TEXAS COASTWIDE EROSION RESPONSE PLAN

2013 Update

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Final Report to the Texas General Land Office

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EXECUTIVE SUMMARY

This update to the *Texas Coastwide Erosion Response Plan (2009)* provides a summary of the latest shoreline change research results published by the Bureau of Economic Geology at the University of Texas at Austin and a review of the Texas General Land Office (GLO) programs that manage or have an impact on erosion. Coastal erosion remains a continuing threat to the Texas Gulf and bay shorelines. Whether the erosion is caused by the lack of sediments to balance the long-term losses within the coastal compartments, or the episodic erosion brought on by storms or human activities, planning and implementation of erosion response and sediment management practices is essential to the sustainability of the shoreline and public beaches.

The upper Texas coast from Sabine Pass to Rollover Pass; the Brazos-Colorado headland from Quintana to Sargent Beach; and sections of South Padre Island have the greatest erosion rates along the Texas Gulf shoreline. Maps are provided that show critical erosion areas along the Texas Gulf shoreline. For these critical areas, there is not enough sand to combat the long-term transgression of the sea.

With limited funding and a shortage of economical sand resources, the state of Texas continues its battle against shoreline erosion. This *2013 Update* presents a review of the Coastal Erosion Planning and Response Act (CEPRA) program projects since 2009, beach recovery following Hurricane Ike, the fallout from the Supreme Court of Texas *Severance* opinion on the CEPRA program and public beach access and use, and the local planning efforts by the Gulf communities.

In 1999, the 76th Texas legislature enacted CEPRA and established a funding mechanism for projects to mitigate the damages caused by erosion. There is no dedicated state funding source for the CEPRA program and funds must be requested from the Texas legislature every biennium. The CEPRA program is administered by the GLO and staff work with local, state, and federal cost-share partners to see projects through completion. The projects awarded under CEPRA Cycles VI and VII are reviewed in this report.

CEPRA funding amounts have varied through each biennial cycle; however, funding requests always exceed the amounts allocated. The application request for CEPRA funding for the two-year cycle was greater than $83 million. A success for Cycles VI and VII is the leveraging of state-appropriated funds with funds from other sources, including $58,452,314.00 in federal funds for Cycle VI and $22,885,526.29 in federal funds for Cycle VII that have been provided as cash or in-kind. Unfortunately, some federal cost-shared funds were unavailable for some of the proposed CEPRA Hurricane Ike repair projects and the projects were not completed (GLO, 2014, personal communication).

Fifty-three projects were funded for Cycle VI and Cycle VII. Nine have been completed, 42 are in progress, one was withdrawn, and one was terminated. The fallout from legal opinions on *Severance v. Patterson* led to the 2010 cancellation of public funds for beach nourishment projects on West Galveston Island and subsequent projects may not be completed because of the implications if public funding is used for now “non-public” lands.

Beach nourishment, studies/monitoring, and shoreline protection were the most common categories that were funded during these cycles. Most of the projects were concentrated on the upper Texas coast that is still reeling from the erosional impacts from Hurricane Ike (September 2008). Coastal Bend and lower coast projects tended to focus on marsh/habitat restoration near Corpus Christi and beach nourishment along South Padre Island. The CEPRA program also offers grant funding for relocation and demolition of structures on the public beach and three applications were submitted, two were funded for Cycle VI.

Though erosion of the Gulf and bay shorelines is continuing, human intervention is making an impact through the efforts of the CEPRA program in maintaining the shoreline position. It is important to stress the necessity for keeping eroded and dredged sediments in the local littoral system and practicing sediment conservation. The highest benefit-to-cost ratios for CEPRA projects occurred where there was a partnership with the US Army Corps of Engineers (USACE) where dredged sands were used for beach nourishment, and for the restoration of dunes and eroded habitats. State/federal cooperative efforts continue to benefit the CEPRA program by providing funding and technical support in regional sediment management, beneficial uses of dredged material, and shoreline studies.

With the exception of a few, local governments are applying shoreline management practices through the implementation of their dune protection/beach access and erosion response planning efforts which protect coastal sand dunes and locate structures landward as possible. These efforts should help ensure public access and use of the beaches and reduce the potential for future public expenditures on managing erosion and storm damage losses.

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INTRODUCTION

Along the 367 Gulf miles and more than 3,300 bay miles of Texas shoreline, erosion has resulted in habitat loss, navigational challenges, and structures on the beach or teetering on the line of vegetation threatening public access. The causes of coastal erosion remain the same as described in previous coastal erosion response plans, lack of sediment delivered to the coast and within the littoral system to balance the impacts from storms, long-term trends, and human influences.

The issue of coastal erosion – both Gulf and bay shorelines – was a key element in initiating the Texas Coastal Management Program (1996) and later, the *Coastal Erosion Planning and Response Act* (CEPRA) (1999) and the erosion response program administered by the Texas General Land Office (GLO). Past coastwide erosion response plans and subsequent updates (GLO, 1996; McKenna, 2004; and McKenna, 2009) described the significance of coastal erosion and the impacts to local communities. These plans also identified critical erosion areas and the efforts by the state to address some of the more vulnerable areas through the CEPRA program and partnerships with federal, local, and non-governmental agencies. These partnerships have provided a cost savings to the state while providing restoration and protection of the shoreline.

In 2009, the 81st Texas Legislature required that governments along the Gulf shoreline develop their own erosion response plans. Coming off the heels of Hurricane Ike and the immense response and recovery efforts that followed, the intention was to minimize future public expenditures for erosion and storm damages. Local governments were required to adopt Erosion Response Plans (ERP) that protected critical dunes and were based on historic shoreline changes. The *2009 Update* provided data sets that governments could use in the development of the local plans.

With limited funding and a shortage of economical sand resources, the state of Texas continues its battle against shoreline erosion. This *2013Update* presents a review of the CEPRA program projects since 2009, beach recovery following Hurricane Ike, the fallout from the *Severance* opinion on the CEPRA program and public beach access and use, and the local planning efforts by the Gulf communities.

GOALS of *2013 Update*

The goals of this update to the Texas Coastwide Erosion Response Plan are to:

- Present the latest shoreline change research results
- Evaluate the overall impact of the CEPRA program on coastal erosion
- Evaluate local government shoreline management practices and impacts on coastal erosion
- Provide existing data sets and document data gaps
- Provide recommendations for future projects, research, changes in management practices, and criteria for choosing priority sites and public funds.

COASTAL EROSION STATUS AND TRENDS

Coastal shoreline change is a complicated phenomenon that is influenced by a combination of factors: depositional history, hydrodynamic forces, littoral drift, elevation, relative sea level rise, tidal passes, and human activities. The geomorphic features that span the Texas Gulf coast include deltaic headlands, peninsulas, barrier islands, and spits, and their depositional origins provide clues on sediment erodibility. The variations in the wave climate impacting those features influences the amounts of sediment that are supplied to the littoral drift (the amount of sediment carried along the shoreline) as well as the direction the sediment travels. Elevations of the beaches and dunes can control whether episodic high wave and tidal events allow overwash and landward barrier migration or merely erosion of the beachface that can be repaired by quieter waves. Relative sea level is the combined effect of changes in global sea level and local changes in elevation of adjacent coastal land. In some areas of the Texas coast, land subsidence is exacerbated by the withdrawal of groundwater or hydrocarbons (Morton et al., 2004). Natural tidal passes that separate the barrier islands and peninsulas can act as sand “sinks” by capturing littoral sediments in either the ebb- (Gulf side) or flood- (lagoon side) tidal deltas. Inlets that have been jettied for navigation can stop the transport of sand and create accretion on the updrift side while erosion results downdrift due to the deficiency of sediments. Other human influences are the construction of revetments, seawalls, and groins which impede sediment transport, and waves from motorized water craft. The latter are more likely to affect coastal wetlands.

Previous Work

Researchers from the Bureau of Economic Geology at the University of Texas at Austin (BEG) have been documenting shoreline changes since the 1970s in an effort to understand long-term trends and the impacts from storms (Morton, 1974, 1975; Morton and Pieper, 1975, 1976, 1977a, 1977b; Morton et al., 1976; Morton and Paine, 1984, 1985; Paine and Morton, 1986). These studies produced the initial standards for shoreline monitoring and provided quantifiable rates of change. In 1993, the GLO’s beach/dune rules (31 TAC§§15.1-15.10) and in 1999, the Texas Natural Resources Code (§33.607) required the BEG to publish historical erosion data for public use (Morton, 1993; Morton et al., 1994, 1995; Paine and Morton, 1993; Gibeaut et al., 2000; 2001; 2002; 2003). The original studies relied on surveyed National Oceanic and Atmospheric Administration (NOAA) T-sheets and aerial photography as sources for monitoring changes. Recently, the collection of light detection and ranging (lidar) airborne surveys has become more commonplace and a valuable tool for measuring elevation changes along the Texas Gulf and bay shorelines (Smyth et al., 2003). The digital elevation models that are generated from the lidar surveys can provide detailed topographic datasets that can be compared to other lidar datasets or to on-the-ground beach profiles. Lidar datasets and accuracies have evolved to enable more precise elevations/locations of shoreline position, line of vegetation, dune crest, landward dune boundary elevations, and calculation of volumetric changes along with shoreline movement. These datasets can be especially helpful when determining beach losses following storms and planning restoration efforts. Digital elevation models produced from lidar surveys were used to verify short-term shoreline recovery patterns following Hurricane Ike (Paine et al., 2013; HDR, 2014). The collaborative efforts between the BEG and the Harte Research Institute for Gulf of Mexico Studies at Texas A&M University, Corpus Christi (HRI) in conducting lidar surveys have been beneficial for providing public shoreline change information and has minimized the amount of research expenditures by the state.

Texas Gulf Shoreline Changes

The most recent evaluation of shoreline changes along the Gulf shoreline were determined from the use of all the methods described above, and calculated long-term or historic (1930s to 2012) changes as well as short-term changes (1950s to 2012 and 2000 to 2012) (Paine, et al., 2014). Each dataset evaluated included shoreline positions following Hurricane Ike. In general, the Gulf shorelines undergoing the greatest rates of erosion (more than -8 ft/year [-2.5 m/yr]) are located between Sabine Pass to Rollover Pass, on Galveston Island west of the seawall, Quintana Beach to Sargent Beach, Mustang Island (north of Packery Channel), Padre Island near Port Mansfield Channel, southern Padre Island (Willacy County and Cameron County sections), and the southern portion of Brazos Island near the Rio Grande (Figure 1). Between the 1930s and 2012, the annual land loss was calculated at 178 acres/year and the total land loss during that time frame was 14,597 acres.

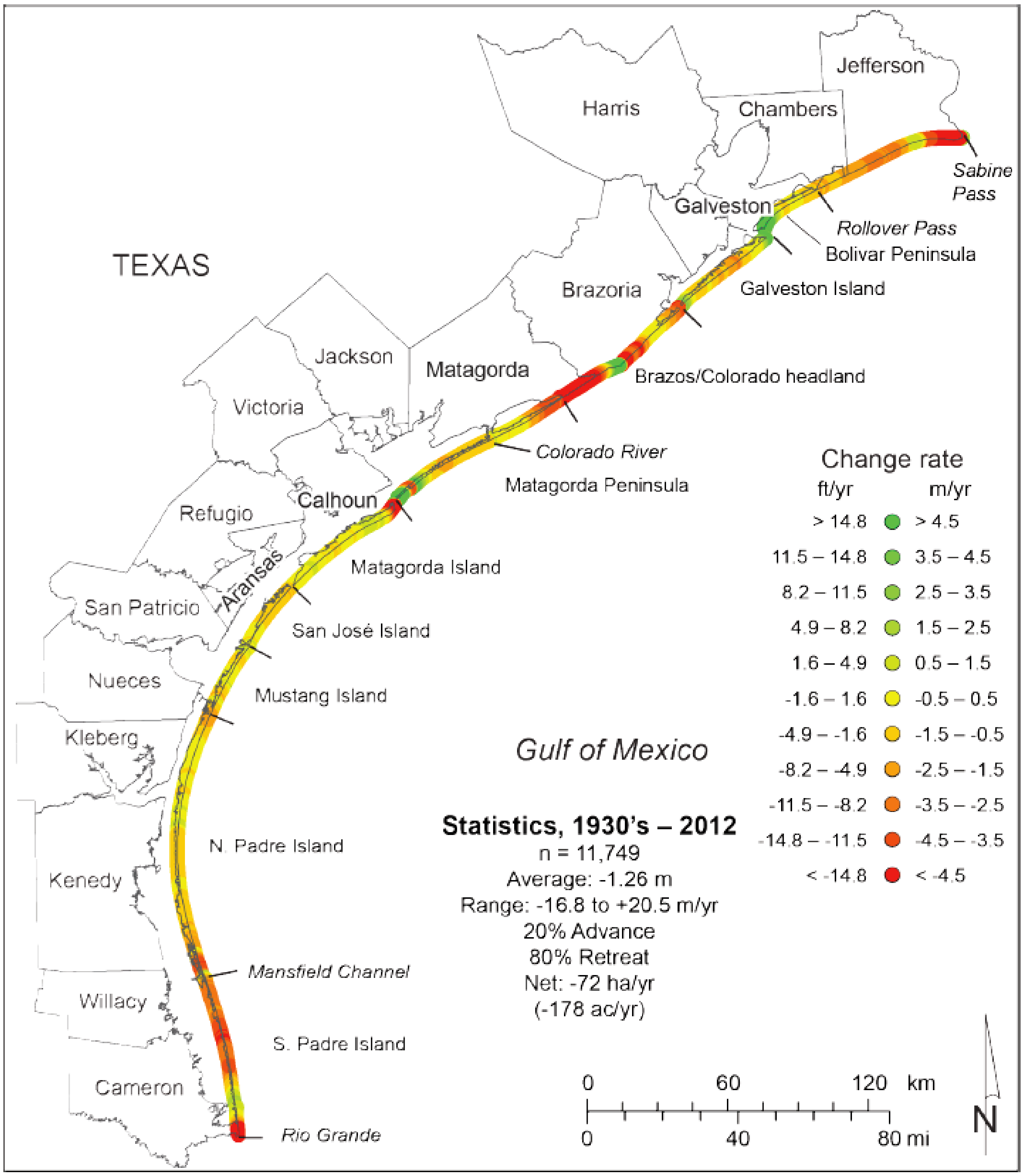

Figure 1. Shoreline changes between 1930's and 2012 (Paine et al., 2014).

Comparison of the 1930s to 2012 and 1950s to 2012 datasets, show that the percentages of advancing and retreating shorelines are similar; nearly 20% advance and 80% retreat. The Paine and others (2014) report also provides an evaluation of the decadal trend for shoreline change from 2000 to 2012. Figure 2 shows the Gulf coast shoreline change rates between 2000 and 2012. The 2000 to 2012 decadal trend demonstrates a 33% advance and 67% retreat for the entire Gulf coast shoreline. Figure 3 compares the trends for three time periods (1930s to 2012; 1950s to 2012; and 2000 to 2012). Possible reasons for the overall percentage differences between advancing and retreating areas could be due to more precise monitoring methods used during the time frame (comparison of lidar surveys), or the percentages may have been influenced by the initiation of CEPRA-funded projects. In general, the locations of eroding shorelines (those losing more than two feet per year) have been fairly consistent through time (Paine et al., 2014).

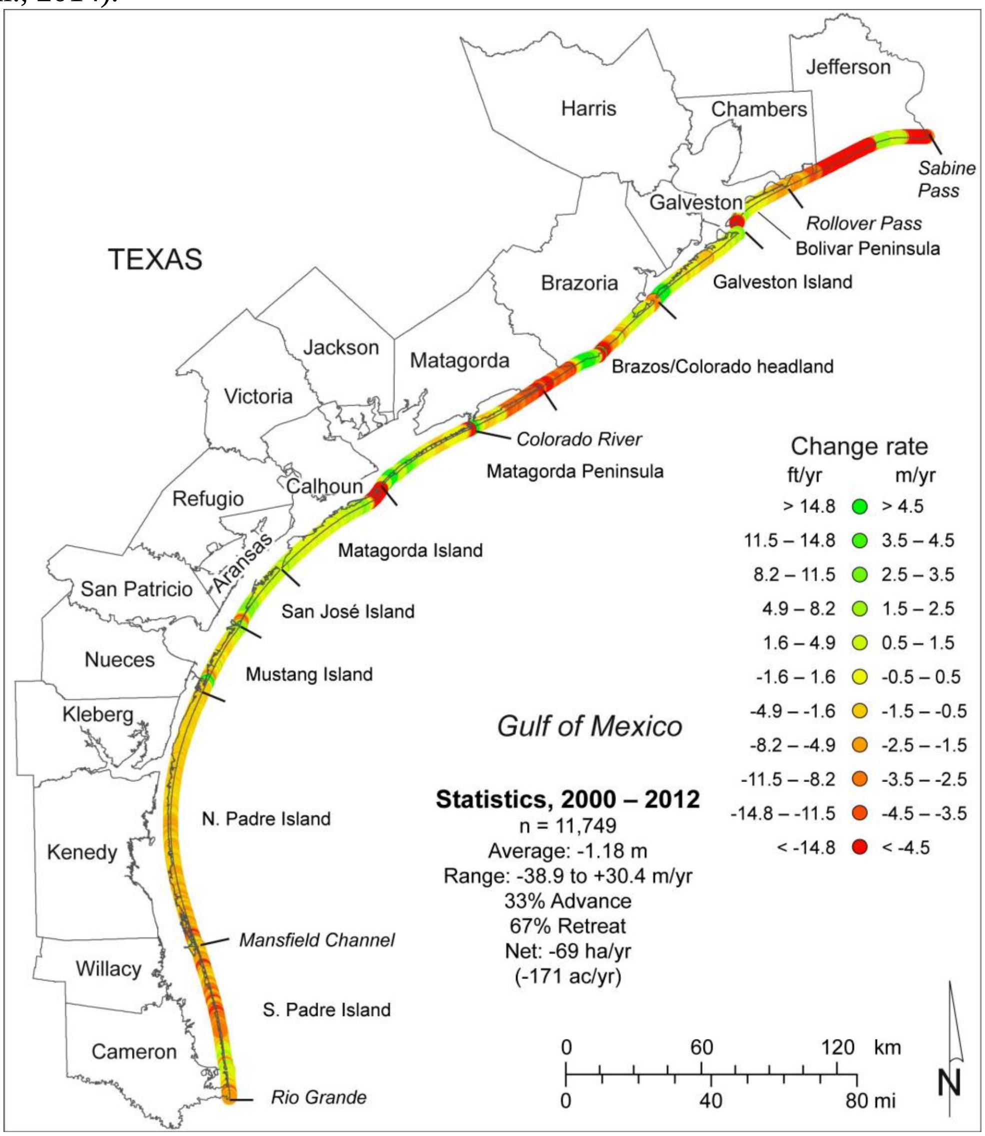

Figure 2. Shoreline change rates for the time period 2000 to 2012 (Paine et al., 2014). This decadal trend includes the impacts of Hurricanes Rita and Ike (upper Texas Coast) and the influence of beach fills/beneficial use projects at Surfside Beach (2011) and City of South Padre Island (2009).

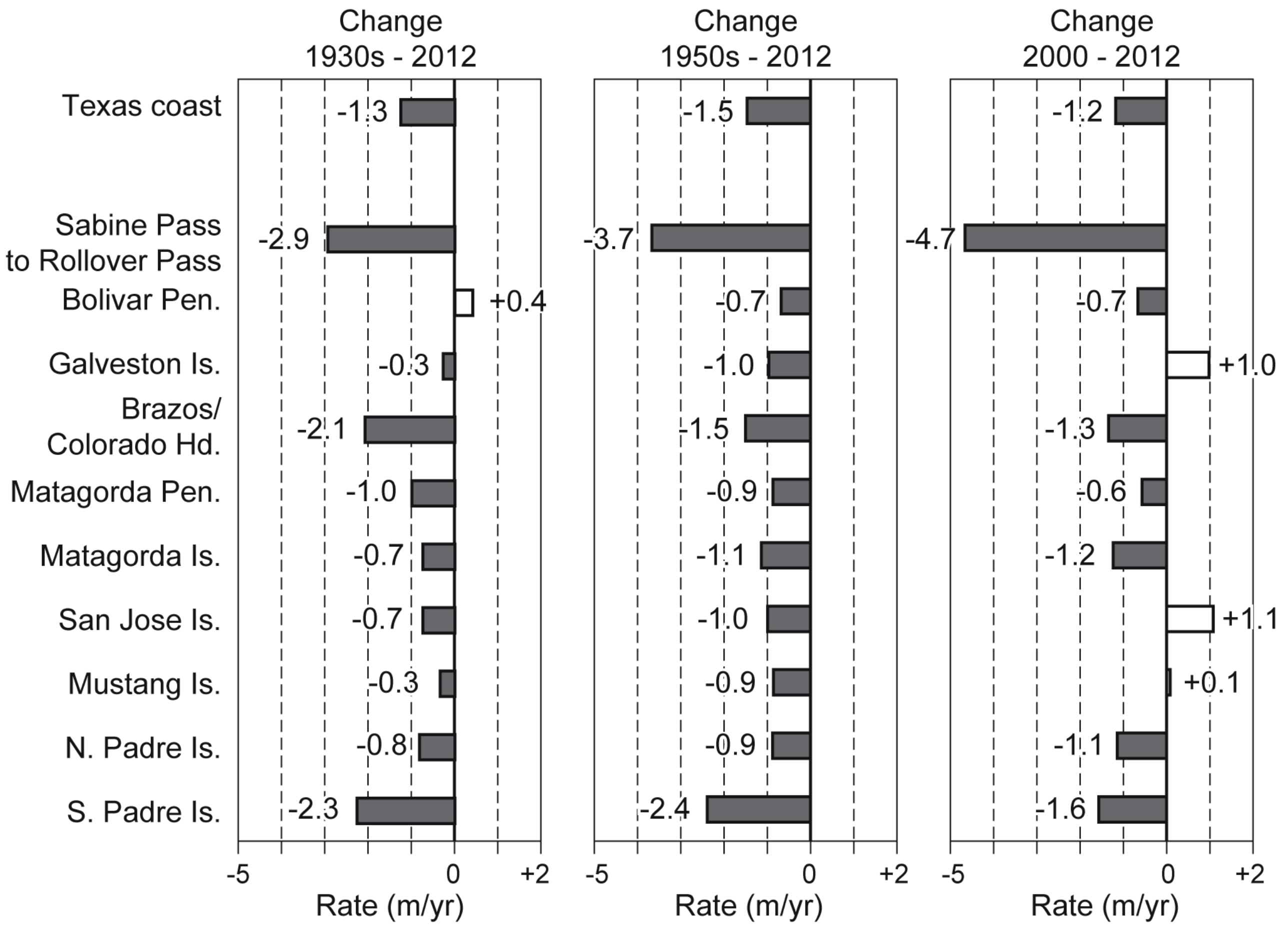

Figure 3. Shoreline change rates for time periods 1930s-2012, 1950s-2012, and 2000-2012 as presented in Paine et al., 2014.

Shoreline change rates are available on-line via the BEG website: (http://coastal.beg.utexas.edu/shorelinechange/). There, a potential CEPRA applicant, local government official, or public member can view shoreline change rates in feet or meters from the three time periods published in the 2014 report.

Texas Bay Shoreline Changes

With over 3,300 miles of bay shoreline, studies of eroding areas are limited to special projects conducted by the Bureau of Economic Geology or Harte Research Institute. Former studies of Corpus Christi Bay, Galveston Bay, and Copano Bay systems noted changes in the bay shoreline positions from historic topographic surveys and aerial photography (Morton and Paine, 1984; Paine and Morton, 1986; Paine and Morton, 1993). With the evolution of airborne remote sensing techniques such as light detection and ranging (lidar), large swaths of topographic changes along bay shoreline are easier to obtain (Smyth et al., 2003; Gibeaut et al., 2003). The BEG leads the *Texas Shoreline Change Project* and plans to generate shoreline change rates for Matagorda Bay, Copano Bay, Aransas Bay, Baffin Bay, Corpus Christi Bay, and West and Christmas Bays (Galveston Bay).

Shoreline Change Rates from Project Monitoring

The GLO established a *Beach Monitoring and Maintenance Plan* (BMMP) protocol for monitoring CEPRA beach nourishment projects for FEMA reimbursement eligibility should the project be damaged by a federally-declared natural disaster. Twelve CEPRA-funded projects are monitored by the Conrad Blucher Institute for Surveying and Science (CBI) under contract to the GLO (Williams, 2013). Figure 4 shows the specific locations along the Gulf and bay shorelines where baseline shoreline position and beach/nearshore profile surveys have been conducted since 2007 and will continue annually in an effort to monitor dry beach width and volumetric changes to determine beach nourishment longevity. The combination of aerial photography and datum-based beach profiling can be effective for small, easily accessible project areas. This process is time consuming but provides good datasets for determining the changes in beach nourishment volumes and also provides the necessary information for determining maintenance renourishment schedules. Recommendations for future nourishment cycles are based upon the performance of an individual project: the amount of sand within the project limits (less than 50% of the recommended width or targeted sand volume) and whether there is "wide-spread," "accelerated," or "hot spot" erosion that threatens dunes or backshore infrastructure in the project area. The recommended actions can include additional sand placement, relocation of existing sand accumulations, or planting vegetation. Monitoring results are reported by CBI annually to the GLO.

Figure 4. Shoreline monitoring locations at some CEPRA beach nourishment projects (Williams, 2013).

Short-term (2010 to 2012) shoreline, beach, vegetation, and dune changes were measured along the entire Gulf coast using airborne lidar technology and on-ground surveys in a collaborative effort by the BEG, HRI, and CBI to record Hurricane Ike (2008) recovery patterns and provide threshold elevations that can be used to determine sand storage and flood and erosion susceptibilities (Paine et al., 2013). Comparisons of the elevation data showed general advancement of the shoreline between 2010 and 2011; most likely from natural storm recovery, and an erosional trend between 2011and 2012. The use of lidar elevations can also provide information on the amount of sand that is available for future storm protection. In this 2013 study, the Jefferson County shoreline was the area identified as most susceptible to storms due to low elevation and limited dunes. The beach and foredune elevations along Mustang Island and north Padre Island shoreline provide the greatest protection from storms along the Texas Gulf shoreline.

Critical Coastal Erosion Areas

The Texas Administrative Code (TAC §§15.1-15.10 [GLO beach/dune rules]) and the Texas Natural Resources Code (TNC Subchapter H. Coastal Erosion, Sec. 33.601) provide the definition, authority, and the rules for identifying "eroding areas" and "critical coastal erosion areas." "Eroding areas" are specific to the Gulf shoreline and are defined as "*A portion of the shoreline which is experiencing an historical erosion rate of greater than two feet per year based on published data of the University of Texas at Austin, Bureau of Economic Geology.*" "Critical coastal erosion areas" are coastal eroding areas determined by the Land Commissioner as eroding coastal areas that "*the commissioner finds to be a threat to: public health, safety, or welfare; public beach use or access; general recreation; traffic safety; public property or infrastructure; private commercial or residential property; fish or wildlife habitat; or an area of regional or national importance.*"

Figures 5 through 9 show the critical erosion areas for the Texas Gulf shoreline and are based upon the 1950s to 2012 dataset. The net rates of shoreline change were calculated using the end-point analyses (Paine et al., 2014). This time period was chosen to reflect the modifications of the shoreline after the installation of most US Army Corps of Engineers (USACE) navigation projects (jetties). These areas are further separated into two categories (-2 to -10 feet/year) and (> -10 feet/year) to show the regions of the shoreline that are the most vulnerable. Not only are these areas eroding at greater than two feet per year, but the erosion threatens some or all of the criteria listed above (TNC Subchapter H. Sec. 33.601). Based on the updated shoreline change data provided by the BEG, net retreat occurred along 80% of the Gulf shoreline (Paine et al., 2014). Consequently, most of the Texas Gulf shoreline qualifies as critical coastal erosion areas.

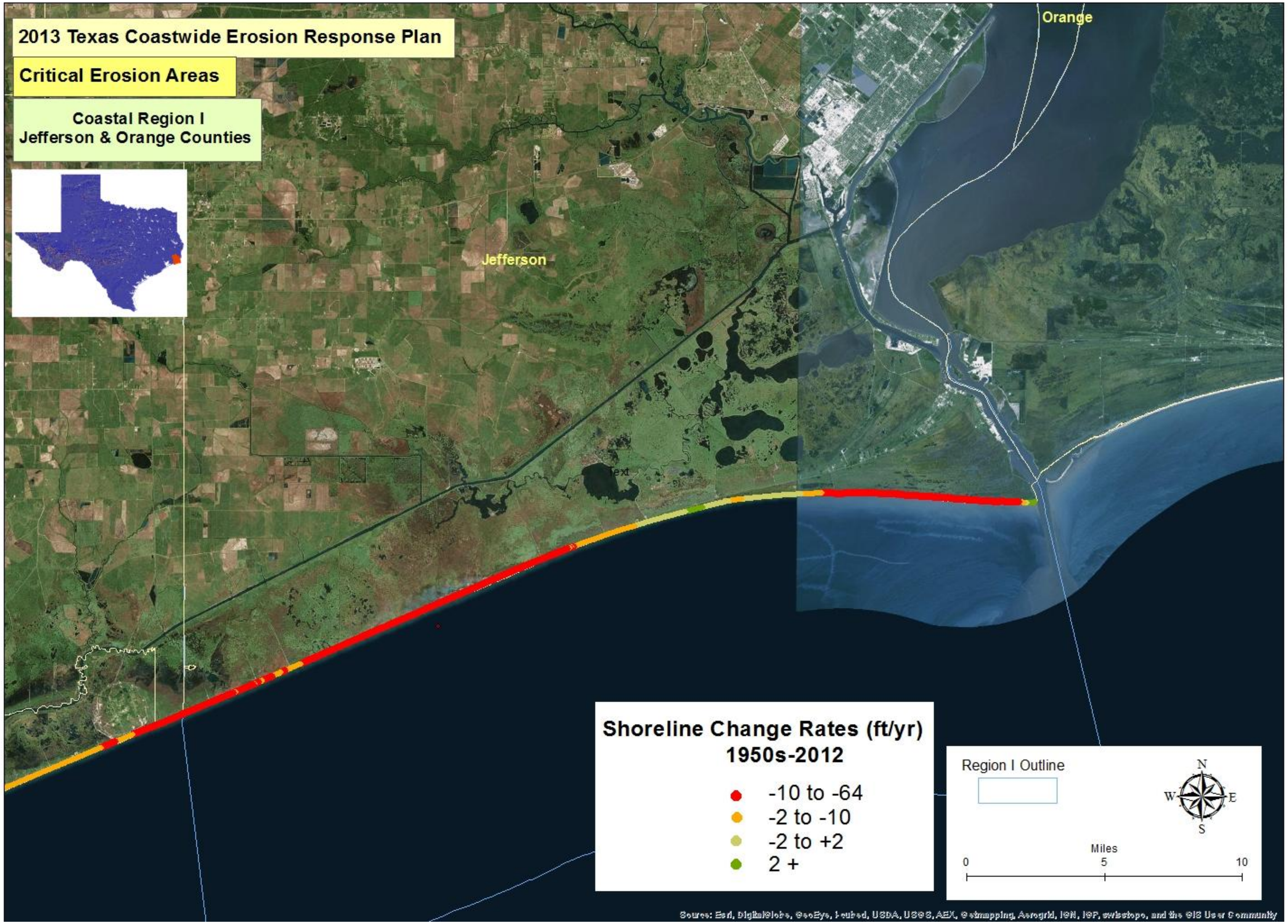

Figure 5. Gulf shoreline critical erosion areas for Region I based upon the most recent historical shoreline change rates as published by the Bureau of Economic Geology, University of Texas at Austin (2014).

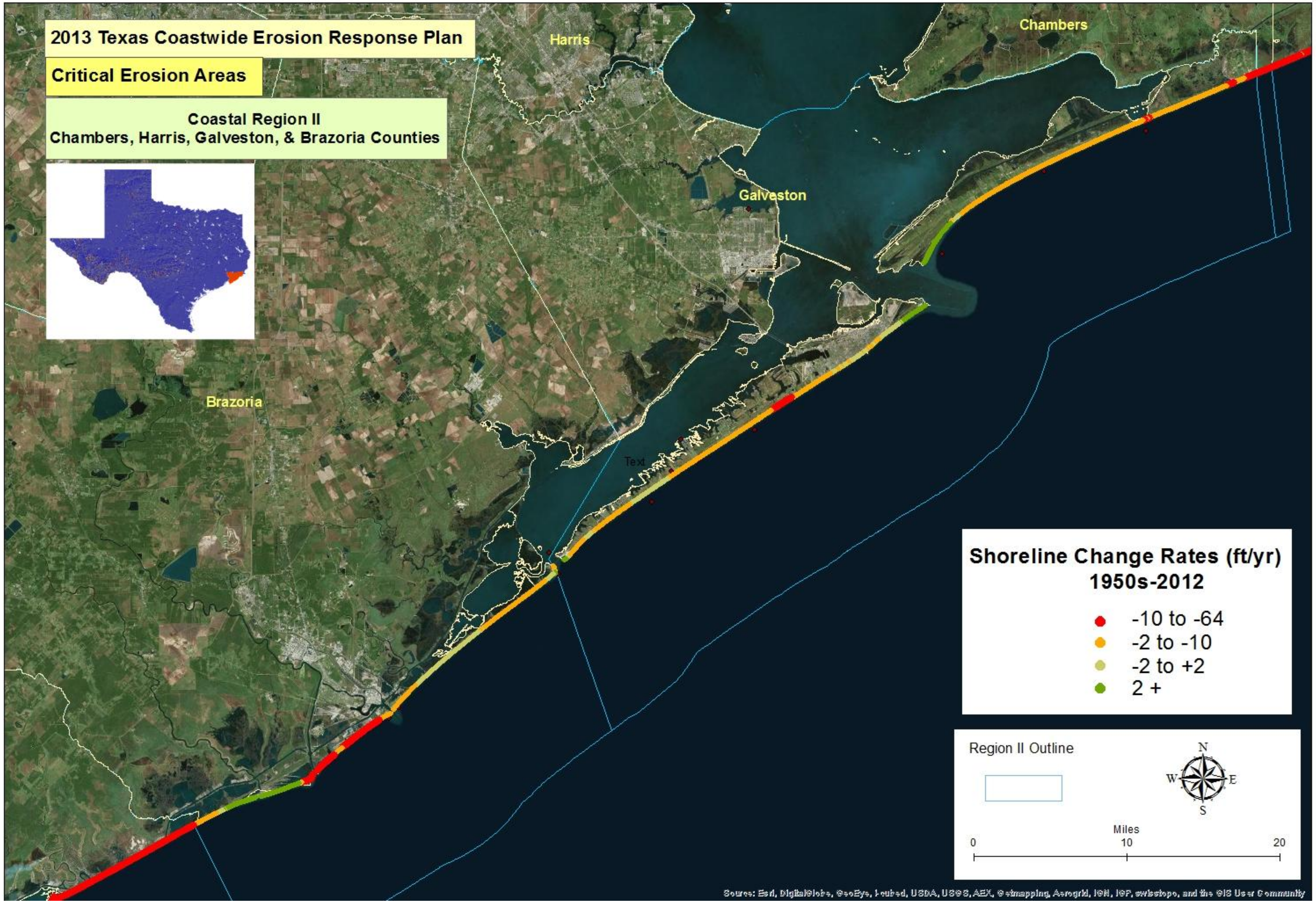

Figure 6. Gulf shoreline critical erosion areas for Region II based upon the most recent historical shoreline change rates as published by the Bureau of Economic Geology, University of Texas at Austin (2014).

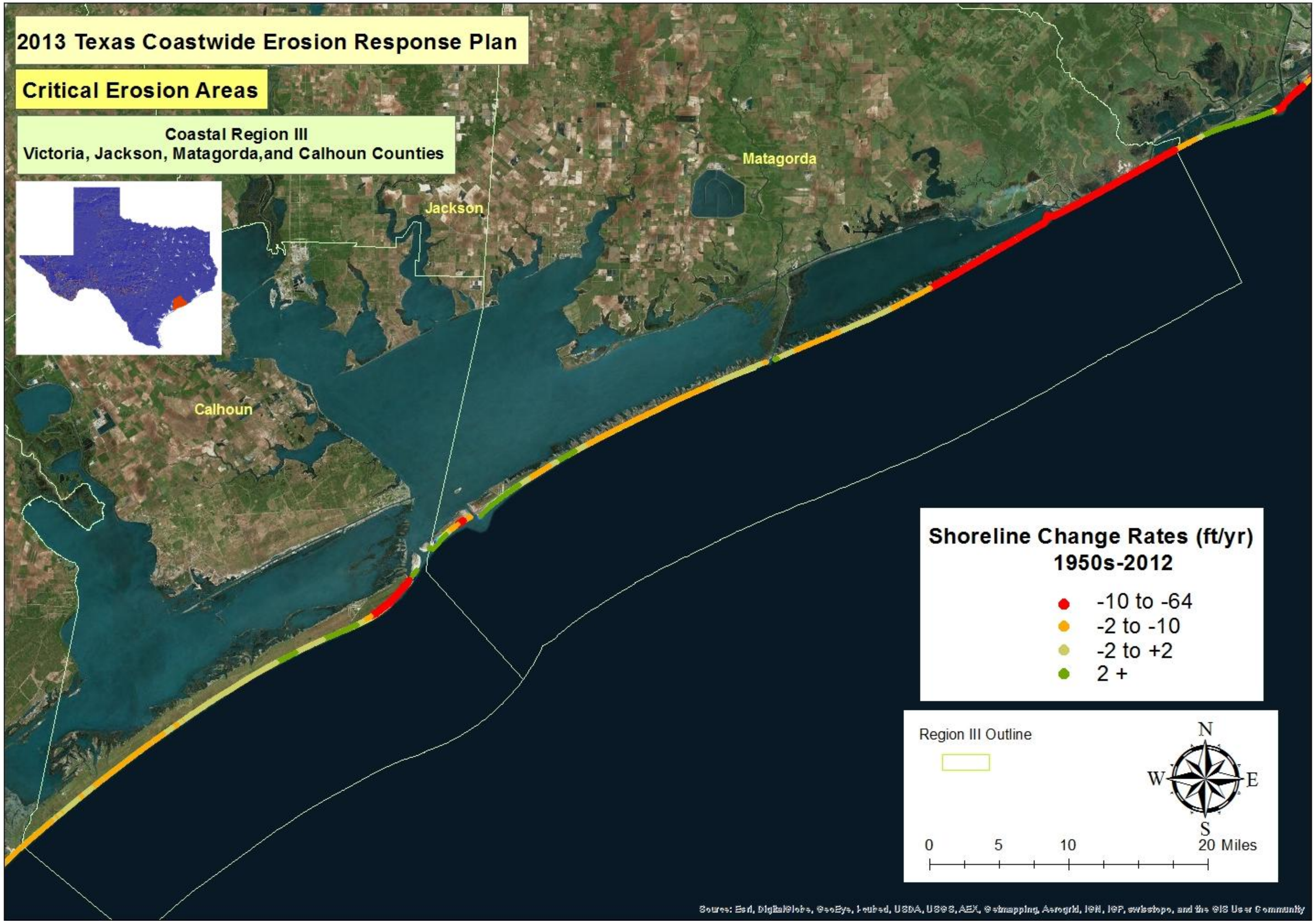

Figure 7. Gulf shoreline critical erosion areas for Region III based upon the most recent historical shoreline change rates as published by the Bureau of Economic Geology, University of Texas at Austin (2014).

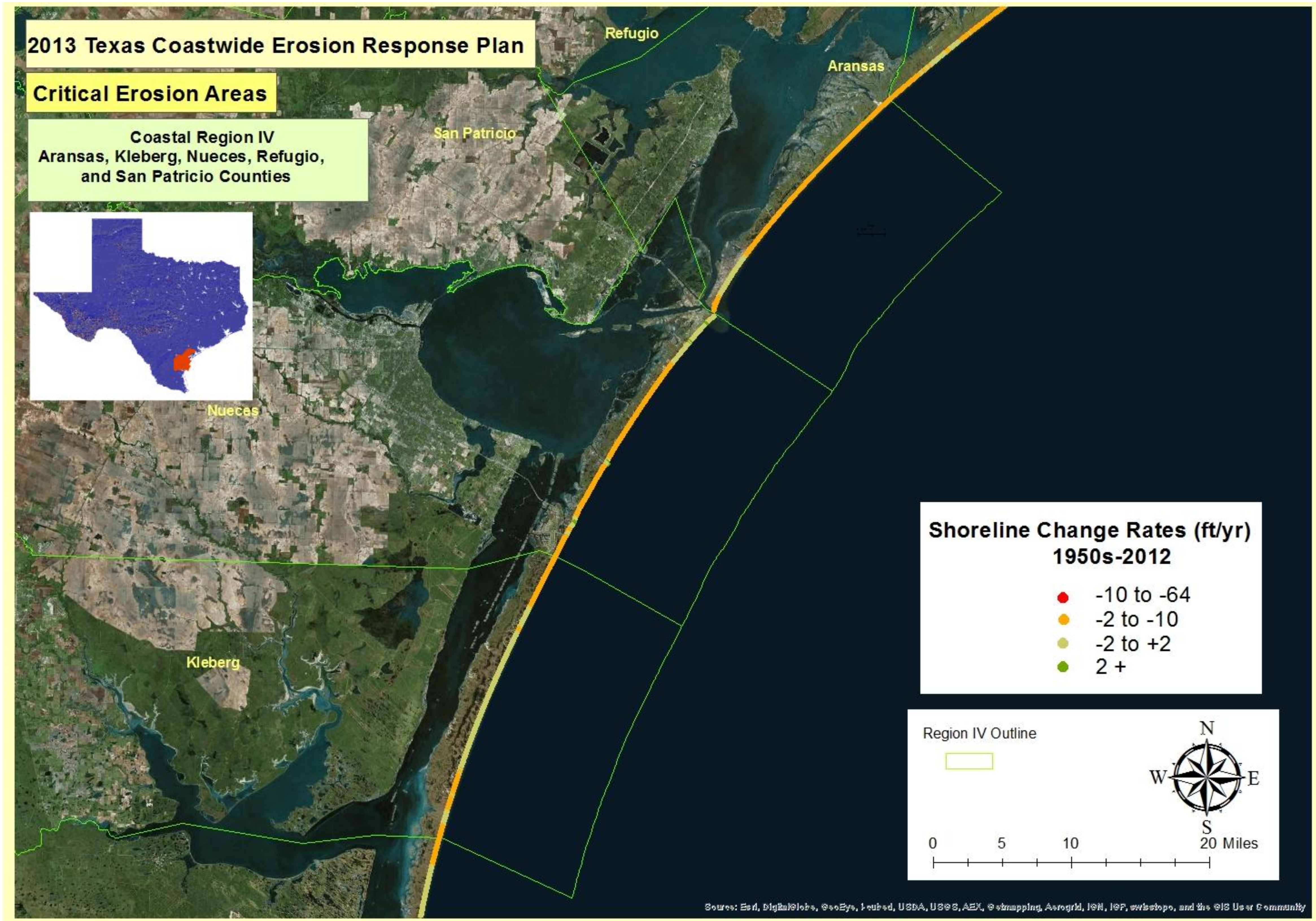

Figure 8. Gulf shoreline critical erosion areas for Region IV based upon the most recent historical shoreline change rates as published by the Bureau of Economic Geology, University of Texas at Austin (2014).

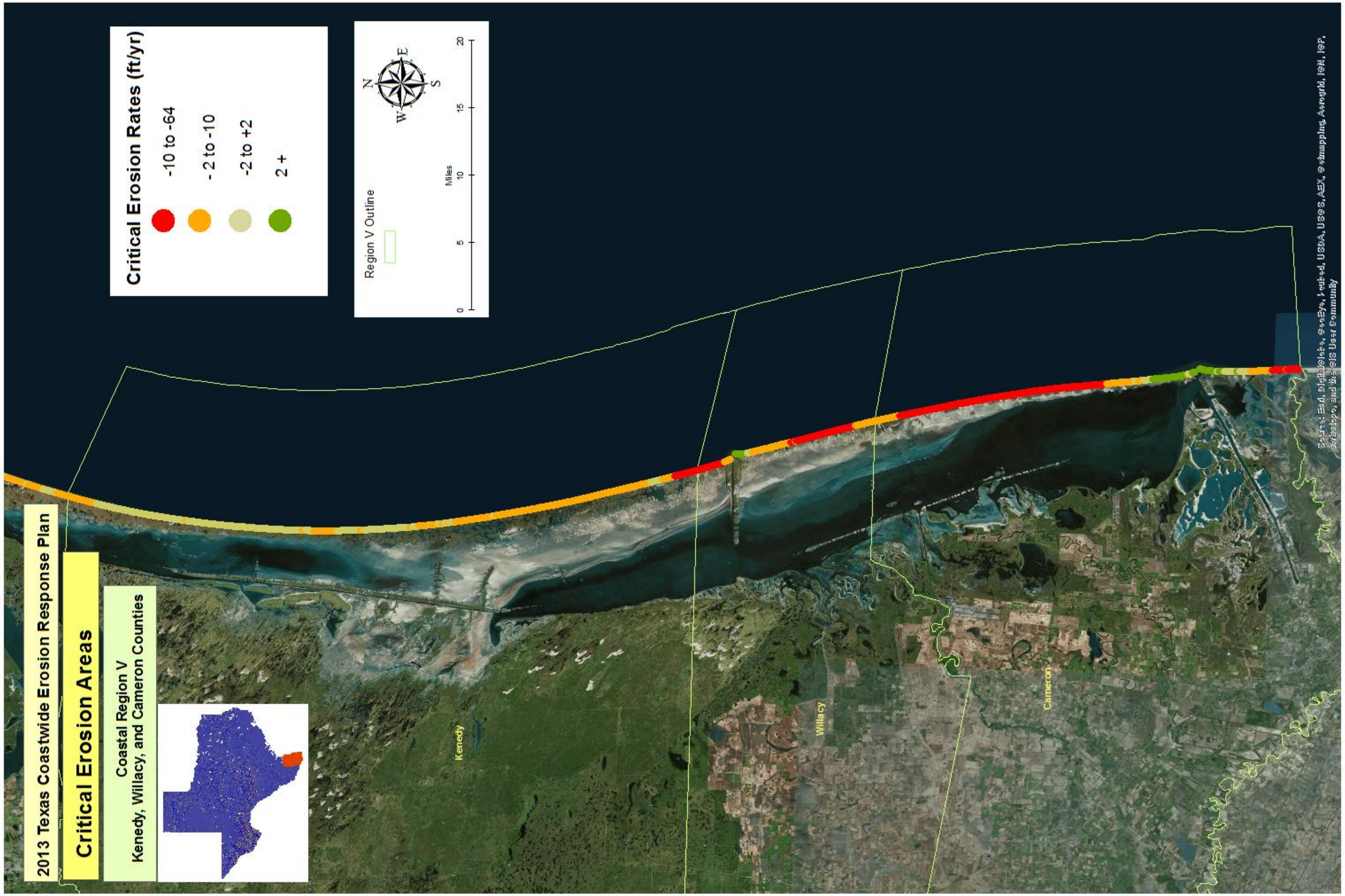

Figure 9. Gulf shoreline critical erosion areas for Region V based upon the most recent historical shoreline change rates as published by the Bureau of Economic Geology, University of Texas at Austin (2014).

Figures 5 through 9 show the shoreline change rates by coastal region. Note the high erosion rates from Sabine Pass to Rollover Pass and portions of Bolivar Peninsula. The erosion threatens evacuation routes and infrastructure (Highway 87), wildlife habitat, and critical natural resource areas at McFaddin Beach (Regions 1 and 2 – Jefferson County, Chambers County, Galveston County jurisdictional areas, City of Galveston) (Figures 5 and 6). Other high rates of erosion were measured at the Brazos/Colorado headland (Regions 2 and 3 – Brazoria County and Matagorda County jurisdictional areas, Village of Quintana Beach) (Figures 6 and 7) and South Padre Island (Region 5 – Willacy County and Cameron County jurisdictional areas, City of South Padre Island) (Figure 9). Areas along the Gulf shoreline such as those near tidal inlets or downdrift from jetties may also experience greater erosion rates. The BEG's shoreline change web viewer allows review of the data at any scale (http://coastal.beg.utexas.edu/shorelinechange/). Figure 10 is a large-scale screen capture of the 1930s to 2012 shoreline change rates on Galveston Island at the west end of the Galveston Seawall where erosion threatens private property and public access.

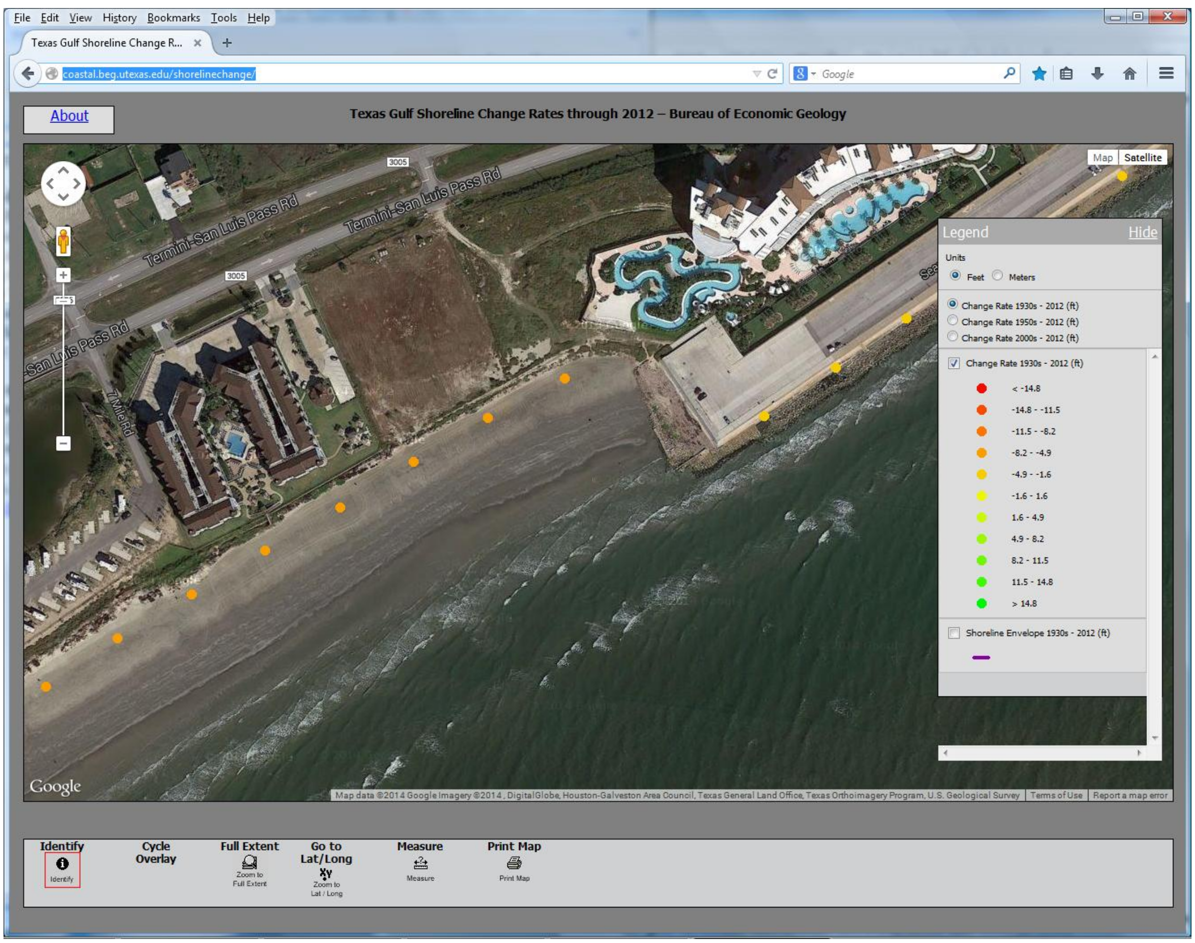

Figure 10. Screen capture showing the shoreline change rates at the end of the Galveston Seawall (courtesy BEG shoreline change web viewer, 2014).

CEPRA PROGRAM PROJECTS

The *Coastal Erosion Planning and Response Act* (CEPRA) program has been in existence for 15 years and has provided the necessary funding for protecting critically eroding areas along the Texas coast. The program which provides funding for erosion response projects and studies has had to endure limited appropriation levels as well as mandatory budget reductions due to state budget deficits in recent years. Funding amounts have varied through each biennial cycle; however, requests for CEPRA funding consideration from potential project partners always exceed the amounts allocated. During CEPRA Cycle VI, mandatory legislative budget reductions and the return of funds by the GLO to the state Legislature for reducing the state's budget deficit, limited the state share for projects. Fortunately, federal and partner matches helped to fund 28 projects in that cycle (Texas General Land Office, 2013). The CEPRA funding request alone for Cycles VI and VII was greater than $83 million. The state-appropriated funds were matched with funds from other sources, including $58,452,314.00 in federal funds for Cycle VI and $22,885,026.29 in federal funds for Cycle VII that were provided as cash or in-kind (GLO, 2014, personal communication).

The CEPRA reports to the Texas Legislature (Texas General Land Office, 2011; 2013) provide project descriptions, partnerships and cost-share amounts for CEPRA Cycle VI (2009-2011) and Cycle VII (2011-2013). Table 1 and Figures 11 through 14 provide the list and locations of the 53 CEPRA Cycles VI and VII projects. Project descriptions can be found at the GLO website (http://www.glo.texas.gov/what-we-do/caring-for-the-coast/grants-funding/cepra/index.html). Nine projects have been completed, 42 are in progress, one was withdrawn, and one was terminated. The fallout from The Texas Supreme Court's opinion on *Severance v. Patterson* led to the 2010 cancellation of public funds for beach nourishment projects on West Galveston Island.

Due to the nature of the types of projects, it can take longer than one biennial funding cycle to plan, permit, and construct a project, especially if background data (e.g., sand resource studies) must be obtained prior to permitting. Beach nourishment, studies/monitoring, and shoreline protection were the most common project categories funded during Cycles VI and VII. Most of the projects were concentrated in the upper Texas coast that at the time was still recovering from the erosional impacts of Hurricane Ike. Coastal Bend and lower coast projects tended to focus on marsh/habitat restoration near Corpus Christi and beach nourishment along South Padre Island. The CEPRA program also offers grant funding for relocation and demolition for structures on the public beach; while three applications for these types of projects were submitted for Cycles VI, leading to the funding of two projects, no applications for these types of projects were submitted for Cycle VII.

Table 1. List of CEPRA Cycles VI and VII projects.

Project No.	Project Name	CEPRA Funding Cycle	County	Status	Project Type	Study / Monitoring (SM)	Beach Nourishment (BN)	Dune Restoration (DR)	Shoreline Protection (SP)	Habitat Restoration / Protection (HR)	Structure Relocation (SR)	Debris Removal (DR)	Maintenance / Emergency (MP)	Beneficial Use of Dredeged Material (BUDM)	Location (UTM -14) X	Location (UTM -14) Y	Location (UTM -15) X	Location (UTM -15) Y	Comments
1384	San Luis Pass Inlet Management Study Phase 3	V, VI, VII	Brazoria	Active	SM	1											292692.75101	3219830.9088	
1391	WGI Seawall End Emergency Beach Nourishment	V, VI	Galveston	Terminated	BN		1										317822.30727	3235874.0998	
1395	Moses Lake Marsh Restoration	V, VI	Galveston	Active	HR, SP				1	1							313631.10456	3259333.7298	
1453	Isla Blanca Park	VI	Cameron	Completed 2010	BN		1								685053.69576	2884749.17579			
1456	SPI Beach Renourishment BUDM	VI	Cameron	Completed 2010	BN		1								683990.58768	2889166.22530			
1458	SPI Beach Renourishment /Park Rd 100	VI	Cameron		BN		1								683943.57538	2892489.64957			
1459	SPI CEMS Beach Stabilization	VI	Cameron	Completed 2012	SP				1						683943.57538	2892489.64957			
1463	Port Aransas Nature Preserve	VI	Nueces	Active	SP				1						688109.70914	3079834.94121			
1469	Town of Quintana BN	VI	Brazoria	Withdrawn	BN		1										275797.12459	3202407.8575	
1471	Surfside Shoreline Stabilization	VI	Brazoria	Completed 2011	SP				1								276793.64293	3203497.3316	
1473	Treasure Island Shoreliine Stabilization-Ph 2	VI	Brazoria		SP				1								293626.37896	3217596.6855	
1477	WGI Subdivisions	VI	Galveston	Active	BN		1										303496.27841	3225183.7703	
1480	WGI 7.3 Mile Dune Restoration	VI	Galveston		DR			1									303496.27841	3225183.7703	
1481	McAllis Point Habitat Restoration	VI	Galveston	Active	HR					1							305498.84534	3228475.4051	
1482	Jamaica Beach Dune Restoration	VI, VII	Galveston	Active	DR			1									308435.55855	3229534.3991	
1483	West Galveston Bay Estuarine	VI	Galveston	Active	HR					1							306527.89313	3231783.7842	
1491	Bolivar Ferry Landing-Little Beach	VI	Galveston		BN		1										334046.06519	3251302.7328	
1493	Bolivar Peninsula Dune/Beach Restoration	VI	Galveston		BN, DR		1	1									344844.60749	3260017.0599	
1494	Rollover Pass BN w/BUDM	VI	Galveston		BN		1										355569.57971	3264308.2973	
1498	McFaddin NWR Protecton, Phase 1	VI	Jefferson		DR			1									383808.53399	3276172.7169	
1499	McFaddin NWR Dune Stabilization	VI	Jefferson	Active	DR			1									383808.53399	3276172.7169	
1504	Effect of Hurricane Ike on the Texas Coast Study-Phase 2-3	VI, VII	Brazoria, Chambers, Galveston, Jefferson	Active	SM	1													
1505	Economic & Natural Resource Benefits Study (Cycle VI)	VI	Coastwide		SM	1													
1506	CEPRA Cycle 6 Aerial Photography	VI	Coastwide	Active	SM	1													
1507	Update of Critical Erosion Rates	VI	Coastwide	Completed 2013	SM	1													
1508	Coastwide Erosion Response Plan Updates	VI	Coastwide		SM	1													
1509	Surfside Feasibility Study Update, Phase II	VI	Brazoria	Completed 2012	SM	1											278953.22059	3206730.1295	
1510	SPI CEMS Independent Review	VI	Cameron	Active	SM	1													
1511	Surfside Emergency BN	VI	Brazoria	Active	BN		1										278953.22059	3206730.1295	
1518	Rollover Pass Closure - Recreational Amenities Plan	VII	Galveston	In Progress	SM	1											355284.67300	3264773.7730	29* 30' 25" N, 94* 29' 58" W
1519	Caplen/GIWW Rollover Bay BUDM	VII	Galveston	Completed 2013	BN/BUDM		1							1			354313.35600	3264638.4990	29* 30' 17" N, 94* 30' 18" W
1520	Bird Island Cove Wetland and Marsh Restoration	VII	Galveston	Active	HR					1							304987.63000	3228927.5670	29* 10' 44" N, 95* 0' 32" W
1521	End of Seawall Beach Nourishment	VII	Galveston	Active	BN		1										318296.03600	3235784.3560	29* 14' 27" N, 94* 52' 18" W
1522	End of Seawall Resen Waves Beach Stabilization Demonstration Project	VII	Brazoria, Galveston	Active	SM	1													
1523	Corps Feasibility Study Re-scoping Project	VII	Brazoria, Chambers, Galveston, Harris, Jefferson, Orange	Active	SM	1													
1524	SPI BUDM	VII	Cameron	Active	BN		1								684511.73000	2885332.44000			26* 04' 52" N, 97* 09' 32" W
1525	Isla Blanca BUDM Cameron County	VII	Cameron	Active	BN		1								684721.50200	2884652.12900			26* 04' 15" N, 97* 09' 20" W
1527	Indian Point Shoreline Stabilization and Habitat Restoration	VII	Nueces, San Patricio	Active	SP				1						662238.25000	3082969.12600			27* 51' 7" N, 97* 21' 13" W
1528	Nueces River Delta Stabilization and Habitat Protection	VII	Nueces, San Patricio	Active	HR					1					646923.42900	3081664.84300			27* 51' 10" N, 97* 30' 47" W
1529	CR257 Dune Restoration	VII	Brazoria	Active	DR			1									286572.83800	3211923.3370	29* 01' 06" N, 95* 11' 48" W
1530	McFaddin Beach Ridge Restoration	VII	Chambers, Jefferson	Active	SP, BN	1			1								383787.15600	3277225.7860	29* 37' 17" N, 94* 12' 02" W
1531	Green's Lake Shore Protection and Marsh Restoration	VII	Galveston	Active	SP				1								306635.38900	3238119.5900	29* 15' 43" N, 94* 59' 40" W
1532	Sargent Beach Restoration	VII	Matagorda	Completed 2013	BN		1										244241.43100	3184191.7410	28* 45' 59" N, 95* 37' 16" W
1535	BMMP - Monitoring and Analysis Report	VII	Coastwide	Active	SM	1													
1562	CEPRA Economic Study	VII	Coastwide	Completed 2013	SM	1													
1563	BEG shoreline change update	VII	Coastwide	Active	SM	1													
1565	Nueces Bay Portland Causeway Marsh Restoration	VII	Nueces, San Patricio	Active	HR				1						663307.76900	3082780.38300			27* 51' 59" N, 97* 20' 48" W
1566	Galveston Seawall Beach Nourishment	VII	Galveston	In Progress	BN		1										327930.77200	3242840.0010	29* 18' 17" N, 94* 46' 30" W
1568	WGI Shoreline Stabilization Demonstration Project	VII	Galveston	Active	SP				1								303496.27841	3225183.7703	
1569	BMMP - Corpus Christi	VII	Nueces	Active	MP								1		659049.99400	3078272.37900			27* 49' 18" N, 97* 23' 11" W
1570	BMMP - Surfside	VII	Brazoria	Active	MP								1				277069.88700	3203491.9890	28* 56' 40" N, 95* 17' 23" W
1571	BMMP - Bryan	VII	Brazoria	In Progress	MP								1				273148.99900	3200020.2110	28* 54' 48" N, 95* 19' 60" W
1573	Surfside	VII	Brazoria	Active	SP, MP				1				1				287655.96100	3160922.4070	28* 33' 47" N, 95* 10' 24 " W
	Totals					15	16	6	11	5	0	0	4	1					

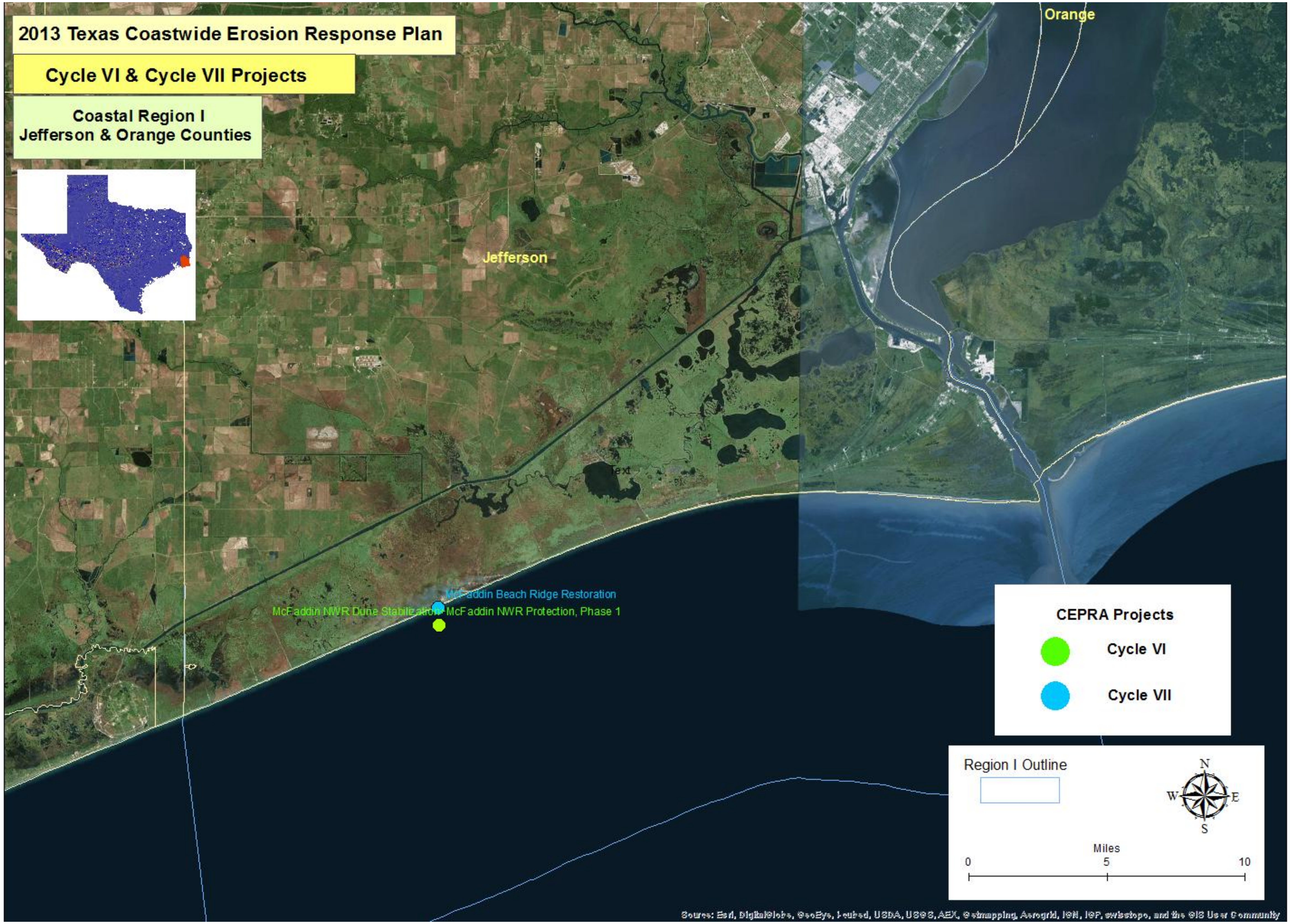

Figure 11. Locations of CEPRA Cycles VI and VII projects in Region I.

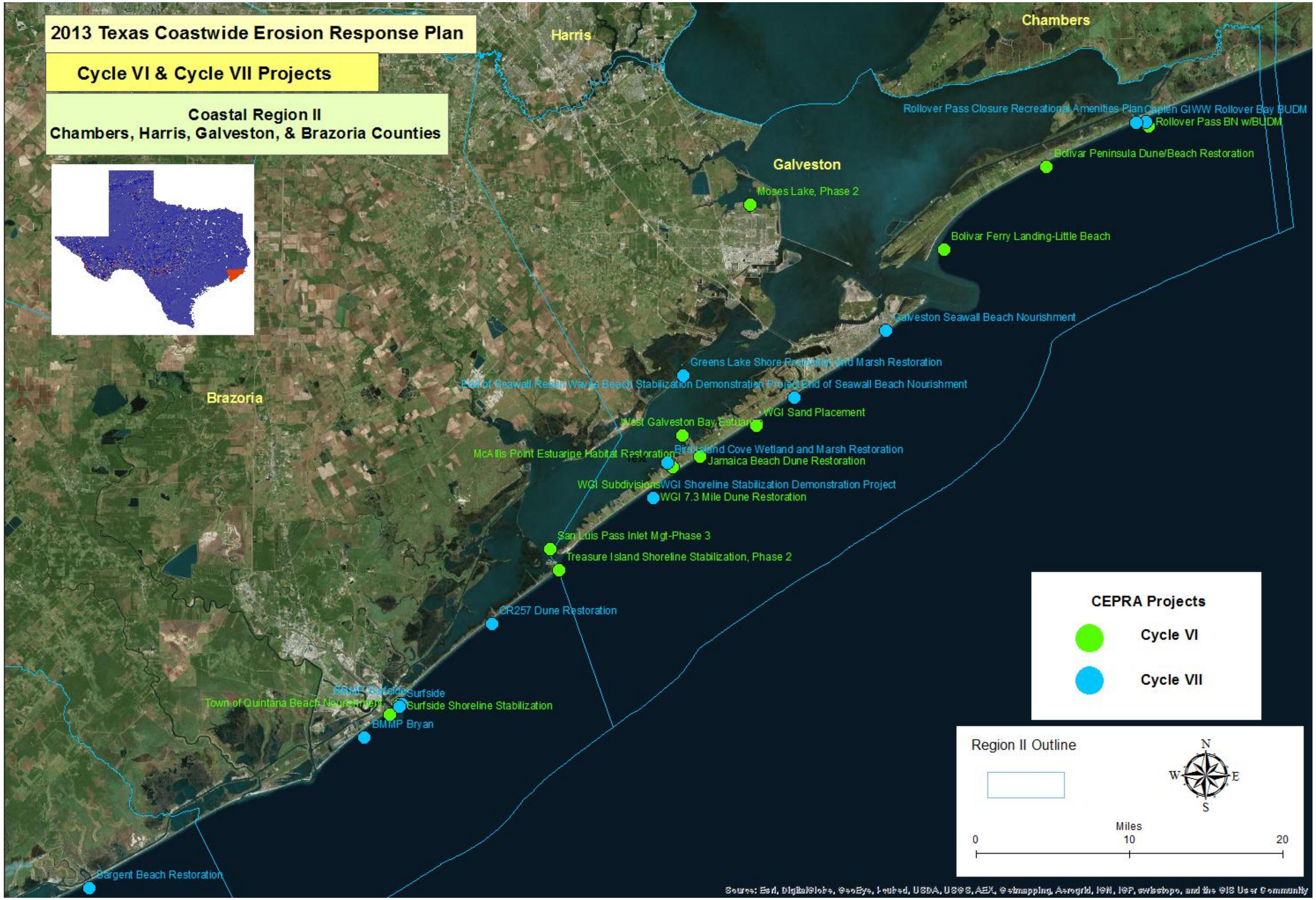

Figure 12. Locations of CEPRA Cycles VI and VII projects in Region II

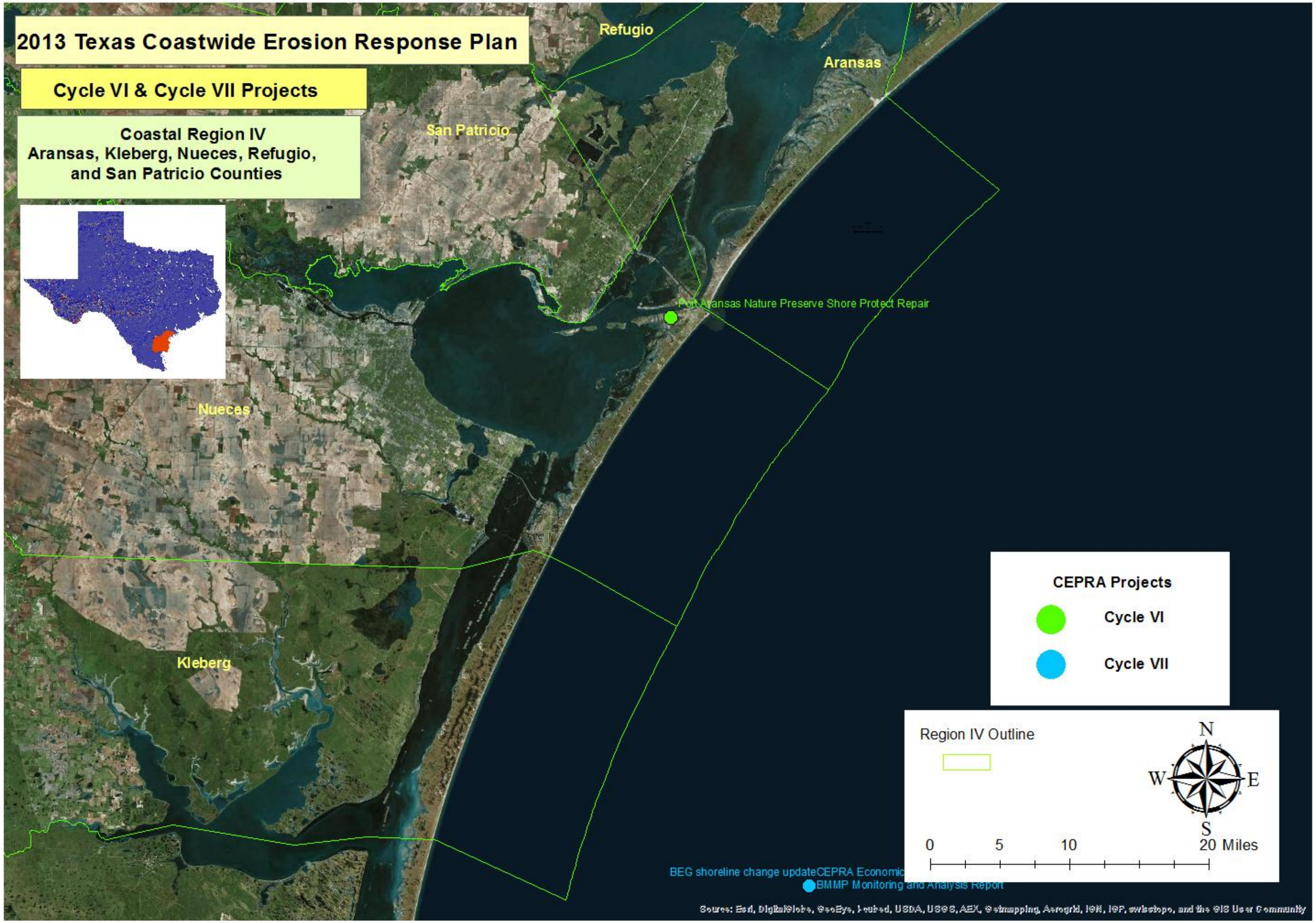

Figure 13. Locations of CEPRA Cycles VI and VII projects in Region IV.

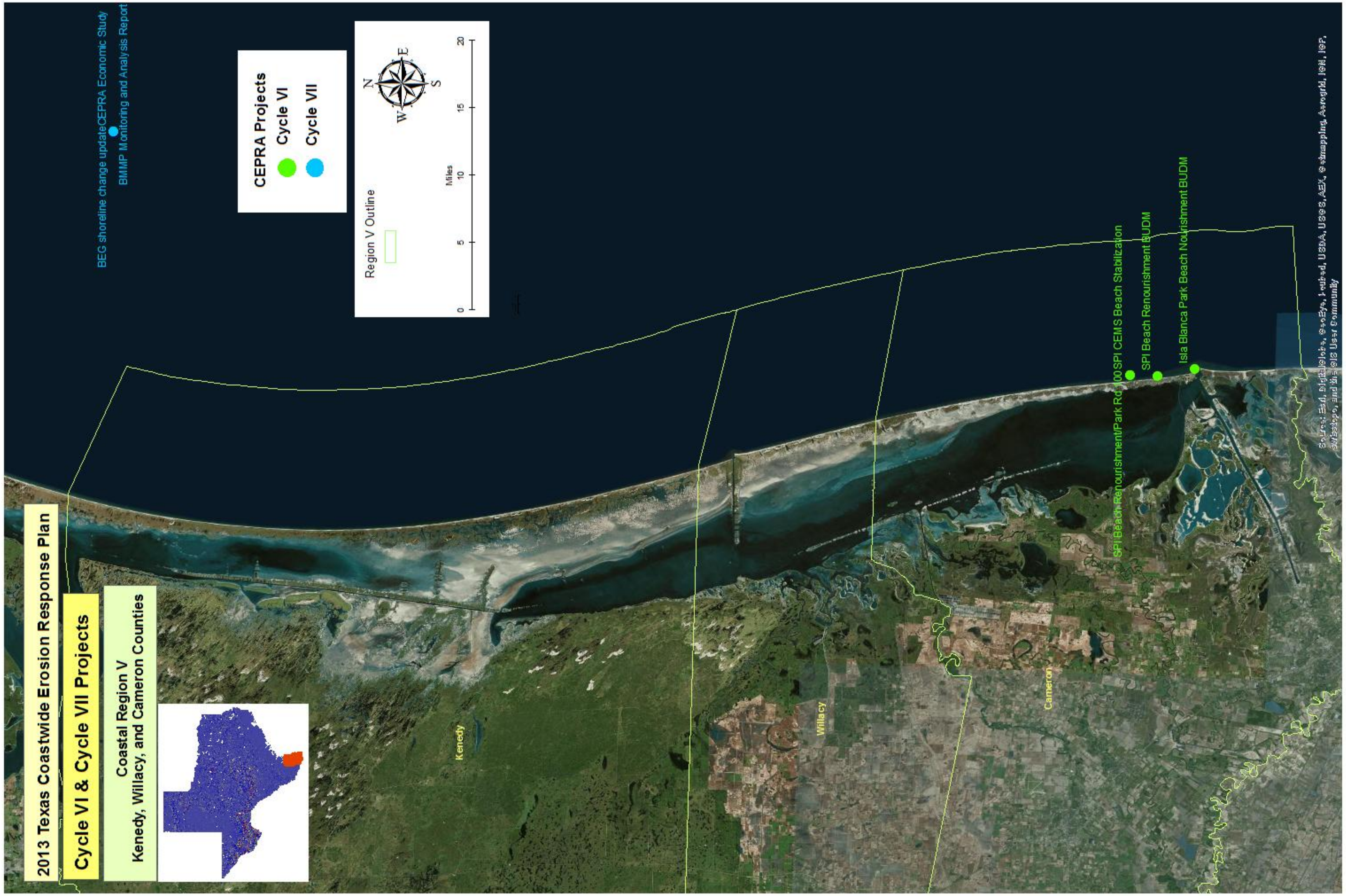

Figure 14. Locations of CEPRA Cycles VI and VII projects in Region V.

A CEPRA application requires the following: project description, type (beach nourishment, shoreline protection, dune restoration, other), location, length, erosion rate, use of dredged material or whether a sand source has been identified, whether the local jurisdiction has an approved erosion response plan, or hazard mitigation plan, monitoring and maintenance plans, and project benefits (http://www.glo.texas.gov/what-we-do/caring-for-the-coast/grants-funding/cepra/cepra-application.html). A commitment to funding, either 25% or 40% depending on the type of project is also required at the time of application. In many cases, this is the limiting factor for project commencement.

Ranking of CEPRA applications and subsequent funding for erosion response projects considers the following: threats to evacuation routes, public safety, public access and recreation, project impacts to Federal/state/local economy, public/private property value, presence of shoreline protection, historical erosion rate, loss of wildlife areas or endangered species, and human impacts. The information provided in the CEPRA Project Goal Summary (the official funding application), agency rules for evaluating criteria, score sheets, erosion rates, infrastructure, beneficial effects to marshes or shoreline, funding commitments, completion within biennium are all included in the metrics that are used to determine which projects are funded. Then, the GLO must request CEPRA funding each legislative session, review the budget and determine what is affordable. This process does not easily facilitate long-term planning for erosion response projects.

The cost of erosion response projects varies mainly due to geography and the availability of obtaining beach-quality sand for beach nourishment and dune restoration projects. Costs can be significantly lower if material is available through partnering opportunities with the USACE for the beneficial use of dredged material (BUDM) resulting from federal maintenance dredging operations (Table 2) (GLO, 2014, personal communication).

Table 2. Example costs for Cycle VI-VII CEPRA beach nourishment and beneficial uses of dredged material (BUDM) projects.

Location	Project Type	Estimated Cost (per cubic yard)
#1519 Caplen/GIWW Rollover Bay	BN (BUDM)	$ 32.35
#1532 Sargent Beach Restoration	BN (non-BUDM)	$ 42.25
#1524 South Padre Island	BN (BUDM)	$ 20.53

The projects funded by the CEPRA program are making positive impacts in local responses to erosion; however, the impacts are localized.

Economic and Natural Resource Benefits of Coastal Erosion Projects

Each biennium, the GLO is required to submit a report to the Texas Legislature that outlines the economic and natural resource benefits of CEPRA-funded projects. Two economic studies have been completed since the *Texas Coastwide Erosion Response Plan 2009 Update* (Krecic et al., 2011; Trudnak et al., 2013). Both of these studies evaluated the direct and net benefits of several CEPRA-funded projects and the value of the investment for the state of Texas. Economic and financial benefits were quantified based on impacts to tourism, ecotourism, commercial and recreational fishing, water quality, carbon sequestration, beach recreation, out-of-state visitor spending, non-Texas project funding, and storm protection.

The 2011 study evaluated beach nourishment, revetment, and ecosystem restoration projects from CEPRA Cycles V and VI. They found that federal participation was substantial for the beach fill project at Isla Blanca Park and this saved the state money. The project was able to utilize the sand dredged from Brazos Santiago Pass for beach nourishment of adjacent beaches within the park. This is a win-win situation in that it helps keep the channels navigable and keeps sediment in the littoral system. The study found a benefit-to-cost ratio of 43.23 (for every dollar spent, there is a $43.23 economic/financial benefit to the state) (Krecic et al., 2011).

The projects evaluated in the 2013 study included CEPRA Cycles VI and VII beach nourishment from the beneficial use of dredged material, emergency beach and dune nourishment, estuarine habitat restoration and shoreline protection. Though some of the projects received federal funding which offset the state's costs, the average benefit-to-cost ratio (8.4) was lower but positive for all projects analyzed and indicates that Texas coastal erosion response projects are a worthwhile endeavor (Table 3) (Trudnak et al., 2013).

Table 3. Economic Summary of CEPRA Cycle VI and VII Projects (Trudnak et al, 2013)

<table>
<tr><th>Project Number</th><th>Project Name</th><th>County</th><th>Year</th><th>Texas Cost[1]</th><th>Total Discounted Cost[2]</th><th>Total Discounted Benefits[2]</th><th>Benefit-to-Cost (B/C) Ratio</th></tr>
<tr><td>1395</td><td>Moses Lake Shoreline Protection Phase 2</td><td>Galveston</td><td>2013</td><td>$328,294</td><td>$328,294</td><td>$376,828</td><td>1.2</td></tr>
<tr><td>1456-B</td><td>SPI Beach Nourishment with BUDM (2011 Event)</td><td>Cameron</td><td>2011</td><td>$716,985</td><td>$774,298</td><td>$1,324,390</td><td>1.7</td></tr>
<tr><td>1471</td><td>Surfside Shoreline Stabilization (FEMA Repair/Enhancement)</td><td>Brazoria</td><td>2011</td><td>$151,449</td><td rowspan="2">$1,447,756</td><td rowspan="2">$21,280,560</td><td rowspan="2">14.7</td></tr>
<tr><td>1511</td><td>Surfside Emergency Beach Nourishment and Dune Restoration Phases 1 & 2</td><td>Brazoria</td><td>2010, 2012</td><td>$1,189,144</td></tr>
<tr><td>1519</td><td>GIWW-Rollover Bay Reach Beach Nourishment with BUDM (2012 Event)</td><td>Galveston</td><td>2012</td><td>64,766</td><td>$67,305</td><td>$11,709</td><td>0.2</td></tr>
<tr><td>1481</td><td>McAllis Point Estuarine Habitat Restoration</td><td>Galveston</td><td>2011</td><td>$613,566</td><td>$662,612</td><td>$2,113,976</td><td>3.2</td></tr>
<tr><td>1524</td><td>SPI Beach Nourishment with BUDM (2013 Event)</td><td>Cameron</td><td>2013</td><td>$446,915</td><td>$446,915</td><td>$4,053,811</td><td>9.1</td></tr>
<tr><td>1525</td><td>Isla Blanca Beach Nourishment with BUDM (2013 Event)</td><td>Cameron</td><td>2013</td><td>$64,000</td><td>$64,000</td><td>$2,563,252</td><td>40.1</td></tr>
<tr><td colspan="4">Totals</td><td>$3,575,119</td><td>$3,791,180</td><td>$31,724,526</td><td>8.4</td></tr>
</table>

Federal funding on projects from the Federal Emergency Management Agency (FEMA), US Army Corps of Engineers (USACE), and the US Fish and Wildlife Service (USFWS) (Coastal Impact Assistance Program and National Coastal Wetlands Conservation Grant) greatly offset the state's cost for some of the CEPRA projects. Non-governmental organizations also provided financial and in-kind partnering. Unfortunately, the flow of non-state funds is not constant or consistent and consequently may not be available for future CEPRA projects. To minimize the expenditure of state-appropriated funds given the relative finite level of funding, CEPRA applicants are encouraged to seek partnerships and are required to find funding sources outside of CEPRA. There are concerns by some potential applicants that the CEPRA funding source is not always guaranteed. Each biennium, the GLO must request funding for the program and since the money is appropriated out of the state's general fund, there is the potential for wide fluctuations in the amounts available. For local governments or those who are planning large, long-term projects, the funding uncertainties can have an impact on project modifications and timing, and in the long term, could increase project costs.

EVENTS THAT IMPACTED CEPRA AND EROSION RESPONSE

Post Hurricane Ike Shoreline Recovery

The September 2008 Category 2 hurricane (Hurricane Ike) made landfall over eastern Galveston Island with a 15-20 foot storm surge that eroded much of the coastline on Bolivar Peninsula (Galveston County) and Chambers County (Berg, 2009; HDR, 2014). Most of those areas were covered with at least 10 feet of water not including the impact of waves. Storm surge levels on Galveston Island, west of landfall, reached 10 to 15 feet and many of the tide gauges failed in the impact area (Berg, 2009). To the south, storm surge was recorded at 5-10 feet (Brazoria County) and ranged 2-5 feet farther south.

Subaerial beach and foredune recoveries were measured for the stretch of Gulf shoreline from Sabine Pass (Jefferson County) to Quintana Beach (Brazoria County) in a CEPRA-funded cooperative research study by HDR Engineering, Inc and HRI using aerial photography, beach profiles, and digital elevation models that were developed from pre- and post-storm lidar surveys (HDR, 2014). The data from which the volumetric changes were calculated include pre-Hurricane Rita lidar elevations (from August 2005) and post-Hurricane Ike (from December 2008); therefore the initial beach and foredune losses presented include the combined impacts and recovery from both storms. The pre-Rita to post-Ike analysis showed that the greatest losses of subaerial Gulf beach occurred in High Island to Sabine Pass (-0.7 yd^3/yd^2) followed by Quintana Beach (-0.5 yd^3/yd^2). The data are normalized and represent volume change per unit area of beach. Measurements of foredune changes indicated that Bolivar Peninsula to High Island experienced the greatest net loss (-1.26 yd^3/yd^2) (Starek, 2012).

Post-Ike (2008) to 2012 (nearly four years following landfall), the studied beaches experienced net erosion except at Quintana Beach and West Galveston Island (both sites are adjacent to inlets). The studied foredune areas gained sand except at Follets Island and along the reach from High Island to Sabine Pass.

Pre- and post-Hurricane Ike beach and nearshore profiles were surveyed for the upper Texas coast in 2006 and 2011 by researchers from Texas A&M University at Galveston (Dellapenna and Johnson, 2012). In addition, geophysical surveys and vibracores were obtained in 2010 for offshore Galveston Island. These data showed extensive scour troughs and a thin sand deposit, likely the results from the storm. Calculations from the changes in the profile datasets resulted in a volume loss of approximately 103 million cubic yards of sediment for Galveston Island (beach/dune to offshore). Note that the time period from which the data were collected includes the impact of the storm (2008) and the period of considerable shoreline recovery for Galveston Island (2010 to 2011) as determined by Paine and others (2013). The volume losses could be attributed to a combination of factors: 1) the landward transport of sands as overwash that were either not captured in the surveys or not relocated back to the beach/dune system; 2) captured in the ebb tidal deltas of Bolivar Roads and San Luis Pass; or 3) transported offshore beyond the reach of waves that could move the deposits back onshore. It is expected that there will not be a full recovery of the beaches and dunes because of the geologic properties of this section of the coast (thin sands overlying silts and clays) and the lack of natural sediment input into the beach/dune system (HDR, 2014).

Post-Ike Funding Partnerships

Federal funding partnerships for erosion response since Hurricane Ike has become challenging for implementing some of the CEPRA program projects. From a media standpoint, Hurricane Ike had to concurrently compete with the Lehman Brothers Holdings, Inc. investment banking financial collapse. Though 29 Texas counties suffered extensive damages to homes, businesses, infrastructure, and natural resources, the focus on the financial collapse overshadowed the storm. Federal funding was slow in reaching the appropriate levels necessary for managing the effects of the storm, and the state was left to carry much of the clean up and recovery burden (GLO, personal communication, 2014). After the presidential disaster declaration, FEMA partnered with the Texas Governor’s Division of Emergency Management (TDEM) and were quick to open disaster recovery centers in the affected areas and obligate funding for public assistance in disaster cleanup and emergency repairs. Cost-shared FEMA public assistance program funding was offered at 90% federal and 10% non-federal, and these funding grants were offered as the federal cost share for some of the CEPRA post-Ike repair projects. However, there were complications with post-project audits and challenges with working with TDEM on post-storm project influence. These issues either slowed progress of several CEPRA Cycle VI and Cycle VII beach nourishment repair projects or stopped the projects altogether because the federal cost-shared amount became unreliable in terms of providing funding to address proposed CEPRA Ike repair projects.

Open Beaches Act and *Severance* Texas Supreme Court Opinion

The Texas Open Beaches Act (OBA) (Texas Nat. Res. Code Ann. §61.011) was passed in 1959 to protect the public’s right to “free and unrestricted” access to and from the “state-owned beaches bordering on the seaward shore of the Gulf of Mexico.” The act prohibits the erection of any physical barrier that would impede public access to the beach and any written or oral claim that the public beach is private property. Fencing or structures could be considered as physical barriers. In addition, the act provides a rolling public easement as the Gulf beaches migrate landward from the effects of erosion. Important terms and shoreline features identified in the act are the definitions of the public beach and the line of vegetation which are subject to the rolling easement:

> "public beach" *shall mean any beach bordering on the Gulf of Mexico that extends inland from the line of mean low tide to the natural line of vegetation bordering on the seaward shore of the Gulf of Mexico, or such larger contiguous area to which the public has acquired a right of use or easement to or over by prescription, dedication, or estoppel, or has retained a right by virtue of continuous right in the public since time immemorial as recognized by law or custom. This definition does not include a beach that is not accessible by a public road or public ferry as provided in Section 61.021 of this code.*
> "line of vegetation" *means the extreme seaward boundary of natural vegetation which spreads continuously inland.*

Conflict arises when the line of vegetation moves landward of beachfront homes (structures). The GLO is bound to enforce the public's right to use and access the public beach. In the past, the state was successful in removing structures that ended up on the public beach. This public right of unimpeded access was challenged by a private Galveston Island landowner after Hurricane Rita moved the line of vegetation behind her structure (GLO, personal communication, 2014). Prior to the 2005 storm, the structure was already partly on the public beach and subject to a moratorium for removal when it was purchased by the new owner. The new owner signed a disclosure form when she purchased the property acknowledging the well-known risk of living near the shoreline and that her structure could wind up on the public beach should a storm move the line of vegetation landward of it and that the state could remove it from the public beach. At the end of the moratorium, the Land Commissioner quantified the structures encroaching on the public beach as part of the development for the "Plan for Texas Open Beaches" which called for offering up to $50,000 in CEPRA funding to owners of structures encroaching on the public beach for voluntary demolition or relocation of the structures. Upon receipt of a letter from the Land Commissioner relaying this assistance offer, the land owner took action to sue the Land Commissioner and the state for a violation of private property rights (GLO, personal communication, 2014).

The case was argued in 2009, and reargued in 2011in the US Court of Appeals for the Fifth Circuit which requested the Supreme Court of Texas to review questions regarding the rolling easement and landowners' entitlement to compensation for imposed restrictions to their private property. That opinion was delivered on March 30, 2012. The Court determined from their review of the original land patent on west Galveston Island that there was no mention of an easement to a public entity and ruled that the property owner had exclusive use of the land. They found that there was no basis in Texas law that supported a rolling public beach access easement even though Texas tradition, common law, former challenges, and a 2009 state constitutional amendment supported it. The decision favors private beachfront property homeowners, not the public and allows a homeowner to threaten trespassing if someone walks or drives the beach in front of the home. The Court opinion noted that the easement could only roll gradually, not rapidly such as would occur during a storm event, setting up the argument between establishing avulsive (a term normally used to describe riverine systems-not coastal systems) versus eroding events.

Even before the initial Supreme Court's opinion was issued, the questioning of the definition of the "public beach" easement from the earlier arguments led to the abrupt cancellation of the West Galveston Island Emergency Beach Nourishment Project (CEPRA Project No. 1391) in 2010; the day the $40 million project to restore and nourish six miles of beach from the west end of the seawall to 13-mile road was to commence (GLO, personal communication). Without the "public beach" easement, no public (federal or state) funding can be used to improve private property along the coast. This includes the grant funding provided by the CEPRA program. For now, this affects the west Galveston Island properties, but if there are future challenges from other homeowners whose structures happen to be on the public beach, then there may be additional hindrances to public beach access or lengthy and costly legal battles until the issues are completely resolved.

What does the Court's opinion mean to state and local governments who manage the shoreline? Erosion has created challenges to beach access in Galveston and restrictions at the seawall on North Padre Island. It's up to the state and local governments how they manage their shorelines – protecting dunes, managing fences and barriers to public access, and keeping development as far away from the public beach and the influence of storm waves as reasonably possible. The local beach access and dune protection plans and erosion response plans provide the best methods for managing the coastal systems. Erosion is erosion, whether it is caused by long-term processes or short-term storm events. The GLO and local governments are left with the difficult and delicate task of balancing the public's right to access and use of the Gulf beaches on eroding shorelines with the pressures from development and the devastating impacts of strong storms.

It remains to be seen how the public access and use of the Gulf beaches will play out for future projects; specifically the project highlighted in H.B. 3459 (2013) which added the legislative finding that a revetment extension of the Galveston seawall to the west end of the island and along Bolivar Peninsula (Ike Dike) would protect the region from storm surge. The Texas Legislature established a joint committee to determine the feasibility and desirability of the proposed system of flood gates and extended revetment. A hearing was held in August to gather local opinions and information for the project. The joint committee is required to report its results by December 1, 2014.

LOCAL GOVERNMENT SHORELINE MANAGEMENT PRACTICES

Coastal county and municipal governments are responsible for the day-to-day management of the Gulf beaches and dunes under state guidance. Three communities were visited to review CEPRA program projects and general beach and dune management practices with respect to the local policies on coastal erosion. The geographical and geomorphological differences between the communities provide the foundation for the different management techniques. In this section some of the issues involved in managing shoreline erosion are highlighted.

The most common shoreline management challenge was coping with the unusually large *Sargassam* deposits that wreaked havoc on the Texas Gulf shoreline. *Sargassam* is a type of open-water brown algae that multiplies and floats in the upper water column in the Gulf of Mexico. In the open water, the *Sargassam* serves as an important habitat for juvenile fish, providing food and shelter. But once deposited on land, the impact becomes a burden on local governments who must balance the natural environment with clean beaches. The invasion began in South Padre Island in April (2014) and soon followed north and east toward Galveston Island in May. These types of events inhibit public access to the shoreline and provide a nightmare to the local governments who clean the beaches. Not only are there differences in opinion about leaving the deposits as natural methods for trapping sand and providing a habitat for shoreline fauna, but there are obligations by the local governments to maintain access and provide a clean, safe environment for beach visitors. Methods for removing and disposing the seaweed are varied among the different shoreline communities, but for the most part, the seaweed is scraped off the beach and placed along the line of vegetation or onto existing dunes.

Erosion Response Plans

Another management objective for local governments is erosion response planning. Since August 2010, local Gulf coast governments are required to adopt an Erosion Response Plan and ordinances that accommodate strategies for managing shoreline erosion and reducing public expenditures (§15.17 of Title 31 Texas Administrative Code). Elements of the plans include applying historical erosion rates in setting building setback lines, reference lines such as the line of vegetation or mean low tide, the location of the local dune protection line, construction requirements, criteria for exempt structures and for buyouts, and procedures for protecting public beach access and critical sand dunes. At this time, all county and municipal governments, except one, have state-approved erosion response plans. An erosion analysis was completed for Cameron County in an effort to evaluate the sustainability of shoreline development practices with on-going shoreline erosion in the unincorporated sections of South Padre Island (Worsham and Ravella, 2013). The study found that the County's plan for maximum seaward development and program for maintaining a static position of the shoreline would incur significant costs that the County may not be willing or able to pay. The study authors recommended that the County take a more conservative approach to shoreline development to reduce future financial risks.

City of Galveston

Galveston Island is located along the upper Texas coast and within a 45-minute drive for over four million people. It is considered the only urban Gulf coast beach in Texas and with the exception of the City of Jamaica Beach and Galveston Island State Park, the entire island lies within the City of Galveston's jurisdictional limits. The shoreline change rates along the seawall and to the east toward Bolivar Pass have been relatively stable. However, at the west end of the seawall and westward, the remainder of the island's beaches is dominantly erosional (Paine et al., 2014). Shoreline management responsibilities are shared between the City of Galveston (City) and the City Park Board of Trustees (Park Board). The Park Board is responsible for managing the ten miles along the Galveston Seawall and the City is responsible for managing the remaining 20 miles of the 30-mile-long barrier island. In addition, the City offers services for its 48,000 citizens. The City has become focused on its aging infrastructure and is indifferent about maintaining several of the GLO's program missions (specifically the *City of Galveston Dune Protection and Beach Access Plan* and the *City of Galveston Erosion Response Plan*). Both plans were adopted by the City government and approved by the GLO (1993 and as amended in 2012). Recently, the City halted sending permit applications to the GLO for review and comment because the City has no commitment to activities along the West Galveston Island beaches. There are no follow-up visits on building permits or construction, and there is no accommodation for managing shoreline retreat.

Shoreline management has become more of a Park Board initiative on Galveston Island (Figure 15). The impact of the *Sargassam* deposits has been substantial to the Park Board at the beaches along the seawall. Stormwater drains at the base of the seawall have been clogged by overnight accumulations. Vehicular access for removing the large quantities of *Sargassam* can be difficult as the beach becomes too soft to support heavy equipment. In some instances, a person can sink several inches into the mix of soft sands and *Sargassam* (Galveston City Park Board of Trustees field supervisor, personal communication, 2014). On the beaches along the west end of the island, local citizen groups and homeowners' associations are taking on dune construction without the assistance of the City. The City Planning Commission has adopted best practices to authorize maintenance permits (e.g., removal of *Sargassam*) but does not monitor the efforts by local citizens or community groups.

Figure 15. The beach, dunes and *Sargassam* mounds in front of the Galveston Seawall. (July 2014, view to the east)

The City has not addressed the impacts from the *Severance* opinion. They note that there are gate closures at some of the beach access areas, but the City has limited capabilities for follow up investigations. The City provides no funding for erosion response projects such as beach nourishment for the west-end communities.

City of Port Aransas

The City of Port Aransas occupies approximately 7.5 miles of the northernmost end of Mustang Island in the coastal bend region of the Texas Gulf coast. The beaches within the city limits are accreting at its northern limit near the Aransas Pass jetties and trend toward erosion to the south (Paine et al., 2014). The City established its dune protection line at 1000 feet landward from mean high tide and any activities seaward of that line must protect critical dunes.

The *City of Port Aransas Erosion Response Plan* was adopted as an amendment to the City's *Coastal Management Plan* and implemented in 2011 (City of Port Aransas, 2011). The plan adopted a building setback line based on the locations of mean high water, line of vegetation, dune protection line, the conditions of the dunes, and the historical erosion rate. This line is located at 200 feet landward of the line of vegetation or at a distance 60 times the historical annual erosion rate (whichever is greater).

Projects for protecting the natural resource areas (beaches, dunes, City's Nature Preserve and the shoreline along the ship channel/Charlie's Pasture to Piper Channel) have received GLO funding and have been completed including the FEMA-Hurricane Ike revetment repair project along a segment of ship channel shoreline in the vicinity of the nature preserve.

Managing *Sargassam* removal and the impacts to shoreline erosion are of great concern to the City and questions arise whether it has a positive or negative impact on sediment deposition. The City uses maintenance techniques such as "front notching" and "back stacking" of man-made dunes in a way to recycle the *Sargassam*-laden sand (Figure 16). The City is concerned about their removal practices and the amount of sand that had to be moved to capture all of the *Sargassam*. They are developing a proto-type removal system with plans to be free of beach/dune impacts by 2016. In addition, researchers from HRI received CEPRA Cycle VIII funding to determine the impacts of beach maintenance and provide recommendations for best practice maintenance measures.

City staff are aware of the *Severance* opinion and have concerns if a large storm event change should change the location of the line of vegetation south of beach access road 1A where shorefront properties extend to mean high water. There may be some consideration for entering into agreements or easements with those coastal property owners to maintain the beaches.

Figure 16. Beach maintenance crews “front-notching” dunes that were created from scraped *Sargassam* and sand and placed along the beach roadway. After the *Sargassam* disintegrates, the sand is placed back onto the beach. (July 2014, view to the west)

City of South Padre Island

The City of South Padre Island is located along the lower Texas Gulf coast and is bounded by Brazos-Santiago Pass to the south and Beach Access Road No. 4 to the north (including its Extraterritorial Jurisdiction). Shoreline change rates vary from accreting near the pass to eroding at rates up to -8.2 feet per year at the northern end (Paine et al., 2014). The City has been proactive in maintaining dune protection seaward of its approved dune protection line and coordinates dune grass plantings with local community groups. The *City of South Padre Island Erosion Response Plan* was adopted and implemented in 2012 and addresses erosion and storm risks within the current city limits, excluding the undeveloped areas in the extraterritorial jurisdiction. With respect to reducing public expenditures, the City is committed to a program for nourishing the beaches and enhancing and restoring dunes as the first tier of protection for upland development and infrastructure (City of South Padre Island, 2012).

For over ten years, the City has partnered with the Galveston District of the USACE to nourish the beaches by taking sand out of the ship channel and placing it on the adjacent shores—referred as beneficial use of dredged material (BUDM). These BUDM projects have added over two million cubic yards of sand to the beaches of South Padre, within the corporate limits of the City of South Padre Island as well as on the beach at Isla Blanca County Park (City of South

Padre Island, 2012). CEPRA funding has been used to cover the non-federal cost for some of the BUDM projects, but in some instances, there were issues relating to matching the timing of federal maintenance dredging events with the ability of the state to provide the non-federal cost share up front so as to beneficially utilize the dredged material. In those cases, the dredged material was placed in a designated offshore placement site at a water depth greater than 30 feet and consequently out of reach to benefit the littoral system.

The City's beaches, dunes and washover areas are considered coastal natural resource areas that are threatened by erosion. Due to management and sand conservation efforts at the north end of town, some former washover areas now support dunes. The management of the *Sargassam* deposits has been an issue for the City and they have had to use excavators to remove the heavier amounts. The relocated *Sargassam* is placed in the dunes along the vegetation line and planted with sea oats by volunteers (Figure 17).

Figure 17. Beach, dune, and *Sargassam* management practices in South Padre Island. (photo courtesy R. Trevino, May 2014, view to north)

<u>Issues of Concern</u>

In the review for this plan update, several management issues arose that are worthy of future state and local discussions. The communities that were interviewed share similar situations that affect shoreline erosion: coastal development, beach maintenance, and seaweed management.

- Dune protection - Issues were raised regarding the effectiveness of the GLO's beach/dune rules and local dune protection and beach access plans in protecting dunes. Some communities allow dune elevations to be reduced. In other communities, dunes are reworked for beach maintenance. In addition, some communities allow construction that damages adjacent dunes without public notification.

- Funds for beach maintenance activities – There are concerns that there may be some inequity in how the state distributes funding for reimbursement.

- Funds for beach access amenities – There are requests for more funding for public parking, walkover construction, access improvements and maintenance.

- Identifying the dune protection line – There are requests for the identification of critical dunes and updates of the dune protection line from airborne lidar surveys.

- CEPRA funding – There are requests for a permanent funding source for CEPRA for better erosion response planning.

PROGRAMS AND PARTNERSHIPS

For shoreline erosion response projects, there are a few key programs and partners that share an overlap with flood and storm damage reduction, restoration of coastal habitats, management of coastal parks, and risks to human populations. An earlier section discussed the involvement and cost-shared public assistance funding by FEMA in response to Hurricane Ike. The US Army Corps of Engineers – Galveston District (SWG), National Oceanic and Atmospheric Administration (NOAA), US Fish and Wildlife Service (USFWS) and Bureau of Ocean Energy Management (BOEM) have provided cost-shared funds for state-supported coastal erosion response projects and studies.

USACE-SWG

Probably the most important partner in addressing shoreline erosion is the USACE. The Civil Works and Environmental missions and programs of the SWG complement state and local erosion response activities. The one that has provided the greatest advantage to the CEPRA program is the Beneficial Uses of Dredged Material (BUDM) option allowing CEPRA to supply the non-federal cost-share for projects at South Padre Island, Surfside, and Caplan Beach on Bolivar Peninsula. The federal/state/local partnership has permitted sediment to be retained within the littoral system by placing the sediments dredged from the navigable waterways onto adjacent beaches. These activities reduce the losses that would have occurred if the dredged sediment was placed in the designated offshore disposal site. The BUDM option can easily be incorporated into another SWG initiative – Regional Sediment Management (RSM) which is a national program that optimizes the use of sediments in planning dredging projects. The SWG has determined sediment budgets and RSM opportunities along the upper Texas coast, from Sabine Pass to the Matagorda Ship Channel. Figure 18 shows the sediment budget amounts and direction of movement for the area from Sabine Pass to Rollover Pass (Willey et al., 2013). Note the greater amounts of onshore transport of sediment in the southern vicinity of McFaddin National Wildlife Refuge.

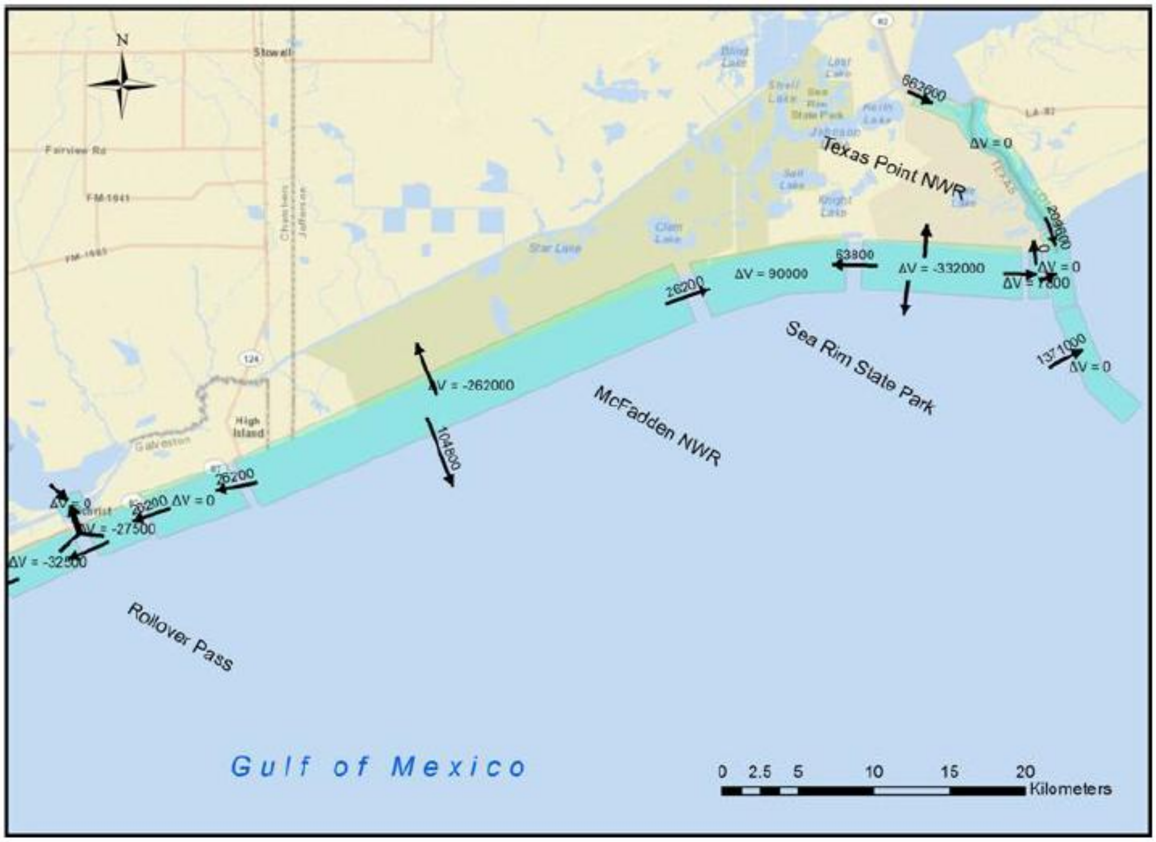

Figure 18. Sediment budgets for the littoral zone from Sabine Pass to Rollover Pass (in m^3/year) (Willey et al., 2013).

Through its Engineer Research and Development Center, the USACE has the capability to conduct studies and test models for erosion control and sediment transport. Beck and others (2012) have been investigating the use of nearshore berms as possible sustainable RSM and dredged material management solutions to eroding shorelines. Nearshore berms are mounds of sand placed in a water depth where waves will help move the sediment onshore. The intention is to create a short-term feature that will attenuate waves, but will also add material to the overall profile. There are two types of nearshore berm designs: one used to nourish beaches and the other used to protect habitat and infrastructure. The design of these features requires significant modeling of the local sediment budget and wave forcing attributes, and in some areas may be considered a risk to water quality because of an excess in fine material. In the spring of 2014, sediments dredged from the Brownsville Ship Channel were placed in a nearshore berm adjacent to South Padre Island (USACE, 2014).

The regulatory branch of SWG reviews the permit applications for all projects that are constructed in federal waters. The City of South Padre Island is working in partnership with SWG in permitting dredging and BUDM activities. The two have agreed to sign a memorandum of understanding for permitting future dredging projects so that species are protected and there are no missed opportunities with respect to future dredging activities or placement of sand.

Through Congressional authorizations, the SWG also has the ability to conduct studies of the shoreline. In the *Sabine Pass to Galveston Bay Shoreline Erosion Study*, the SWG is investigating storm damage reduction and ecosystem restoration measures along the shorelines of Brazoria, Galveston, Harris, Chambers, Jefferson and Orange counties (USACE, 2012). Through the funding by the CEPRA program, the GLO is the feasibility non-federal cost-sharing partner. Another project underway by SWG is the *Coastal Texas Protection and Restoration Project* which is a reconnaissance-level study (Tirpak, 2014). The result from the study will pave the way for a plan that outlines projects for flood and storm damage reduction and ecosystem restoration. The plan will investigate the engineering, economics, and environmental impacts for the use of high surge protection structures such as levees and flood walls as well as mixed low-elevation sills and plantings. The SWG requires a non-federal cost-sharing partner to move into a feasibility-level review.

<u>NOAA and USFWS</u>
The National Oceanic and Atmospheric Administration (NOAA) provides federal Coastal Zone Management Act grants that are administered through the Texas Land Commissioner and GLO Coastal Management Program (CMP) for projects in the coastal zone. The CMP categories (e.g., coastal natural hazards response) complement the CEPRA program, and the state has taken advantage of the funding federal partnership for several projects. Federal contracts, grants, and loans were made available through the American Recovery and Reinvestment Act of 2009 (ARRA) and administered through NOAA (via the Texas CMP) for infrastructure, scientific research, and education. Another source of federal grant funds that has been tapped for coastal projects in Texas is the Coastal Impact Assistance Program (CIAP). CIAP is funded from federal offshore oil and gas revenues and Texas was allocated over $109 million for protection, conservation, mitigation, planning, and restoration of coastal areas. Under the US Department of the Interior, the Fish and Wildlife Service (USFWS) has program oversight (previously administered by the Minerals Management Service, then BOEMER) and the state Coastal Land Advisory Board advises and makes recommendations for which project should be funded. CIAP funding ended in FY10 and projects must be completed by 2016.

<u>BOEM</u>
The Bureau of Ocean Energy Management (BOEM) Marine Minerals Program authorizes the use of sand (considered a non-energy resource) from federal waters for coastal restoration. The authorization follows a review of all environmental impacts for sand extraction and the interagency memorandums of agreement that are signed include mitigation measures that address the impacts to physical, biological or cultural resources. The BEG has evaluated the use of Sabine Bank and Heald Banks as a potential sand sources for shoreline restoration projects (Morton and Gibeaut, 1993; 1995). BOEM also promotes the importance of marine spatial planning especially in the areas of the Gulf where there are potential conflicting uses of offshore areas.

<u>GLO Programs with Shoreline Missions and Funding</u>
Within the structure of the GLO, there are several programs that manage or fund coastal erosion response, shore protection, or planning projects. Traditionally, grants and cost-shared funding sources have been administered through CEPRA and CMP. But in the aftermath of the 2008 hurricanes, the GLO was appointed the lead state agency to administer long-term recovery efforts and funding from the US Department of Housing and Urban Development through Community Development Block Grants. These funds are used for housing, infrastructure and economic development activities within the hurricane disaster declaration areas. The program is

administered through the GLO's Disaster Recovery Program and in 2011, the program awarded more than $197 million in grant funding to local governments for repair and improvements of several public infrastructure projects, economic development programs, and housing (GLO, 2011). The program supports hazard mitigation projects and funding though it can be used to buy-out properties in the flood zone if they were impacted by the natural disasters and funding a study that involves the feasibility of creating and maintaining a structural surge barrier system that surrounds Galveston Island, Bolivar Peninsula and the entrance to the Houston Ship Channel at Bolivar Roads.

AVAILABLE DATA AND TOOLS

There are several available web viewers that supply information that can be helpful to local governments or those applying for CEPRA funding. Typing in "Texas Coastal Web Viewers" into your internet search engine can provide information regarding coastal flooding and sea level rise (NOAA) to the status and trends of coastal vulnerability (TAMU-Galveston) as well as many other sites. The GLO website provides several web viewers for storms, disaster recovery, and leases in the coastal counties (http://www.glo.texas.gov/GLO/agency-administration/gis/). Some of these mapping viewers may be beneficial to CEPRA applicants. For instance, the GLO's interactive land lease mapping viewer shows locations of energy resources and pipelines that are located offshore and/or crossing the coastal barriers and bays. The Texas Sediment (TxSed) Mapping Viewer shows locations of cores and grab samples (in the Gulf as well as within the bays and upland areas), dredged material placement sites, and waterways (http://gisweb.glo.texas.gov/txsed/index.html) (Figure 19). Some of the data presented include percentages of sand/silt/gravel that can be found in a particular core. This can be helpful, for example, in locating potential borrow sites for future beach nourishment projects and the information from the mapping viewer can be used in applying for a CEPRA grant. The database is periodically updated when sand resource studies are completed and the data are submitted to the GLO.

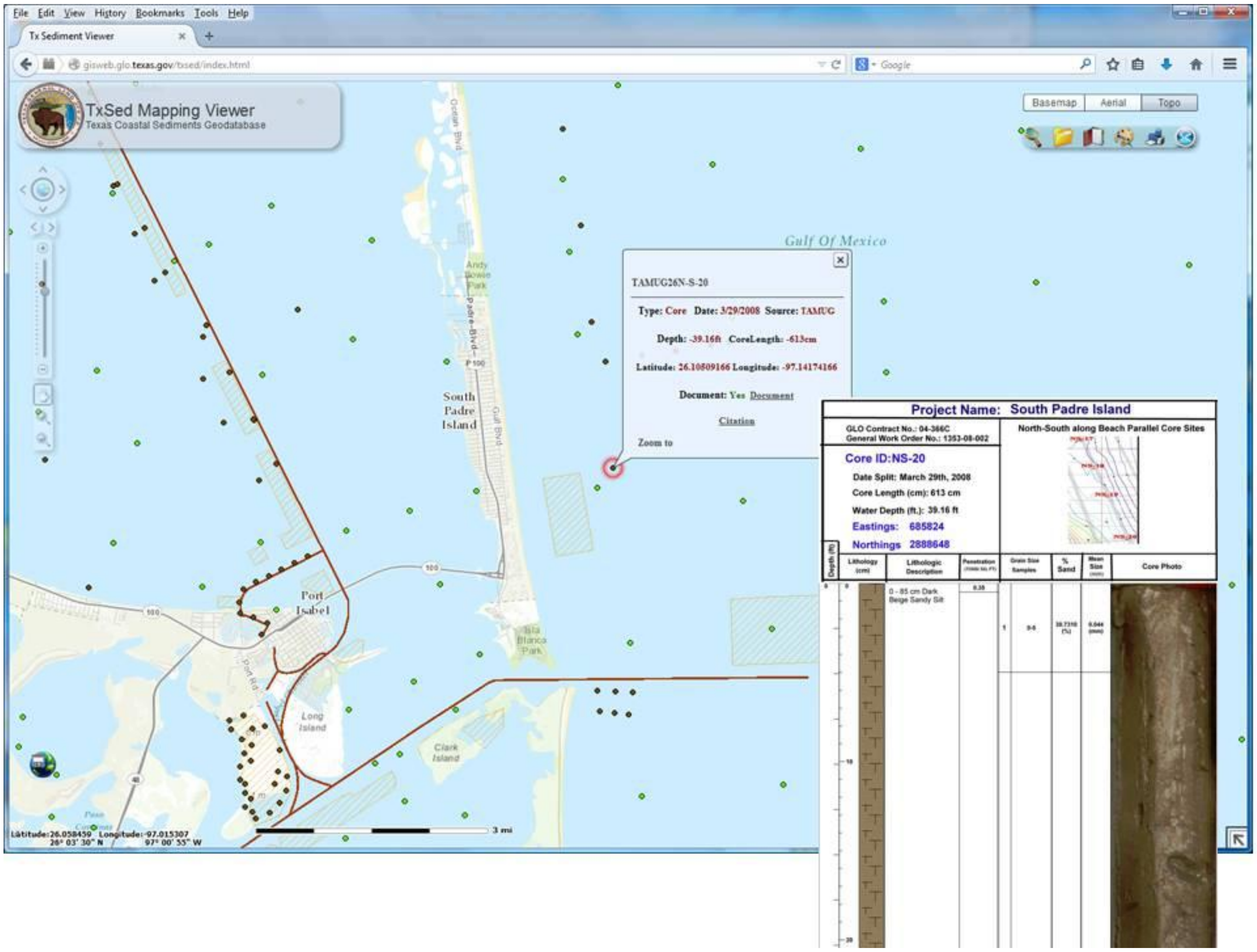

Figure 19. Screen-captured example from the GLO TxSed Mapping Viewer that shows the location of a core, photo, and general description of the type of sediments that can be found offshore South Padre Island.

As described earlier, the BEG provides a Gulf shoreline change web viewer (funded by CEPRA contract no. 09-074-000) that provides local governments, landowners, and the general public information on shoreline change rates at half-kilometer (approx 1640 feet) increments (http://coastal.beg.utexas.edu/shorelinechange/). Maps can be generated from the viewer to show community or property vulnerabilities. The data are also available for download that can be used in geographic information system (gis) analyses.

HRI developed a map viewer (funded by Coastal Impact Assistance Program, Bureau of Ocean Energy Management, Regulation, and Enforcement, U.S. Department of Interior. Award M11AF00025) that provides geohazard information for three barrier islands (Galveston Island, Mustang Island, and South Padre Island). The viewer shows the locations of critical environments such as wetlands, beaches and foredunes and their susceptibility to storm-surge flooding, washover, erosion, and sea level rise (http://geohazards.tamucc.edu/). Parcel overlays are provided so that potential property owners can learn about the geoenvironment, elevation of the property, and any potential geohazard (Figure 20).

The CBI Coastal Habitat Restoration GIS (CHRGIS) program hosts a map viewer that shows the locations of the CEPRA-funded projects monitored by CBI. The viewer provides a description of the project area, historic aerial photographs, before- and after-project photographs, and beach profile survey data that could be used for post-storm applications to FEMA (http://www.cbi.tamucc.edu/CHRGIS/).

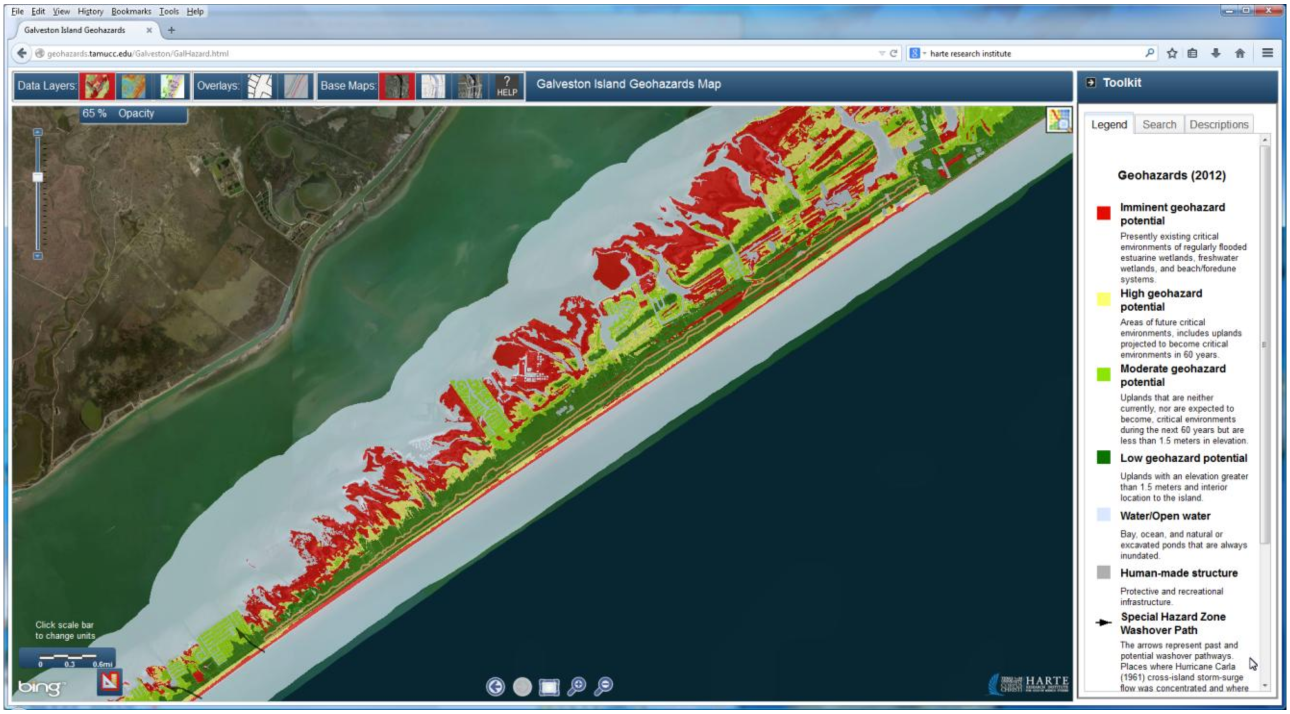

Figure 20. Screen capture of the HRI geohazard web viewer for Galveston Island. The arrows at the bottom of the figure show where former washover channels formed in past hurricanes (HRI, geohazards web link).

DATASETS USED TO ESTABLISH PRIORITIES

The rules set forth in §15.17 Title 31 Texas Administrative Code (2010) for the development of local erosion response plans require Gulf shoreline governments to create building setback lines based upon the BEG's historical shoreline change rates measured from a reference line of the local government's choosing (line of vegetation, mean low tide, mean high tide, or coastal boundary survey). The plans supply maps that show the location of the dune protection line (approved from earlier beach access and dune protection plans) and an evaluation of public beach access areas to determine if improvements are necessary to protect from erosion or storm surge. The datasets used in the erosion response plans are also important for the implementation of the CEPRA program as some of the information may be used in applying for grant funding and could be useful in post-storm assessments.

When a project application is submitted to the CEPRA program for funding, each is ranked using the following priority criteria: *relative severity of erosion in each area; if it addresses an* *emergency erosion situation; the needs in other critical coastal erosion areas; if federal and local governmental financial participation in the project is maximized; if financial participation by private beneficiaries of the project is maximized; whether the project achieves efficiencies and economies of scale; whether funding the proposed project will contribute to balance in the geographic distribution of benefits for coastal erosion response projects in Texas that are proposed or have received funding from the Account; and the cost of the proposed project in relation to the amount of money available in the Account* (§15.41 Title 31 Texas Administrative Code).

The datasets that would best help accomplish the goals for erosion response planning and fund allocation include: historical shoreline change rates; shoreline and dune elevations; line of vegetation; mean low tide; mean high tide; building setback line; dune protection line; public access areas; inventory of public amenities; elevation, width, and percent vegetative cover of critical dunes; dune areas that need restoration (e.g., blowouts in foredunes); locations of re-vegetation projects; coastal public infrastructure; coastal natural resource areas and those that are threatened by erosion. Some of the information is readily available, but others such as the location of mean low tide and mean high tide require licensed state land surveys. Other information is developed by the local governments (building setback lines and dune protection lines) and will require a gis-based effort to consolidate all of the information into one central location. The following are descriptions of available datasets.

Shoreline Change Rates (Gulf)

The maps presented earlier in Figures 5 through 9 show the BEG 1950s-2012 shoreline change rate datasets (in feet) to identify the critical erosion areas along the Gulf shoreline. The rates are calculated from a compilation of maps, aerial photographs, ground surveys and airborne lidar surveys (Paine et al., 2014). This time period was chosen to reflect the conditions after many of the USACE projects were constructed and the shoreline was able to maintain equilibrium with respect to the presence of the structure. The data shown were calculated using end-point analyses (the net amount of change from the earliest 1950s shoreline available to the 2012 shoreline location). This is the method commonly used as a planning tool in the GLO's Coastal Resources program. Shoreline change data are available from the BEG website (http://www.beg.utexas.edu/coastal/tbd_morph.php).

Elevation

The GLO provided digital one-foot contour elevations that were derived from 2012 lidar surveys. The contours cover the entire Gulf shoreline and reach as far landward as 1,200 feet from the wet/dry line. Elevation contours of the beaches and dunes are also included. For this dataset, the 2.0 ft (0.6 m) ((mean sea level - msl) contour is presented in Figures 21 through 25 as this contour elevation generally represents the location of the shoreline and is used in determining shoreline change rates by the BEG (Paine, et al., 2014). Not presented in maps, but important in managing the shoreline, the 4.5 ft (1.2 m) (msl) contour has been determined to generally represent the elevation for the potential location of the natural line of vegetation (Gibeaut and Caudle, 2009). Though this elevation is not identified in the Open Beaches Act, local governments could use it as a point of reference for comparison to the existing line of vegetation and establish it as a proxy that could be used for implementing construction setbacks. The BEG website provides the 2012 datasets for the potential vegetation line and dune boundary

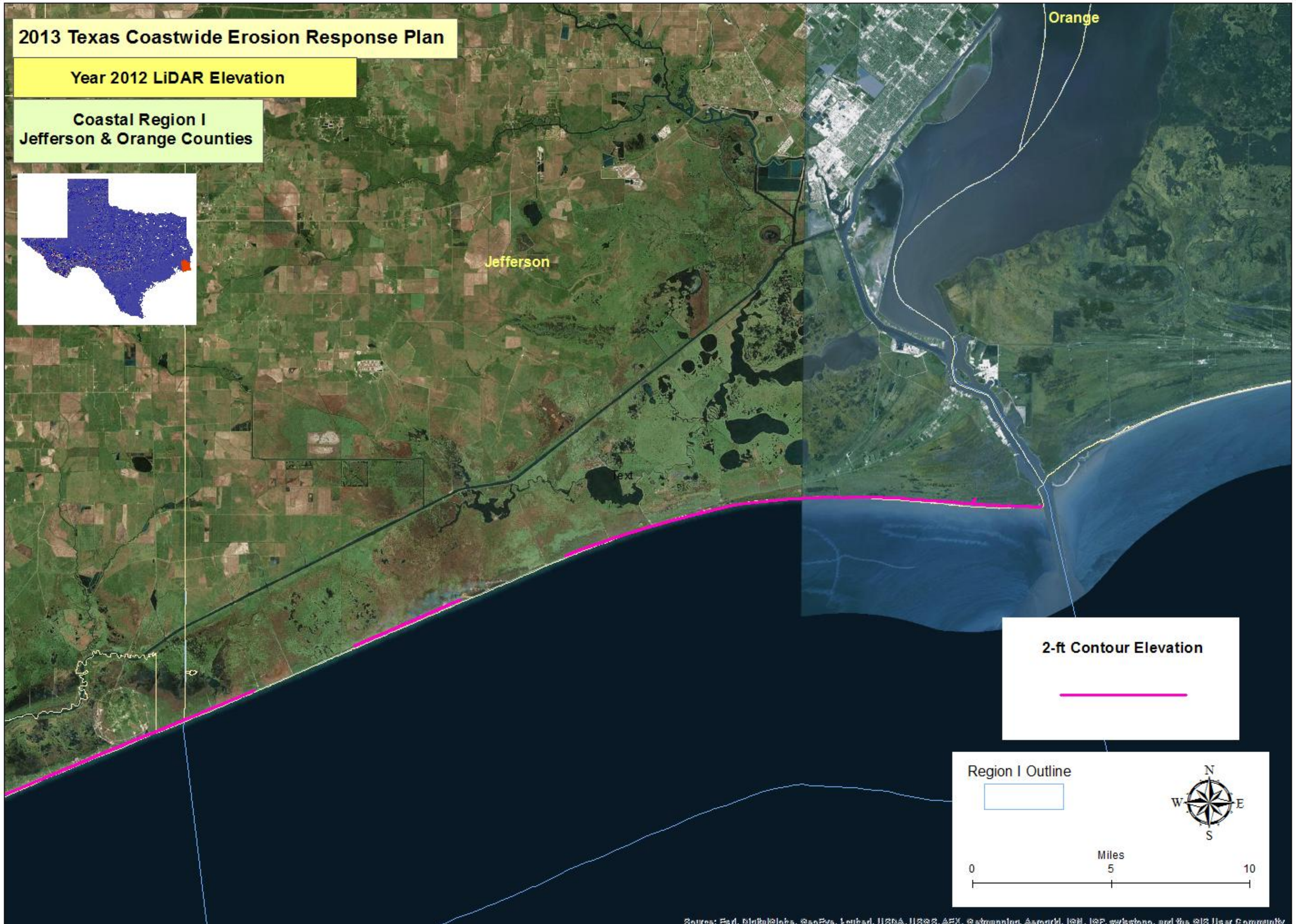

Figure 21. Location of the 2-ft (msl) contour that generally represents the position of the shoreline in Region I.

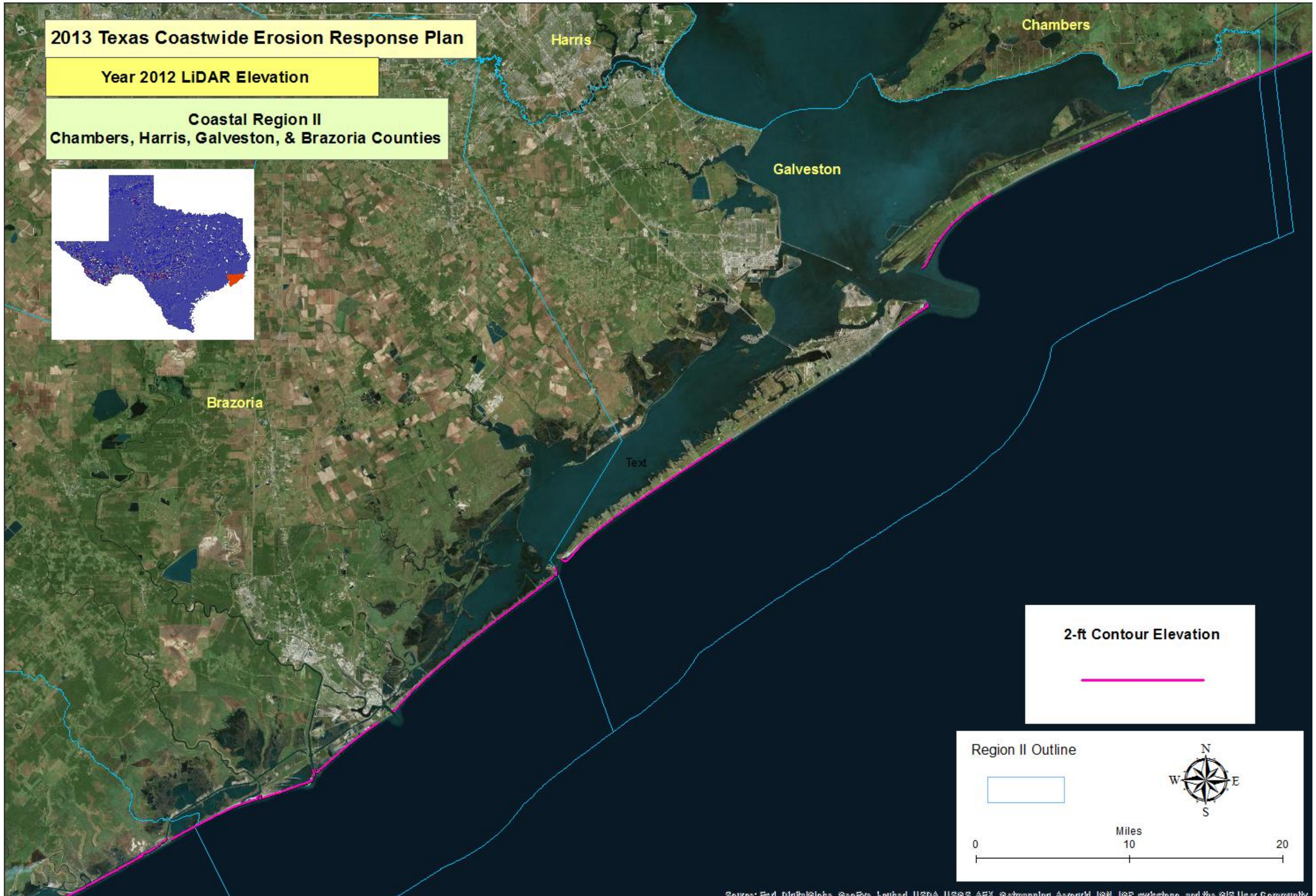

Figure 22. Location of the 2-ft (msl) contour that generally represents the position of the shoreline in Region II.

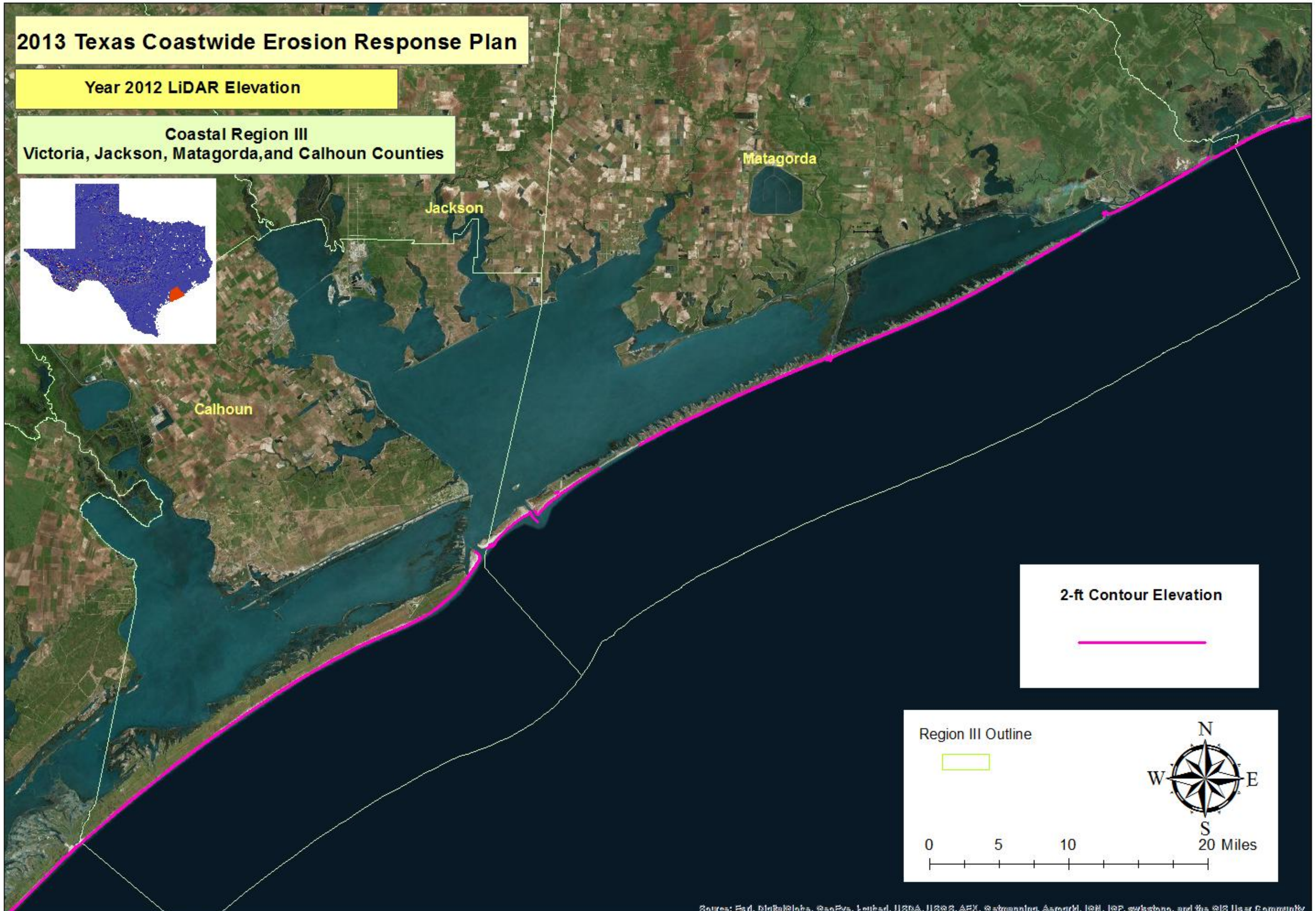

Figure 23. Location of the 2-ft (msl) contour that generally represents the position of the shoreline in Region III.

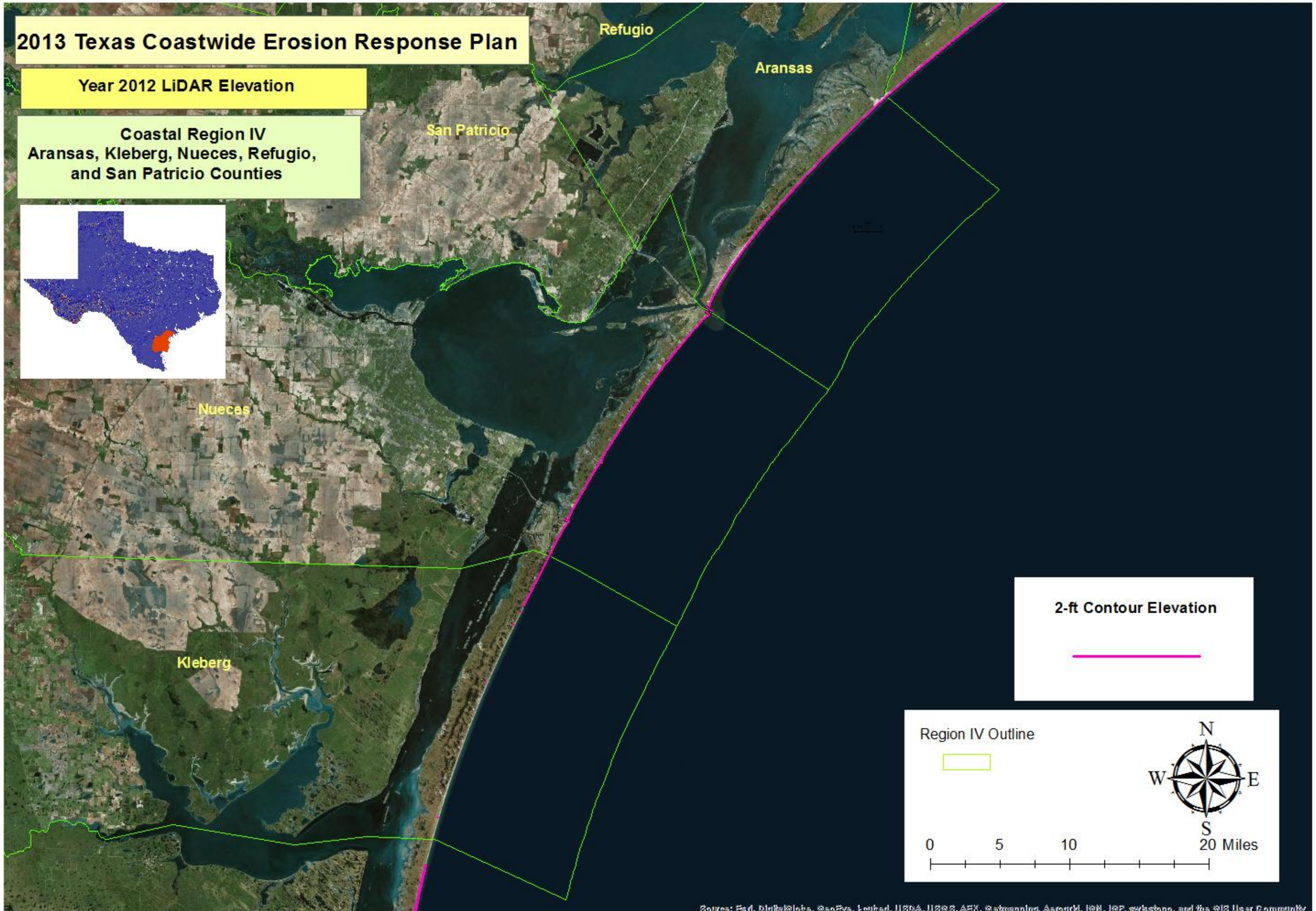

Figure 24. Location of the 2-ft (msl) contour that generally represents the position of the shoreline in Region IV.

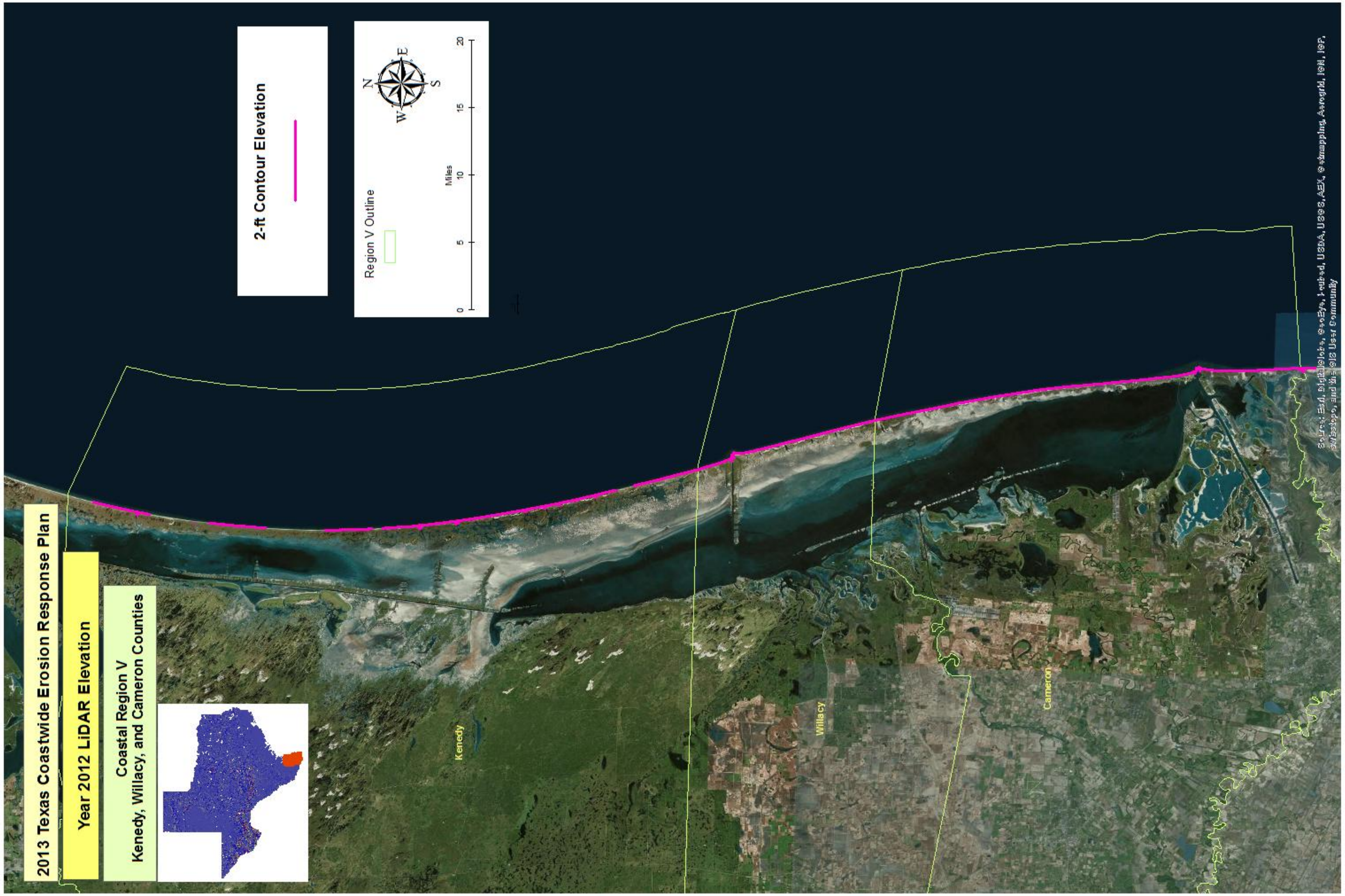

Figure 25. Location of the 2-ft (msl) contour that generally represents the position of the shoreline in Region V.

(http://www.beg.utexas.edu/coastal/tbd_morph.php). Greater detail can be viewed using the associated .kml file for *Google Earth* software.

Beach Access
Figures 26 through 30 show the Gulf beach access points that were generated by the GLO using information from the local coastal governments (http://www.glo.texas.gov/GLO/agency-administration/gis/gis-data.html). The *Texas Beach and Bay Access Guide, 2nd Edition* was created by the GLO (http://www.glo.texas.gov/what-we-do/caring-for-the-coast/_publications/TexasBeachBayAccessGuide.pdf) to show designated public access to the shorelines, wildlife refuges and management areas along the Texas coast. The guide includes descriptions of about 360 bay and Gulf access points and provides listings of amenities and recreational opportunities. The CMP has provided funding to the Texas Sea Grant College program to create a digital database of these access points. The database would also help identify potential access for oil spill response, as well as to CEPRA for setting project priorities.

Coastal Natural Resource Areas (CNRAs) and Resource Management Codes
CNRAs are defined in §33.203(1) of the Texas Natural Resources Code and can include beaches, dunes, washover areas, sand flats as well as coastal preserves and historic areas. The Harte Research Institute for Gulf of Mexico Studies (HRI) is working with the GLO and TNRIS to update the state's Resource Management Codes and will include CNRAs in the updated dataset. The project should be completed by the end of 2014. Resource Management Codes apply to state-owned tracts along and within the Texas bays and offshore Gulf of Mexico. The codes provide guidance for development or other activities in potentially sensitive areas. Dredging, for example, may be limited in some tracts and the codes may indicate that any potential work should be located at a specific distance or water depth from a sensitive area.

CNRAs threatened by erosion (2009 list)
As described above, CNRAs are identified in the Texas Natural Resources Code (§33.203). When these areas are threatened by erosion, they can be labeled as critical and may be good candidates for CEPRA projects. CNRAs that were threatened by erosion were identified by natural resource managers in 2009. Two locations that received CEPRA funding are marshes along the West Galveston Bay shoreline at Delehide Cove and Jumbile Cove. The West Galveston Bay Estuarine Habitat Restoration project was completed using CEPRA Cycle VI and partnership funding sources from the American Recovery and Reinvestment Act (ARRA funds are managed through NOAA), and NRG Texas Power. The project is a GLO-Texas Parks and Wildlife Department partnership and entails the creation of 328 acres of marsh complex along the back barrier portion of West Galveston Island near Galveston Island State Park and Jumbile, and Carancahua Coves. Figures 31 through 35 show the locations of the CNRAs that were determined as threatened by erosion.

Coastal Infrastructure
Coastal infrastructure is presented in Figures 36 through 40. The dataset consists of bridges, bulkheads/docks, exposed riprap structures, seawalls, and facilities at coastal parks, historical sites, oil and gas pipeline crossings on the Gulf shoreline, the liquefied natural gas facility, and the Gulf Intracoastal Waterway (GIWW). These data layers were downloaded from the GLO website and from the Texas Natural Resources Information System (TNRIS). Greater detail can

be viewed using the associated .kml file and *Google Earth* software. In addition, the Center for Texas Beaches and Shores (CTBS) at Texas A & M - Galveston has created a web viewer (with funds from National Science Foundation, TX Sea Grant, Texas General Land Office, and NOAA) for the Texas coastal zone that shows among others –census information, transportation routes, oil and gas facilities, cultural locations, building codes, and hurricane, FEMA flood hazard, fire and wind risk areas (http://coastalarc.tamug.edu/).

Current Data Initiatives

Marine spatial planning is a digital tool that can be used by governmental bodies as a guide to decision making whether it be for economic development or for conservation. The intention is to provide the information to the public to reduce user conflicts, improve regulatory processes, and promote community involvement. Grants from the GLO CMP support the work by the HRI in assembling coastal resource datasets (including vegetative cover, volume, and beach morphology). Other HRI activities include mapping the existing built environment and assessing sea-level rise impacts to Galveston Bay, evaluating ecosystem services of coastal habitats, and hosting the datasets and map service generated under the Gulf of Mexico Research Initiative Information and Data Cooperative. Several of the datasets generated by these initiatives could be used for erosion response planning.

Data Gaps

One of the requirements in applying for CEPRA funding is to supply the erosion rate at the proposed project location. While Gulf shoreline change rates are readily available via the BEG website, available bay shoreline change rates are lacking and a potential applicant must bear the burden of acquiring the appropriate surveys to supply the rates to the GLO. Other datasets that would be beneficial to local governments for erosion planning include digital compilations of: county and municipal building dune protection lines and building setback lines (from the local dune protection and beach access and erosion response plans); locations and relevant information for GLO-funded projects (CEPRA, CMP, CIAP); locations and relevant information regarding FEMA- approved hazard mitigation plans; and locations and relevant information on shoreline change monitoring studies. The GLO and/or TNRIS should either host the data layers or supply links to an appropriate website for access to the information.

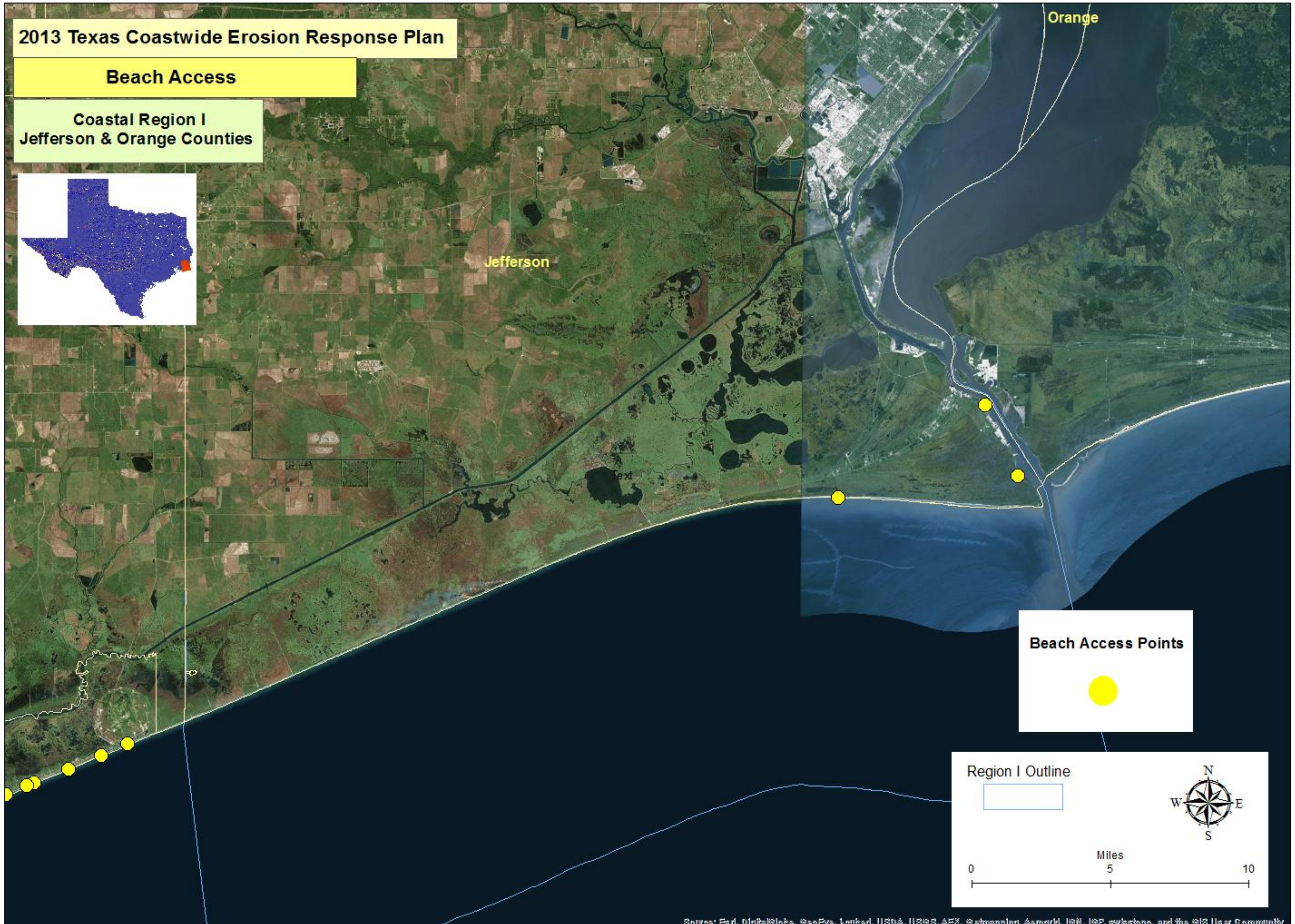

Figure 26. Location of beach access points in Region I.

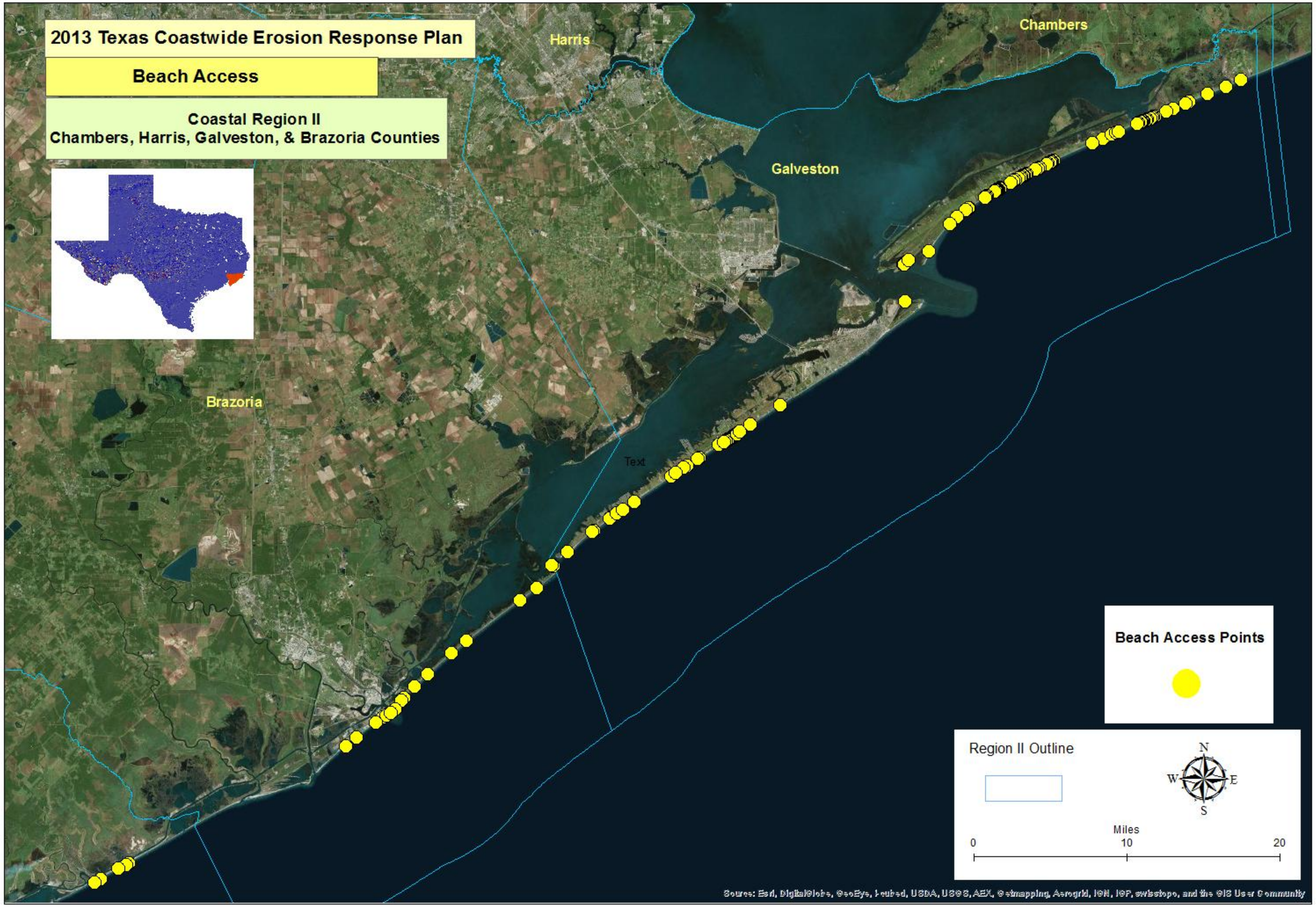

Figure 27. Location of beach access points in Region II.

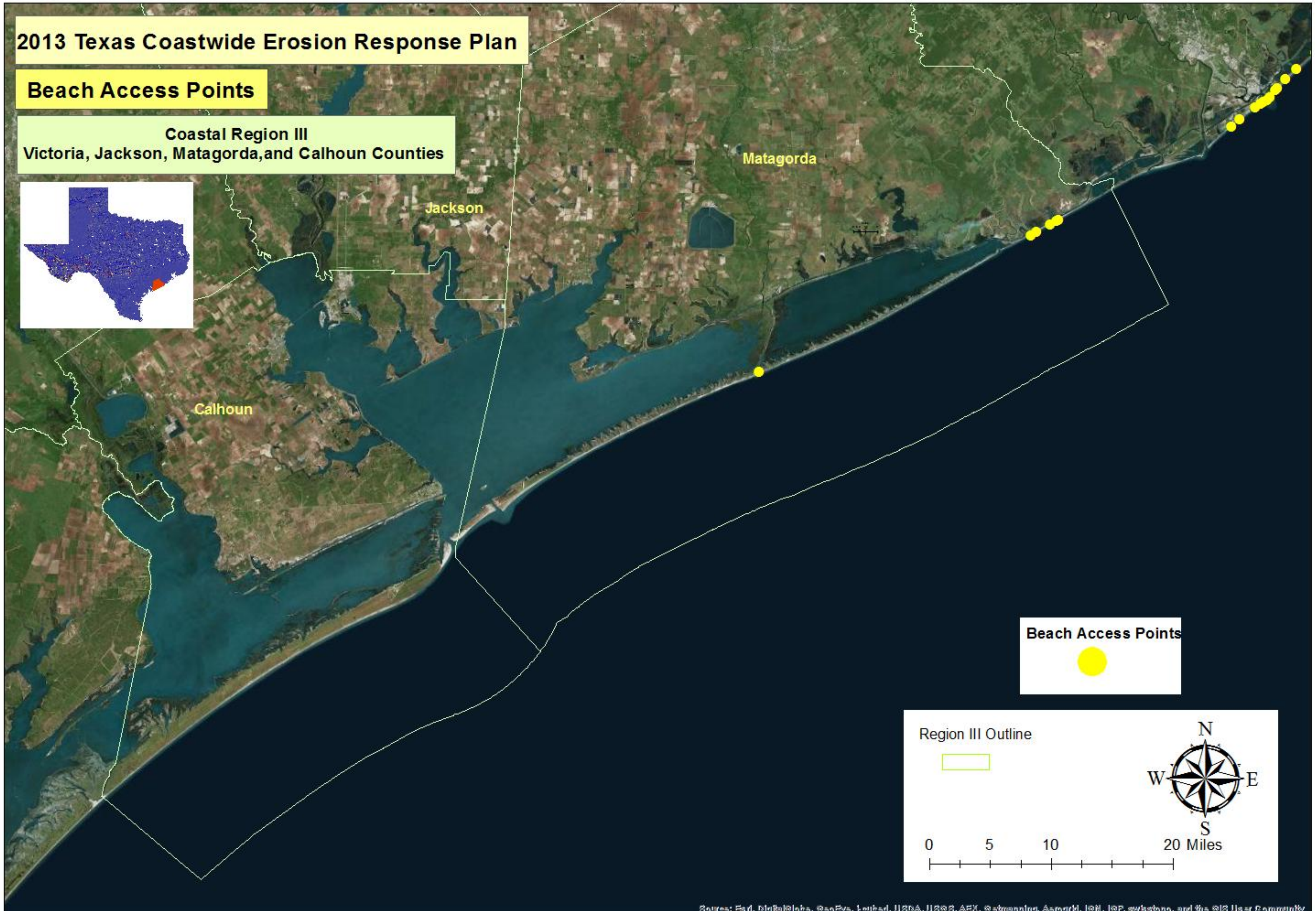

Figure 28. Location of beach access points in Region III.

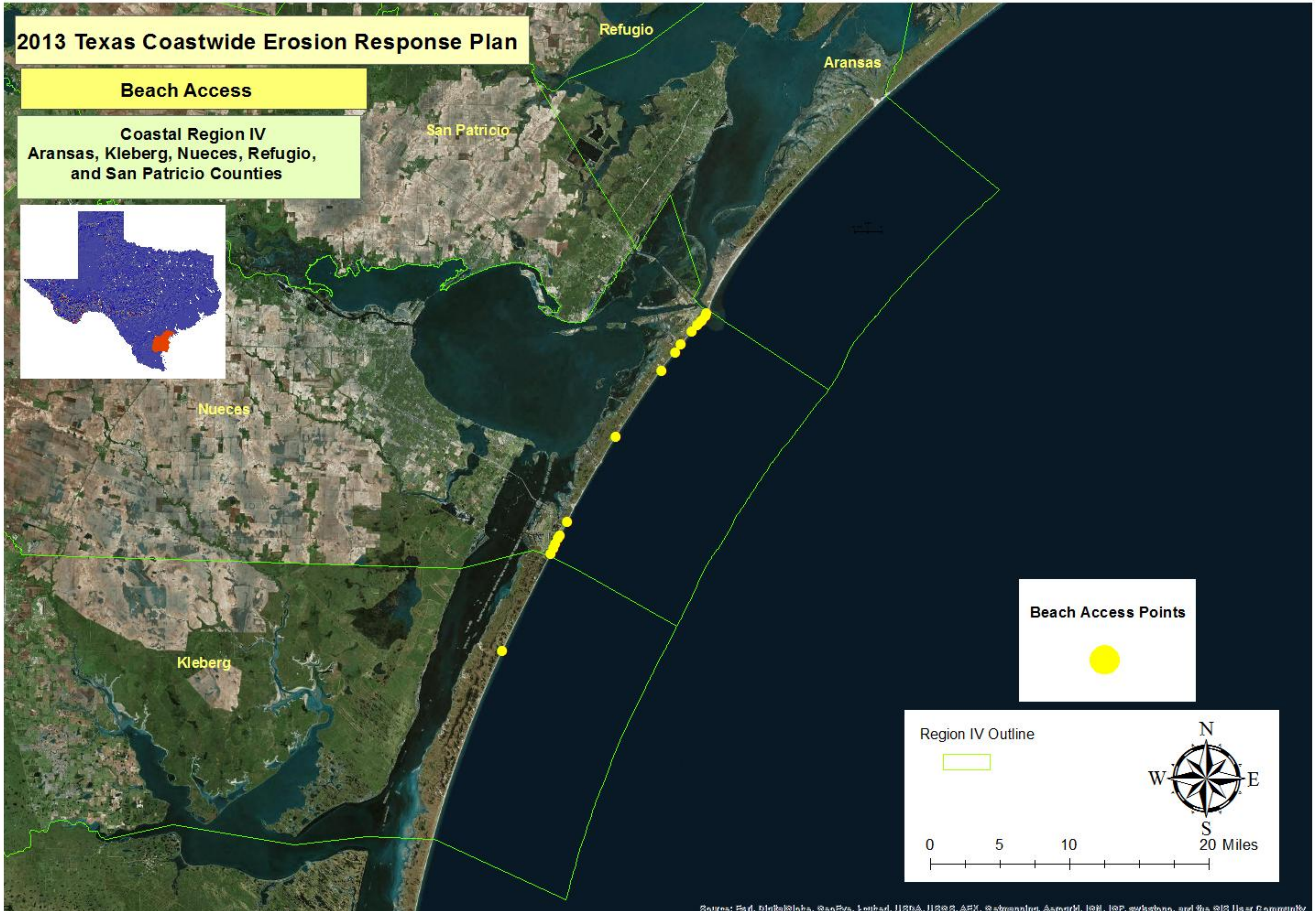

Figure 29. Location of beach access points in Region IV.

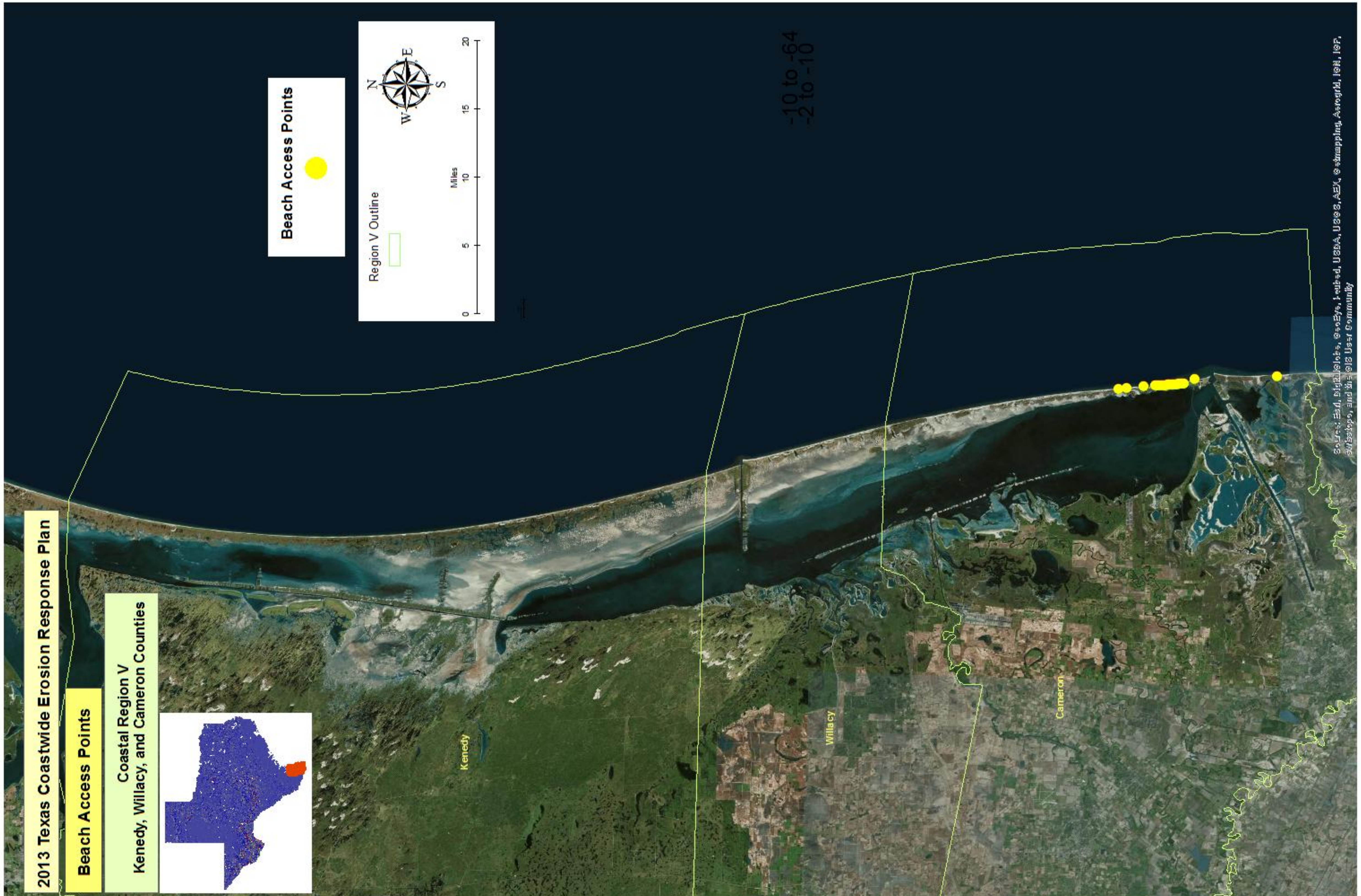

Figure 30. Location of beach access points in Region V.

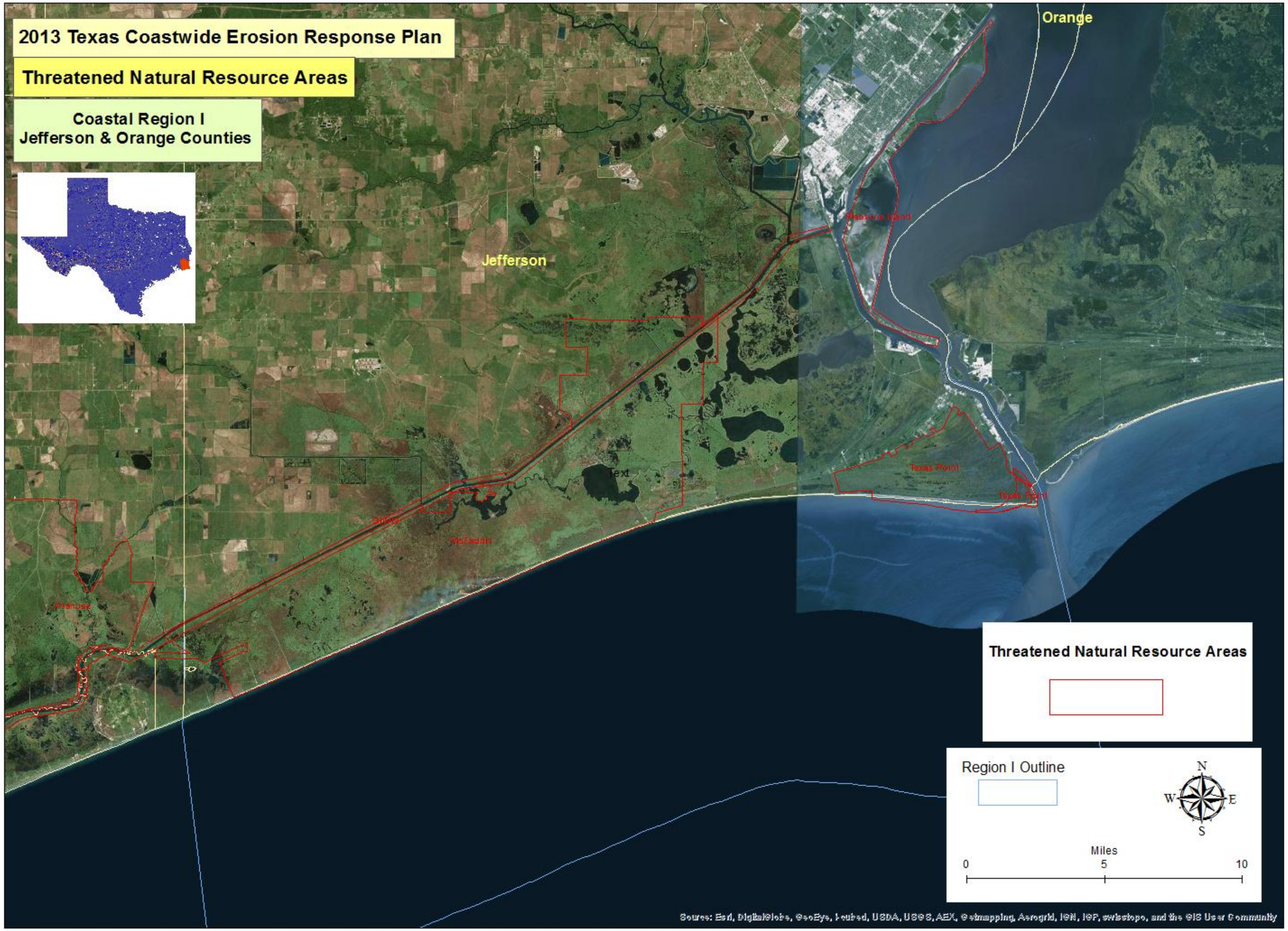

Figure 31. Location of coastal natural resource areas threatened by erosion in Region I.

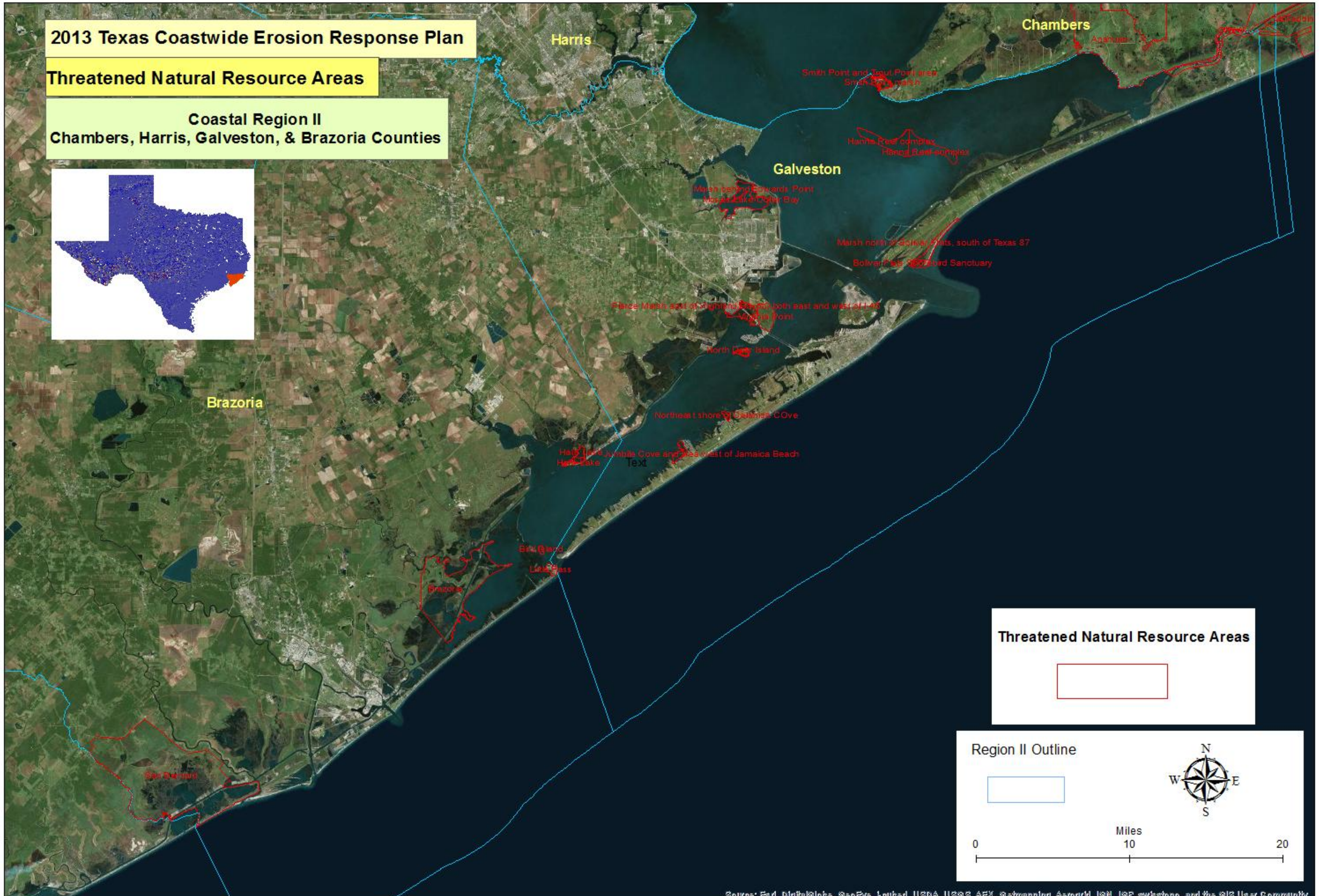

Figure 32. Location of coastal natural resource areas threatened by erosion in Region II.

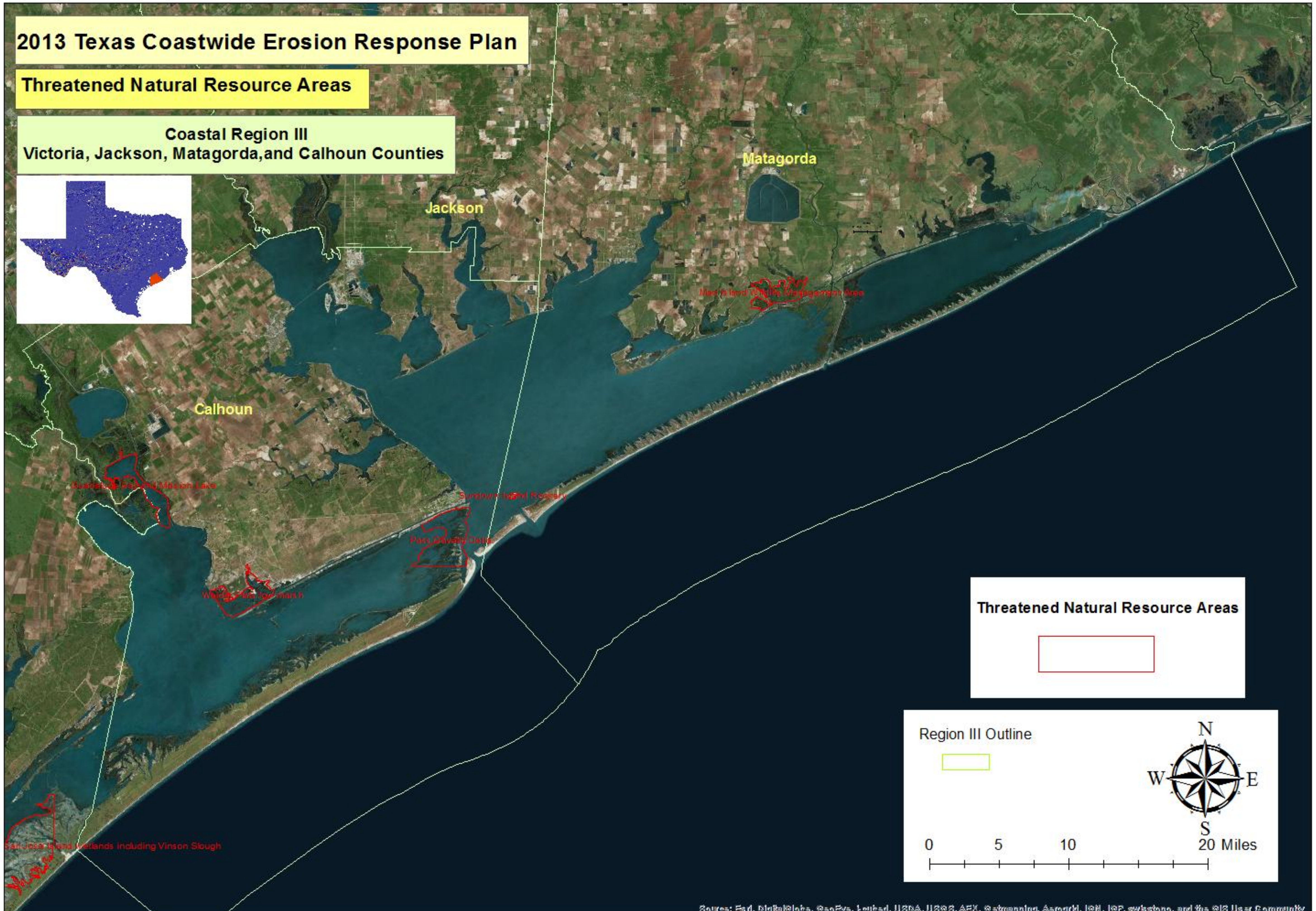

Figure 33. Location of coastal natural resource areas threatened by erosion in Region III.

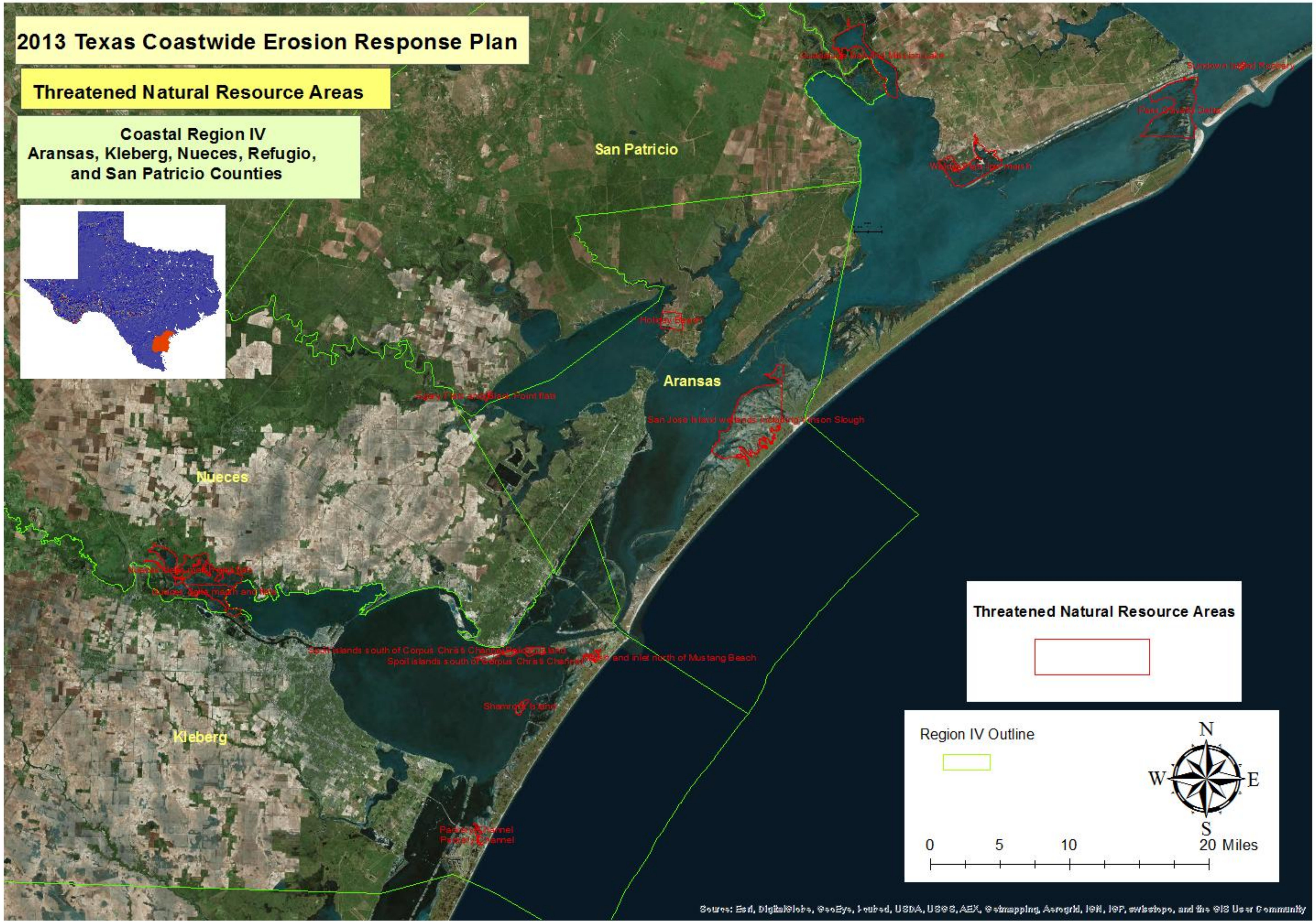

Figure 34. Location of coastal natural resource areas threatened by erosion in Region IV.

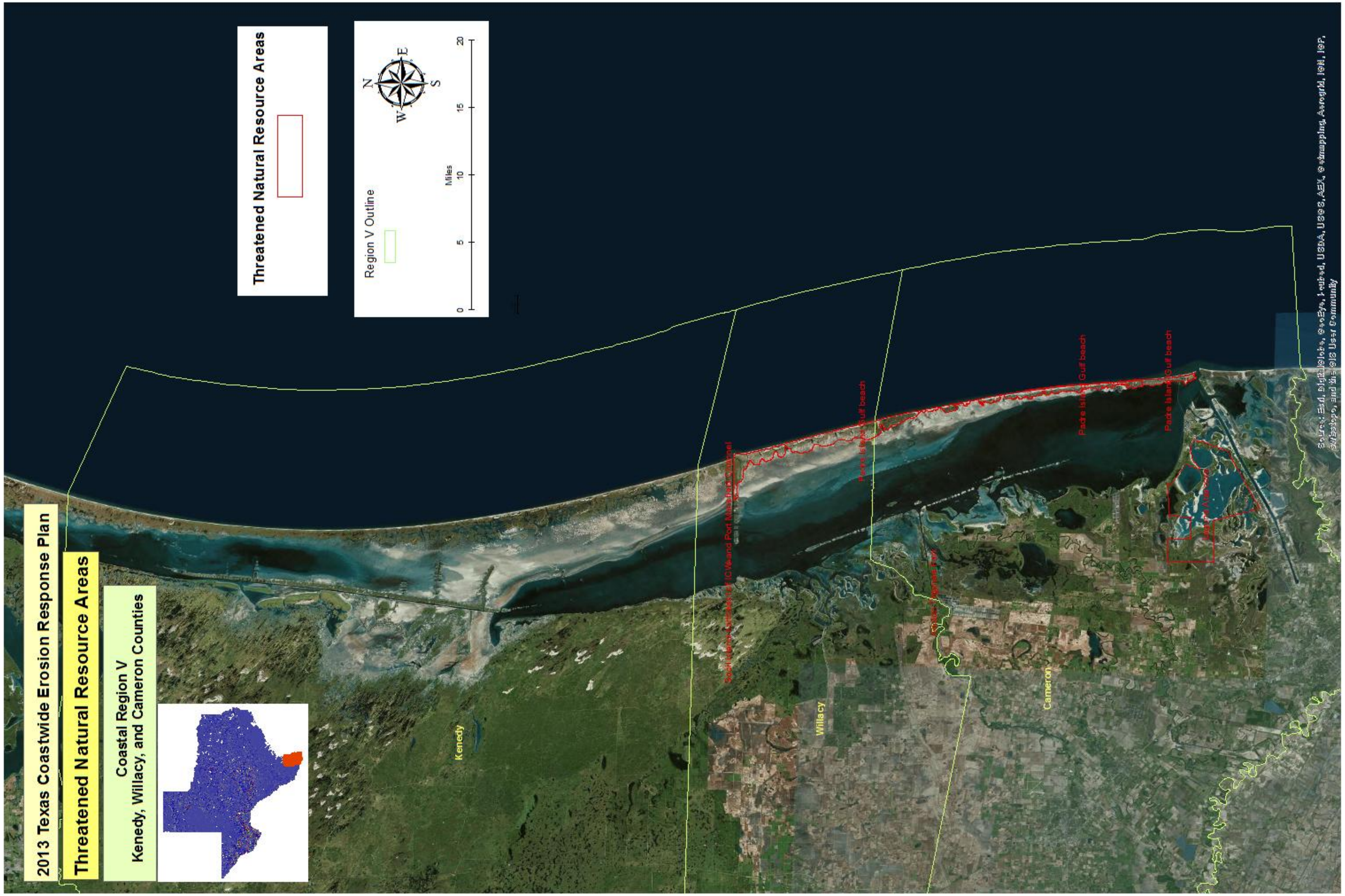

Figure 35. Location of coastal natural resource areas threatened by erosion in Region V.

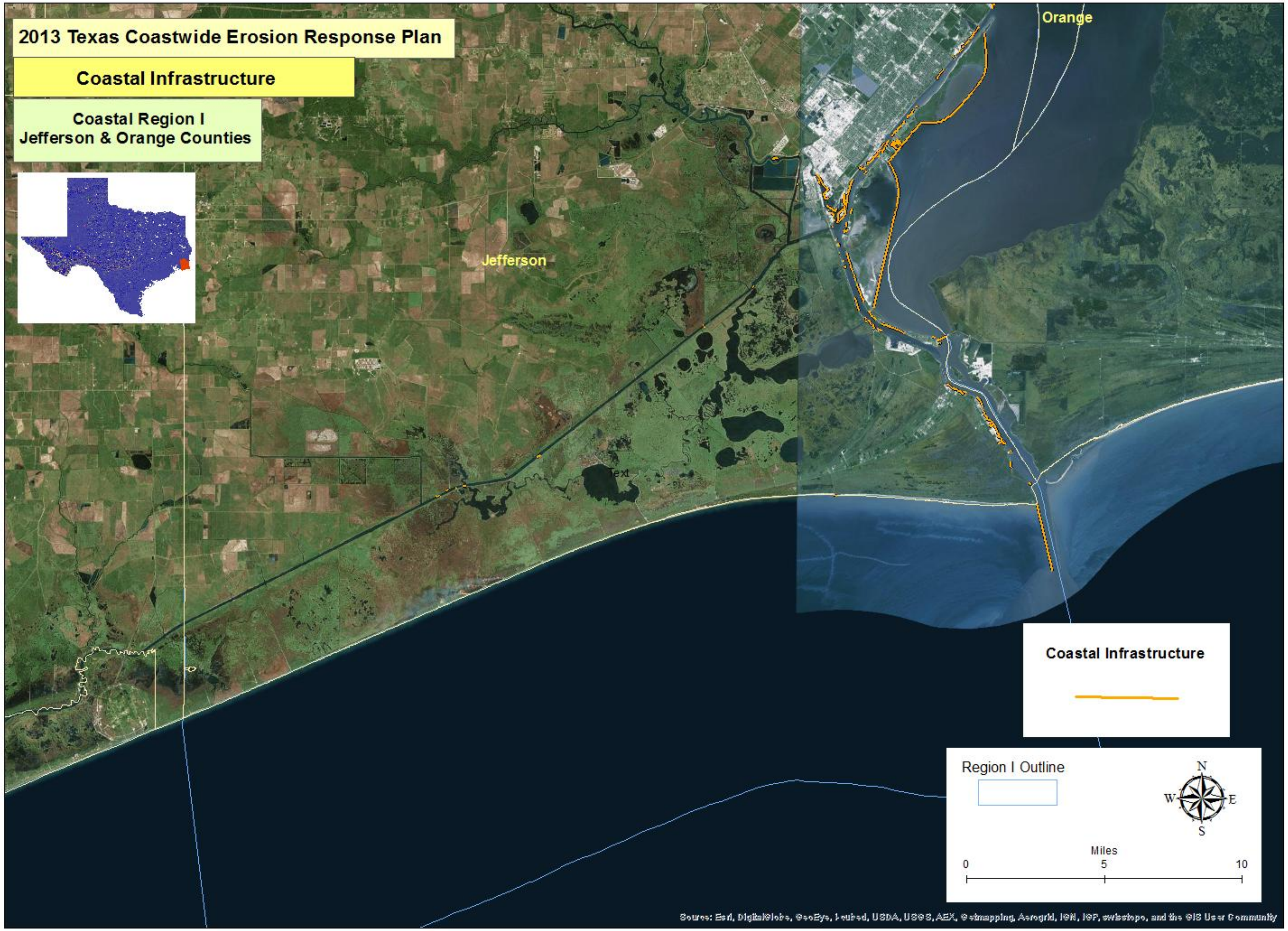

Figure 36. Location of coastal infrastructure in Region I.

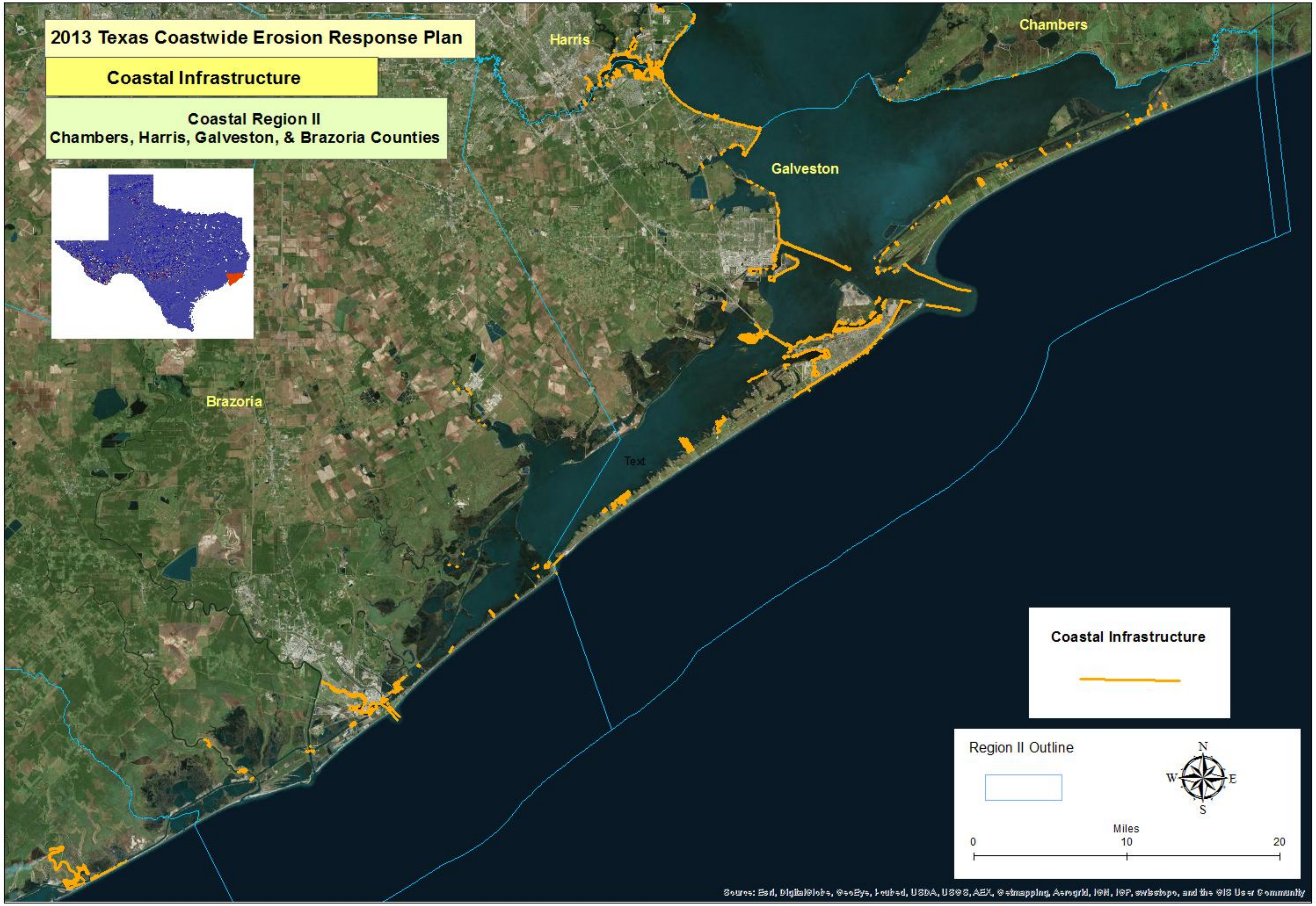

Figure 37. Location of coastal infrastructure in Region II.

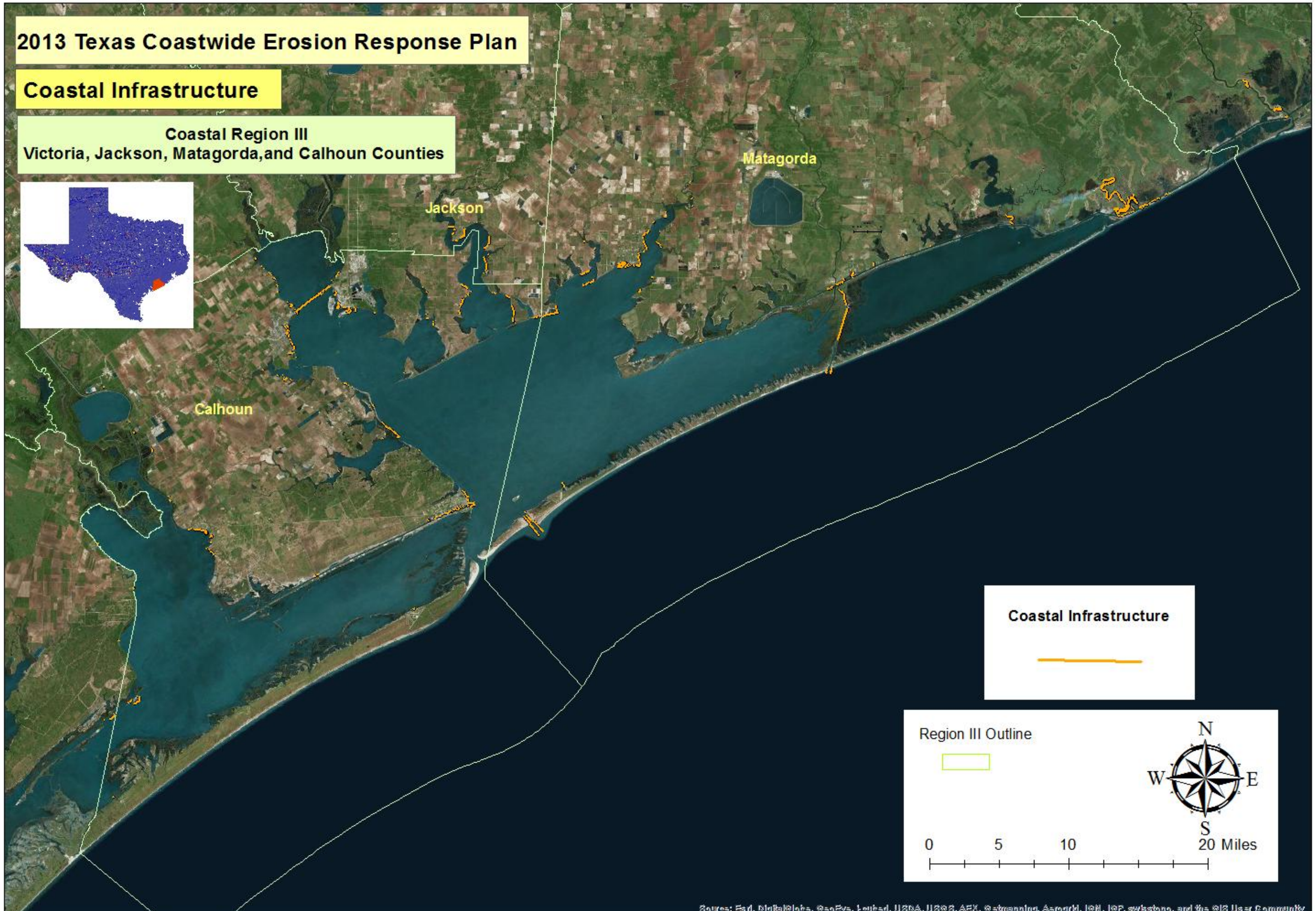

Figure 38. Location of coastal infrastructure in Region III.

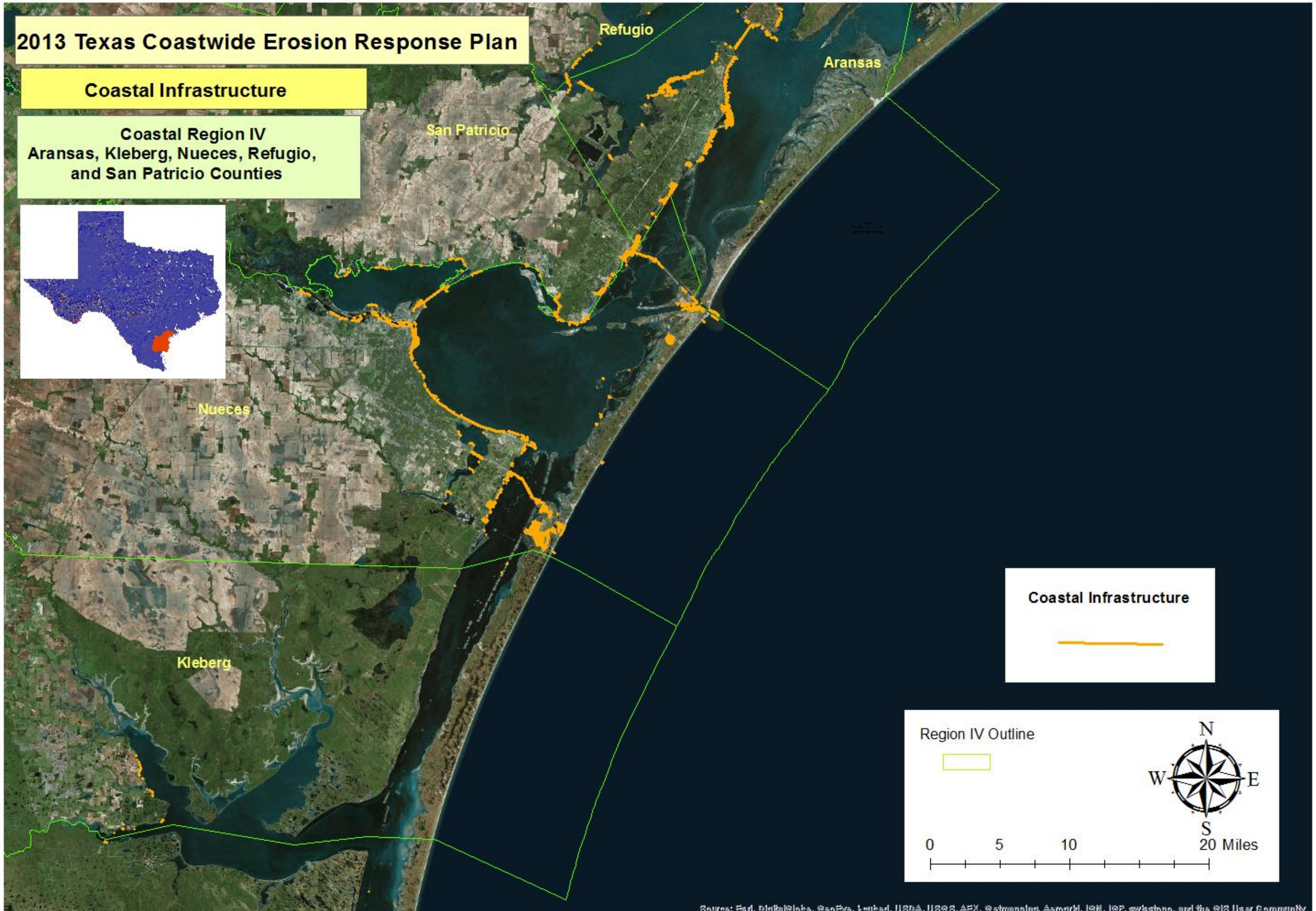

Figure 39. Location of coastal infrastructure in Region IV.

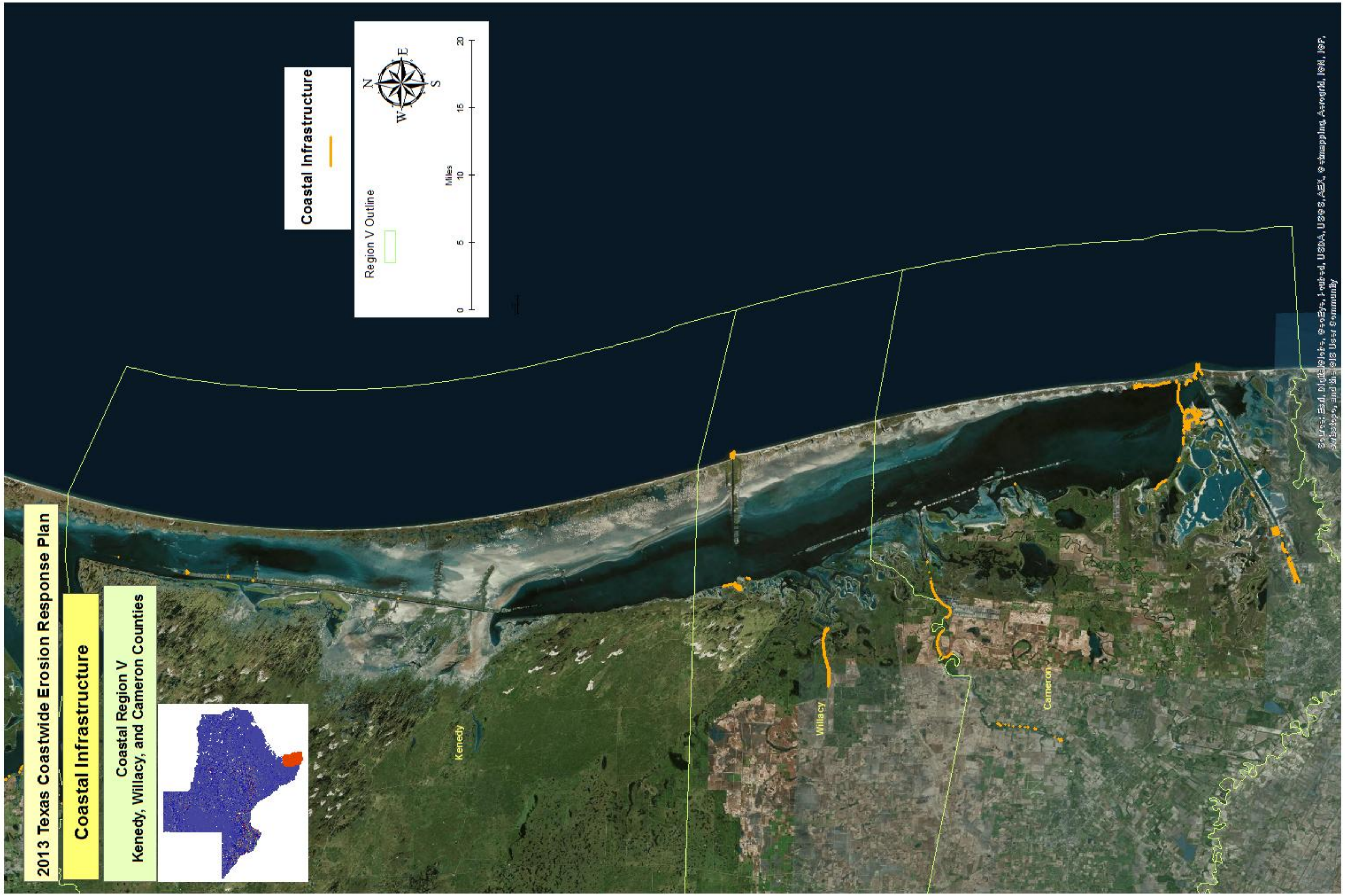

Figure 40. Location of coastal infrastructure in Region V.

SUMMARY

Coastal erosion remains a continuing threat to the Texas Gulf and bay shorelines. Whether the erosion is caused by the lack of sediments to balance the long-term losses within the coastal compartments, or the episodic erosion brought on by storms or human activities, planning and implementation of erosion response and sediment management practices is essential to the sustainability of the shoreline and public beaches. This report summarizes the latest shoreline change research results published by the Bureau of Economic Geology at the University of Texas at Austin and maps are provided that show critical erosion areas along the Texas Gulf shoreline. The CEPRA program is still dealing with Hurricane Ike recovery issues as many emergency recovery projects relied on FEMA cost-shared funds and a number of those projects continue to await federal cost-shared funding approval. Managing coastal erosion and maintaining the balance with private property and the public's right to access and use of the Gulf beaches has become even more difficult since the Texas Supreme Court opinion was issued in 2010 and reaffirmed in 2012. The results from the Supreme Court of Texas opinion regarding public access to the Gulf beaches and the "hands off" management by the City of Galveston have allowed west Galveston Island shorefront landowners and local homeowners associations to face public use and construction activities on their own. Since Galveston does not follow up with construction inspections after permits are issued, it is not known if structures are built within the appropriate rules for protecting dunes or from flood risks. With high erosion rates, beachfront homes on west Galveston Island are more vulnerable to storms and elevated water levels and without proper erosion response projects, will eventually wind up on the public beach and eventually on state-owned lands. Though erosion of the Gulf and bay shorelines are continuing, human intervention is making an impact through the efforts of the CEPRA program in maintaining the shoreline position. It is important to stress the necessity for keeping eroded and dredged sediments in the local littoral system and practicing sediment conservation. The highest benefit-to-cost ratios for CEPRA projects are realized from partnerships with the USACE for the beneficial use of dredged material arising from federal navigation maintenance events for beach nourishment and dune restoration, and the restoration of eroded habitats. With the exception of a few, local governments are doing their best at shoreline management practices through the implementation of their dune protection/beach access and erosion response planning efforts which protect coastal sand dunes and locate new structures as far landward as possible. These efforts should help ensure public access and use of the beaches and reduce the potential for future public expenditures on managing erosion and storm damage losses.

OBSERVATIONS AND RECOMMENDATIONS

The following are recommendations arising from this study:

- Establish a permanent, more reliable funding source for CEPRA and allow carry-over authority for funds into subsequent biennial funding cycles. Today, the Texas Legislature appropriates the biennium funding from the General Revenue Fund. Erosion response projects can take longer than two years to plan, design, permit, and construct and potential projects may not receive the adequate funding from one funding cycle for all phases from planning to construction.

- Maximize federal participation in erosion response planning efforts and include USACE BUDM, shore protection, and regional sediment management planning efforts, BOEM sand resource studies, and NOAA Coastal Management Program funding.

- Complete a sand-needs resource assessment for the critically eroded areas and investigate sand resources in state waters. Sediment supply and balances are important in maintaining the shoreline position and mitigating erosion caused by storms and long-term erosional trends. Continue updates to publicly-available *TxSed* geodatabase.

- Mapping the elevations of the line of vegetation, dune crest, and landward limit of the dunes was completed by the BEG (Paine et al., 2013). These areas should be revisited following a major storm and/or through acquisition of coastal lidar for monitoring shoreline changes and data made available to local governments for planning and emergency response to storms.

- Provide funding opportunities for local governments that implement proactive rules that protect dunes, anticipate erosion, establish building setbacks, and defend the public beach easement.

- Provide technical assistance and funding that address best management practices for the removal of *Sargassam*.

- Continue CEPRA funding for structure and debris relocation/removal projects that ensure greater public beach access and allow for the facilitation of potential beach nourishment projects.

- Continue allocating CEPRA funding for erosion response studies including sand resource, shoreline change, and BMMP studies. It is important to rely on good science and engineering when considering erosion response projects for a specific area. Several CEPRA-funded monitoring projects and sand resource studies help identify the vulnerability, the need for protection, and final design. The studies also provide the information required by FEMA for reimbursement following declared disasters.

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ACRONYMS

Bureau of Economic Geology, University of Texas at Austin (BEG)
Beneficial Use of Dredged Material (BUDM)
Bureau of Ocean Energy Management (BOEM)
Coastal Erosion Planning and Response Act (CEPRA)
Conrad Blucher Institute for Surveying and Science (CBI)
Harte Research Institute for Gulf of Mexico Studies at Texas A&M University, Corpus Christi (HRI)
National Oceanic and Atmospheric Administration (NOAA)
Regional Sediment Management (RSM)
Texas General Land Office (GLO)
Texas Governor's Division Emergency Management (TDEM)
Texas Open Beaches Act (OBA)
US Army Corps of Engineers (USACE)
US Army Corps of Engineers – Galveston District (SWG)
US Fish and Wildlife Service (USFWS)

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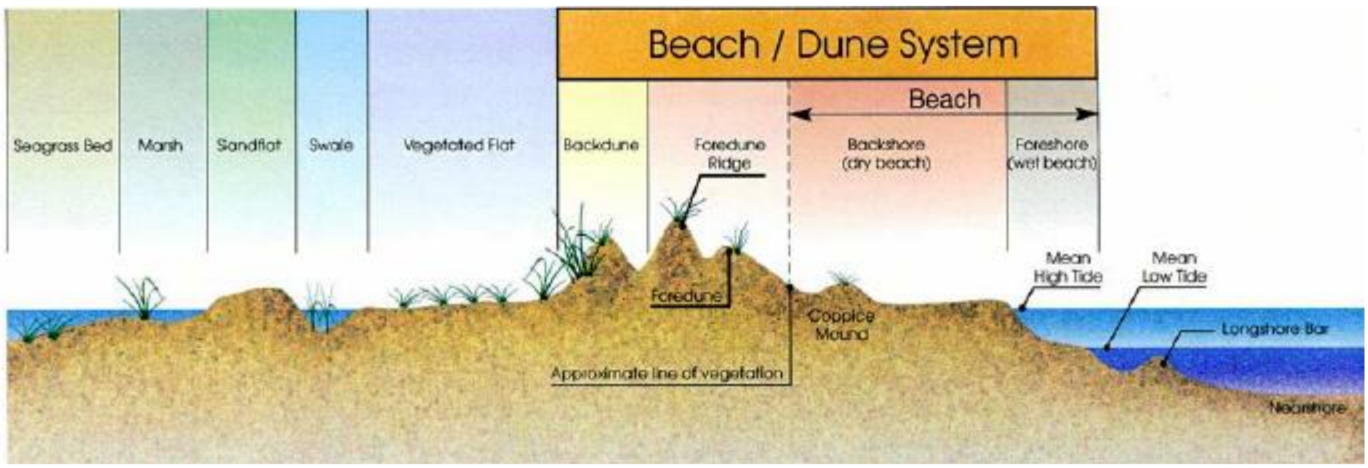

Cross section from a Texas barrier island and terms used in report (from GLO, 2001)