mississippi River via a 22-mile long pipeline whereas the marsh platform was constructed from an offshore borrow source of mixed sediment. Although this project was designed under CWPPRA, construction began in December 2012 using Berm Funds. This created approximately 2.16 miles of beach and dune fill to close the breach areas and restore/protect the eroding beach. The dune component included a 50-foot wide crest width at +6 feet NAVD88. The beach fill template included a 100-foot wide construction berm at +4 feet NAVD88. The surface area of the beach platform was approximately 223 acres measured at +4 feet NAVD88. The required fill volume was approximately 2.03 MCY (required excavation (cut) volume was approximately 2.64 MCY). An approximately 2.23-mile long back barrier marsh platform on the bay side of Scofield Island was constructed. The surface area of the proposed marsh platform is approximately 375 acres with target marsh platform elevation of +3.0 feet NAVD88. The required fill volume was approximately 1.74 MCY (the required excavation (cut) volume is approximately 2.79 MCY).

It may be noted that Emergency Berm W-10 (see #5c below) was built in front of this island using about 0.964 MCY of sand.

6. Western Berm Reaches (West of Mississippi River along Shell, Pelican and Scofield Islands; Berm Funds; 2010) – In response to the *Deepwater Horizon* oil spill which began on April 20, 2010, the State of Louisiana constructed approximately 16 miles of sand berms along several sections of the state's barrier islands east and west of the Mississippi River. The objective of these projects was to provide a barrier to oil and minimize the potential impact of the oil spill to thousands of acres of fragile barrier islands and wetlands ecosystem in coastal Louisiana.
    a. Berm Reach W8 (Shell Island; 2010): The initial template of berm reach W8 was located within the footprint of the Shell Island restoration project which was proposed under the Barataria Basin Barrier Shoreline LCA project. However, pre-construction surveys indicated that the island had receded, so the profile was shifted approximately 750 feet north. The construction template for the W8 berm reach was identical to the templates used on the other berm reaches: a 20-foot crest width, +5 feet, NAVD 88 crest elevation, 1V:25H side slopes above -2.0 feet, NAVD88 and 1V:50H below -2.0 feet, NAVD 88. Construction of approximately 9,000 linear feet of berm on Shell Island started on October 9, 2010 and was completed by November 23, 2010. Approximately 0.777 MCY cubic yards of sand was placed along the island.
    b. Berm Reach W9 (Pelican Island; 2010): Construction of berm reach W9 along Pelican Island started on July 18, 2010 and was completed by October 2, 2010. Sand was placed within the construction template, which was identical to the template used for the other berm reaches. The template was superimposed on the existing island and within the footprint of the proposed CWPPRA Pelican Island Restoration Project (BA-38-1). A total length of 12,700 feet of berm was constructed and approximately 1.3 MCY of sand was emplaced within the berm along Pelican Island.
    c. Berm Reach W10 (Scofield Island; 2010): Construction of berm reach W10 on Scofield Island started on September 13, 2010. Approximately 0.935 MCY of sand was placed between September 13 and November 23, 2010 for constructing approximately 14,755 feet of berm. The construction template for berm reach W10 was identical to the other berm reaches. The berm was constructed within the footprint of the proposed CWPPRA Scofield Island Restoration Project (BA-40).

2.3.2 Funded for Construction

None.

2.3.3 Future Projects

None.

2.4 St. Bernard Delta System

2.4.1 Constructed Projects

1. Chandeleur Islands Marsh Restoration (PO-27; CWPPRA; 2001) – This project was intended to accelerate the recovery period of barrier island areas overwashed by Hurricane Georges in 1998 through vegetation plantings. The overwash areas, which encompass 364 acres, are located at 22 sites along the Chandeleur Sound side of the island chain and were planted with smooth cordgrass (*Spartina alterniflora*).

2. Eastern Berm Reach E4 (East of Mississippi River along Chandeleur Islands; Berm; 2010) – In response to the *Deepwater Horizon* oil spill which began on April 20, 2010, the State of Louisiana constructed approximately 16 miles of sand berms along several sections of the state's barrier islands both east and west of the Mississippi River. The objective of this project was to provide a barrier to oil and minimize the potential impact of the oil spill to thousands of acres of fragile barrier islands and wetlands in coastal Louisiana. A total of 47,000 feet (8.9 miles) of berm was constructed along the Chandeleur Islands using about 5.85 MCY of sand dredged from Hewes Point in the north.
3. Louisiana Outer Coast Restoration Project: North Breton Island (NRDA; 2021) – Funded as an Early NRDA Restoration Project, the Louisiana Outer Coast Restoration project comprises four island segments including Breton Island. North Breton Island is the southern-most of a chain of barrier islands forming the Chandeleur Island and is part of the Breton National Wildlife Refuge. The goals of this project are to restore beach, dune, and back-barrier marsh habitats, as well as habitat for brown pelicans, terns, skimmers, and gulls to help compensate the public for spill-related injuries and losses to these resources. The restoration involves emplacement of compatible sediments to restore beach, dune, and back-barrier marshes; installation of sand fencing to trap and retain windblown sediments and foster dune development; and re-vegetation of appropriate native species in dune and back-barrier marsh habitat. The US Fish and Wildlife Service (USFWS) is the lead implementing agency for this project and has awarded a contract for $54.9 million to Callan Marine LTD to pump up to 5.87 million cubic yards of sand onto the island, creating 400 acres of barrier island habitat. Borrow area is sand deposit in the Gulf of Mexico three miles away from the island. Sand was be placed on the north end of the island first where mangroves provide valuable brown pelican habitat. Callan Marine worked from north to south to place the sediment, and construction was completed in 2021.

2.4.2 Funded for Construction

None.

2.4.3 Future Projects

Chandeleur Island Restoration Project (PO-0199) – This project initiated in November 2021, is currently under engineering and design (E&D) funded by the Region-wide Trustee Implementation Group using natural restoration damage assessment (NRDA) funds. The Chandeleur Island chain is a series of barrier islands in eastern St. Bernard and Plaquemines Parishes in Southeast Louisiana, between the Gulf of Mexico and Chandeleur Sound. This E&D effort planned for next year focuses on restoration of the large Chandeleur Island, the seagrass beds behind it, and New Harbor Island. The islands and seagrass beds that would be the focus of this project are state and federally owned and collectively managed by the United States Fish and Wildlife Service (USFWS) via memorandum of agreement with the Louisiana Department of Wildlife and Fisheries as Breton National Wildlife Refuge. This project will focus on building habitat for nesting and foraging birds and sea turtles as well as other fauna that depend on these islands. CPRA is the lead implementing agency and the USFWS is the federal lead for this project.

3.0 Monitoring and Maintenance

Louisiana's barrier islands are part of a complex system controlled by many overlapping and interrelated processes. The four primary barrier island systems have been monitored and evaluated by recent efforts, such as the Barrier Island Comprehensive Monitoring (BICM) program (Section 3.2) and the monitoring of the Emergency Berms (Section 3.6). In addition to this monitoring, a very specific monitoring (with regional ramifications) for quantification of compactional subsidence caused by the load of emplaced sand during restoration was undertaken under Caminada-Moreau Subsidence Study (CMSS; Section 3.3). Besides monitoring, the Barrier Island Maintenance Program (BIMP; Section 3.4) provides a framework for prioritizing planning, design, and construction of barrier island maintenance projects when needs are identified. These programs have provided information to the CPRA regarding the current condition and stability of Louisiana's barrier islands. To reduce the acceleration of island disintegration that commonly occurs after islands breach, a barrier island Breach Management Program was developed to address both breach prevention and response to breaches when they occur (Section 3.5). This program was expected to improve the state's ability to repair storm-induced damages and extend the project-life and integrity of Louisiana's barrier shorelines. Now it has been replaced by Barrier Island System Management (BISM) which is discussed later in section 6.7. Finally, to ensure optimum, efficient and effective use of limited sediment resources within the borrow areas, a Borrow Area Monitoring and Maintenance (BAMM) project was undertaken to understand the evolution of the borrow pits (inland, riverine, and offshore) over time, especially the infilling characteristics (rate and types of sediment) and gradient of the pit-slopes (Section 3.7). BAMM is an integral component of Louisiana Sediment Management Plan (LASMP) which embraces a regional sediment management strategy upon which restoration projects are planned within a regional purview as opposed to merely a project-specific approach. All these monitoring efforts some of which are ongoing and some are completed fall under an overarching System-Wide Assessment and Monitoring Program (SWAMP).

3.1 System-Wide Assessment and Monitoring Program (SWAMP)

Given the need for coastal management programs to be able to adapt to not only the changing landscape, but ecosystem restoration priorities, allocation of project funding, and developments in new data gathering technology, an overarching monitoring and assessment program for Louisiana's coast is implemented as System-Wide Assessment and Monitoring Program (SWAMP). The first phase of SWAMP became operational for the Barataria Basin in the fall of 2015 followed by areas east of the Mississippi River (2017) and the rest of the state, west of Bayou Lafourche (2019).

One of the first steps in the development of SWAMP was the formulation of a SWAMP Framework, completed in the fall of 2013 through various workshops with a long list of agencies and academic participants who were familiar with Louisiana's coast and its issues/challenges. This framework identified both natural and human drivers of change to our coastal system. Following this framework development, performance measures were identified and prioritized to support the state's coastal protection and restoration program. These performance measures were directly tied to the drivers of system change, such as atmospheric and oceanic processes, geological processes, surface and groundwater inputs, and ecosystem utilization, which represent the information that is

necessary to monitor to document change and to document collective effectiveness of Louisiana's Coastal Master Plan.

Following the Framework development and the identification of Performance Measures, a prototype SWAMP monitoring plan "Barataria Pilot" was developed for Barataria Basin which not only integrated existing monitoring programs, but also filled in data gaps and needs that were identified but were not being addressed by other programs at the time.

The key design of SWAMP was to support a comprehensive network of coastal data collection activities to ensure effective development, implementation, and adaptive management of the coastal protection and restoration program. SWAMP now helps to tie in all of the supporting monitoring programs under one umbrella, such as the Coast-wide Reference Monitoring System-Wetlands (CRMS), the Barrier Island Comprehensive Monitoring (BICM) program, and the Louisiana Sand Resource Database (LASARD), to improve project efficiency and remove duplicative efforts.

Since 2015, bathymetric/hydrographic and geophysical surveys (including sub-bottom profile/seismic, side scan sonar, magnetometer) have been undertaken along approximately 6,600 nautical miles (nm) of track-line in various basins and lakes from Chandeleur Sound in the east to Sabine lake in the west in four phases covering an area of approximately 5,114 square miles (sq. mi). The main objective was to acquire baseline data for elevation (bathymetric), surficial as well as subsurface oyster occurrences delineation; establishment of subsurface geology for sediment exploration/investigation; delineation of pipelines and identification of debris on water bottom.

SWAMP helped to integrate above/below ground biomass to assist wetland monitoring, added chlorophyll and nutrient components to help evaluate inshore water quality in the Mississippi Delta, enhanced fisheries monitoring protocols, and allowed for improved bathymetry data to better understand the potential effects of sediment diversions and help improve predictive ecosystem models.

SWAMP was implemented in Barataria Basin beginning in 2015; and in Pontchartrain, Breton Sound, and the Mississippi River Delta in 2017;, and west of Bayou Lafourche in 2019. A key area for SWAMP's improvement will be the continued adaptation of standard operating procedures for the various monitoring and assessment programs throughout the coast. CPRA still receives numerous data sets that are not consistent with other data management programs. Improving data standards and accessibility will enable efficient data collection and utilization and also enhance data transparency across CPRA's programs and other coastal activities.

3.2 Barrier Island Comprehensive Monitoring (BICM) program

As detailed in earlier status reports (CPRA, 2021) BICM was developed and implemented to establish baseline conditions for the state's barrier shoreline after hurricanes Katrina and Rita, as well as to refine the methods and products for use in programs such as LCA, CWPPRA, CIAP, BIMP, NFWF, RESTORE, and NRDA.

The advantage of BICM over project-specific monitoring alone, is the ability to provide integrated long-term data on all of Louisiana's barrier shorelines, instead of only those areas with constructed projects. As a result, a greater amount of long-term data are now available to evaluate constructed projects, facilitate planning and design of future barrier island projects, assist operations and maintenance activities, and determine storm impacts. Because data were collected for the entire barrier island system concurrently, BICM datasets are more consistent and regionally encompassing than previous barrier island data collection efforts.

As reported earlier BICM datasets include 1) post-storm damage assessment photography and videography, 2) shoreline position, 3) land/water analysis, 4) topography, 5) bathymetry, 6) habitat composition, and 7) surficial sediment characteristics. Additionally, these datasets have been compared to historic datasets (where available) that have been standardized, thereby providing digital datasets to user groups for their use in multiple restoration efforts. Data collection for all seven BICM components initiated in 2005 was completed in 2008 and a second cycle of data collection was completed in 2019. Final datasets and reports are currently available through the CPRA web site. A final report for the first program cycle entitled "Louisiana Barrier Island Comprehensive Monitoring (BICM) Program Summary Report: Data and Analyses 2006 through 2010: U.S. Geological Survey Open-File Report 2013–1083" was published as a USGS open file and can be accessed online via the CPRA website (coastal.LA.gov) or at http://pubs.usgs.gov/of/2013/1083/ (Kindinger et al., 2013).

The second BICM data collection cycle (2015-2019) was initiated with region-wide collection of data for all parameters beginning in 2015 (Figure 2). A final synthesis and assessment report for the BICM programs second cycle is in the process and expected to be completed in 2024.. Additionally, BICM data management through CPRA Coastal Information Management System is ongoing with the majority of data, reports, and maps available on BICM Project page (https://cims.coastal.louisiana.gov/outreach/Projects/Bicm). All the individual reports of various components of BICM were finalized and delivered and could be accessed through CPRA website.

Shoreline Positions have been revised from the earlier BICM datasets, and development of additional shorelines for the 1950s, 2008, 2012, and 2015 has been completed (Figure 3). These data are available and provide updated shoreline erosion data, which better evaluates changes in shoreline positions, particularly in regards to various restoration efforts since 2006.

BICM collected updated bathymetric data in 2016 and 2017 within all BICM regions, with data currently available (Figure 4). Repeat bathymetric survey was conducted during 2023 and the data are still in processing. Coordinated integration with SWAMP and BICM programs collected updated topographic LiDAR surveys across the coastal zone. LiDAR data were acquired from the Caminada Headland to Sandy Point in March, 2013 as part of a lower Barataria Basin LiDAR update through a partnership with USGS and the processed data were delivered by USGS in early 2015. BICM collaborated with USGS to survey the Early Lafourche Delta region in early 2015 and SWAMP coordinated a LiDAR survey of the Chenier Plain with USGS in early 2017 to complete the BICM area. These data are currently available. Coordination with SWAMP and BICM has resulted in Topo-Bathy DEMs for three time periods, and an operational sediment budgets for the Raccoon Island to Sandy Point area of the coastline (see Section 6.3) and the Chandeleur Islands region have been completed with data and reports available (Figures 5 and 6).

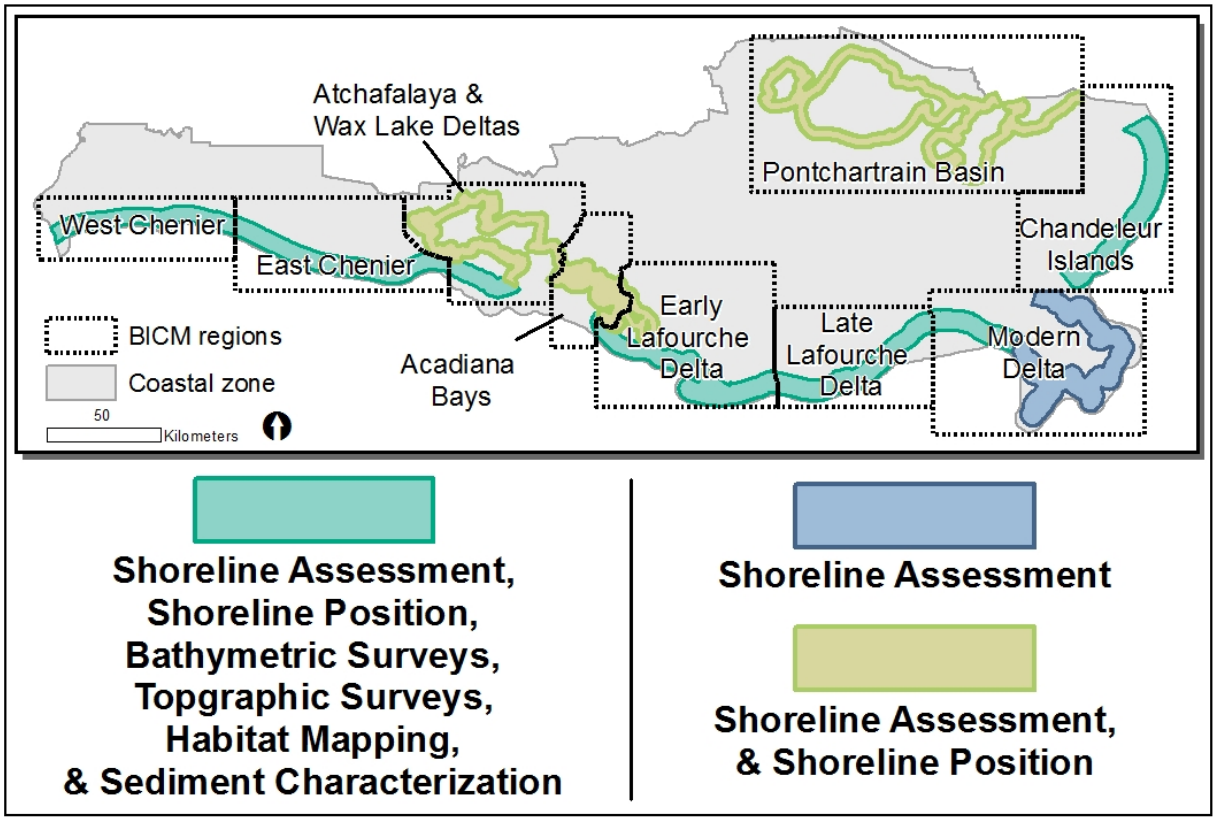
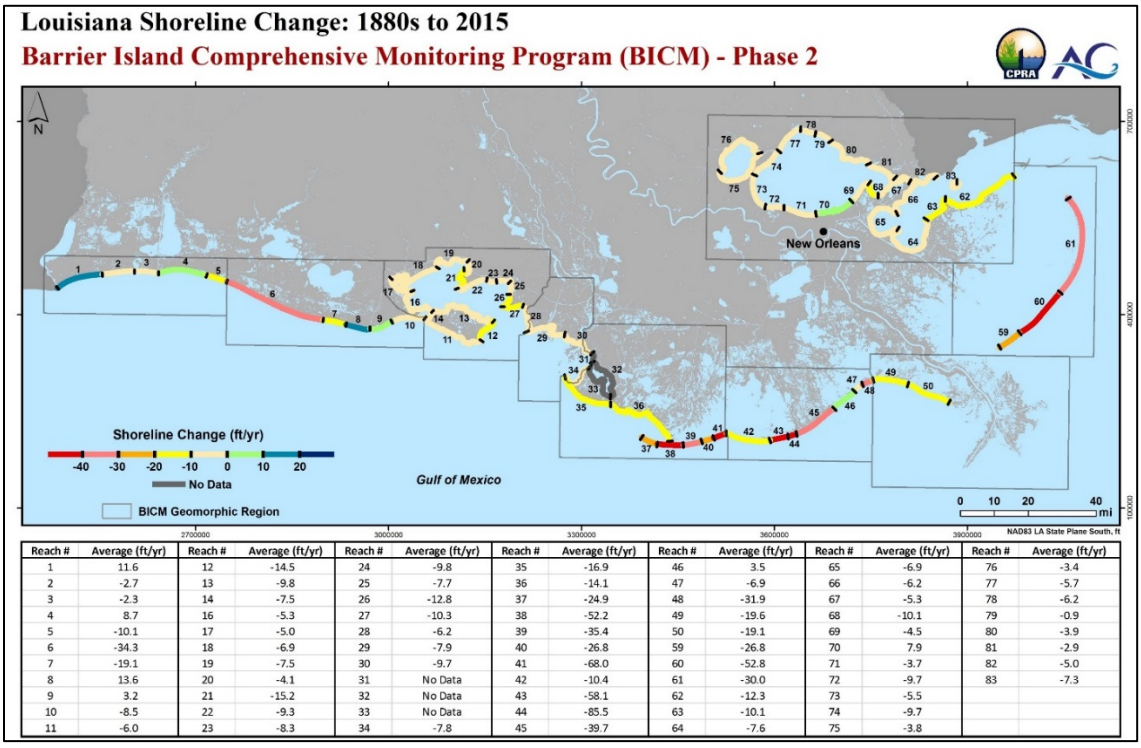


Figure 2: BICM data collection for the 2015 through 2019 cycle. Note the additional areas of effort in the Eastern Chenier Plain and Early Lafourche Delta regions compared to previous BICM collections.



Reach #	Average (ft/yr)	Reach #	Average (ft/yr)	Reach #	Average (ft/yr)	Reach #	Average (ft/yr)	Reach #	Average (ft/yr)	Reach #	Average (ft/yr)	Reach #	Average (ft/yr)
1	11.6	12	-14.5	24	-9.8	35	-16.9	46	3.5	65	-6.9	76	-3.4
2	-2.7	13	-9.8	25	-7.7	36	-14.1	47	-6.9	66	-6.2	77	-5.7
3	-2.3	14	-7.5	26	-12.8	37	-24.9	48	-31.9	67	-5.3	78	-6.2
4	8.7	16	-5.3	27	-10.3	38	-52.2	49	-19.6	68	-10.1	79	-0.9
5	-10.1	17	-5.0	28	-6.2	39	-35.4	50	-19.1	69	-4.5	80	-3.9
6	-34.3	18	-6.9	29	-7.9	40	-26.8	59	-26.8	70	7.9	81	-2.9
7	-19.1	19	-7.5	30	-9.7	41	-68.0	60	-52.8	71	-3.7	82	-5.0
8	13.6	20	-4.1	31	No Data	42	-10.4	61	-30.0	72	-9.7	83	-7.3
9	3.2	21	-15.2	32	No Data	43	-58.1	62	-12.3	73	-5.5		
10	-8.5	22	-9.3	33	No Data	44	-85.5	63	-10.1	74	-9.7		
11	-6.0	23	-8.3	34	-7.8	45	-39.7	64	-7.6	75	-3.8		

Figure 3: 1880's to 2015 average shoreline erosion rates for individual BICM shoreline reaches.

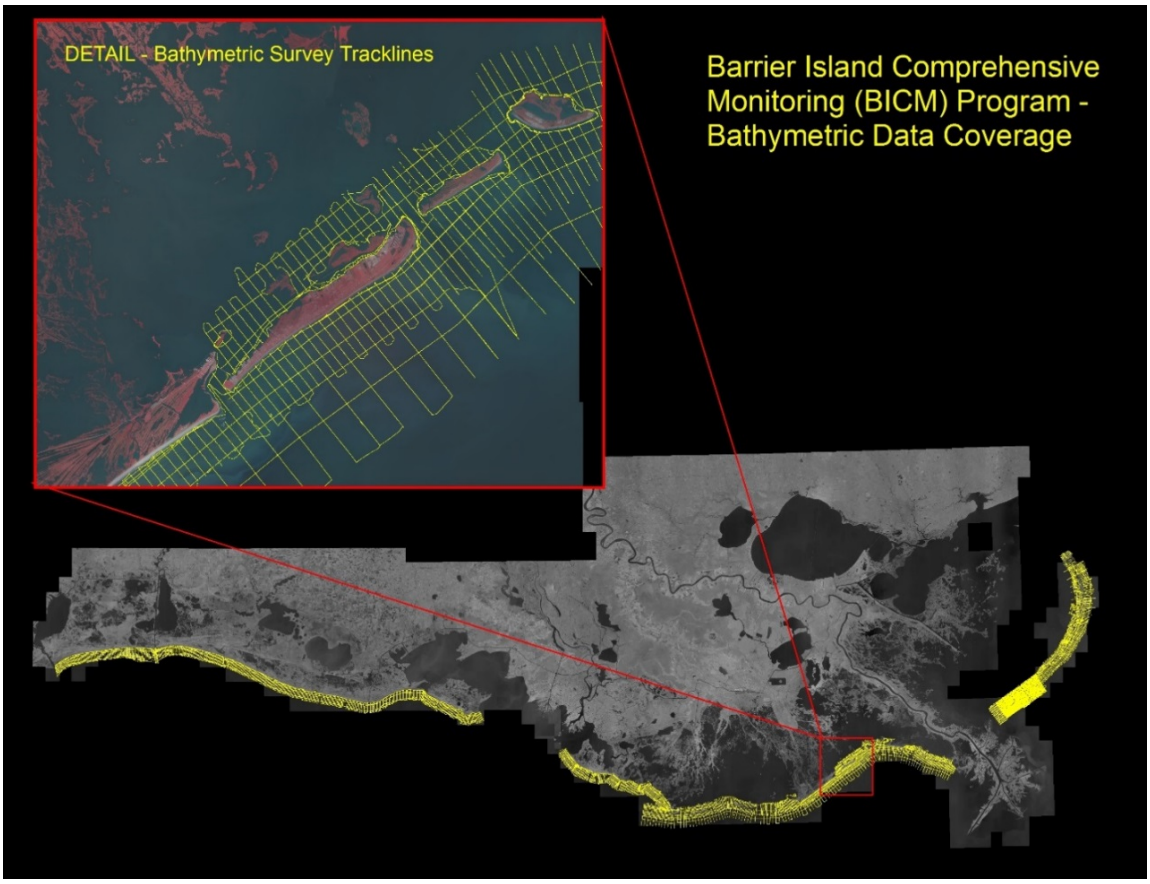


Figure 4: Bathymetric data collection coverage for the second BICM data collection cycle (2015-2017).

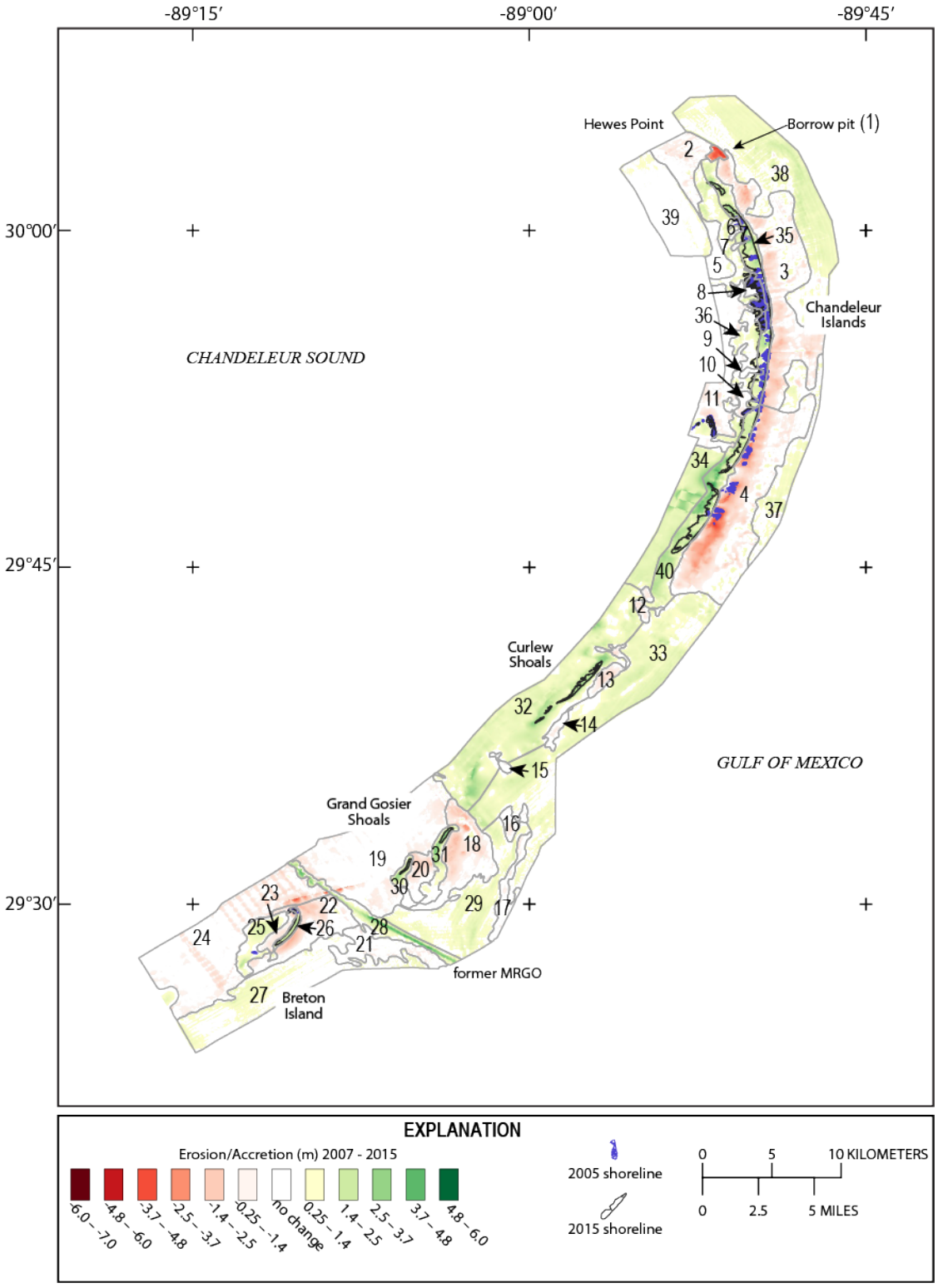


Figure 5: Chandeleur Islands 2007 to 2015 elevation change map with accretion/erosion areas identified by polygons

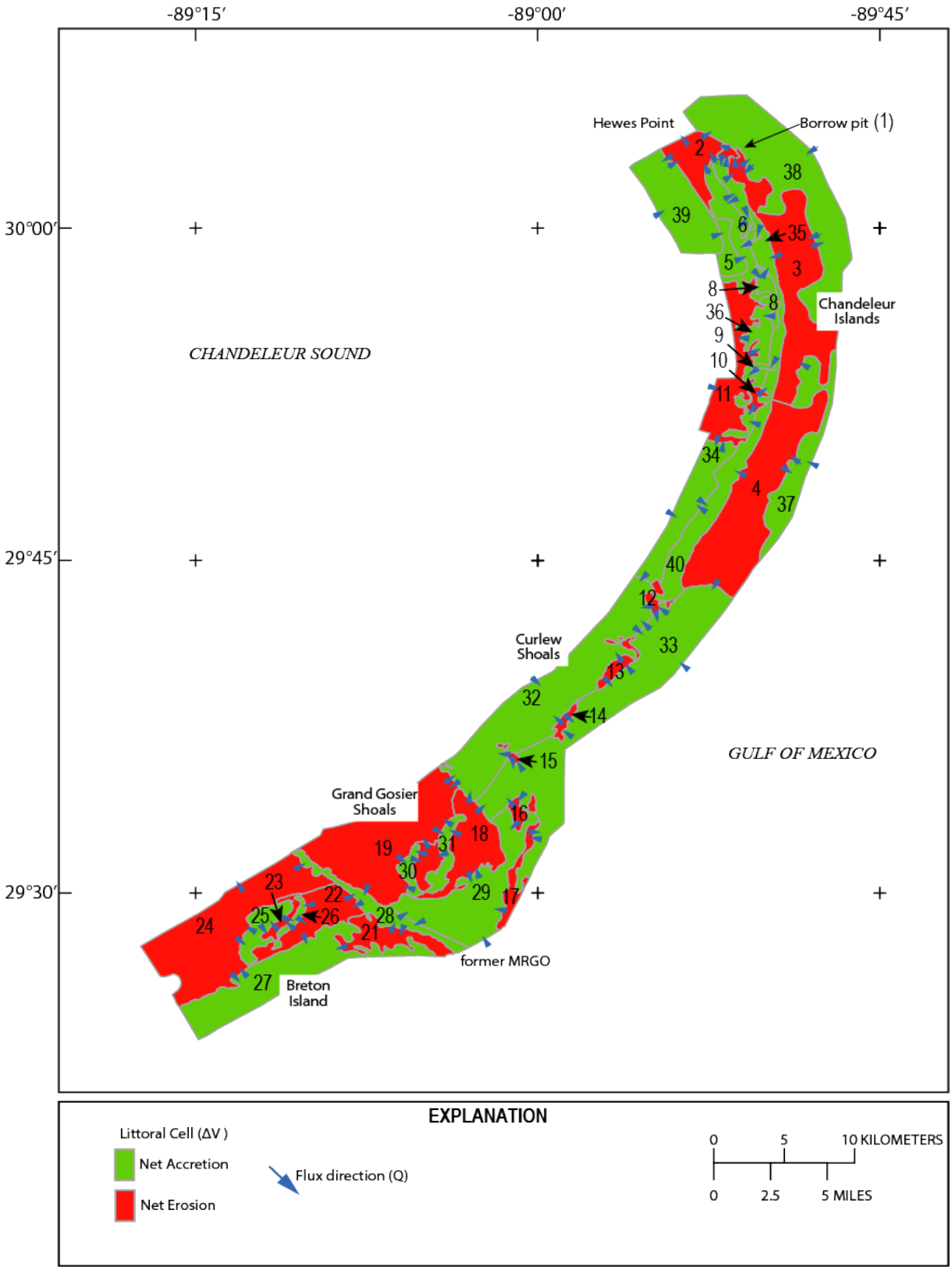


Figure 6: Littoral cells for the 2007 – 2015-time period at the Chandeleur Islands where the net volume (ΔV) is positive (green) or negative (red). Blue arrows represent flux direction from (Q-source) and to (Q-sink) the cell and residual volumes are calculated to determine sediment movements and quantities.

Habitat mapping, on the basis of the 2008 and 2015/16 coast-wide color infrared photography commenced in 2016, with data delivery and synthesis completed in 2019. Currently, habitat and habitat change data for all BICM regions is complete and available for use (Figure 7). Additionally, a web-based Habitat Reporting Tool (HRT) has been developed which allows users to export maps by BICM reach (https://cims.coastal.louisiana.gov/viewer/BICM-HRT.aspx). Older BICM datasets are being converted for integration into the HRT Tool.

Surficial sediment sampling was repeated, and expanded into additional regions in 2015 and 2016. The samples have been collected, processed, and datasets are available. Analysis of changes in surficial characterizations are underway for final reporting have been completed and final reports are available (Figure 8). These sedimentological data have been incorporated into Surficial Sediment Distribution (SSD) maps in coordination with SWAMP (Section 6). Additionally, shore assessment oblique photography has been collected and individual photos, photo pairs, and photo time series are available for use in reporting and outreach (Figure 9).

Additional data collection such as subsidence, overwash and recovery, and vegetation sampling are continuing to be developed and budgeted in coordination with BISM, SWAMP and CRMS programs, based on user input and needs identified for the 2023 Master Plan update, as well as storm damage assessments and other programs. Final Reporting for the second BICM cycle is underway with completion projected for 2024. A third iteration of the BICM program was commenced in the fall of 2022. In addition to the seven (7) BICM datasets listed above, three (3) new variables have been added to the BICM protocol for the third cycle. These new methodologies consist of vegetation composition sampling, subsidence monitoring, and overwash and recovery monitoring. The tropical activities associated with the 2020 and 2021 Hurricane seasons make this an appropriate time to initiate the third repetition of the BICM data variables and document post-storm change. Bathymetry data collection at BICM reaches began in 2022. Collection of the other historical BICM variables were initiated in 2023. These variables include shore assessment oblique photography, shoreline position, habitat composition mapping, and surficial sediment characteristics. Topographic LiDAR will be acquired along the outer coastal margins of Louisiana from 2021 Coastal Louisiana LiDAR (LA DOTD & USGS), 2022 Breton to Chandeleur Islands Topobathy (USGS), 2023 Louisiana Coastal Parishes LiDAR (LA DOTD & USGS), and 2023 NOAA Topobathy LiDAR (NOAA). The additional BICM methodologies will commence in 2024.

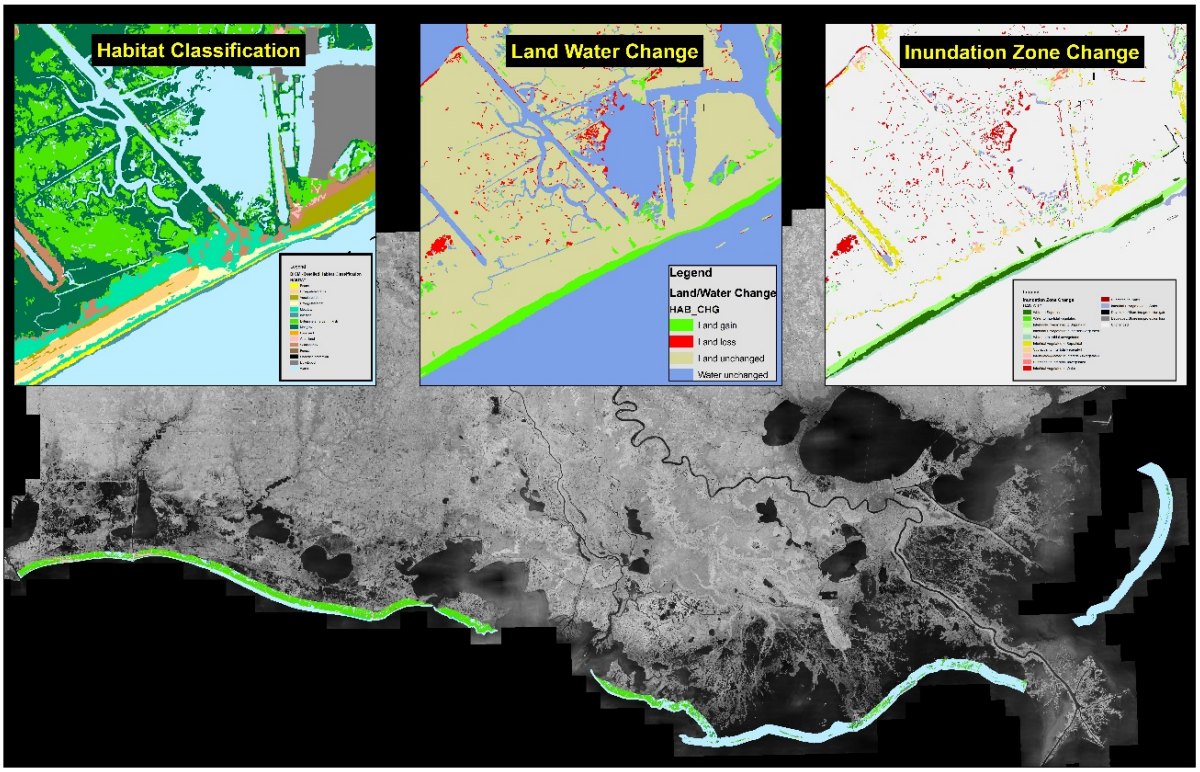


Figure 7: Coverage of BICM Habitat Mapping efforts with Habitat and Habitat change examples for BICM Regions.

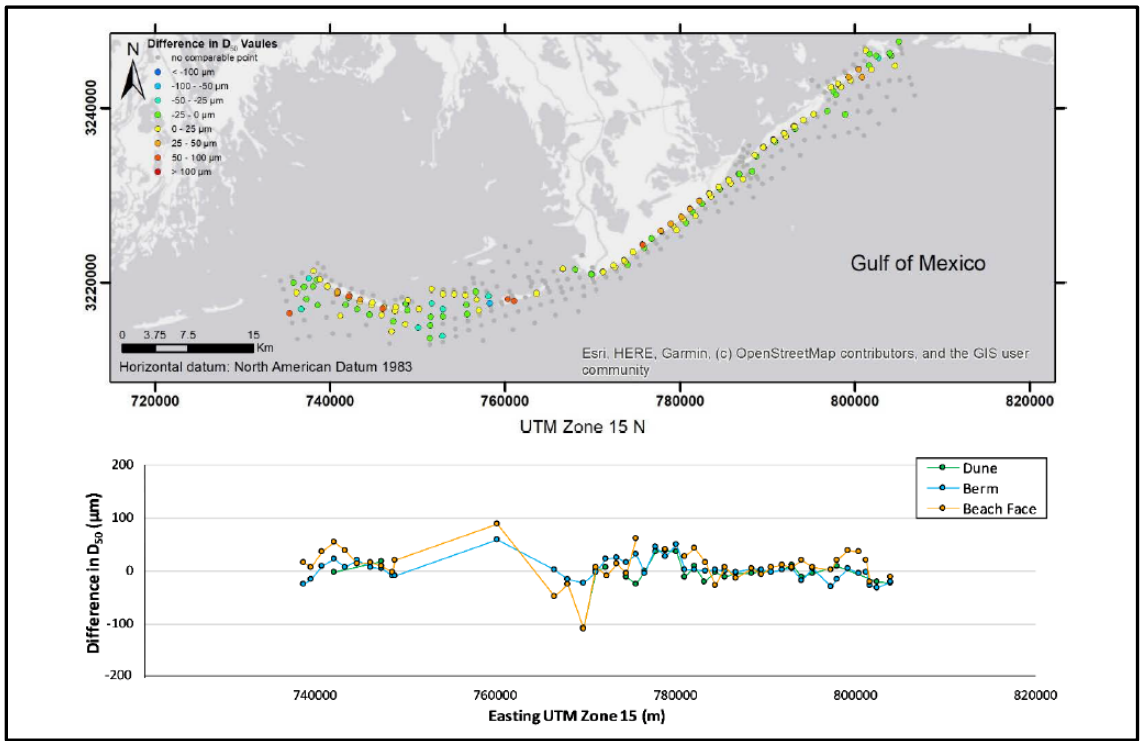


Figure 8: The difference in grain size (D50) along the Late Lafourche Delta from 2008 to 2015 in plan-view (top) and graphically (bottom) for the onshore environments (dune, berm, and beach face).

Figure 9: Shoreline Assessment 2007 – 2017 photo pairs examples.

3.3 The Caminada – Moreau Subsidence Study (CMSS)

Marsh and barrier island restoration rely on placement of large quantities of sediment on existing substrates that often are compressible. At the same time, the emplaced sediment also compacts in time. Engineering design of restoration projects require knowledge of background subsidence rates, the relationship between surface loading and subsurface consolidation, and settlement of the fill after placement. The Caminada – Moreau Subsidence Study (CMSS) was conceptualized, planned, developed, and undertaken to evaluate the existing geological profile of deltaic deposits at foreshore, dune, and backshore locations along the Caminada - Moreau headland, evaluate natural subsidence near the restoration site, and monitor consolidation settlement after placing sediment for restoration of Caminada – Moreau Headland beach (CPRA 2021). This attempt to quantify consolidation settlement is a first-of-its-kind study as no direct measurements of subsidence and its partitioning with depth had been previously attempted (Byrnes et al., 2015: Rosati, 2009).

This first 3 phases of the study were funded by CIAP and formed a part of the Performance Evaluation and Science Monitoring Project. An evaluation of localized sediment consolidation associated with placement of 3.62 million cubic yards of sand for the Caminada Headland Restoration Project (BA-0045) along coast in south Louisiana was initiated in February 2012. A Phase 4 final report was submitted to CPRA in mid-2016. Phase 5 measurements were completed in February 2017. Fenstermaker & Associates completed another set of surveys in April 2018 and in March 2020 following the same procedures described in the Phase 4 final report by Gahagan & Bryant (GBA, 2016). A high-accuracy leveling survey was conducted for each 10 anchor locations

relative to the control benchmark (CMS-BM-01) to an accuracy of ±0.03 feet (Figure 10). Survey results documented continued consolidation settlement at all depths in the sediment column at all locations; however, the rate of change decreased as a function of depth and time after fill placement (Table 2). A general trend of decreasing consolidation settlement also is consistent with geotechnical estimates of consolidation.

Prior to installation of ten subsurface monuments, geologic borings were collected at four locations along a 3.5-mile segment of barrier beach to document subsurface sediment characteristics to a depth of approximately 120 ft. At each of the borings, the upper 20 to 25 ft. consisted of fine sand and shell fragments, interbedded with soft silty clay and organic layers, representing barrier beach, bay/marsh, intra-delta, and relict beach deposits. Fine-grained inter-distributary sediment dominated between -20 and -80 ft., below which a relatively thin layer of delta front/nearshore gulf sediment capped a thick sequence of homogenous pro-delta clay.

Based on geological characteristics of subsurface deltaic sediment layers, 13 samples were obtained from four clay layers at subsurface monument sites for geotechnical analyses to estimate settlement within each layer. Consolidation settlement estimates due to applied vertical stress associated with beach fill placement were calculated for periods ranging from 6 months to 20 years. Typically, these kinds of estimates are used to determine construction tolerance elevations before beach fill placement to account for settlement over the life of a project. Elevation change monitoring site anchor depths were collocated with geotechnical samples to record consolidation settlement below each of the dominant sediment layers beneath the Caminada - Moreau Headland. Variability in sediment layer composition and geotechnical properties resulted in differences in percent settlement in defined layers. Ten subsurface anchor monuments at three sites were surveyed periodically between May 29, 2013 and March 20, 2020 to document elevation changes associated with beach fill loading (ACRE, 2020a). Prior to this study, no independent measurements of elevation change were available to verify the reliability of consolidation estimates based on geotechnical sampling and modeling.

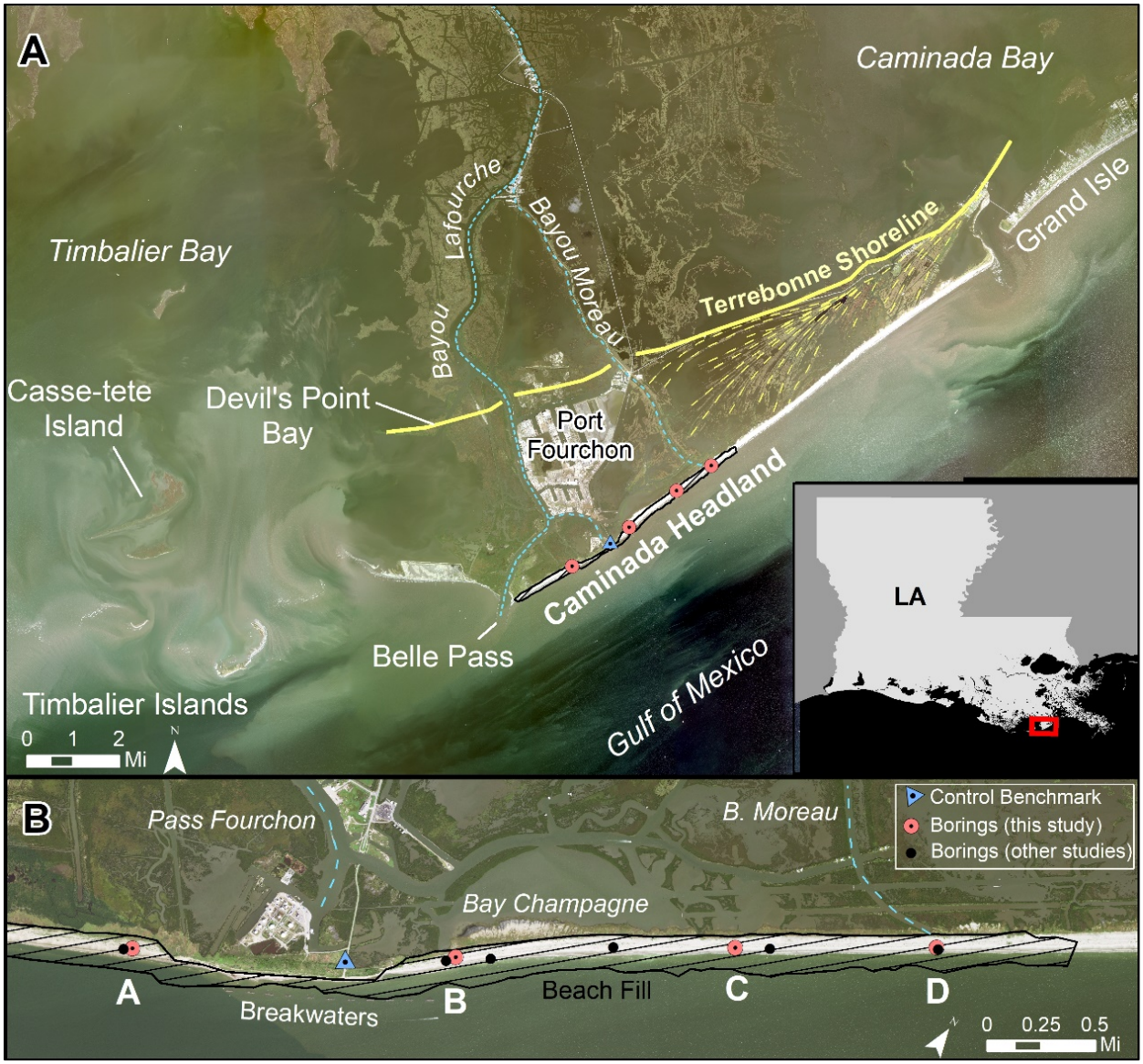


Figure 10: Site locations for sediment borings (A through D) and anchored monuments (A through C) for documenting subsurface geologic characteristics and monitoring elevation changes in response to beach restoration along the Caminada - Moreau Headland (Lafourche shoreline) in south Louisiana. The Terrebonne shoreline was formed during early Lafourche delta abandonment of the Terrebonne, Bayou Blue, and Point au Chien lobes. The beach fill polygon is the as built areal extent of the fill for Caminada Headland Restoration Project (BA-0045). CMS-BM-01 is the project control benchmark.

Within the surface sediment layer (surface to about 20 to 25 ft. deep), approximately 24 to 31% of total elevation change was recorded at Sites A and C (Figure 10). However, percent settlement for this layer at Site B is anomalous in that it represents only about 9% of the total consolidation. This may be due to the absence of organic deposits, a slightly thinner mud layer, and its geographic location relative to Bay Champagne. Fine-grained inter-distributary layers represent the thickest mud deposits (~60 ft.) beneath the Caminada - Moreau Headland and record greatest consolidation percentage (~40 to 50%). Although residual settlement below -65 ft. was relatively large (~35% of total settlement), settlement below -85 ft. was approximately 15% of total elevation change.

Measured changes in anchor monument elevations are greater than those predicted using geotechnical analyses after the six-month prediction period. At Site A, predicted settlement two years after placement of the beach fill was consistent with that recorded by surveys, but by four years after placement, predicted changes are less than those derived from survey measurements. Based on the complete survey record at Site A (~7 years), measured elevation change equals that predicted using geotechnical data at 20 years after the fill placement. Site B consolidation estimates based on geotechnical data illustrated greatest discrepancy with high-resolution elevation change measurements, where actual loading from beach fill placement was approximately 1.8 times estimated loading. Using as-built fill dimensions to estimate consolidation may have reduced uncertainty; however, comparison of consolidation estimates and measurements at Site A indicated that predictions using geotechnical analyses underestimated measured elevation change after two years, even though differences in loading estimates were small. Further, according to final design documents for the Caminada - Restoration project, a construction tolerance elevation of 1 ft. was established to account for initial fill adjustments, subsurface consolidation settlement, and inaccuracies in construction methods. Based on our survey results, applied vertical stresses associated with beach fill placement have resulted in 1.5 to 1.9 ft. elevation change in 5.5 to 7 years, indicating an increase in design elevation tolerance may be appropriate for attaining desired protection and habitat objectives.

After seven years of monitoring, elevation change associated with applied vertical stress from beach fill placement has decreased with time but continues to be measurable at all site monuments. The long-term data set developed during this analysis appears valuable for informing beach restoration decisions regarding construction tolerance elevations for meeting project ecological requirements. The concept applies to marsh and ridge restoration projects as well, but the degree to which elevation tolerances are applied would vary depending on fill sediment properties and project design elevations relative to water level. Although the March 2020 survey was considered project completion, it is recommended that survey measurements be continued on a three-year basis through the beach restoration project design life to document longer-term impacts of vertical stress from beach fill placement for informing future project designs.

Table 2: Measured elevation changes (ft) for settlement plates and anchored benchmarks at Caminada Headland Sites A, B, and C.

Site	Survey	Pre-Fill S1	Fill at Sta A	S2	Fill at Sta B	Supp'l	S3	S4	S5	Fill at Sta C	S6	S7	S8	S9	S10	S11	S12	S13
	Date	**5/29/13**	**9/30/13**	**10/30/13**	**12/8/13**	**12/11/13**	**1/10/14**	**4/4/14**	**10/8/14**	**10/10/14**	**11/14/14**	**1/17/15**	**3/18/15**	**7/22/15**	**1/15/16**	**2/25/17**	**4/24/18**	**3/20/20**
	Day	**0**	**124**	**154**	**193**	**196**	**226**	**310**	**497**	**499**	**534**	**598**	**658**	**784**	**961**	**1368**	**1791**	**2487**
SP-02	Elevation		10.785			10.604	10.575	10.490	10.303		10.280	10.238	10.188	10.115	9.998	9.752	9.576	9.300
	Change					-0.182	-0.211	-0.296	-0.482		-0.505	-0.547	-0.597	-0.671	-0.787	-1.033	-1.209	-1.485
	Background					-0.002	-0.003	-0.006	-0.019		-0.021	-0.026	-0.030	-0.039	-0.058	-0.069	-0.088	-0.130
	Consolidation					**-0.179**	**-0.207**	**-0.290**	**-0.463**		**-0.484**	**-0.522**	**-0.567**	**-0.632**	**-0.729**	**-0.964**	**-1.121**	**-1.355**
A1	Elevation	-19.096		-19.221		-19.262	-19.281	-19.323	-19.457		-19.469	-19.493	-19.533	-19.585	-19.675	-19.870	-20.015	-20.232
	Change			-0.124		-0.165	-0.184	-0.227	-0.360		-0.372	-0.396	-0.437	-0.489	-0.578	-0.774	-0.919	-1.136
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation			**-0.119**		**-0.159**	**-0.177**	**-0.217**	**-0.337**		**-0.347**	**-0.366**	**-0.403**	**-0.446**	**-0.516**	**-0.701**	**-0.827**	**-1.002**
A2	Elevation	-41.087		-41.158		-41.199	-41.178	-41.185	-41.261		-41.264	-41.272	-41.298	-41.323	-41.383	-41.523	-41.619	-41.770
	Change			-0.071		-0.113	-0.091	-0.098	-0.174		-0.177	-0.185	-0.212	-0.236	-0.296	-0.437	-0.533	-0.684
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation			**-0.066**		**-0.106**	**-0.084**	**-0.088**	**-0.151**		**-0.152**	**-0.155**	**-0.178**	**-0.193**	**-0.234**	**-0.364**	**-0.441**	**-0.550**
A3	Elevation	-62.086		-62.147		-62.190	-62.161	-62.161	-62.225		-62.227	-62.233	-62.253	-62.270	-62.320	-62.441	-62.513	-62.624
	Change			-0.060		-0.103	-0.074	-0.075	-0.139		-0.140	-0.147	-0.166	-0.184	-0.234	-0.355	-0.427	-0.538
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation			**-0.056**		**-0.097**	**-0.067**	**-0.065**	**-0.116**		**-0.115**	**-0.117**	**-0.132**	**-0.141**	**-0.172**	**-0.282**	**-0.335**	**-0.404**
SP-03	Elevation				12.396		12.243	11.979	11.712		11.676	11.620	11.571	11.488	11.372	11.131	10.953	10.737
	Change						-0.153	-0.417	-0.684		-0.720	-0.776	-0.825	-0.908	-1.024	-1.265	-1.443	-1.659
	Background						-0.001	-0.004	-0.017		-0.019	-0.024	-0.028	-0.037	-0.056	-0.067	-0.086	-0.128
	Consolidation						**-0.152**	**-0.413**	**-0.668**		**-0.701**	**-0.753**	**-0.797**	**-0.872**	**-0.968**	**-1.198**	**-1.357**	**-1.531**
B1	Elevation	-18.785		-18.808		-18.926	-18.971	-19.072	-19.274		-19.298	-19.344	-19.394	-19.478	-19.602	-19.861	-20.050	-20.296
	Change			-0.023		-0.140	-0.186	-0.287	-0.488		-0.513	-0.558	-0.608	-0.693	-0.816	-1.076	-1.265	-1.511
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation			**-0.018**		**-0.134**	**-0.179**	**-0.277**	**-0.466**		**-0.487**	**-0.529**	**-0.574**	**-0.650**	**-0.755**	**-1.003**	**-1.173**	**-1.377**
B2	Elevation	-48.284		-48.291		-48.387	-48.423	-48.519	-48.712		-48.737	-48.782	-48.829	-48.914	-49.033	-49.290	-49.482	-49.733
	Change			-0.007		-0.103	-0.139	-0.235	-0.429		-0.453	-0.498	-0.545	-0.630	-0.749	-1.007	-1.199	-1.450
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation			**-0.002**		**-0.097**	**-0.132**	**-0.225**	**-0.406**		**-0.427**	**-0.468**	**-0.511**	**-0.587**	**-0.687**	**-0.934**	**-1.107**	**-1.316**
B3	Elevation	-64.284		-64.284		-64.350	-64.368	-64.383	-64.451		-64.457	-64.473	-64.492	-64.519	-64.574	-64.709	-64.797	-64.919
	Change			-0.001		-0.066	-0.084	-0.099	-0.167		-0.173	-0.189	-0.208	-0.235	-0.290	-0.425	-0.513	-0.635
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation					**-0.060**	**-0.077**	**-0.089**	**-0.144**		**-0.148**	**-0.159**	**-0.174**	**-0.192**	**-0.228**	**-0.352**	**-0.421**	**-0.501**

Table 2. Continued.

Site	Survey	Pre-Fill S1	Fill at Sta A	S2	Fill at Sta B	Supp'l	S3	S4	S5	Fill at Sta C	S6	S7	S8	S9	S10	S11	S12	S13
	Date	**5/29/13**	**9/30/13**	**10/30/13**	**12/8/13**	**12/11/13**	**1/10/14**	**4/4/14**	**10/8/14**	**10/10/14**	**11/14/14**	**1/17/15**	**3/18/15**	**7/22/15**	**1/15/16**	**2/25/17**	**4/24/18**	**3/20/20**
	Day	**0**	**124**	**154**	**193**	**196**	**226**	**310**	**497**	**499**	**534**	**598**	**658**	**784**	**961**	**1368**	**1791**	**2487**
B4	Elevation	-87.787		-87.786		-87.838	-87.855	-87.862	-87.920		-87.925	-87.938	-87.956	-87.981	-88.034	-88.160	-88.245	-88.365
	Change			0.001		-0.051	-0.067	-0.074	-0.132		-0.138	-0.151	-0.169	-0.194	-0.246	-0.373	-0.458	-0.578
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation					**-0.045**	**-0.060**	**-0.064**	**-0.110**		**-0.113**	**-0.121**	**-0.135**	**-0.151**	**-0.184**	**-0.300**	**-0.366**	**-0.444**
SP-05	Elevation								13.966		13.811	13.619	13.476	13.273	13.063	12.717	12.450	12.102
	Change										-0.155	-0.347	-0.490	-0.693	-0.903	-1.249	-1.516	-1.864
	Background										-0.003	-0.007	-0.011	-0.020	-0.039	-0.050	-0.069	-0.111
	Consolidation										**-0.152**	**-0.340**	**-0.479**	**-0.673**	**-0.864**	**-1.199**	**-1.447**	**-1.753**
C1	Elevation	-23.595		-23.626		-23.654	-23.650	-23.672	-23.751		-23.837	-23.896	-23.943	-24.040	-24.165	-24.421	-24.610	-24.881
	Change			-0.032		-0.059	-0.055	-0.078	-0.157		-0.242	-0.301	-0.348	-0.445	-0.570	-0.827	-1.016	-1.287
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation			**-0.027**		**-0.053**	**-0.048**	**-0.068**	**-0.134**		**-0.216**	**-0.271**	**-0.314**	**-0.402**	**-0.508**	**-0.754**	**-0.924**	**-1.153**
C2	Elevation	-41.379		-41.379		-41.395	-41.375	-41.371	-41.397		-41.464	-41.491	-41.504	-41.534	-41.578	-41.689	-41.749	-41.848
	Change			0.000		-0.016	0.004	0.008	-0.019		-0.085	-0.112	-0.125	-0.155	-0.199	-0.310	-0.370	-0.469
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation					**-0.010**					**-0.060**	**-0.082**	**-0.091**	**-0.112**	**-0.137**	**-0.237**	**-0.278**	**-0.335**
C3	Elevation	-85.073		-85.072		-85.067	-85.061	-85.053	-85.076		-85.122	-85.133	-85.137	-85.152	-85.178	-85.263	-85.292	-85.345
	Change			0.001		0.006	0.012	0.020	-0.003		-0.049	-0.060	-0.064	-0.079	-0.105	-0.190	-0.219	-0.272
	Background			-0.005		-0.006	-0.007	-0.010	-0.023		-0.025	-0.030	-0.034	-0.043	-0.062	-0.073	-0.092	-0.134
	Consolidation										**-0.024**	**-0.030**	**-0.030**	**-0.036**	**-0.043**	**-0.118**	**-0.128**	**-0.139**

Notes: 1) The analysis start date was the most recent pre-fill survey for all Sites.
2) A supplemental survey (Supp'l) was conducted on 12/11/2013 to record the pre-fill elevation for the settlement plate at Site B (SP-03). However, SP-03 was damaged during the fill and was reset and surveyed one month after fill placement. As such, a pre-fill elevation estimate for SP-03 was based upon the initial elevation change recorded at Site C.
3) Elevation measurements are referenced to NAVD 88, Geoid 12B.
4) Elevation change is cumulative relative to initial survey elevations.
5) Background refers to ground elevation changes measured away from the project (natural subsidence) at benchmark CMS-BM-01.
6) Consolidation refers to cumulative elevation change since the initial survey minus natural subsidence. Consolidation values greater than zero were considered unreliable.

3.4 Barrier Island Maintenance Program (BIMP)

Several legislative programs have been established on both the state and federal levels that call for the implementation of a program to stabilize and preserve Louisiana's barrier islands and shorelines. House Bill No. 429, Act No. 407, authored by Representative Gordon Dove during the 2004 Regular Session, outlined the process by which the CPRA would annually develop a list of priority projects to be submitted to the House and Senate Committees on Natural Resources. These projects would be funded by the Barrier Island Stabilization and Preservation Fund, which was established by House Bill No. 1034, Act No. 786 of the 2004 Session to provide appropriations, donations, grants and other monies for the program. The legislation requires this fund to be used exclusively by the CPRA to support the Barrier Island Stabilization and Preservation Program, with all interest earnings and unencumbered monies remaining in the fund at the end of the fiscal year.

In accordance with this legislation, and with the understanding that maintenance is an integral part of stabilization, preservation, and restoration of any barrier island or shoreline, BIMP was conceptualized by the CPRA. BIMP potentially provides the framework for categorizing, prioritizing, selecting, and funding state barrier island maintenance projects, while coordinating with CWPPRA and other existing restoration mechanisms. Previous efforts are described in past status reports and no new projects have been initiated under this program.

The BIMP 2009 Sand Fencing (LA-0246; State, FEMA; 2009) installed sand fences on several previous project sites to trap sand and buffer wind and wave energy after over-wash damages from Hurricanes Gustave and Ike (2008) impacted the Gulf of Mexico shoreline. A total of 37,200 linear ft. of sand fencing were placed on Pass La Mer to Chaland Pass Restoration (BA-38-1), Timbalier Island Dune and Marsh Creation (TE-40), Isles Dernieres Restoration East Island (TE-20), New Cut Dune and Marsh Restoration Project (TE-37), and Isles Dernieres Restoration Trinity Island (TE-24). This program is inactive.

3.5 Breach Management Program

A Breach Management Program was developed to identify, classify, and prioritize methodologies and recommendations for breach prevention (proactive) and response (reactive) measures. A detailed analysis of coastal restoration projects completed in 2014 quantified the effects of breaching on barrier islands and headland beaches, specifically computing the significant increases in shoreline erosion rates. The Breach Management Program has developed a methodology to classify breach potential along the Louisiana coastline between Raccoon Island to the west and Scofield Island to the east. Barrier islands classified as having the potential to breach within four years are classified as severe and breach prevention measures are being developed for those areas. Opportunities are being explored to strategically partner breach prevention measures with other barrier island projects scheduled in the near-term within the Coastal Master Plan or as Beneficial Use Projects for disposal of maintenance dredged sediments from federal navigation channels. Additionally, breach management provides a component of BIMP, and CPRA as noted previously, will continue to integrate breach management into comprehensive shoreline adaptive management. This concept and approach has been merged with BISM discussed briefly in section 6.7 and so the program is inactive.

3.6 Monitoring of the Emergency Berms

In response to the Deepwater Horizon oil spill which began on April 20, 2010, the State of Louisiana constructed approximately 16 miles of sand berms along several sections of the State's barrier islands both east and west of the Mississippi River. The objective was to provide a barrier to oil and minimize the potential impact of the oil spill to thousands of acres of fragile barrier islands and wetlands ecosystem in coastal Louisiana. It should be noted and appreciated that these berms are man-made features, were constructed for a specific purpose, and are different geomorphologically than native barrier islands. However, significant insights into coastal processes which affect barrier islands were gained by monitoring their changes over time. Details of these monitoring could be found in the following 360-Day Monitoring Report were submitted to CPRA.

(1) Chandeleur Island Emergency Berm
(2) Pelican Island Emergency Berm
(3) Scofield Island Emergency Berm
(4) Shell Island Emergency Berm

Further, the monitoring of the Emergency Berms has also been summarized in previous status reports (CPRA, 2016). No new monitoring has occurred. However, BICM data collection initiated during the summer of 2015 may provide an opportunity to evaluate the fate of sediment additions and the sediment pathways caused by the sand berms to the barrier shoreline in future reports.

3.7 Borrow Area Management and Monitoring (BAMM) Program

To ensure the efficient and effective use of limited sediment resources in Louisiana, a Borrow Area Management and Monitoring (BAMM) Program was initiated and funded through CIAP as a part of the Performance Evaluation and Science Monitoring Project. The BAMM project provides information to understand the evolution of the borrow pits (inland, riverine, and offshore) over time, especially the infilling characteristics (rate and types of sediment), gradient and depth of the pit-slopes, and the potential development of hypoxic conditions. Also a numerical modeling effort was undertaken to analyze and evaluate potential adverse impacts to wave climate and hydrodynamics if large inland borrow areas are dredged to mine approximately 50 MCY of sediment since borrow areas of this size are being considered for Master Plan project implementation.

The goals of BAMM were to develop general guidelines for developing criteria for location, delineation, and design of potential borrow areas in inland, riverine and offshore environments for coastal restoration and protection projects in Louisiana. These guidelines were supposed to help ensure that borrow areas are designed in a cost effective manner with minimal adverse impact on the adjoining coastal system. This included review of potential dredge impacts, existing wave analysis work and other related studies. Geophysical, geotechnical, and water quality data were collected from several borrow areas in coastal Louisiana. The combined information gathered during these efforts was analyzed and used to provide recommendations on borrow area location, depth of dredging, and design. It may be added that BAMM is an integral component of Louisiana Sediment Management Plan (LASMP) and as such will aid in reinforcing a regional sediment

management strategy upon which restoration projects are recommended to be planned within a regional purview as opposed to merely a project-specific approach.

Additionally many of the current marsh creation and restoration projects (including back barrier marsh platform) in Louisiana specify that fill material be obtained from borrow areas designed within interior lakes and bays. The use of "inland" borrow areas is governed by numerous restrictions and/or regulations. Most of these regulations focus on vertical and horizontal dredging limits. The impacts of these aspects of borrow area design on wave heights and energies and the surrounding marsh environment, as well as the potential for development of hypoxic conditions are not clearly understood. Therefore, the scientific basis of these restrictions and/or regulations needs to be investigated to determine whether these borrow area design constraints are justified.

The project as explained earlier was divided into five tasks that are discussed in the Final Report and in its associated appendices (CB&I, 2015). During the various phases of this program, geophysical and geotechnical surveys were conducted at eight borrow areas. The maps created from this data collection were analyzed/processed to assist in the calculation of infilling rates of the borrow areas and general bathymetric changes in elevation. Hypoxia monitoring (Task 3) involved the deployment of gauges that measure dissolved oxygen, salinity and temperature in six borrow area locations. One gauge was placed within each selected borrow area and another was placed approximately 0.5 miles outside of the borrow area and acted as a control. The gauges were deployed for approximately four consecutive months (June-October) with data collection occurring once a month. The gauges were collected for a final time in the last week of October 2013. In addition, inventories of existing borrow areas in coastal Louisiana, and their respective design characteristics, as well as past hypoxia studies have been provided. Two inland conceptual borrow areas were modeled to analyze and evaluate potential impacts to wave climate and hydrodynamics due to dredging of relatively large volumes (50 million cubic yards) of sediment. SWAN wave modeling and Delft3D flow and morphology modeling were conducted in Timbalier Bay, Terrebonne Bay, Lake Borgne and Lake Ponchartrain. The digital copy of the report and data are located in the CIMS Document Library at the following link: http://cims.coastal.louisiana.gov/DocLibrary/FileDownload.aspx?Root=0&id=15062.

During 2022, BAMM 2 was initiated to (1) evaluate the impact of dredging large quantities of sediment from borrow pits in estuaries/bays especially Barataria Bay and (2) Understand and enumerate infilling rates in borrow pits dredged in the Lower Mississippi River. The details are mentioned in section 6.6 below.

4.0 Barrier Island Performance Assessment

4.1 Overall Barrier Shoreline Condition

Louisiana's barrier shoreline is one of the fastest eroding shorelines in the world. Due to the geologic setting and the predicted changes in sea level during coming decades, these shoreline habitats and the services they provide are some of the most vulnerable features of our coastal landscape. The CPRA's BICM Program has been established to assess and report on the changes of the coastal shoreline to help develop programmatic approaches to restoration and maintenance. A study (CEC, 2012) was funded to look at barrier island performance during the five years since BICM data were collected. The result of this study was summarized in earlier status report (CPRA 2016).

A number of barrier island projects have been constructed in the Early Lafourche, Late Lafourche, and Modern delta reaches since 1994. With the adoption of the 2012 *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (CPRA, 2012), and a revision in 2017, it is timely to consider the status of the already-accomplished restoration projects. In order to improve the understanding of barrier system evolution and enhance the science behind barrier system restoration design, it is both essential and prudent to evaluate performance of the constructed projects as completed in the recently-commissioned barrier island performance study (CEC, 2012).

The Barrier Island Status Report is a compilation of four "Technical Memos" along with "Implementation Strategies," evaluates the performance of restored barrier islands, and can be found in the CPRA document library at http://cims.coastal.la.gov, with the individual accessible via the following links:

11050_CEC-Executive Summary-12-14-2012.pdf
11050 Tech Memo 1 Data Gap Analysis-12-13-2012-final.pdf
11050 Tech Memo 2 Future Monitoring-12-13-2012-final.pdf
11050 Tech Memo 3 BVA-12-13-2012-final.pdf
11050 Tech Memo 4 Performance Analysis-12-14-2012-final.pdf
11050- Tech Memo 4 Appendix A-Modern Delta.pdf
11050_Tech Memo 4 Appendix B_Plaquemines.pdf
11050_CEC-Implementation Strategy-12-14-2012.pdf

4.2 Benefits of Barrier Island Restoration on Longevity of System(s)

With several major restoration projects in place, the post-restoration estimated Year of Disappearance (YOD) for several barrier island systems in Louisiana have been extended by years to decades. This increase in island longevity throughout the system is a direct benefit of the restoration projects. Further, with the increase in both frequency and intensity of major hurricanes over the past 12 years (and similar projections into the future), in the absence of the restoration and protection program, it is expected many of these islands would have disappeared much sooner than original projections. Additional BICM data collection efforts will allow revisions of YOD rates and allow CPRA to prioritize future restoration efforts based on the status and trends of shoreline and project evolution.

5.0 Minimized Design Template

A "Minimized Design Template" was developed for utilization in modeling and analyzing future barrier island projects as component of the 2017 Coastal Master Plan (CEC, 2015). The minimized design template is defined as a design template with minimal barrier island dimensions that restores the barrier shoreline's geomorphic form and ecologic function and retains this form and function after being subjected to the design storm events. There are several components needed to construct the minimized design template for a barrier system including bathymetric/topographic data, sediment transport pathways, design storm criteria, subsidence and compaction, existing restoration project footprints, and site constraints (e.g., unique environmental habitats).

A minimized design template was developed for the Terrebonne Basin barrier shorelines extending from East Timbalier Island to Raccoon Island as part of the Louisiana Coastal Area program for the Terrebonne Basin Barrier Shoreline Restoration Project (TBBSR) (USACE, 2010). The design storms selected included a hypothetical 50-year design storm and historic storms, Hurricanes Katrina and Rita, which occurred in 2005, and Hurricanes Gustav and Ike, which occurred in 2008. Table 3 presents dimensions of the minimized restoration template developed for the Terrebonne Basin islands.

Table 3: Summary of Minimized Restoration Templates for the Terrebonne Basin Barrier Shoreline Restoration Project (TBBSR).

Island	Raccoon	Whiskey	Trinity	East	Timbalier	East Timbalier
Gulf-side Beach Width (ft.)	250	250	250	250	250	250
Dune Crest Width (ft.)	100	100	100	100	100	100
Bay-side Beach Width (ft.)	100	100	100	100	100	100
Marsh Width (ft.)	1,000	1,000	1,000	1,000	1,000	1,000
Beach Elev. (ft., NAVD88)	4.2	4.0	4.0	4.0	4.0	4.0
Dune Elev. (ft., NAVD88)	6.4	6.2	6.2	6.2	6.2	6.2
Marsh Elev. (ft., NAVD88)	2.5	2.1	2.3	2.3	2.2	2.3

During 2015, system-wide barrier island and barrier headland restoration design templates were developed for Coastal Master Plan 2017. These templates achieve the goals of restoring the geomorphic form and ecological function of the barrier shorelines through simulation of historical conditions by enlarging the existing barriers in width, elevation, and by reducing/eliminating the occurrence of breaching. Based upon the templates developed for previous projects (in Terrebonne and Barataria) along with the results of the sustainability analyses, an optimization process was undertaken to yield a system-wide restoration design template that could achieve the study goal of providing habitat sustainability throughout the 50-year period of analysis while meeting the breach prevention criteria at TY50. The primary differences between the 2012 Master Plan template and the recommended templates developed for this study include the addition of a constructed dune feature, increased widths of the beach berms, increased elevations for the marsh platforms, and include a terraced feature for the marsh (see Figure 11). All of these features have been added to reduce the potential for breaching and to accommodate island over-wash with the objective of maximizing the retention of sediment in the back-barrier.

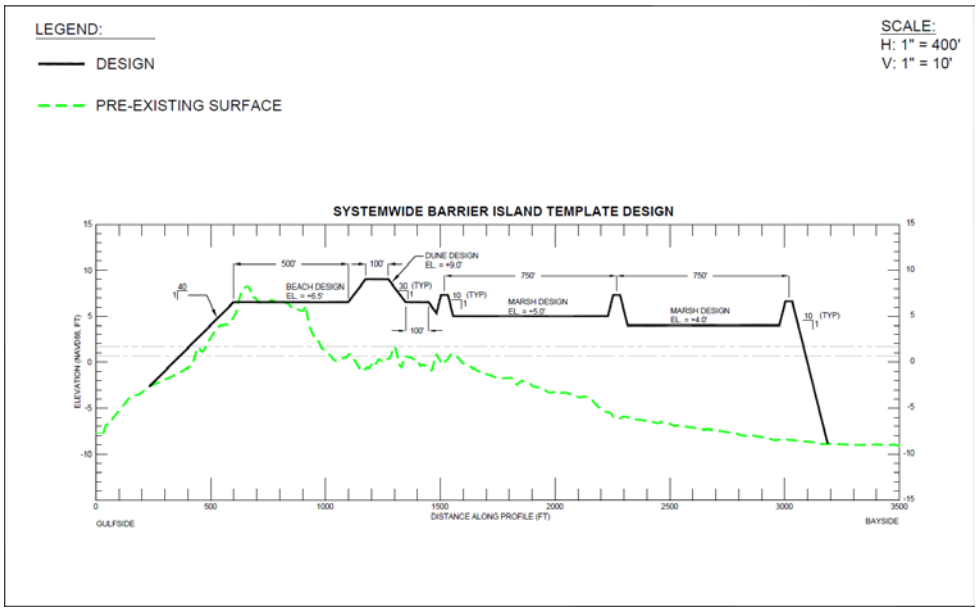


Figure 11: System-wide Barrier Island Design Template.

In conjunction with the development of the barrier island design template, a barrier headland design template was also developed. Based upon the barrier island template designs and results of the sustainability analyses, an optimization process was undertaken to yield a system-wide barrier headland design template that achieved the objective of providing habitat sustainability throughout the 50-year period of analysis while meeting the breaching criteria at TY50 for a headland feature (Figure 12). The final report along with the drawings of templates can be found at the following link: http://cims.coastal.louisiana.gov/DocLibrary/FileDownload.aspx?Root=0&id=13277.

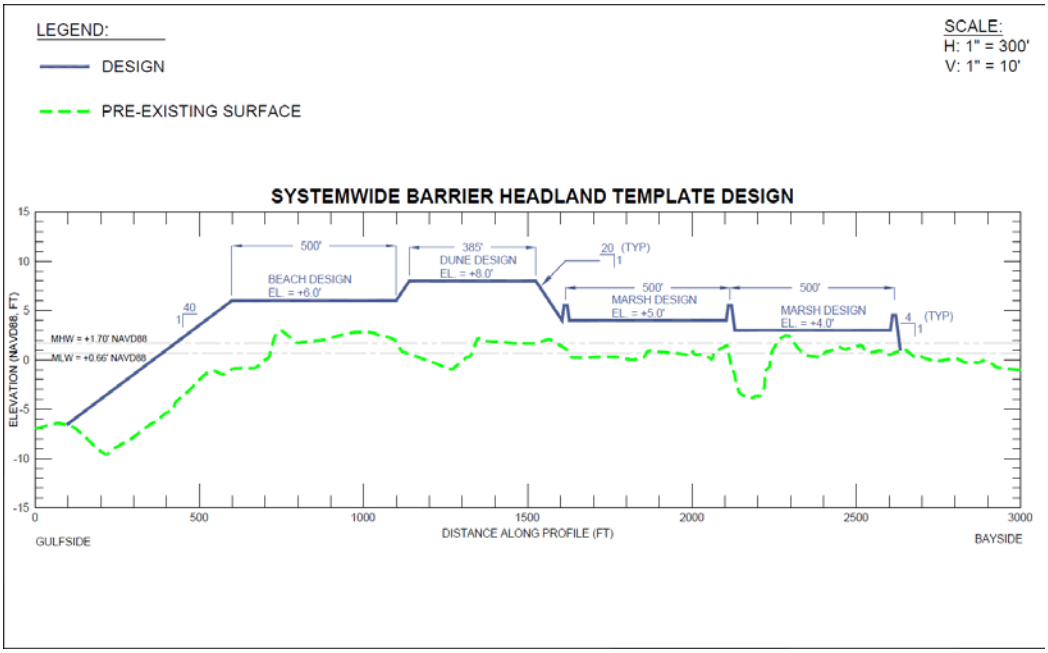


Figure 12: System-wide Barrier Headland Design Template.

6.0 Current and Future Activities

Louisiana has invested hundreds of millions of dollars over the past two decades restoring its barrier islands and shorelines and intends to continue to invest in rebuilding and maintaining these features. The critical element in a barrier island restoration especially when CPRA is transitioning towards system approach is availability of adequate and compatible sediment which could be dredged and emplaced efficiently and cost effectively. To this end under the aegis of Louisiana Sediment Management Plan (LASMP) several tools viz. Louisiana Sand/Sediment Resources Database (LASARD), Operational Sediment Budget (OSB), Surficial Sediment Distribution (SSD) Maps, Louisiana Sediment Availability and Allocation Program (LASAAP) have been developed as briefly mentioned below.

Unlike the 2012 Coastal Master Plan, which called for restoration of specific/individual barrier islands, the 2017 Coastal Master Plan recommends funding Louisiana's BISMwhich CPRA is currently developing. Rather than recommending specific barrier island and shoreline projects and assigning them to a certain implementation period, CPRA intends to restore the Terrebonne, Timbalier, and Barataria barrier islands and shorelines as part of a regular rebuilding/management program. In addition, CPRA plans to continue system-wide monitoring, exploration and management of compatible sediment via acquisition of geotechnical and geophysical data, and improving overall understanding of sediment management requirements to support the sediment needs and prioritization of the current Coastal Master Plan projects. This will allow monitoring and assessment of these critical features to drive project investment and for CPRA to be able to nimbly react when catastrophic events like future hurricanes impact these areas.

6.1 Louisiana Sediment Management Plan (LASMP)

One of the metrics the State of Louisiana has chosen to track their progress is average rate of land change for the next 50 years. The goal is to change the trajectory of land loss from net loss to one of stability if not net gain. To ensure progress is being made, the state must depend upon sound environmental and fiscal management of sediment resources (Khalil and Finkl, 2009). As such, introduction of river sediment and freshwater nutrients to coastal marshes must be an integral component of restoration efforts, and sand deposits associated with ancient distributary channels and remnant shoals formed during the destructive phase of delta evolution should continue to be pursued as viable sources for barrier island and back-barrier marsh restoration (Khalil et al., 2010). Moreover, sediment needs are likely to increase due to rapid subsidence in south Louisiana and potential increases in sea-level rise over the next century. Thus, the success of restoration efforts depends on locating, managing, and utilizing sediments in a cost-effective manner.

LASMP is a working model to incorporate the influence of scale on resource availability (river, in-shore, and continental shelf) and resource distribution for effective restoration. Although technical considerations associated with sediment borrow areas, river sediment, and engineering activities are critical for successful plan implementation, coastal policy/regulation requirements are expected to have significant influence on plan implementation.

The desired result of LASMP is a more cost-effective implementation of the Coastal Master Plan via comprehensive management of renewable and non-renewable sediment resources; a reduction in project costs and environmental impacts; and a long-term, safe and sustainable coast to protect

Louisiana communities, national critical energy infrastructure, and state natural resources for future generations.

In order to implement LASMP the entire coastal Louisiana has been divided into 6 regions. During 2020-2021 with funding from BOEM an investigation for restoration-quality sediment resources was undertaken for implementing Louisiana Sediment Management Plan (LASMP) in Region 1 (Barataria- Terrebonne basins). This investigation utilized the existing data from LASARD, SWAMP, and BICM and other sources (e.g. ACRE, 2019; Kindinger et al., 2002; Flocks et al., 2009) to: (1) develop and explore unconventional out-of-system offshore sand resource prospects for barrier island restoration; (2) develop and explore mixed-sediment resource prospects for marsh, ridge, and landbridge restoration and evaluate impacts of using in-system borrow material in Barataria and Terrebonne/Timbalier Bays; and (3) characterize sand sources and sinks in the active barrier island system to refine operational sediment budgets (ACRE, 2019) and inform barrier island sand management and restoration strategies. These sediment sources will help restoration of barrier islands more efficiently and cost effectively.

6.2 Louisiana Sand Resources Database (LASARD)

LASARD was developed to archive, populate, and maintain the geoscientific and related data acquired for ecosystem restoration on a GIS platform. The objective of LASARD is to centralize relevant data from various sources for archival and better project coordination while avoiding any duplication. This has and will facilitate planning for delineating and utilizing sediment resources for a sustainable ecosystem restoration in coastal Louisiana by streamlining access to existing data sources, which will minimize the cost and time required to identify appropriate resources. To keep pace with the large amount of data being delivered to the CPRA from ongoing projects, the current LASARD database has been updated to incorporate these new data sets. Keeping LASARD current facilitates the benefit of real cost savings to upcoming projects by not only providing valuable data for planning, but also by reducing the potential for costly, redundant data collection efforts. This includes finalizing updates to the LASARD attribute formats, updating existing data to match these new formats, and processing additional data sets that are generated by ongoing implementation of coastal restoration projects. The data which have been collected during BICM 1 and which will be collected in future studies will ultimately reside in LASARD. Various geoscientific data residing in LASARD are the fountainhead for various tools which have been developed to implement LASMP. The LASARD database, along with the Surficial Sediment Distribution (SSD) Maps, is an important component of the Louisiana Sediment Management Plan (LASMP). The Louisiana Sand Resources Database (LASARD) Standard Operating Procedures (SOP) for Geo-scientific Data Management (Khalil et al, 2022) could be accessed from https://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=12362 .

6.3 Louisiana Operational Sediment Budget (OSB): Raccoon Point to Sandy Point (1985-89 to 2013-16)

An Operational Sediment Budget (OSB) for the barrier islands and shorelines of south Louisiana between Raccoon Point and Sandy Point was developed to determine net littoral sediment transport rates for use with shoreline restoration planning and design, and for estimating project longevity (ACRE 2020b). The significance of sediment to the sustainability of coastal Louisiana and

developing a sediment budget to promote effective utilization of sediment resources is a critical element for implementation and ultimate success of the State's Coastal Master Plan. One of the ways to quantify the volume of sediment necessary to counter the effects of relative sea level rise, to better assess long-term sediment movement trends within a coastal system, and to ensure cost effective and optimal use of sediments during restoration efforts is to quantify the regional sediment budget in and adjacent to proposed restoration areas. This also addresses questions associated with rock/breakwater placement regarding impact of these structures upon the local sediment budget (i.e., the immediate barrier island shoreline and adjacent down-drift shorelines).

The operational sediment budget for the barrier island coastline (littoral transport zone) of south Louisiana between Raccoon Point and Sandy Point was developed on the basis of analysis of existing survey data sets. These survey data were analyzed to improve knowledge of regional sediment transport controls on barrier island system evolution as guidance for present-day restoration efforts. Comparison of topographic/bathymetric surfaces for the same geographic area but different time periods documented erosion and deposition patterns that revealed net sediment transport pathways. Erosion and deposition volumes defined the magnitude of sediment exchange associated with transport pathways, providing the foundation for development of a littoral sediment budget. Effective design and management of barrier island restoration requires reliable net sediment transport estimates for predicting project longevity and planning for future restoration needs. It was observed that net littoral sand movement in the project area is controlled regionally by dominant east-to-west directed waves and currents, hydraulics associated with passes between the islands, and barrier shoreline protection/restoration activities. An analytical comparison of topography/bathymetry data isolated areas of erosion and deposition for documenting sediment transport patterns and quantifying trends. Sediment sources and sinks in the littoral zone were identified based on net geomorphic changes between 1985-89 and 2013-16. Overall, ebb shoals were net erosional (sediment sources) as passes widened and channels present in the 1980s filled (sediment sinks). Although coastal restoration projects along all segments of the barrier coastline have been critical for establishing a more resilient barrier island system to protect estuarine environments in Barataria and Terrebonne Bays against Gulf of Mexico marine processes, average sand losses over the 30-year analysis period illustrated that the pace of restoration with sand from outside the littoral system should take place at 1.5 to 3 times the existing rate to keep pace with historical sand losses from the littoral zone. Surface sediment samples and cores from the LASARD for areas adjacent to the sediment budget boundaries documented about 10-20% seafloor sand content, the exception being west of Raccoon Point where sediment samples indicated 70-80% sand. This suggested that approximately 1.0 to 1.7 MCM of sediment lost from the littoral system annually was sand. Large-scale restoration efforts over the last 30 years have offset losses at a rate of approximately 586,000 m3/yr. of additional sand from outside of the littoral zone.

Development of an operational sediment budget for coastal Louisiana will complement and support Louisiana's long-term Master Plan goals for wetland and barrier island creation, restoration, and protection by:

- Predicting project longevity, and developing timelines for future restoration needs (project planning perspective);
- Providing a regional accounting of sediment sources, sinks, and pathways, as well as engineering activities that benefit the planning, operations, and maintenance of restoration projects (operational planning tool);

- Creating fundamental information for coastal engineers and geologists to analyze and explain shoreline and bathymetric changes and to project future coastal response to wave climate and relative sea-level rise;
- Producing critical information for refining construction cost estimates and sediment resource quantities needed for planning Master Plan projects;
- Improving the State's ability to optimize use of sediment resources by taking advantage of natural long-term sediment movement trends to assist in the redistribution of sediment to project and adjacent project areas; and
- Expanding the State's ability to quantify sediment losses for FEMA claims and prepare for post-storm recovery projects.

As a part of this study, the performance of detached breakwaters at Raccoon Island was also analyzed. Breakwater placement along eastern Raccoon Island resulted in significant changes to the island by impeding natural littoral transport processes and landward island migration. It was observed that though these structures have provided a measured level of stability to eastern Raccoon Island, they have also contributed to a reduction in down-drift littoral transport that has decreased the overall resilience of the island system. The full report can be downloaded from the following link: https://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=23926

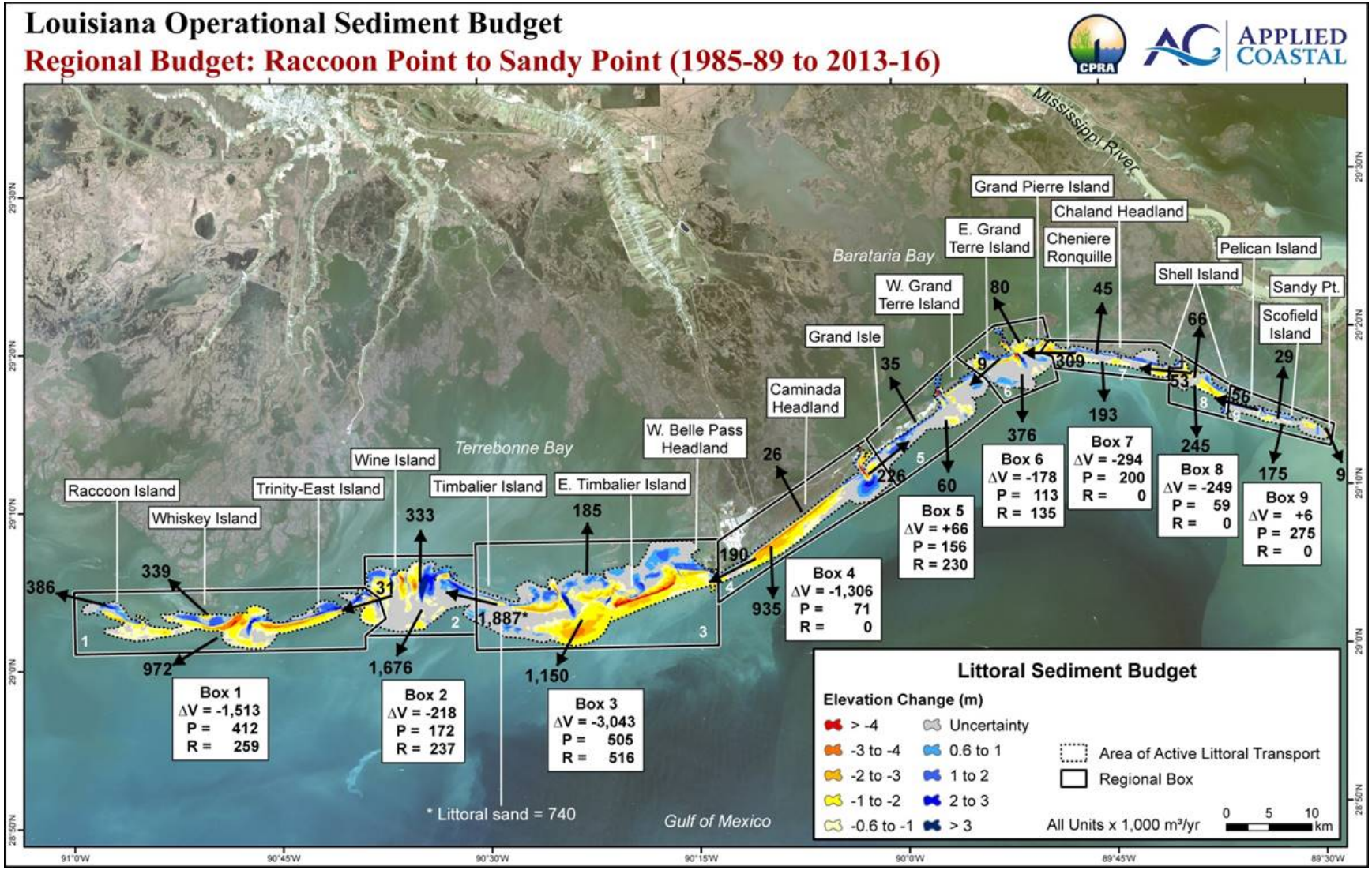


Figure 13: Macro-scale littoral sediment budget for the south Louisiana barrier shoreline, 1985-89 to 2013-16. Arrows represent net direction of sediment movement and numbers reflect magnitudes of net sediment transport in thousands of m3/yrs. P= Placement; R = Removal.

6.4 Surficial Sediment Distribution (SSD) Maps – Offshore & Lower Mississippi River

LASMP identifies and delineates potential sediment sources for restoration and provides a framework for managing sediment resources wisely, cost effectively, and in a systematic manner. Having both an inventory of potential sediment resources and the ability to track sediment needs are crucial to the development of regional strategies for the sedimentological components of ecosystem restoration including barrier island restoration (APTIM, 2020; Khalil et al., 2018). To help fulfill the goals of the LASMP, which in turn assists in Louisiana's coastal restoration efforts, (SSD maps for nearshore, offshore, and the Lower Mississippi River were developed based mainly on existing sedimentological, geotechnical, and geophysical, data residing in LASARD. Keeping the needs of coastal restoration in mind, the mapped/delineated sediment deposits were broadly classified as sand, mixed sediment, and fines. However, a large portion of offshore areas were classified as "unknown" due to a lack of sufficient reliable data. Based on these maps, total and available (by excluding sediment made inaccessible by oil and gas infrastructure) volume estimates were calculated for sand, mixed sediment, and fines (silt and clay). These volumes are first order estimates as these calculations are based on various types of geoscientific information with varying degrees of confidence (Forrest et al., 2019). Estimates based on these maps indicate the potential of availability of sediment but dredging all of these sediment resources is not necessarily feasible or technically sound even with sufficient resources.

The development of such maps is a painstakingly intensive effort. These maps are living documents and are updated as new data become available. As such, the mapping is updated periodically and the volumes are updated accordingly. The first SSD map was compiled in 2011 and has gone through several iterations and the modifications/updates are perceptible. These SSD maps are basic but important tools and were initially compiled for resource planning and played a critical role in the management of sediment resources at a regional level. They play a vital role in stakeholder engagement, conflict resolution and the enforcement of federal and state regulations related to the removal of decommissioned pipelines and coastal zone management. Removal of decommissioned pipelines helps free up valuable offshore sediment resources for restoration. Recently, these maps formed the basis of development of the Louisiana Sediment Availability and Allocation Program (LASAAP) which provides a GIS tool to help analyze sediment sources (dredge locations) vis-a-vis restoration projects based on sedimentological, hydrographic, geotechnical, and geophysical data in a spatial format in order to efficiently manage valuable sediment resources. These maps also form templates and/or base maps for development of comprehensive biotic and abiotic habitat maps. Additionally, these maps are good indicators of the presence or absence of sufficient geoscientific data. As such, they are a useful tool for conducting data gap analyses, which are typically conducted at planning stages of various investigations. Most importantly the utility of these maps is not limited to the Louisiana coastal area. The SSD maps and the report has been updated recently and can be downloaded from the CPRA CIMS Library https://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=24126

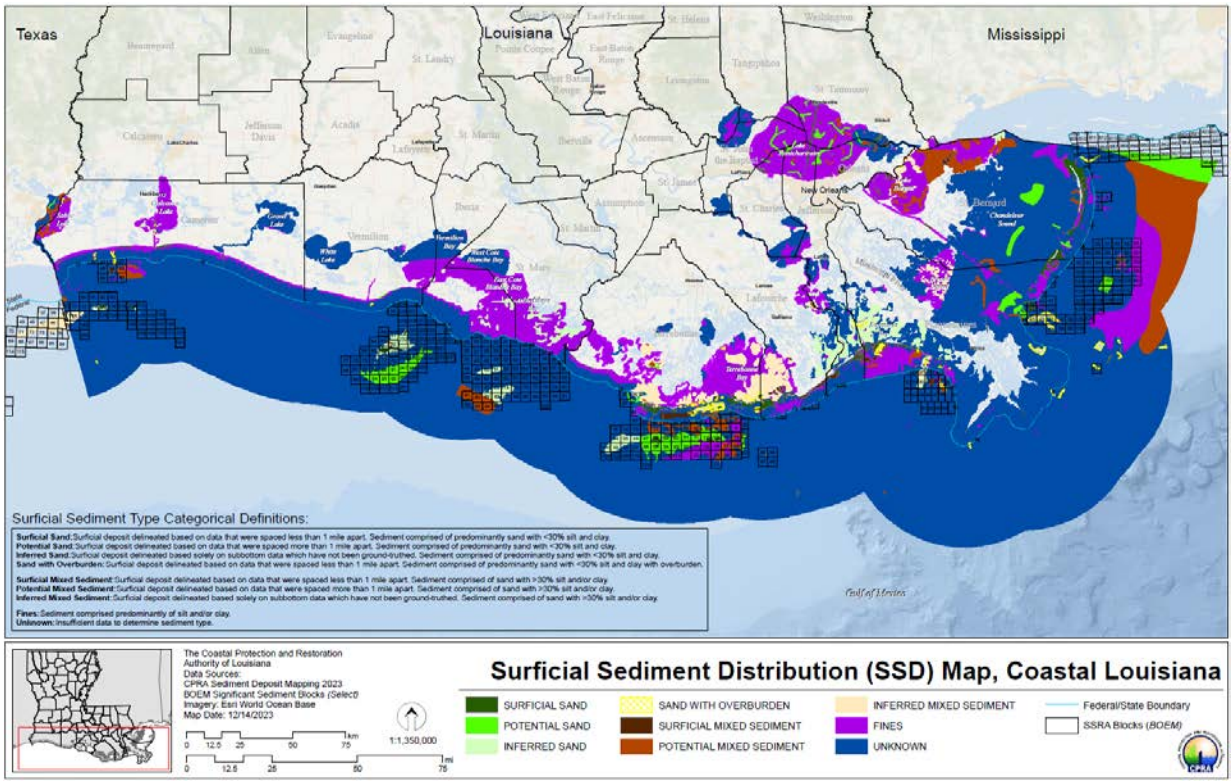


Figure 14: Map showing surficial distribution of various sediment types in Coastal Louisiana.

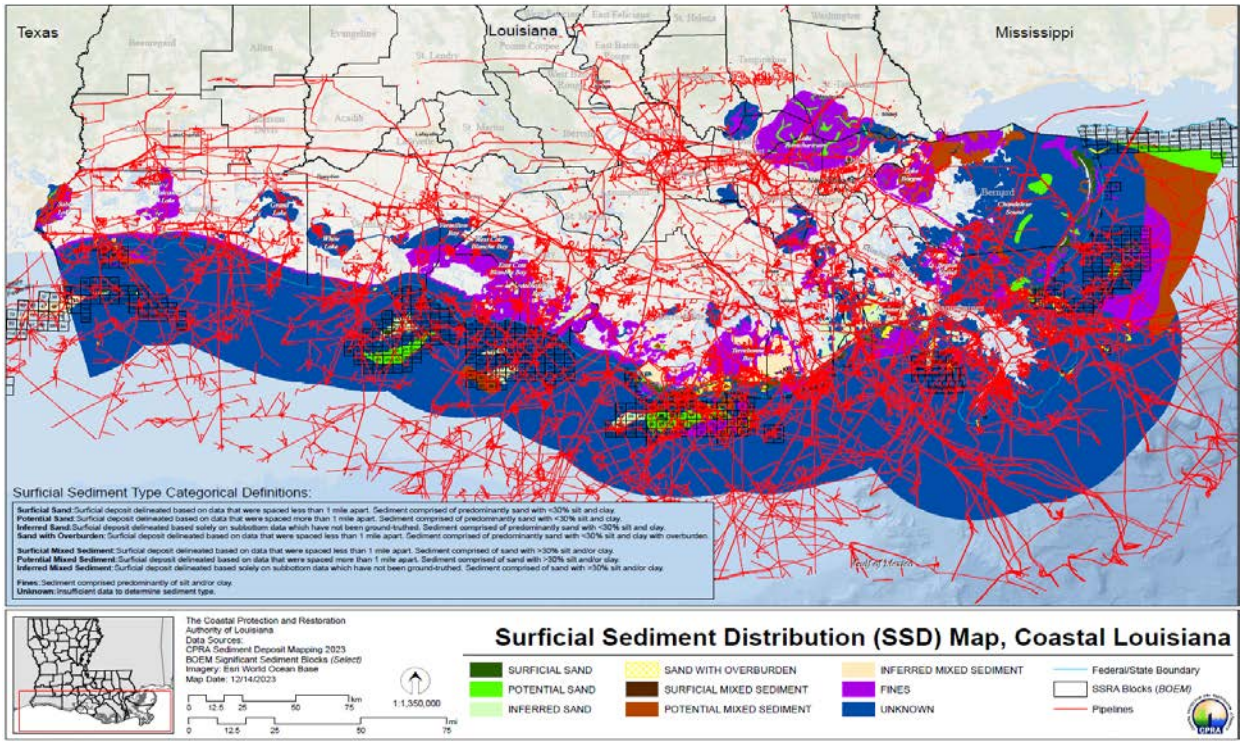


Figure 15: Map showing surficial distribution of various sediment types in Coastal Louisiana overlain by oil and gas active pipelines.

6.5 Louisiana Sediment Availability and Allocation Program (LASAAP)

In order to implement LASMP efficiently and cost effectively the "Louisiana Sediment Availability and Allocation Program (LASAAP)" was conceptualized and initiated. The tool's primary goal is to link the sediment needs for the State's marsh, barrier island and ridge creation/restoration projects to the coast-wide potential sediment sources within state and federal waters. This tool analyzes potential sediment resources and construction/project locations along with existing sediment resource development data in a spatial format in order to efficiently and cost effectively manage limited compatible sediment resources. The long-term goal of this tool is to enhance State's planning capabilities to optimize sediment resource utilization, capitalize on synergistic project opportunities, reduce project costs, maximize land-building potential, and ensure projects have the necessary sediment available for the 50-yr planning horizon of the CMP. Based on LASAAP template, Barrier Island System Management (BISM) Program is developing a similar tool which better fits within their modeling framework.

To test the tool's effectiveness and functionality, a pilot study was conducted in Barataria Basin. Eleven CMP restoration projects fall within the Barataria Basin. Three of these projects are marsh creation projects and one is a comprehensive barrier island restoration project. These projects were broken down into their individual barrier island or marsh components and each was evaluated using the tool to identify potential sand and/or mixed sediment resources. Based on the outcome of the pilot study, several recommendations were made to improve the overall tool and make it more accessible to a wider audience.

Following the pilot study, the tool was implemented on a statewide basis using the 2023(draft) and 2017 CMP projects. A standardized state report was developed that gives LASAAP a baseline for understanding the current project needs and potential resources available for entire State of Louisiana. This report was completed in 2022 and identified 1st order sediment-volume availability per project, potential project resource conflicts, showed where the State would benefit from more geotechnical investigations and discussed further tool enhancements for increasing the understanding of these resources. This report is currently being updated with the 2023 CMP projects. Automating report updates as new CMPs are released every 5-6 years is being explored. In 2023, the tool was made available through an online wizard for the ease of users. A manual and a video tutorial were developed to help users run the tool and guide them through the online wizard.

6.6 Borrow Area Management and Monitoring (BAMM) Program - 2

Coastal restoration projects rely on alignment of project needs with economic and compatible sediment resources in nearby borrow areas. Developing on previous BAMM effort two investigations were conducted: (1) Impact of in-bay borrow pits on estuarine sediment dynamics in Barataria Bay and (2) Sediment infilling rates in borrow pit in the Lower Mississippi River, were undertaken during 2022. These investigations appear to be separate but basically are integral to the implementation of LASMP.

1. CPRA has been evaluating the potential for the occurrence and use of high-quality sediment resources that occur as buried paleo-channel deposits in the subsurface of modern-day Barataria Bay. The Water Institute was contracted to develop a process-based numerical model (Delft3D Flexible Mesh) to evaluate the hydrodynamic and morphologic impacts using in-bay sediment resources. This project investigates (1) the effect of in-bay sediment mining on the tidal prism, (2) the potential of an in-bay borrow pit to capture sediment that would otherwise be exported from the system or deposited elsewhere, and (3) the influence of pit orientation on sediment dynamics

both local and regional. Model results show that hypothetical borrow pits do not affect the tidal prism; however, borrow pits influence local hydrodynamics (i.e., wave heights and flow velocities) during higher energy events such as cold fronts and tropical cyclones. The sediment captured by the borrow pits assessed in this study is primarily (>90%) sourced from the Barataria Bay floor. Additionally, results show that sediment trapping by the borrow pits studied does not adversely impact marshes peripheral to Barataria Bay. Model results also suggest that all but one of the evaluated borrow pits contribute to reduced sediment export from the bay overall, because part of the infilled sediment (<10%) would otherwise be exported to Barataria Bight and the Gulf of Mexico. The report "Final Report: Assessing the impact of In-Bay Borrow Pits on Estuarine Sediment Dynamics, Barataria Bay, Louisiana", (The Water Institute, 2023a) can be accessed https://cims.coastal.la.gov/RecordDetail.aspx?Root=0&sid=25168

2. Another study by The Water Institute (contracted by CPRA) in the Mississippi River used numerical models and field observations to examine the governing processes that control borrow pit infilling in the river, to promote sustainable sand extraction. The analysis focused on borrow pit infilling rates, and on the local and regional effects induced by the presence of borrow pits. The goal is to help planners, project managers, engineers, and scientists make informed decisions about restoration projects using renewable river sand/sediment by providing insights into the rate at which sand can be sustainably extracted from river bars. Existing borrow pit pre-dredging surveys, post-dredging surveys, and repeat bathymetry surveys collected by dredging companies and engineering firms working with CPRA on existing restoration projects, were used to improve the understanding of borrow area morphologic response and dynamics, and to calibrate and validate numerical models. Two areas were investigated: the Alliance Anchorage Bar (River Mile 65) and the Venice Anchorage Bar (River Mile 8). Both surveys and numerical model results were used to provide insights on the relative importance of processes and parameters that control infilling rates. Analysis and modeling results show that the hydrograph shape, particularly the rate at which the river discharge increases during the rising limb, strongly influences infilling trends. Three trends and corresponding infilling rates were identified for the Venice Anchorage Borrow Pit: no infilling rates for river discharge below 10,000 m^3/s (i.e., 353,000 cfs), 0–100,000 m^3/week for river discharge between 10,000 and 20,000 m^3/s (i.e., 353,000–706,000 cfs), 100,000 to 300,000 m^3/week for river discharge above 20,000 m^3/s (i.e., 706,000 cfs). Similarly, three trends and corresponding infilling rates were identified for the Alliance Anchorage Bar: no infilling rates for river discharge below 15,000 m^3/s (i.e., 530,000 cfs), 0–100,000 m^3/week for river discharge between 15,000 and 22,000 m^3/s (i.e., 530,000 – 777,000 cfs), 100,000–300,000 m^3/week for river discharge above 22,000 m^3/s (i.e., 777,000 cfs). These relationships can be used to estimate the recharge rate for borrow pits and quantify long-term sand availability to inform the Louisiana Coastal Master Plan and the Barrier Island System Management Program and, ultimately, the design of the projects contained within those programs.
   The final report "Numerical Modeling to Estimate Sediment Infilling Rate of Lowermost Mississippi River Borrow Pits and Impacts on Downstream Dredging" (The Water Institute of Gulf 2023b) can be accessed
   https://cims.coastal.la.gov/RecordDetail.aspx?Root=0&sid=25089

6.7 Barrier Island System Management (BISM) Program

The 2017 revision of Louisiana's Coastal Master Plan recommended a Barrier Island System Management (BISM) Program to meet the need for ongoing maintenance of the state's barrier island systems , many of which have been partially restored in recent years through several funding mechanisms including recovery efforts from the Deepwater Horizon Oil spill. The BISM program (formerly Barrier Island Renourishment Program (BIRP)) brings together several previous efforts led by CPRA, including BICM, LASMP, LASARD, LASAAP, and the Breach Management Program. BISM reflects an integrated, holistic approach to categorizing, prioritizing, selecting, and funding state barrier island maintenance projects while continuing coordination with existing and future restoration mechanisms (Khalil et al.,2019). BISM is designed to be an adaptive management approach to regional sediment management that prioritizes projects and the use of available sediment based on short- and long-term benefit to the entire coastal system.

A BISM workflow was developed for project selection and use of available sediment based on a structured decision making (SDM) process. Using this workflow, CPRA can prioritize and implement future projects based on science and data interpreted through input elicited from experts in a structured process. In addition to the workflow, an inventory was created of data and model outputs in the state of Louisiana that may be incorporated into BISM, including sediment resource data collected under LASARD, the LASAAP sediment source selection tool, monitoring data collected under BICM, and guidance on barrier island restoration thresholds. A stakeholder concern inventory was also created to identify areas of concerns relevant to Louisiana barrier island project selection and implementation.

In 2022 CPRA received funding through the Louisiana Trustee Implementation Group (LA TIG) for development of the Barrier Island Restoration Tradeoff Analysis (BIRTA) toolkit, a quantitative framework that automates implementation of the BISM workflow through data analysis and predictive modeling. The BIRTA toolkit will enhance the BISM workflow by allowing direct leveraging of data and models as part of a consequences and tradeoff analysis in project prioritization and optimization of use of sediment across multiple projects. Data input files are projected to be completed by early 2024 and a draft version of the BIRTA toolkit is expected to be available to CPRA by the beginning of 2025.Throughout this process, the program continues to focus on the implementation of CPRA adaptive management processes necessary to manage BISM through time and coordinate with the development of the 2023 Master Plan.

7.0 References

Applied Coastal Research and Engineering (ACRE). 2020a. Consolidation Settlement Associated with Beach Restoration Along the Caminada Headland, LA: February 2013 to March 2020. Final Report prepared for Louisiana Coastal Protection and Restoration Authority. Baton Rouge, LA. 29 p.

Applied Coastal Research and Engineering (ACRE), 2020b. Louisiana Operational Sediment Budget: Raccoon Point to Sandy Point, 1985-89 to 2013-16. Final Report prepared for Louisiana Coastal Protection and Restoration Authority, Contract 4400009020, Task 5, 118 p. plus appendices.

APTIM, 2020. Report on Louisiana Surficial Sediment Distribution (SSD) Map Compilation. Boca Raton, Florida: Aptim Environmental & Infrastructure, LLC, 150p. (Prepared for Coastal Protection and Restoration Authority of Louisiana).

Byrnes, M. R., Hedderman, C., Hasen, M., Roberts, H., Khalil, S., and Underwood S. G., 2015. Differential sediment consolidation associated with barrier beach restoration: Caminada headland, south Louisiana. Proceedings of Coastal Sediments 2015. World Scientific Publishing Company

Campbell, T., Benedet, L. and Finkl, C. W. 2005. Regional strategies for barrier island restoration. *In:* Finkl, C.W. and S. M. Khalil, (eds.), *Louisiana Barrier Island Restoration.* West Palm Beach, Florida: *Journal of Coastal Research*, Special Issue No. 44, 240–262.

CB&I. 2015. Louisiana Borrow Area Management and Monitoring (BAMM) Program-Final Report. Boca Raton, Florida: CB&I Government Solutions, 488p. (Prepared for Coastal Protection and Restoration Authority).

Coastal Engineering Consultants, Inc. 2012. Barrier Island Performance Analysis. Prepared for Coastal Protection and Restoration Authority under contract 2503-12-22. http://cims.coastal.la.gov

Coastal Engineering Consultants, Inc. 2015. Barrier Island / Barrier Headland Restoration, Design Template Development, Technical Memorandum, CEC File No. 13.084. http://cims.coastal.la.gov

CPRA (Coastal Protection and Restoration Authority), 2021. A Brief Chronology of CPRA's Approach & Various Studies on Subsidence Measurements in Coastal Louisiana, Coastal Protection and Restoration Authority of Louisiana (CPRA), Baton Rouge, LA, 10p.

CPRA (Coastal Protection and Restoration Authority), 2017. Louisiana's Comprehensive Master Plan for a Sustainable Coast. Baton Rouge, LA.

CPRA (Coastal Protection and Restoration Authority), 2016. Integrated Ecosystem Restoration & Hurricane Protection in Coastal Louisiana: Fiscal Year 2016 Annual Plan. Baton Rouge, LA. http://cims.coastal.louisiana.gov/DocLibrary/FileDownload.aspx?Root=0&id=11477

CPRA (Coastal Protection and Restoration Authority), 2012. Louisiana's Comprehensive Master Plan for a Sustainable Coast. Baton Rouge, LA.

Ewing, L. and Pope, J. 2006. Viewing the Beach as an Ecosystem? Shore & Beach, 74 (1), 2.

Forrest, B., Khalil, S. M., Haywood, E., and Raynie, R. 2019. The Role of Surficial Sediment Distribution Maps in Regional Sediment Management. Proceedings of Coastal Sediments 2019. World Scientific Publishing Company

Georgiou, I.Y., Fitzgerald, D.M., and Stone, G.W. 2005. The impact of physical processes along the Louisiana coast, Journal of Coastal Research, Special Issue No. 44, pp. 72-89.

Gahagan & Bryant Associates (GBA). 2016. Caminada Moreau Subsidence Study Phase 4 Final Monitoring Report. Prepared for Coastal Protection and Restoration Authority, Baton Rouge, LA, 178 p.

Khalil, S.M. and C.W. Finkl. 2009 Regional sediment management strategies for coastal restoration in Louisiana, USA. Journal of Coastal Research, Special Issue No. 56, pp. 1320-1324.

Khalil, S.M., Finkl, C.W., Roberts, H.H., and Raynie, R.C. 2010. New approaches to sediment management on the inner continental shelf offshore coastal Louisiana, Journal of Coastal Research, 26 (4), 591-604.

Khalil, S.M., and Raynie, R.C. 2015. An integrated system-based approach to restoration of Louisiana's barrier islands. Proceedings of Coastal Sediments 2015. World Scientific Publishing Company

Khalil, S. M., Haywood, E., Wager, R., and Forrest, B., 2022. Standard Operating Procedures for Geo-scientific Data Management, Louisiana Sand Resources Database (LASARD) Revised 2022, Coastal Protection and Restoration Authority of Louisiana (CPRA), 29pp. https://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=12362

Khalil, S. M., Forrest, B., Haywood, E., and Raynie, R. 2018. Surficial Sediment Distribution Maps for Sustainability and Ecosystem Restoration of Coastal Louisiana: Shore & Beach, Vol. 86, No. 3 Summer 2018, 21-28 pp

Khalil, S.M., Raynie, R.C., and LeBlanc, J. 2019. Louisiana's Barrier Island System – A Programmatic Approach to Restoration. Proceedings of Coastal Sediments 2019. World Scientific Publishing Company

Kindinger, J.L., Buster, N.A., Flocks, J.G., Bernier, J.C., and Kulp, M.A. 2013, Louisiana Barrier Island Comprehensive Monitoring (BICM) Program Summary Report: Data and Analyses 2006 through 2010: U.S. Geological Survey Open-File Report 2013–1083, 86 p., at http://pubs.usgs.gov/of/2013/1083/.

McBride, R.A. and M.R Byrnes. 1997. Regional variations in shore response along barrier island systems of the Mississippi River delta plain: historical change and future prediction. Journal of Coastal Research 13(3):628-655.

Rosati, J. D. 2009. Barrier Island Migration Over a Consolidating Substrate. Coastal Inlets Research Program, U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory. ERDC/CHL TR-09-8. Vicksburg, MS. 219 pp.

The Water Institute, 2023a. Assessing the Impact of In-Bay Borrow Pits on Estuarine Sediment Dynamics, Barataria Bay, Louisiana. Final report prepared for the Coastal Protection and Restoration Authority. Baton Rouge, LA. Task Order 72.1. 31 p + appendices. https://cims.coastal.la.gov/RecordDetail.aspx?Root=0&sid=25168

The Water Institute of the Gulf 2023b. Numerical Modeling to Estimate Sediment Infilling Rate of Lowermost Mississippi River Borrow Pits and Impacts on Downstream Dredging The Water Institute. Prepared for and/or funded by the Coastal Protection and Restoration Authority. Baton Rouge, LA . https://cims.coastal.la.gov/RecordDetail.aspx?Root=0&sid=25089

U.S. Army Corps of Engineers. 2010. Louisiana Coastal Area Ecosystem Restoration Study. Vol. V of VI. Integrated Feasibility Study and Final Environmental Impact Statement for the Terrebonne Basin Barrier Shoreline Restoration, Terrebonne Parish, Louisiana. New Orleans, Louisiana.