Calhoun County Texas Shoreline Access Plan

Appendix B

Geologic History, Physical Processes, Habitat Inventories, and Environmental Recommendations

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Photo: Seadrift Shoreline Park

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Introduction

This appendix was developed to present some of the environmental and natural resources information available on Calhoun County. This information may be needed to develop action plans on potential solutions related to shoreline access points or recreation alternatives on the bay shorelines. The information was also presented as a tool that can support future efforts on the protection of these natural resources and the development of specific public shoreline infrastructure. The information covers the geology of county shorelines; the location of erosion problems on the shorelines; and the habitat-related data, which is needed when addressing public access to the county shorelines for recreational activities such as fishing, hunting, swimming, bird watching, kayaking, windsurfing, etc. In addition, a list of recommendations on localized environmental problems affecting the shorelines has been included, using the same areas described in the Calhoun County Shoreline Access Master Plan.

Geology

The evolution of the Calhoun County shorelines is associated with the deposition of several river deltas in the last 125,000 years. This deposition was a response to the sea level changes that occurred in the Gulf of Mexico as the result of climatic variations, and the response of the rivers interacting with a changing coast (McGowen et al. 1976). On the east side of the county, the San Antonio and Guadalupe River Delta systems controlled the geologic deposition of the region. On the west side, the Lavaca-Navidad River System left extensive fluvial and deltaic deposits as well. These fluvial (river deposits) and delta systems (delta deposits) controlled the landscape in the county, leaving a flat fluvial-deltaic coastal plain environment. The changes in the sea level curve in the Gulf of Mexico for the past 125,000 years reflect the transgressions (sea level moving up) and regressions (sea level moving down), which developed the coastal morphological features of Calhoun County (White and Morton 1987). Figure B1 shows the geology of the county, which is manifested by different types of sediments as a response to these sea level rise adjustments. According to the geologic models forecasting the relative sea level rise, it is expected that the process of coastal change will continue in the future years. Although, in the short-term these changes are not expected to be noticeable by the public, they will be noticeable in the medium-term in respect to adaptation of human activities and natural habitats (Anderson 2007).

In general, the geologic evolution of Calhoun County in recent times can be divided into two general time dominated episodes: the units formed in the Pleistocene between 125,000 to ~10,000 before present (BP) and the geologic units formed in modern times (Holocene) between ~10,000 years (BP) and the present (McGowen et al. 1976). These two events can be observed directly in the morphology of the bay shorelines. The following description of the geology shows the geographic distribution of these geologic units also expressed by the local shoreline morphologies, presence of sandy beaches, marshes, inlets, bayous, bays, deltas, etc. (Figure B1).

Pleistocene fluvial deltaic system. The Pleistocene Fluvial-Deltaic system appears on the northern side of Calhoun County and consists of the original delta streams that controlled the formation of the coastal plain (McGowen et al. 1976). These deltaic sediments consist mainly from highly consolidated mud and clays, which when eroded by modern shoreline erosion, leave steep slopes (cliffs) along the shorelines (Figure B1).

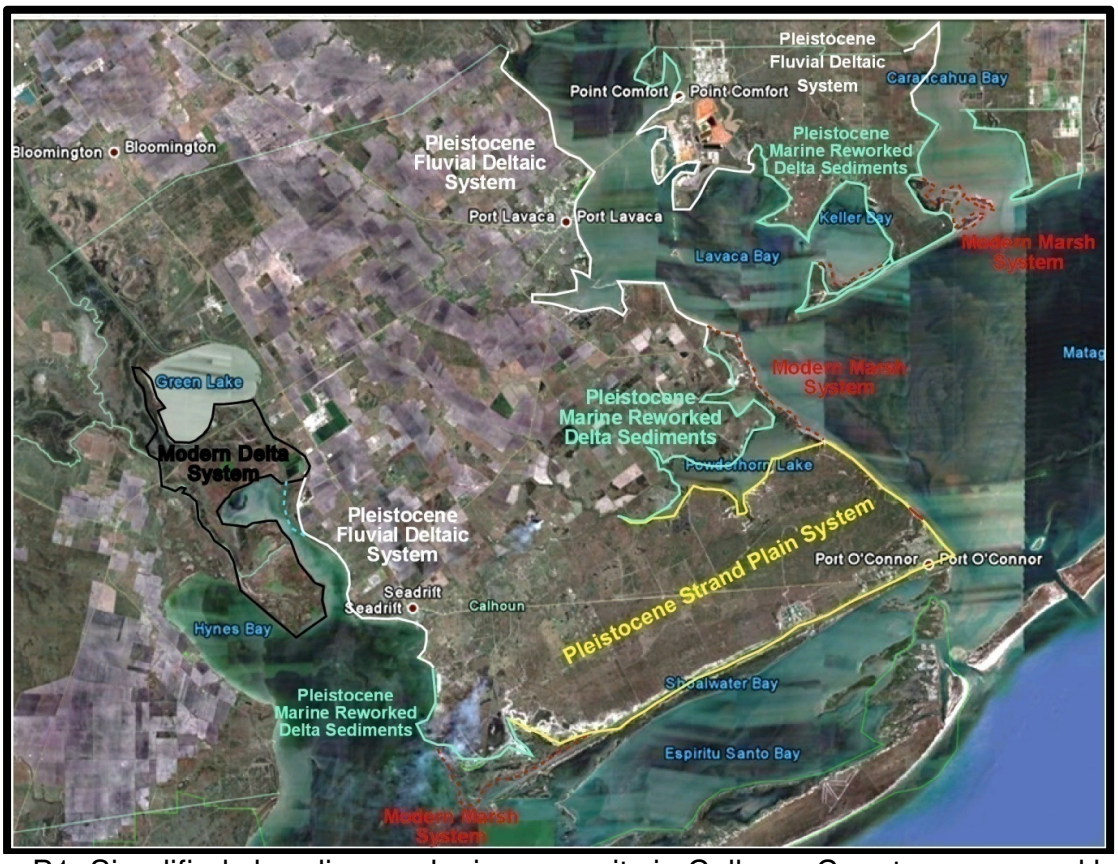


Figure B1. Simplified shoreline geologic map units in Calhoun County as mapped by the University Of Texas Bureau Of Economic Geology (McGowen et al. 1976).

Pleistocene marine reworked delta sediments. These sediments consist of materials that were eroded from the original delta system when the Gulf of Mexico coast used to be located north of Port O'Connor (McGowen et al. 1976). These sediments are consolidated as fluvial deltaic deposits and consist mainly of mud and clays, which when eroded by modern shoreline erosion, also leave steep slopes (cliffs) along the shorelines (Figure B3).

Pleistocene strand plain system. The Strand Plain System consists of the ancient sandy shorelines of the Gulf of Mexico (McGowen et al. 1976). The area mapped as the Strand system consists of a former Gulf of Mexico barrier island. The shorelines of this geologic unit consist of semi-consolidated and loose sands, which tend to be highly erodible (Figure B1).

Modern delta system. The Modern Delta System corresponds to the recent delta sediments deposited in the last few thousand years (McGowen et al. 1976). For a few thousands of years, the deltas were growing due to the natural inputs of fluvial sediments. However, in the last 100 years, these deltas started being affected by erosion and local subsidence due to the limited amount of sediment inputs generated by human impacts. The sediments forming these deltas consist of unconsolidated mud and sands, which tend to be removed easily by erosion (Figure B1).

Modern marsh system. The modern marsh system deposits consist of the organic and fine sediments that created the marshes and wetlands present on the modern shorelines, bayous, and creeks in the region. These sediments are loose and highly erodible (Figure B1).

Modern shoreline beaches. Although not presented in the geologic map due to their limited presence, the modern shorelines have pockets of sand and sandy shells that are highly unconsolidated and highly erodible. These sandy beaches tend to be affected by shoreline erosion and are in constant migration.

Bay Water Circulation

Shoreline processes are associated with geology-shoreline composition, wind, waves, and bay water circulation (White and Morton 1987). The bay water circulation is the process that generates the general trends of sediment transport due to the longshore drift. A basic bay water circulation model was developed by McGowen et al. (1976) for

the region, which shows the general trends of water circulation in the bays of Calhoun County (Figure B2). As can be seen in Figure B2, the cumulative wind direction during the year is a very important influence as it dictates the bay water circulation processes; erosion; and, accumulation affecting the shorelines. From the wind data observed by the Texas Coastal Ocean Observing Network (TCOON), it can be concluded that the shorelines of Calhoun County are affected by two sets of winds: winds coming from the north-northeast and from the south-southeast. Winds from the north-northeast are common in the winter and can extend up to five months. Winds from the south-southeast are common on the summer and can reach up to seven months in duration (TCOON 2012).

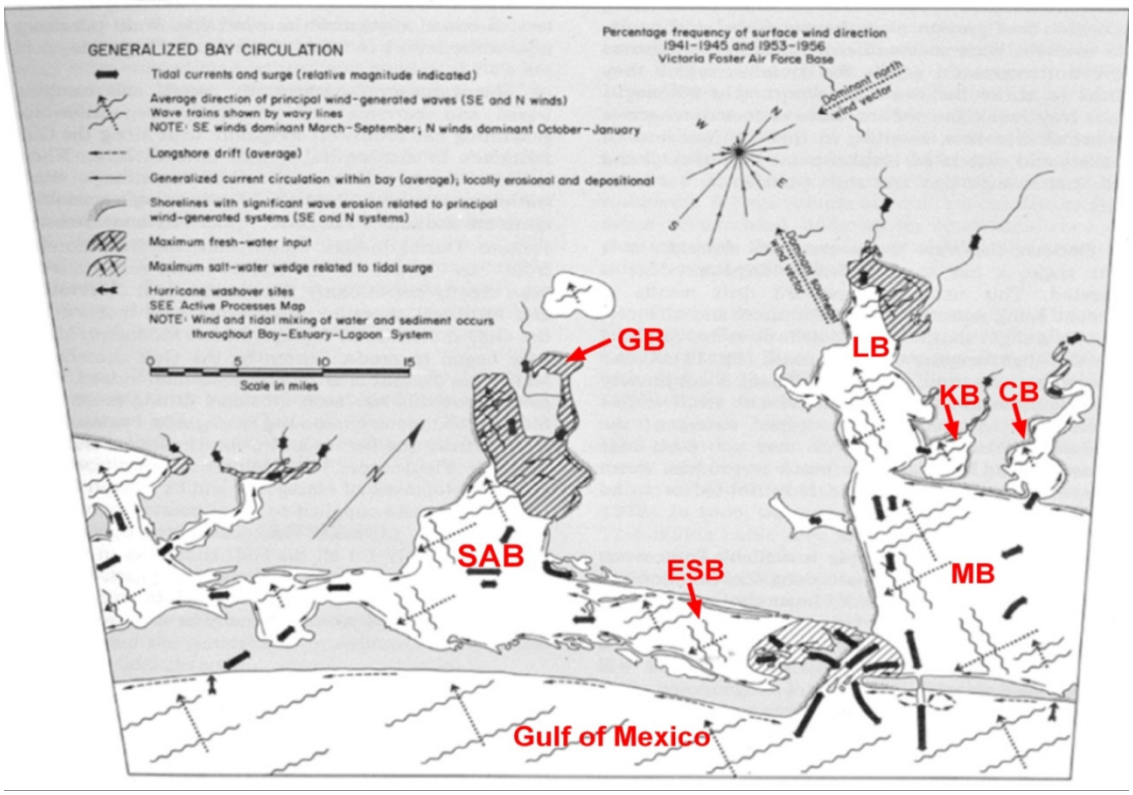


Figure B2. Generalized Water Bay Circulation from McGowen et al. (1976). SAB: San Antonio Bay; GB: Guadalupe Bay; ESB: Espiritu Santo Bay; MB: Matagorda Bay; LB: Lavaca Bay; KB: Keller Bay; and CB: Carancahua Bay.

Geographic distribution of bays in Calhoun County. Figure 1 in the Calhoun County Shoreline Access Master Plan, which shows the bays analyzed in the report, has been included in this Appendix as Figure B3 to facilitate the ease of comparison/inclusion of geographic analysis:

SAB: San Antonio Bay; GB: Guadalupe Bay; ESB: Espiritu Santo Bay; MB: Matagorda Bay; LB: Lavaca Bay; KB: Keller Bay; CB: Carancahua Bay

Figure B3. Bays in contact with Calhoun County.

In general, for San Antonio Bay (SAB), the shorelines on the west side of the county appear to be protected from the prevailing southeastern winds (Figure B2). The longshore bay circulation appears to be mainly towards the north along these shorelines. An active area of wave and circulation energy appears to be on the southwest corner of the county at the intersection of the Gulf Intracoastal Waterway (GIWW) and SAB in the area called Welder Flats Wildlife Management Area, where extensive marshes and seagrasses cover an area on public and private low lands. Also in SAB, the upper part of the bay, including Guadalupe Bay (GB), appears to be influenced by fresh water inputs coming from the San Antonio and Guadalupe Rivers. In both bays, SAB and GB, the longshore processes appear to move the sediments along the shorelines preferentially to the north (McGowen et al. 1976) (Figure B2).

For Espiritu Santo Bay (ESB), the shorelines of the county are protected from wind-fetch effects by the GIWW. On the areas located south of the GIWW, which are in contact with SAB, the sediment longshore circulation appears to be predominantly from east to west. An area of Gulf of Mexico flow intrusion near the Port O'Connor area appears to come from Pass Cavallo (Figure B2), which may have some influence on the circulation patterns on the shorelines (McGowen et al. 1976).

The McGowen et al. (1976) model for the shorelines of Matagorda Bay (MB) shows that the general longshore sediment and flow circulation on the east shorelines of Calhoun County move the sediments from north to south from Magnolia Beach to Port O'Connor. On the north side of MB, next to Cox and Carancahua Bays, the model shows that the longshore processes move sediments along the shorelines from east to west. However, local geomorphologic features observed in recent years near Magnolia Beach show that longshore sediment circulation has been seasonally moving to the north, as expressed by the sediment accumulation occurring on fishing piers and rock groins at King Fisher Beach Park and Indianola and Magnolia Beaches.

For Lavaca Bay (LB), the McGowen et al. (1976) model suggests a different shoreline longshore cell around the bay shorelines. Starting at the west side at Alamo Beach on West Lavaca Bay, the model suggests that longshore processes move from south to north until the longshore circulation reaches Chocolate Bayou (Figure B2). The model suggests that longshore sediment transport north of Chocolate Bayou tends to be from north to south. This is confirmed by the sand accumulation observed on the north side of an abandoned fishing pier located about 0.6 miles south of Lighthouse Park.

The McGowen et al. (1976) model also suggests that for Keller Bay (KB), a counter clockwise longshore circulation cell controls the longshore processes, which when intersecting LB, produces a local longshore circulation cell that tends to move from north to south towards MB. Carancahua Bay (CB) presents the same counter clockwise circulation pattern (See Figure B2).

Shoreline Types

The shorelines of the western portion of Calhoun County have been classified by McGowen and Brewton (1975) according to their morphologic characteristics. These shorelines are located in different areas of the county.

Cliffed shorelines with Pleistocene deposits exposed in the swash zone. These features correspond to shorelines composed from hard Pleistocene clays, which are expressed by steep cliffs. The submerged shorelines tend to be hard clays and soft mud.

Shell and rock fragments beaches. The shell and rock fragments shorelines correspond to cumulative beaches with high content of gravels, sandy shells, calcareous debris, broken, and entire bay shells. These beaches are located in areas where shells are an important component of the shallow beaches, and tend to be accumulated by wave actions.

Terrigenous sand beaches. Sandy beaches, sometimes acting as pocket beaches, are common in localized areas along the county shorelines. These areas tend to be small but important in the general sediment accumulation occurring on the bay shorelines.

Marsh dominated strandline. These shorelines correspond to the marshes, wetlands, and vegetated bayous in contact with the bays.

Marsh dominated modern shorelines. These modern shorelines are not connected to the marshes on the strandline. These shorelines have marshes in different areas where creeks, coves and bayous have developed marshes that connect to the bay tides in restricted or protected areas.

Shoreline altered by human activities. These shorelines correspond to the shorelines modified by human activities through dredging and the construction of bulkheads, rock revetments, groins, boat ramps, etc. (McGowen and Brewton 1975).

Shoreline Retreat Rates

The shoreline processes affecting the bays include erosion and accumulation processes. Shoreline erosion is a common problem in Texas bays. The rates of retreat or accretion are measured in ft/yr, and are determined by the Bureau of Economic Geology of the University of Texas at Austin, which has conducted different historic studies on the shorelines of Calhoun County. Although some data on the shoreline processes is historic, the general shoreline erosion trends tend to be steady due to the lack of regional modifications (Figure B4).

Two sets of shoreline retreat data are available for Calhoun County: 1) a study conducted by McGowen and Brewton (1975) for Lavaca and Matagorda bays; and, 2) a study from White and Morton (1987) for San Antonio and Espiritu Santo bays (Figure B3). The study conducted by McGowen and Brewton (1975) consisted of erosion and accretion rates based on shoreline profiles run in 1971-1972, which were then compared with data from 1956-1957. The study conducted by White and Morton (1987) consists of average rates that were compared from data collected in the period 1859-60 and compared with the data collected in the period of 1974-1982. There is no recent data collected for these bays. The rates in Figure B4 show that there are a few areas in the bay with high erosion rates that exceed >20 ft/yr of shoreline retreat, but the general trends are erosion rates that range between -2 and -5 ft/yr.

Figure B4. Erosion and accretion rates in ft/yr.

Coastal Habitats in Calhoun County Bays and Shorelines

Calhoun County's coastal areas contain abundant and valuable natural resources. These natural resources attract many user groups with different recreational goals. Over-visitation may impact some specific resources. In some instances, a coastal natural resource is protected under both state and federal regulations, which must be recognized when considering new access points. Several coastal natural resources are represented in Figure B4 and described below.

Tidal wetlands. Wetland areas are influenced by the ebb and flow of tidal flows and energies. Depicted as hatched blue lines in Figure B4, this resource is protected under both federal and state regulations. These areas can include brackish marshes, tidal mud and salt flats, salt marshes, etc. Any discharge of fill within tidal wetlands would require a Clean Water Act (CWA) Section 404 permit through the U.S. Army Corp of Engineers (USACE); any work or construction in tidal wetlands would require authorization under Section 10 of the Rivers and Harbors Act (RHA, also regulated by USACE); and, coordination with the Texas General Land Office would be necessary as it is considered a Coastal Natural Resource Area protected through the Coastal Zone Management Act (CZMA). The data presented in Figure B5 was derived from U.S. Fish and Wildlife Service National Wetland Inventory data.

Oyster reefs. Oyster reefs are abundant in the bays surrounding Calhoun County. The areas where these resources are abundant are depicted as yellow polygons in Figure B5. These fish and natural habitats are also protected under Section 404 of the CWA, Section 10 of the RHA, and the CZMA. The data presented in Figure B5 was derived from National Oceanic Atmospheric Administration's National Marine Fisheries Services databases.

Seagrass. Shoal grass (*Hadule beaudettei*) and turtle grass (*Thalassia testudinum*) are typical species in the area and provide important ecological functions, including provision of nursery habitat for estuarine-dependent species; provision of organic biomass for coastal food webs; coastal erosion and sedimentation stabilization; and is part of the general coastal nutrient and water cycling processes. Boat propeller scarring is observed in aerial photos next to the shorelines of Calhoun County where seagrass is abundant. During low tides or in shallow areas, boat propellers tend to destroy important areas of seagrass. Coastal visitors should notice that fish productivity and seagrass stability are factors that go together, so the protection of seagrass areas should be

considered part of the success of coastal fisheries. The data presented in Figure B5 was derived from National Oceanic Atmospheric Administration's National Marine Fisheries Services databases. The location of seagrass is presented in Figure B5 as yellow polygons, which are also protected under Section 404 of the CWA, Section 10 of the RHA, and CZMA.

Note: Limited data is available for Lavaca and Matagorda Bays on oyster reefs and seagrass.

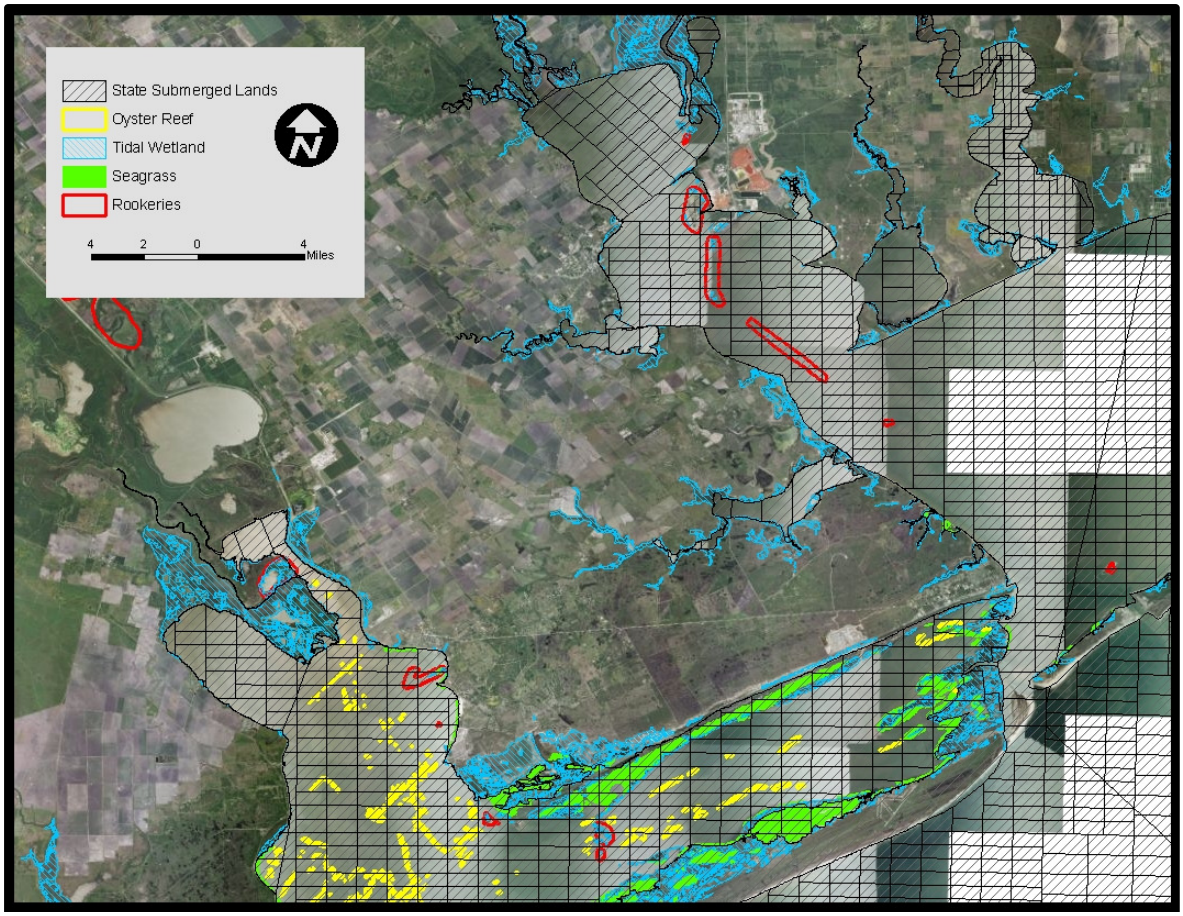


Figure B5. Habitats located around the shorelines of Calhoun County. Sources: National Oceanic Atmospheric Administration's (NOAA) National Marine Fisheries Services (NMFS) databases; Texas Parks and Wildlife Department's Natural Diversity Database; and, Texas GLO spatial databases.

Rookeries. These are large nesting areas for colonial waterbirds. Colonial waterbirds tend to be isolated and protected from predators. These habitats tend also to be isolated islands away from human activities as well. These habitat areas are protected under the Migratory Bird Treaty Act (MBTA). Usually, construction or visitation in or

immediately near a rookery should be avoided during breeding season (generally April through August). The data presented in Figure B5 was derived from Texas Parks and Wildlife Department's Natural Diversity Database and Texas GLO spatial databases. The protection of nests under the MBTA includes nests such as those found in shrubs, trees, and brush. Active nests should be avoided by visitors, mainly if visitation takes place between April and August (the general nesting season for migratory bird species).

The locations of resources depicted in Figure B5 should only be used as a reference for general location. For example, recent field visits to project sites revealed areas of seagrass and oyster reefs along the shorelines of Boggy Creek Park that were not shown in various state and federal spatial inventories. The natural resource agencies and the County are encouraged to make sure that inventories are current and data is available to the public so that impacts to the habitats will be limited.

State submerged lands. These are areas under tidal influence, which are owned or managed by the Texas General Land Office (GLO). Depending on the nature of the area, activities that may impact submerged public lands may require GLO coordination and approval. The GLO is in charge of the enforcement of the Texas Coastal Zone Management Program, which includes the policies that apply directly to these coastal submerged lands. The submerged land spatial data depicted in Figure B5 was obtained from the GLO website.

Information on Coastal Resources and Potential Regulatory Concerns

Calhoun County contains habitat that is protected under the Endangered Species Act. Although several federally listed species are known to potentially occur in and around Calhoun County and its waters, the primary species that would be scrutinized during a coastal access improvement project would likely be the piping plover (*Charadrius melodus*). The piping plover uses many types of tidal shoreline interfaces including beachfronts, tidal and mud flats, etc. Many potential visitation and recreational areas contain suitable piping plover habitat. Piping plovers winter in Texas and typically occupy the habitat from October through March. A survey of potential piping plover habitat is recommended for future shoreline access projects.

The distribution of tidal wetlands is displayed in Figure B5. Some non-tidal waters (including streams, wetlands, rivers, etc.) are protected under Section 404 of the Clean

Water Act and discharge of fill into such waters would require a permit. A survey for potentially regulated waters should be developed on any shoreline access initiative.

Shoreline Access and Environmental Recommendations

Geographical Distribution

Although a map with the shoreline access zones was presented in Figure 4 in the Calhoun County Shoreline Access Master Plan, it is presented again in this Appendix as Figure B5, to facilitate the understanding of areas described in this partial document. The geographic shoreline access zones used in the project inventory include: Zone A--San Antonio Bay and West Calhoun County; Zone B--Gulf Intracoastal Waterway (GIWW) and Espiritu Santo Bay; Zone C--South Lavaca Bay; Zone D--North Lavaca Bay; and Zone E--East Calhoun County (Figure B6).

Figure B6. Shoreline Access Zones used in this inventory.

Zone A

Seadrift Recreational Recommendations

Replacement of the Seadrift seawall. The Seadrift seawall shows indicators of deterioration. Scouring is happening at the base of the seawall, where several segments of the wall are toppling towards the water. Calhoun County is in the process of searching for funding to replace the entire seawall, so that the public can continue to enjoy access to the bay as well as the amenities at the park.

Shoreline protection at the ends of the Seadrift seawall. Shoreline retreat is affecting the two ends of the seawall. A shoreline protection measure is needed on both sides. Breakwaters built in the bay may allow for accretion and the creation of more marshes in a sustainable manner. On the east side of the seawall, next to the Seadrift Marina boat ramp, another breakwater in the bay may serve as a sediment trap for sediments coming from the creek and sediments from the bay through longshore processes. The accumulation of sediments would provide for more marsh habitat. On the west side of the seawall, the recommended breakwater may also result in expansion of marshes already established on the shorelines, as presented in Figure B7.

Figure B7. General physical characteristics of the shorelines at Seadrift, showing areas that have hard structures, areas with incipient marshes, and recommended areas for breakwaters.

Marsh restoration as shoreline protection. The Seadrift seawall controls the erosion that is affecting the shorelines, but does not provide any natural benefits to the area. A potential habitat restoration project in front of the seawall may provide better conditions for fishing and bird habitat. Historical aerial photos show that the western segment of the seawall is shallow and has accreted sediments on the bay bottom. These sediments could be used to build marshes and improve the habitat conditions and the esthetics of the area. The construction of marshes, combined with breakwaters, may allow for the expansion of these marshes as a shoreline protection measure.

Beneficial use of dredge material and bird islands. The sediments that are shoaling the boat access and navigation channels next to the Seadrift embayment may offer some habitat restoration opportunities in this area. The dense number of recreational and navigation channels (Figure B8) indicate a need for dredge material placement areas nearby. One of the best environmentally friendly alternatives is to beneficially use dredged materials for habitat creation like bird islands and marsh. The development of bird islands on top of the spoil islands and new marsh habitats would encourage more recreational opportunities for fishing, kayaking, and bird watching.

Figure B8. Location of the recreational and navigation channels near Seadrift and potential habitat areas where spoil islands can be created from dredged material.

Zone B

Shoreline Access along the Gulf Intracoastal Waterway (GIWW) and Navigation Safety in Calhoun County

Shoreline access and safety. Currently there are plans to develop recreational facilities on the southern portion of the GIWW next to Port O'Connor. If these plans are executed, more demand for access to the boat ramps will be observed, which will include traffic on the streets and in the GIWW. In the long-term, it appears that development toward the west or the south of the GIWW at Port O'Connor will bring safety concerns and more traffic to the entire GIWW in county waters (Figure B9).

Figure B9. Location of the GIWW in Calhoun County.

Several minor and major accidents have occurred along the GIWW. These accidents necessitate the discussion about the role of shoreline access and safety concerns for visitors. Just as people seek shoreline access areas to enjoy the bays, they may also need to find access areas for boat egress to leave the waters during emergencies. If many boats try to leave the bays through the GIWW at the same time, it could create a large navigation safety issue that may impact navigation in the GIWW since it acts as a water highway. For that reason, it is recommended that an emergency plan be developed that will outline strategies to exit the water and/or egress to safe land areas in case of emergencies. The data source on safety of the GIWW was found in Mileski et al. (2010), which was developed by the Texas Transportation Institute. This report

mentions that the portion of the GIWW in Calhoun County has been considered a safety concern since it can affect the safety of maritime transportation.

Two major accidents occurred near Port O'Connor 2004 and 2009. The 2004 accident involved a vessel that collided with and destroyed the Alligator Head Fishing Club. Because of the lessons learned from that accident, Mileski et al. (2010) mention three major safety concerns for the area. First, the accumulated effect of development on the GIWW has a dramatic impact on the ability of barge operators to navigate the waterway. Second, the type of structures on the shorelines has a profound impact on navigation. Finally, the Port O'Connor area already has many structures along the waterway from mile marker 473 to 475, and it is expected that more will be built in the near future.

These safety issues deserve special attention because they have expanded beyond the local level to the state and federal level. These issues include: (a) the development of structures on the shorelines of the GIWW may encroach the channel, further narrowing accessibility; (b) there is a lack of strategic mooring or push-in (hold-up) places needed in inclement weather; and, (c) congestion caused by additional inexperienced recreational boaters entering and egressing from boat ramps may end in catastrophic events along the GIWW (Mileski et al. 2010). Calhoun County should address these issues in a master safety GIWW plan. The county should look for options for managing structures along the GIWW, with guidance from shoreline developers, state, and federal stakeholders, in order to maintain the safety and productivity of the maritime industry while balancing the need for public recreational purposes.

GIWW safety responsibilities. The Mileski et al. (2010) report streamlined the general stakeholders responsibilities associated with the safety of navigation on this section of the GIWW, which includes public and private entities. The public entities include: Texas Department of Transportation (TxDOT), United States Coast Guard (Coast Guard)**,** Texas General Land Office (GLO); United States Army Corps of Engineers (USACE), county and municipal officials and Port Authorities. The private sector is represented by: the Gulf Intracoastal Canal Association, the Texas Waterway Operators Association, developers/economic development corporations, and shippers.

According to Mileski et al. (2010), the above-mentioned entities contribute to the discussion of corridor maintenance and navigation on the GIWW. TxDOT has easements over the GIWW right-of-way and, under the 1975 Texas Coastal Waterways Act, TxDOT acts as the state's agent in fulfilling the non-federal sponsorship of the

GIWW in Texas. TxDOT is required to continually evaluate the GIWW as it relates to Texas, including identifying major problems. Therefore, TxDOT is a major stakeholder in the GIWW navigation and its safety.

The U.S. Coast Guard (Coast Guard) is responsible for policing traffic in the GIWW and has the authority to impose restrictions on traffic (U.S. Coast Guard, 2009a). Therefore, the Coast Guard is a key stakeholder in how the GIWW is preserved for navigation and in how to ensure that traffic through the GIWW flows quickly, efficiently, and safely. As a result of its policing responsibilities, the Coast Guard requires the reporting of certain incidents that occur on the waterways. Form 2692 requires vessel operators to report any incident involving property damage of $25,000 or higher or any incident that results in injury (Mileski et al. 2010).

The Texas General Land Office (GLO) grants leases for residential and commercial shoreline developments along the waterway. Therefore, indirectly the GLO is a key stakeholder in determining the impacts of shoreline development on GIWW navigation. The GLO Permitting Assistance Center for the upper Texas coast resides on the campus of Texas A&M University at Corpus Christi. A good source of information on obtaining a permit from the GLO is located on its website at http://ww.glo.state.tx.us/psc. In general, the GLO coordinates with USACE on issuing permits along the GIWW. The GLO's policy for development on the GIWW is found in the Texas Administrative Code at Title 31 Natural Resources and Conservation, Part 16 Coastal Coordination Council, Chapter 501 Coastal Management Program, Subchapter B Goals and Policies, Section 501.24 Policies for Construction of Waterfront Facilities and Other Structures on Submerged Lands. This policy has specific information about what is required based on the type of project, such as a marina or pier/dock. This policy states that structures built must not impede commercial navigation. This policy is also part of a greater coastal management program, Title 31 Natural Resources and Conservation, Part 6 Coastal Coordination Council, Chapter 501 Coastal Management Program, Subchapter B Goals and Policies.

The USACE has jurisdiction over the GIWW right-of-way and disposal easements, and is responsible for operating and maintaining the GIWW. As such, USACE is a major stakeholder in how GIWW navigation is impacted by shoreline development. Finally, "the permitting rules regarding obstruction of navigable water generally, wharves, piers, etc. and excavations and filling is found under 33 USC, Chapter 9, Subchapter I Section

403. Section 403 states that, “the creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is prohibited; and it shall not be lawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines, or where no harbor lines have been established, except on plans recommended by the Chief of Engineers and authorized by the Secretary of the Army; and, it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor or refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of the Army prior to beginning the same.”

Barge operators are the largest group of commercial navigators in the GIWW and are key components to the discussion of navigation hazards in the GIWW. The two industry associations identified as most important to the discussion of navigation on the GIWW are the Gulf Intracoastal Canal Association (GICA) and the Texas Waterway Operators Association (TWOA). According to Mileski et al. (2010), approximately 80 percent of the operators in the Texas portion of the GIWW are members of one of these organizations.

The primary representative of the barge operators is GICA. The GICA (2008) website states that they seek, “a comprehensive, coordinated, and consistent approach across the Gulf Coast that allows development to safely coexist with barge transportation on the Gulf Intracoastal Waterway. We must work together with development interests to insure that the primary purpose of the Intracoastal Waterway is preserved.” The website also states that the GICA would like to see, at a minimum, waterways without obstructions within reach of barges; have plenty of room for barges to be able to pull aside for other traffic, wait on weather, or stand-by for locks; and, have no blinding lights or confusion at bridge approaches. Additionally, the GICA encourages the education of recreational boaters, a presence of enforcement personnel, monitoring of conditions as development progresses, and a consistent plan across the Gulf Coast administered by the USACE (GICA, 2008).

Calhoun County representatives not only permit and police shoreline development, but also represent the public at large for use of the county shoreline. These officials can

identify prospective development, zoning, and subdivision regulations that may impact GIWW navigation. Therefore, this group of stakeholders is a key group in determining the impacts on GIWW navigation of shoreline development according to Mileski et al. (2010).

Development of the shoreline may lead to encroachment into the GIWW and affect navigation. Therefore, developers must be included in any discussion of plans along the GIWW. The structures that may be built into the waterway include piers, wharves, docks, dolphins, moorings, pilings, breakwaters, excavation, dredging, filling, riprap, revetments, retaining, walling, marinas, and marina/canal connections (Taylor Engineering, 2007). These encroachments may pose a navigation hazard particularly to commercial navigation since commercial vessels require large stopping distances, have substantial blind spots, and lack the maneuverability of a recreational boat (Taylor Engineering, 2007). Therefore, coastal developers and the economic development groups that represent them are important stakeholders in maintaining the GIWW corridor (Mileski et al. 2010). Finally, the shippers whose traffic needs have an impact on the navigation, according to Mileski et al. (2010), must be considered.

As mentioned above, these findings show that Calhoun County has direct interaction with potential uncontrolled development of shoreline structures along the GIWW, which in turn may have important safety implications for the visitors accessing the bays from the boat ramps located on the GIWW.

Construction permits needed along the GIWW

According to the USACE, the factors considered when issuing a permit for development along the GIWW include:

- Each permit is reviewed on a case-by-case basis.
- Each project is subject to internal review by the Corps.
- Each project is sent to the USACE environmental department for review.
- All structures must be at least 50 feet from the top cut of the GIWW channel.
- All lights must be directed downward.
- Loose riprap is not allowed in any development plan.
- All permits require “no wake” zones in and around neighborhood developments along the GIWW.

The USACE meets regularly with the Gulf Intracoastal Association to discuss pending development along the GIWW. USACE engineers closely review any development permit request for project proximity to bridges with strong currents, to bends within the channel, and to any known navigation hazards. The Navigation/Operations Division reviews the project plan for navigation hazards. The Real Estate Division and Programs/Project Management Division have a legal right to deny a poorly designed project based on solid information.

The USACE has begun to develop and refine a navigation system computer simulation to assist in its duties in permitting. Additionally, the USACE keeps a library of digital photos that show all the features they have constructed and maintained (channels, disposal areas, etc.) marked on aerial photos.

Zone C

Shoreline Erosion, Sediment Issues, and Environmental Recommendations

Beneficial use of dredge material (BUDM) opportunities at King Fisher Park. Sediments coming from BUDM activities at the GIWW are coordinated by the U.S. Army Corps of Engineers (USACE) and the County for the benefit of King Fisher Beach Park (Figure B10 and B11). Dredged sediments improve the recreational opportunities and environmental conditions of the shorelines and submerged habitats. Seagrass and migratory birds tend to come to the new shallow sand bars. This BUDM project has created a wider beach in a large section of the park, protecting also the original bulkhead from erosion (Figure B12). The southern portion of the park has a dry beach ~200 feet wide, but the northern portion has limited sand, where erosion and wave action are affecting the bulkhead. North of the park, the intense erosion rates are affecting the habitats and private properties.

One of the strongest assets in Port O'Connor is a long fishing pier located in the middle of the center area of the park. Unfortunately, its shallow depth makes the pier an underutilized resource. If the BUDM project continues as it is today, more shoaling problems will occur at the pier, making this important infrastructure obsolete.

A long-term solution to this erosion and accumulation problem near King Fisher Park may be obtained through a close collaboration with the USACE in identifying a more

specific location for the sediment disposal north of the park. The entire bay shoreline in this area needs sediments to reduce the erosion and shoreline retreat processes. Figure B4 shows the source of the sediments dredged at the GIWW and the disposal area near King Fisher Park. It appears that the predominant longshore processes in that portion of the bay tend to move the sediments to the south several months of the year (McGowen and Brewton 1975), disposing the dredged sediments north of King Fisher Park along the shorelines. This process may provide a natural longshore source of sediments to the park beach, thereby reducing the shoreline retreat rates. According to McGowen and Brewton (1975), the erosion rates are up to -32 ft/yr just 1.5 miles north of the park.

Another alternative to reduce the severe erosion problem may be to negotiate with the USACE and the Calhoun County Port Authority about the placement of sediments from the Matagorda Ship Channel along the shorelines located north of the park as a BUDM alternative, as presented in Figure B11.

Figure B10. Dredging source for the sediments at the GIWW near Port O'Connor that are placed at the King Fisher Park. Source: Image modified from the GIWW USACE O&M Project Map Book, Galveston District.

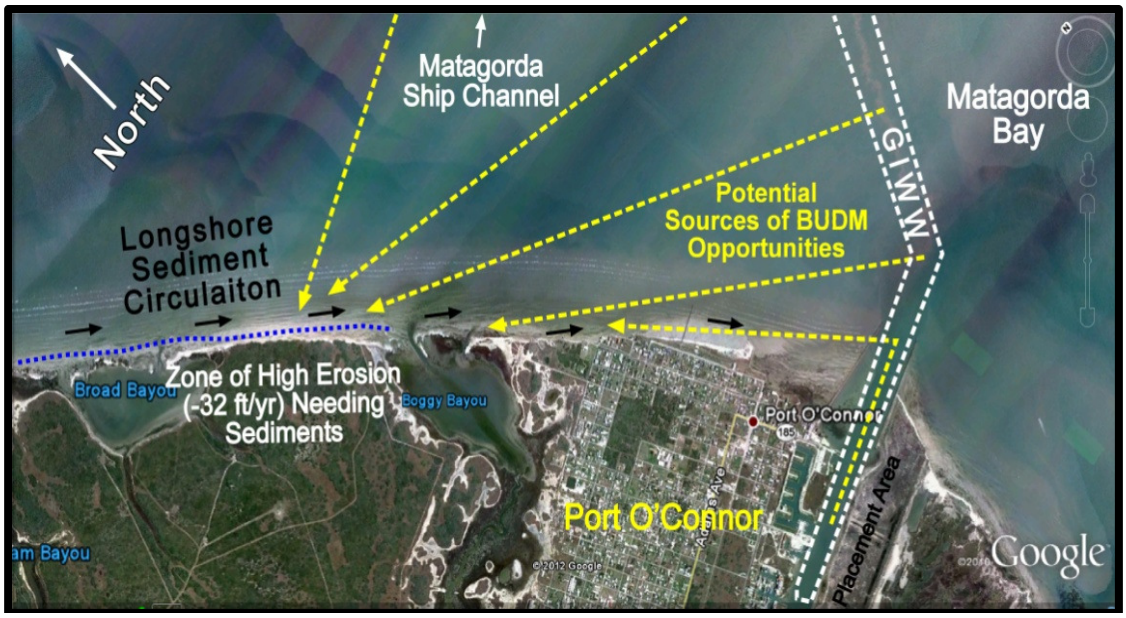


Figure B11. Potential sources of sediments for BUDM opportunities coming from the navigation channels north of Port O'Connor. Sediments coming from future dredging projects may reduce the erosion rates on the county shorelines.

King Fisher Park recommended sediment management alternatives. The bay bottom at King Fisher Park is shallow due to the accumulation of sand bars formed by the beneficial use of dredge material projects developed by the county in a partnership with the by U.S. Army Corps of Engineers. The sediments consist mainly of sands. The placement of these sediments has improved the beach park, but has shoaled the pier. The creation of a nice beach has provided relative protection to the original park bulkhead, which is more evident on the southern portion. However, on the northern portion of the park, the bulkhead is exposed to wave action and it needs sediments to reduce the wave action. Sediments at the base of the fishing pier may be used to expand the beach and protect the north side of the bulkhead as shown in Figure B12. Dredging the pier area between two and three feet deep along the last 300 feet of the pier may provide enough sediment to widen the beach and allow for better fishing at the pier.

Figure B12. Potential dredging at the King Fisher Park may allow for more depth at the end of the fishing pier. The dredged sediments may be placed on the north side of the bulkhead, thereby reducing the shoreline erosion problems.

Erosion affecting the habitats of Brad, Big Dam, Huckleberry and Boggy Bayous. The high amount of erosion is also affecting the shorelines of the Brad, Big Dam, Huckleberry, and Boggy Bayous (Figure B13). Brad Bayou bay shorelines appear to be affected by -32 ft/yr of shoreline retreat according to McGowen and Brewton (1975). Although these processes may be affecting private property, the protection of the habitats in these bayous may be in the best interest of the natural conditions. Protecting these shorelines should be also a priority for the natural resources groups and agencies working in the area since the marsh ecosystems are disappearing.

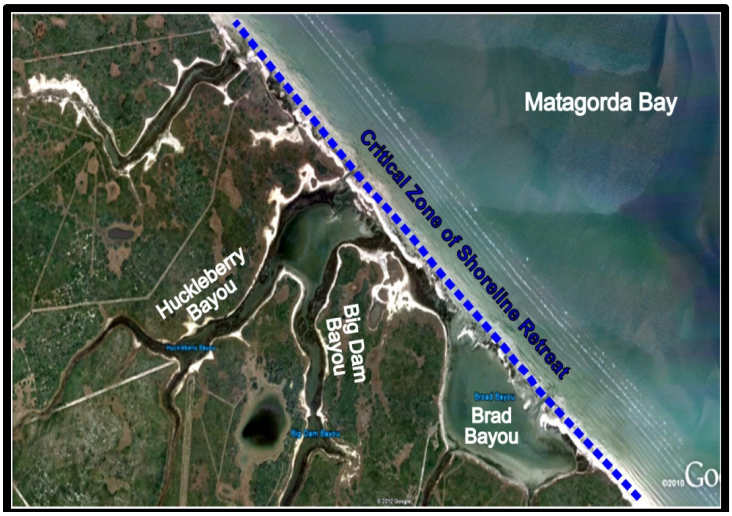
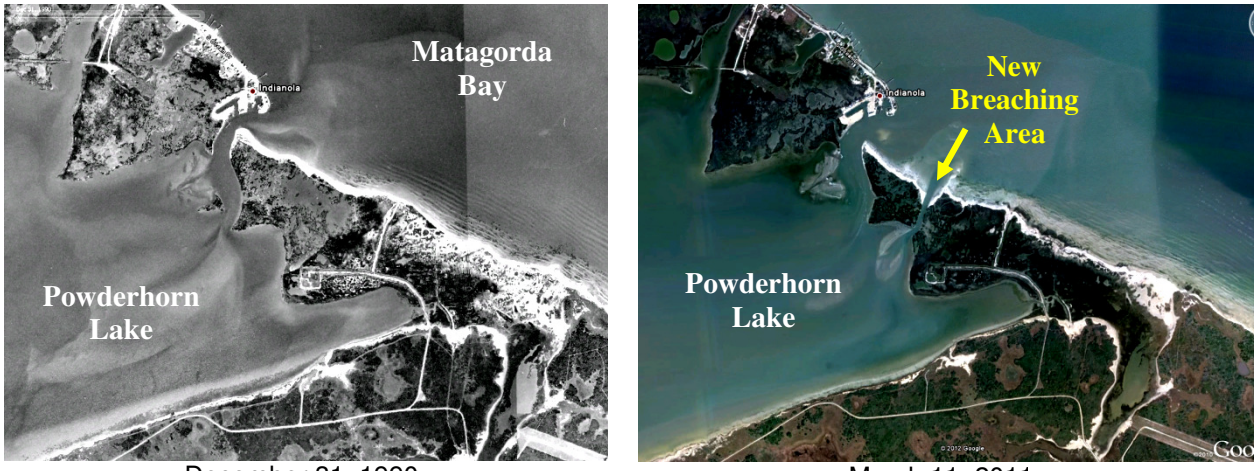


Figure B13. The marshes observed on the shorelines of Huckelberry Bayou, Big Dam Bayou and Brad Bayou have retreated drastically due to severe shoreline retreat.

Erosion at Powderhorn Lake Peninsula. The inlet that connects Powderhorn Lake with Lavaca Bay consists of a shallow access, which is used intensively by fishermen. The analysis of historical aerial photos in the Powderhorn Lake Peninsula, which separates Lavaca Bay from Powderhorn Lake, shows that the high erosion rates in the area have started to impact the lake habitats (Figure B14). The peninsula has breached in recent years and created two inlets. The breaching happened just before 2005, as shown in the Google Earth images, and occurred on a marsh area south from the original inlet (Figure B14). The breaching created a new island that is now eroding on the lake and the bay sides. More than five acres of marshes were lost between 1996 and 2009 and will continue disappearing due to wave action.

The aerial photos in Figure B14 show that the breached area is affecting marshes and shoreline and submerged habitats, such as oyster reefs. A large shoreline protection project is needed in the area to save these important habitats. The project needs new sediments for marsh restoration and a shoreline protection measure on the bay side, which may control or delay the shoreline retreat.



December 31, 1990 March 11, 2011

Figure B14. Historical comparison of shoreline retreat at the shorelines, marshes, and sand bars of Powderhorn Lake in contact with Matagorda Bay. Aerial photos show a new breached area, which is now eroding marshes and submerged habitats on the lake side.

Riprap and shoreline protection at Indianola. The shoreline erosion between Magnolia and Indianola beaches is intense. As a way to reduce erosion on public lands,

the Texas General Land Office and Calhoun County installed different types of riprap. In general, the riprap consisted of concrete slabs and concrete blocks, which have reduced the shoreline retreat, but have not stopped the general sediment loss from these beaches. Beach scouring is now evident behind the riprap, as can be seen in Figure B15. Sediments behind the riprap barriers are vitally needed to maintain the beach. Since Indianola and Magnolia Beaches are historic assets to the coast and contain thousands of acres of healthy marshes, shoreline protection measures should be considered an environmental emergency project. The county should search for financial resources from state and federal agencies as these areas are critical habitats for environmental, natural resources, ecologic, and historic values to the State of Texas. The filling of these scouring areas with beach material should be a priority for the State due to the value of the resources in the area.

Figure B15. Distribution of concrete riprap between Magnolia and Indianola beaches. Erosion is creating a beach-scouring process behind the riprap, making the area more susceptible to environmental damage and impacts to the marshes behind these barriers.

BUDM plan for the southeastern portion of Calhoun County. The shoreline erosion or shoreline retreat affecting this portion of the county is severe (McGowen et al. 1975). Erosion is affecting important ecosystems that are a source of recreation and which contain important natural resources in the region. Shoreline retreat is also affecting bay shorelines connected with fresh water bodies. The critical aspect is where the shorelines that protect the bayous are disappearing, taking the land that is protecting the marshes. The sandy shoreline that separates Lavaca Bay from Powderhorn Lake,

Blind Bayou, Old Town Lake Huckelberry Bayou, Big Dam Bayou, Brad Bayou, and Boggy Bayou is losing large volumes of bay shallow habitat due to these active processes.

One of the main aspects that the public may not know about shoreline retreat is the fact that shoreline erosion has a 3-D component. When you have a shoreline retreat rate of -32 ft/yr (McGowen et al. 1975), it means the shorelines are not only loosing sediments on the surface, but also on the bay submerged slopes. Figure B16 shows the depths of the bay bottoms next to the shorelines. When comparing these bay depths with the shoreline loss, it is clear that erosion represents millions of cubic yards of sediments that go to the bay and never return to the shorelines.

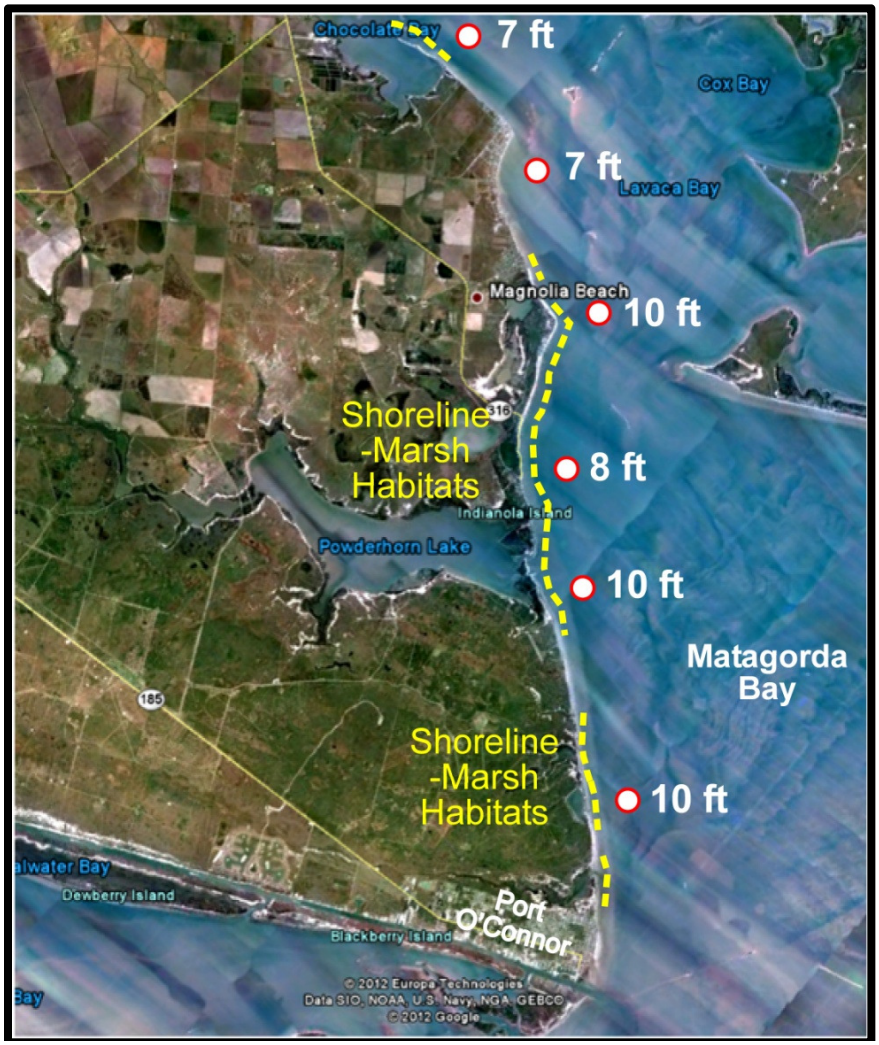


Figure B16. The numbers represent bay depths in feet next to the shorelines and habitat areas along of South Lavaca and Matagorda Bays (Source: NOAA, 2008).

One area that requires attention is the Powderhorn Lake peninsula, which is breaching and disappearing significantly. The shoreline retreat problem should be considered a major problem in the county and should be coordinated with different natural resources groups, federal and state agencies, non-profit organizations, land owners, and the local navigation districts. It requires coordination, funding, and the development of a Beneficial Use of Dredge Material (BUDM) Master Plan for Restoration.

This BUDM Master Plan may be strongly associated with the sediments coming from the maintenance dredging of the GIWW and the Matagorda Ship Channel between Port O'Connor and of Magnolia Beach as a habitat restoration and beach nourishment initiative. The BUDM restoration concept may be expanded to private properties to include all the mentioned bayous as part of the BUDM plan since some of the habitat loss areas are located in private lands.

Some of the dredge sediments may be placed on the shorelines of these water bodies as an alternative to the placement areas (PA's) located on submerged areas next to the Matagorda Ship Channel (MSC). The beach nourishment areas marked in Figure B17 were presented as potential alternatives. They consist of BN 1, BN 2, and BN 3. New proposed BN4 and BN5 projects have been recommended here. Although the plan was developed a few years ago, these areas can be also considered as alternatives to the submerged PAs. The sediments in the channel may be dredged independently from U.S. Army Corps or Calhoun Port Authority participation if coordination with the potential project partners is synchronized in advance.

Fine sediments available in the channel may also be used for restoration of the marshes, mainly on the Powderhorn Lake shoreline areas. Since some of the properties where the bayous, lakes, and marshes are located are private properties, these projects should be considered as habitat projects for the benefit of the environment and protection of the natural resources in the county.

The Calhoun Port Authority has already considered the shoreline protection of some beaches in Magnolia and Indianola beaches as part of its BUDM Plan for the dredging maintenance of the ship channel. As a continuous effort to coordinate some potential environmental benefits out of the dredging activities in the navigation channels, Calhoun County should create a BUDM Team. .The presence of the Victoria Navigation Channel, Matagorda Ship Channel, and GIWW present a need for the creation and coordination of a proactive BUDM Team. This BUDM Team can discuss the long-term goals of the

dredging projects evaluating the best environmental alternatives for the dredge materials, which can be translated into better environmental projects such as the creation of marshes, wetlands, beaches, bird islands, oyster reefs, etc.

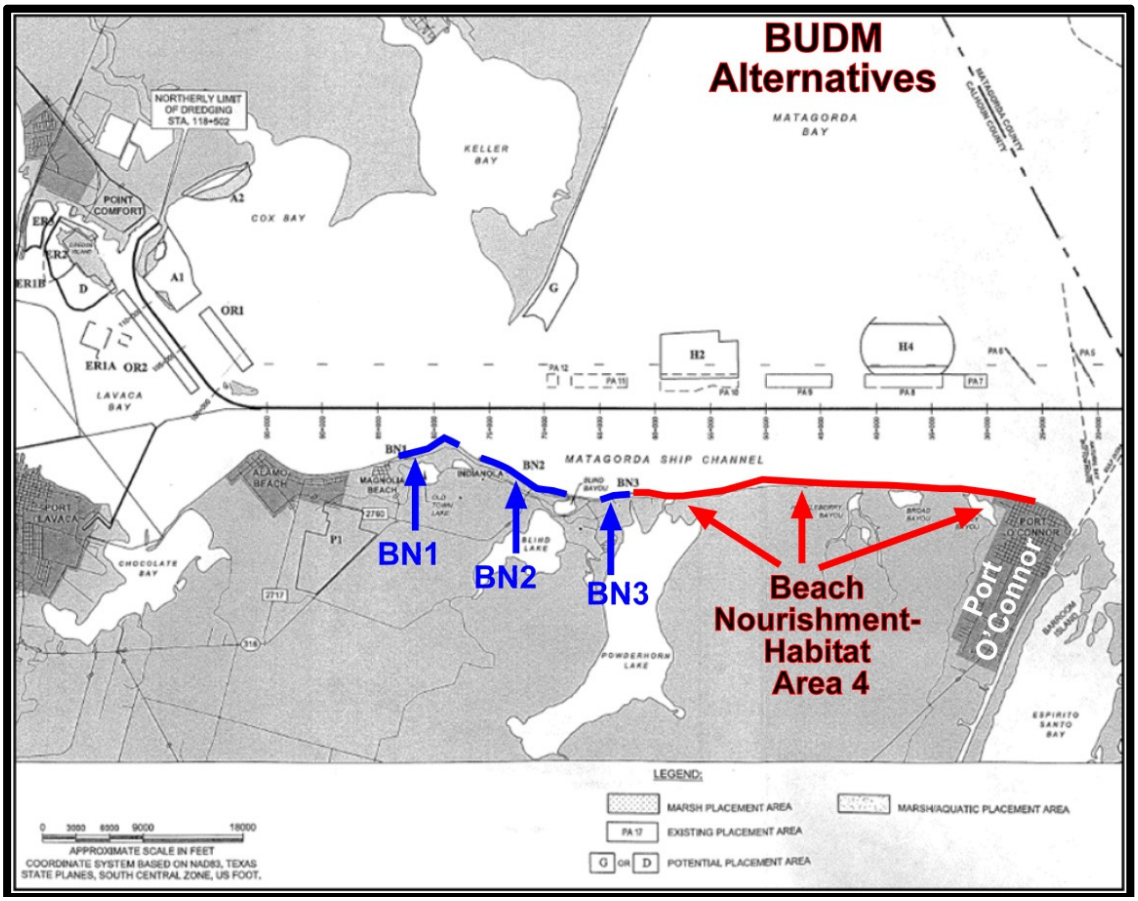


Figure B17. The available BUDM Plan for the Matagorda Ship Channel shows in blue the recommended Indianola and Magnolia placement areas (PAs), as preliminary proposed by the Calhoun Port Authority. BN1, BN2 and BN3 PAs correspond to potential beach nourishment projects. The beach nourishment-habitat Area 4 is proposed in this report as part of the potential plan searching for dredged sediments to restore the marshes and water bodies affected by shoreline retreat. Source: (USACE 2006).

Shoaling at the Magnolia Beach inlet. Although erosion is the predominant factor on the bay shorelines, there is a sediment-shoaling problem on the west side of Magnolia Beach (Figure B18). The figure shows shoaling problems in different areas next to the inlet or channel entrance to Old Town Lake and at the boat ramp located on the bay shorelines. The boat ramp is protected by a rock groin, but sediment circulation is abundant and shoaling and sediment transport which are affecting the boat ramp. A groin of about 250 feet was built recently by Texas Parks and Wildlife to protect the boat

ramp from shoaling problems. The shoaling problem at the inlet may be resolved by developing a local sediment management plan to use the shoaling sediments at the inlet in beach nourishment or marsh restoration projects.

Figure B18. Shoaling areas in Magnolia next to the inlet channels connecting Matagorda Lavaca Bay with Old Town Lake.

Zone D

Shoreline Erosion, Sediment Issues, and Environmental Recommendations

Point Comfort Park shoaling problems. Shoaling is a problem at the Point Comfort boat ramp access channel. Comparison of historical aerial photos shows that the access channel is shoaled with sediments coming mainly from the north, perhaps from the suspended sediments from Lavaca River and Swan Lake, which move through longshore processes toward Lavaca Bay. The county should explore the possibility of using future dredged sediments coming from this channel on the marshes on the north side of the park (Figure B19), which may create a barrier and prevent further shoaling. A combination of marsh buildup and a rock groin may reduce the shoaling of the boat access channel. The shoreline erosion problems on the south side of the bulkhead should also be addressed. The area has favorable conditions to develop the concept of living-shorelines in the water using natural and sustainable habitat solutions. A marsh

habitat area may be created in the water, using oysters and rock revetments to create fish habitat.

Figure B19. Potential BUDM opportunities and improvements to the boat ramp area, where dredged sediments could be used for the creation of marshes.

Zone D includes the entire northern shorelines on the east and west sides of Lavaca Bay. These are located on the old delta Pleistocene deposits (Figure B1). These deposits are characterized by hard clays that tend to leave shoreline bluffs up to five feet high. Due to the semi-protection of the bay and the hard clays on the shorelines, the shoreline erosion rates along these shorelines are less than other bays (Figure B4) (White and Morton 1987).

Zone E

Shoreline Erosion, Sediment Issues, and Environmental Recommendations

Marshes in Cox and Carancahua Bays. The shorelines on Lavaca Bay are located on Pleistocene delta sediments (McGowen et al. 1976). Physically, both geologic units are expressed by hard clays, forming shoreline cliffs up to five feet in elevation (McGowen and Brewton, 1975) (Figure B20).

Due to the semi-protection of these small bays and the hard clays on the shorelines, the shoreline erosion rates vary according to the exposure to waves and wind. Values up to -9 ft/yr of shoreline retreat rates are observed on the frontal effects of Matagorda Bay shorelines due to the strong fetches (McGowen and Brewton, 1975) (Figure B20). The western shorelines of Keller and Carancahua Bays have values between -6 and -5 ft/yr. Sandy shorelines appear to have lower erosion rates than the ones formed by hard clays.

The shorelines on these bays are composed mainly of hard clays with cliffs and marsh systems (Figure B1). Comparison of historic aerial photos of the bay shorelines show that these marshes are quickly disappearing due to erosion and relative sea level rise.

Figure B20. Distribution of shorelines types in the Keller and Carancahua bays. Yellow dashed lines are steep shorelines on hard Pleistocene clays. White lines depict recent marsh habitats.

Historical Shoreline Resources in Calhoun County

Nationally recognized historical resources can be accessed and observed along the shorelines of Indianola beaches. Some of these resources can be accessed from the waters of Lavaca and Matagorda Bays and from North Ocean Drive between Magnolia and Indianola (Figure B21).

Indian Point. Indian Point has been identified as a place visited by the 1685-1687 La Salle Colonization Expedition and in the 1840s. It served as an entry port for German immigrants in route to the Texas Hill Country. Several historical piers appear to be submerged on the shorelines of Indian Point, which make it attractive for divers. The location is shown in Figure B21 on the south side of the map. The majority of the remains of Indian Point are now underwater.

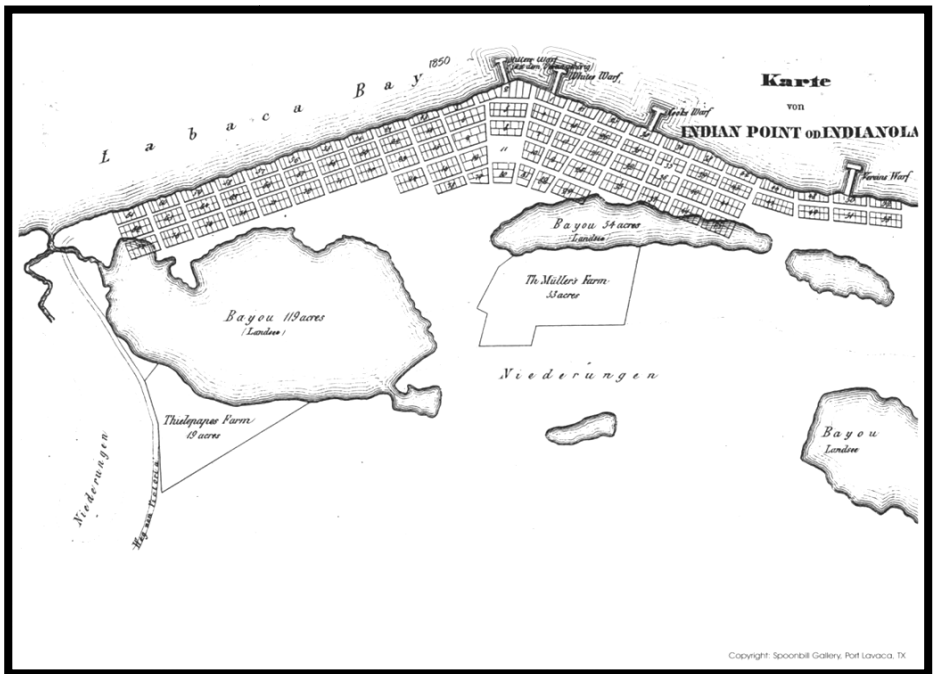


Figure B21. Location of Indian Point in Lavaca Bay, north of Indianola.

Indianola and the La Salle Monument. The town of Indianola was founded in 1846 and, over the years, became a major port that covered Indian Point and the shorelines of Powderhorn Lake. Indianola was destroyed by storms in 1875 and 1886. In 1875, when the city was hit by its first major storm, the city had a population of 5,000. The original plat of the city is shown in Figure B22. Minimum remains can be observed today of what used to be this important port and town. Erosion and storms left very little of the area occupied and the majority of the remains are underwater. The La Salle Monument

marks the area where the Indianola Courthouse used to be located. The La Salle Monument consists of the statue of René-Robert Cavelier, Sieur de La Salle (Figure B23). The monument is used as a point of reference by fishermen in Lavaca and Matagorda Bays.

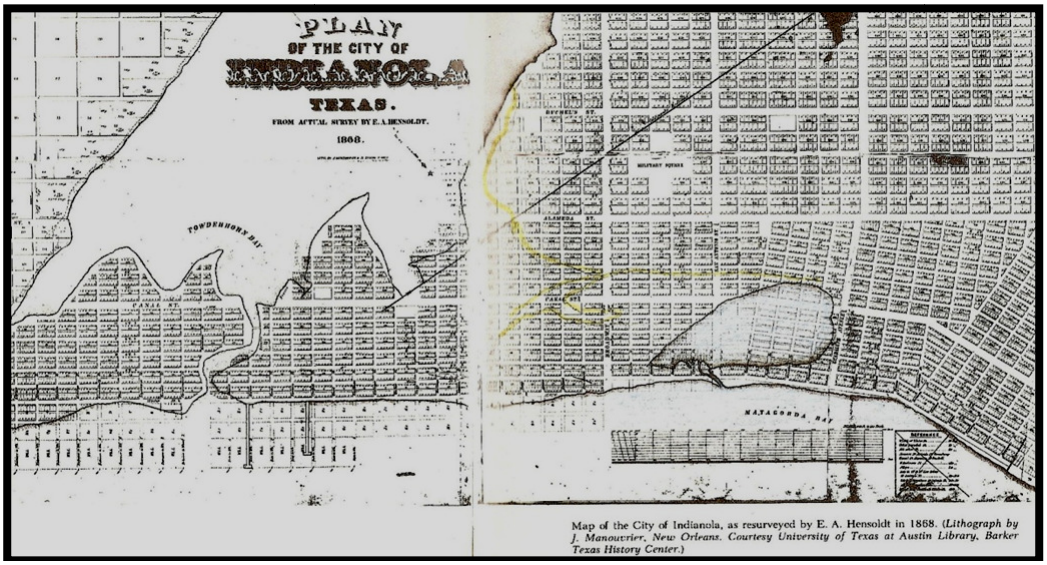


Figure B22. The original plat of the town of Indianola in 1858. Courtesy of Mr. Keith Schmidt.


Figure B23. The La Salle Monument, located along the Indianola shoreline.