TEXAS COASTAL RESILIENCY MASTER PLAN

MARCH 2023

Commissioner Dawn Buckingham, M.D.
Texas General Land Office

TEXAS GENERAL LAND OFFICE
ESTABLISHED 1836


(Photo Credit: Freese and Nichols, Inc.)

Note from Texas Land Commissioner, Dr. Dawn Buckingham:

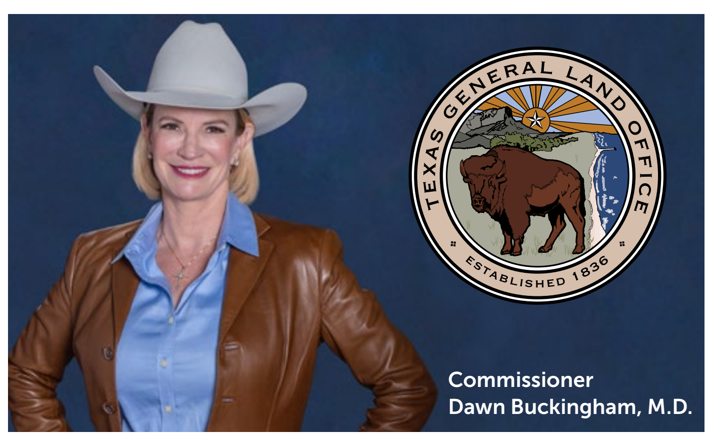
As I assume the role of Commissioner of the Texas General Land Office (GLO), I'm excited about the many opportunities in front of us to restore, enhance, and protect the many vibrant human and natural communities that currently prosper along the Texas coast. Growing up near the Texas coast and living in Galveston for more than a decade, our Texas coastal areas are very near and dear to my heart. The state's coastal area is widely known for its unique environments that beckon travelers from around the country and world. This draw to our Texas coastal area plays a crucial role in the creation and transportation of numerous products that contribute to our economic success. While we have much to be thankful for as Texans in terms of our quality of life and effective economic prospects, we also know that it's necessary to prepare ourselves for the next storm or set of environmental challenges. With this 2023 Texas Coastal Resiliency Master Plan, I aim to advance a vision to invest in the long-term protection of our people, infrastructure, and natural resources in meaningful ways.

This Plan should be viewed as complementary and concurrent to the massive investments being made in partnership with the U.S. Army Corps of Engineers through the Coastal Texas Program to reduce risk from hurricanes and restore vast areas where wildlife habitats have been degraded. The GLO's role in this partnership is imperative for the future of the Texas coast and one that I will continue with the fullest support of my administration of the GLO. This update to the Texas Coastal Resiliency Master Plan presents a critical part of my strategy to capitalize on the momentum of support through the prior versions released in 2017 and 2019 to identify actions and strategies that will boost our coastal system's ability to respond positively to vulnerabilities that exist within the coastal area that are observable today or predicted for the future. As Texans, we've always been strong spirited and resilient through the historical hardships we've endured; hurricanes, floods, and other disasters have never slowed down our endeavors in establishing a place on the world stage. We know that volatile weather is a condition of our geography as a Gulf coast state and we are prepared to dig our heels in to do what is necessary to ensure a strong future and maintain our legacy as a dynamic leader in the nation, and the world. Through careful consultation with local stakeholders and coastal experts, the Tier 1 projects prioritized in this Plan will continue to assist the GLO in making informed decisions over where to invest funding to combat erosion, fortify storm protection, and safeguard water resources.

I will persevere in this mission by utilizing the various GLO programs that implement this Plan, working together with local, state, federal, and all partners to leverage funds to build important projects that innovate to defend our state. The vision I have laid out in this Plan will work to the benefit of all Texans and will conserve a thriving coast for an independent Texas. I know the work of stewarding our coastal resources will require determined adaptation that doesn't rest alone on the recommendations within this Plan now in 2023. This state-led, ongoing, and long-term planning process is one of many in my role as the Texas Land Commissioner that I am highly committed. Resolute communities are critical in guaranteeing a promising future. The information in this Plan can help coastal communities identify the methods needed to increase preparedness and mitigate the negative impact of natural disasters and environmental degradation issues.

The GLO is committed to working with all coastal partners to implement the actions and strategies that provide benefits to the environment and the economy. The cumulative development and implementation of future updates to this Plan will ensure highly efficient investments to enhance our coastal communities, infrastructure, and ecosystems by way of ideas that aim high and think big for current and future generations of Texans.

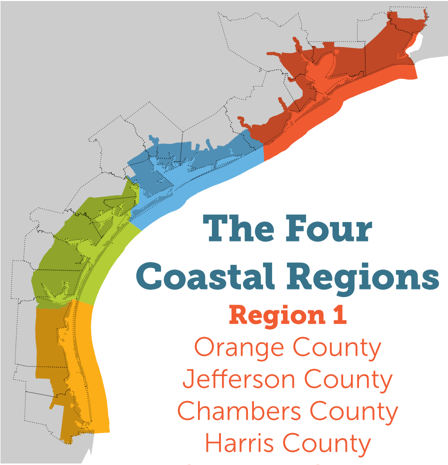
For Texas,
Dawn Buckingham, M.D.
Commissioner, Texas General Land Office



Commissioner
Dawn Buckingham, M.D.

(Photo Credit: Rusty Feagin)

Executive Summary



The Four Coastal Regions

Region 1
Orange County
Jefferson County
Chambers County
Harris County
Galveston County
Brazoria County

Region 2
Matagorda County
Jackson County
Victoria County
Calhoun County

Region 3
Refugio County
Aransas County
San Patricio County
Nueces County
Kleberg County

Region 4
Kenedy County
Willacy County
Cameron County

The Texas General Land Office (GLO) is pleased to present the 2023 Texas Coastal Resiliency Master Plan (Plan)—the third installment of its statewide plan to protect and promote a vibrant and resilient Texas coast that supports and sustains a strong economy and healthy environment for all who live, work, play or otherwise benefit from the natural resources and infrastructure along the Texas coast.

The Texas coast is made up of more than 3,300 miles of bay shorelines and vast expanses of tallgrass prairie uplands, saltmarsh wetlands, beaches and dunes, estuaries, and other ecosystems that contribute priceless natural and aesthetic resources to humans. Moreover, nearly 6.92 million people in 18 counties call the Texas coast their home, and industries contributing to the coastal economy employ upwards of 400,000 people in coastal counties and over 1.55 million people statewide.[1,2] To protect the livelihoods, communities, safety, and security of our people, Texans need a Texas-sized plan to protect our coast.

This Plan proposes to do just that. With an estimated $1.87 billion in proposed coastal resiliency projects, spanning 10 priority statewide actions that range from Managing Coastal Habitats to Enhancing Emergency Preparation and Response, the GLO is prepared to manage the public coastline, steward its natural resources, protect its ecosystems, and defend its businesses and people from hurricanes and natural disasters, now and into the future.

The Continued Need for Resiliency

The economic importance of the Texas coast cannot be understated. The Texas coast is home to a thriving coastal economy built on waterborne commerce, energy and chemical industries, military, commercial and recreational fishing, marine transportation, ship building, and tourism and ecotourism sectors. Throughout Texas's four coastal regions in 2020, annual wages supported by the coastal economy exceeded $25.6 billion over nearly 20,000 businesses.[2] Texas's ports include three of the top five fastest growing ports in the nation by export revenue from 2010 to 2020 and the ports system as a whole provides, collectively, $450 billion in economic value to the state on an annual basis.[3] Texas, the largest energy producing state in the nation, accounted for 43% of the nation's crude oil production and 26% of its marketed natural gas production in 2020.[4] Nearly one-third of the state's employment in heavy construction is found in the 18-coastal county area.[2] These are just some of the measures that emphasize the critical role coastal resiliency plays to support the state's economic backbone and allow it to continue to provide the resources, benefits, and protections Texans need.

Resiliency is a guiding principle for how the GLO plans for the future of the Texas coast. For the GLO, "resiliency" means setting a high bar for itself where coastal management is concerned. It means that the GLO is continually being proactive in its directive to manage the Texas coast, looking at the coastal system as a whole, listening to the needs of stakeholders, identifying projects that address multiple vulnerabilities, working with nature, adapting to living with (or, at times, without) water, anticipating and planning for future threats to its shorelines, and capably responding to hazards and natural disasters as they arise. The resiliency needs of the coast differ for each of Texas's four coastal regions. Prioritized projects have been identified within this Plan for each region to allow comprehensive coverage for the entire Texas coast. Additionally, the GLO is working alongside the Federal government through its ongoing support of the U.S. Army Corps of Engineer's Sabine-to-Galveston Coastal Storm Risk Management Program and Coastal Texas Program so that resiliency needs are addressed at state, federal, and local levels.

Go Deeper

Throughout this Plan, you will find color-coded text boxes to explain important terms, elaborate on topics, and explore successful projects.

Key Terms: Detailed explanations of terms used throughout the Plan.

Deep Dives: Examples of challenges currently faced along the Texas coast.

History of Success: Projects with successful implementation along the Texas coast.

Highlight Projects: Projects currently underway along the Texas coast.

A Data-Driven and Stakeholder-Informed Plan

Understanding that coastal resiliency can come with important, but competing priorities, the GLO has worked diligently to craft a Plan that is data-driven and stakeholder-informed. The recommendations presented herein reflect updated sea level rise and storm surge models, best available shoreline and landcover change data, and the latest socioeconomic statistics. Over the past 4 years of the planning cycle for this Plan, the GLO has engaged coastal planners, community leaders and decision-makers, coastal scientists and engineers, ports and navigation professionals, private industry leaders, technical experts, resource agency and regulatory staff members, and individual citizens as part of a Technical Advisory Committee (TAC) to hear more about what is working well and where improvements could be made. Throughout the 2023 Texas Coastal Resiliency Master Plan, sections that relied significantly on data analytics and mapping and stakeholder involvement will be flagged to acknowledge the key contribution that these two elements bring to this Plan.

Data Informed
Stakeholder Informed

This Plan uses findings from best available coastal datasets as well as targeted feedback from coastal practitioners and experts to evaluate potential solutions. These icons will be used throughout this document to showcase elements of this Plan that are stakeholder and/or data informed.

Navigating This Plan

The tabs below are used throughout the 2023 Plan. These tabs can be found at the top of each page, as well as color coded tabs for region-specific content.

- The Planning Process
- Texas Coastal Systems
- The State of the Coast
- Changing Landscapes
- Actions Toward Building Resilience
- Texas's Path Forward & Implementation

Kemps ridley sea turtle hatchling (Photo Credit: Patty Alexander)

This Plan's Structure

This Plan is divided into six sections, which include:

- **Section 1: The Planning Process.** Introduces the overall need for this Plan, the GLO's goals and objectives, the GLO programs responsible for coastal resiliency, major partners working alongside the GLO, enhancements since the 2019 Plan, and completed and ongoing projects from the 2019 Tier 1 list.
- **Section 2: Texas Coastal Systems.** Gives a backdrop of the natural, social, and economic systems in Texas, the interactions between them, and how these systems individually and collectively pertain to coastal resiliency.
- **Section 3: The State of the Coast.** Describes statuses and trends for the Texas coastal systems from the perspective of the coastal vulnerabilities. These vulnerabilities drive negative changes to the health or function of the coastal systems that require robust, multiple-lines-of-defense style solutions.
- **Section 4: Changing Landscapes.** Details the modeling and data inputs that were used to develop the statuses, trends, and recommendations in this Plan. The main areas of focus include relative sea level rise planning ranges, landscape change modeling, storm surge and wave modeling, and geohazards mapping.
- **Section 5: Actions Toward Building Resilience.** Overviews the 10 coastwide actions that the GLO sees as priorities to address coastal resilience and presents the Tier 1 projects prioritized within the actions.
- **Section 6: Texas's Path Forward & Implementation.** Describes the next steps to implement this Plan, including the timeline toward implementation, potential funding sources and opportunities, monitoring and adaptive management for resiliency projects, and new ideas and innovations to help Texas move toward resiliency over the near- and long-terms.

Texas Coastal Systems, Vulnerabilities, and Changing Landscapes

The Texas coastal system can be thought of as three interconnected elements—natural, social, and economic—related to one another through reciprocal effects and feedback loops that interact on multiple scales. The symbiotic reliance between nature, society, and economy is immediately apparent in our coastal areas. Many economic sectors such as tourism, recreation, and resource extraction rely directly on the health of the natural systems of the state's coastal environments and estuaries. When developing solutions for a more resilient coast, each of the three elements must be considered all together as a unified coastal system to avoid unintended responses from one or more of the elements to another. This Plan presents causal chains that explicate how coastal resiliency projects can be used to protect the Texas coast from the natural, social, and economic drivers and pressures that lead to coastal vulnerabilities and detract from the overall health or state of the coast through this Plan's Coastal Resiliency Framework.

The Coastal Resiliency Framework developed for this Plan identifies eight vulnerabilities (called 'issues of concern' in previous versions of the Plan) that can arise from coastal drivers and pressures. The assessment of these vulnerabilities is a crucial way that the TAC evaluates regional or coastwide concerns that negatively impact the coast and identifies the need for resiliency projects in specific coastal locations. The coastal vulnerabilities are described in three overarching categories: land change, flooding, and degraded water resources and are listed below with a corresponding vulnerability icon.

Land Change

- Degraded or Lost Habitat
- Bay Shoreline Change
- Gulf Shoreline Change

Flooding

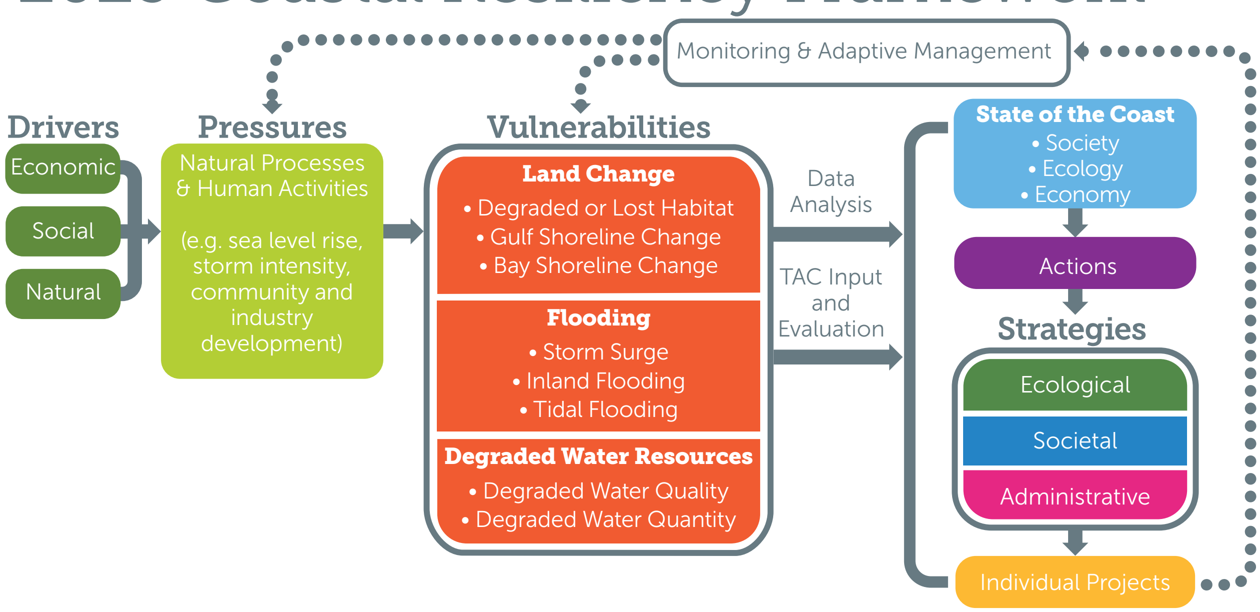
- Storm Surge
- Inland Flooding
- Tidal Flooding

Degraded Water Resources

- Degraded Water Quality
- Degraded Water Quantity

The TAC's assessment of coastal vulnerabilities is supplemented by cutting-edge science and data analysis to inform which natural systems are vulnerable to hazards such as floods, storms, and storm surges and, subsequently, to guide decision-making. For this Plan, two sea level rise scenarios and nineteen storms were modeled to assess the impacts to the environments and communities on the coast. Simulating one storm for one metropolitan area in each of the four coastal regions, the models show a considerable increase in damaged buildings between present day and 2100 "no action" conditions. The number of buildings damaged by each storm increases by nearly 515% on average for just a Category 2 hurricane assuming a low sea level rise (SLR) scenario, and by close to 1,290% assuming a high rate of sea level rise, with total economic losses increasing by a factor of 3 for the low SLR scenario and 9 for the high. Using these results, it is clear that the "no action" scenario is not viable for Texas or the nation as a way to effectively steward state and federal economic resources nor to protect what matters most—the lives and livelihoods of those people in the areas of impact for the next major disaster. Alongside these results, this Plan presents a series of geohazard maps to illustrate the ongoing geological processes on the Texas coastal plain over the next 80 years to expose the level of hazard potential ranging from Extreme to Low. Collectively, the findings from the analyses presented within this Plan can be used to guide decisions about land use, policy, and the challenges and limitations of living on the coastal plain.

2023 Coastal Resiliency Framework



2023 Actions and Tier 1 Projects

Implementing this Plan requires coordinated responses at multiple scales, requiring significant collaboration of funding and information sharing at the statewide and local levels. This Plan defines 10 actions as a series of coordinated approaches that show where Texas's coastal resiliency needs now intersect with the vision that GLO and its partners share to improve the future of the coast. The GLO hopes to champion future resiliency projects that align with one or more of the proposed actions, which can and often do accomplish more than one resiliency goal. Through an actions-based approach, the GLO and present and future project stakeholders will be equipped to alleviate coastal vulnerabilities and further enhance coastal resiliency in a targeted and effective manner.

(Photo Credit: Lee von Gynz-Guethle)

The 10 actions to address coastal vulnerabilities include:

- Managing Coastal Habitats
- Managing Gulf Shorelines
- Managing Bay Shorelines
- Improving Community Resilience
- Adapting to Changing Conditions
- Managing Watersheds
- Growing Key Knowledge and Experience
- Enhancing Emergency Preparation and Response
- Addressing Under-Represented Needs
- Maintaining Coastal Economic Growth

This Plan presents 121 Tier 1 projects, including 50 projects that were carried over from the 2019 Plan as awaiting future funding and implementation. Each Tier 1 project selected for this Plan is presented within the context of the primary action it addresses, noting additional and secondary actions that also pertain to each project. These Tier 1 projects have been thoroughly reviewed and vetted by the GLO and the TAC and have been selected for their collective ability to mitigate the vulnerabilities identified in this Plan. The total cost of the Tier 1 projects proposed in this Plan is $1.87 billion. Enacting these Tier 1 projects will help the GLO be successful in ensuring that the state's investment in coastal resiliency will return benefits to the state's economy, environments, and communities.

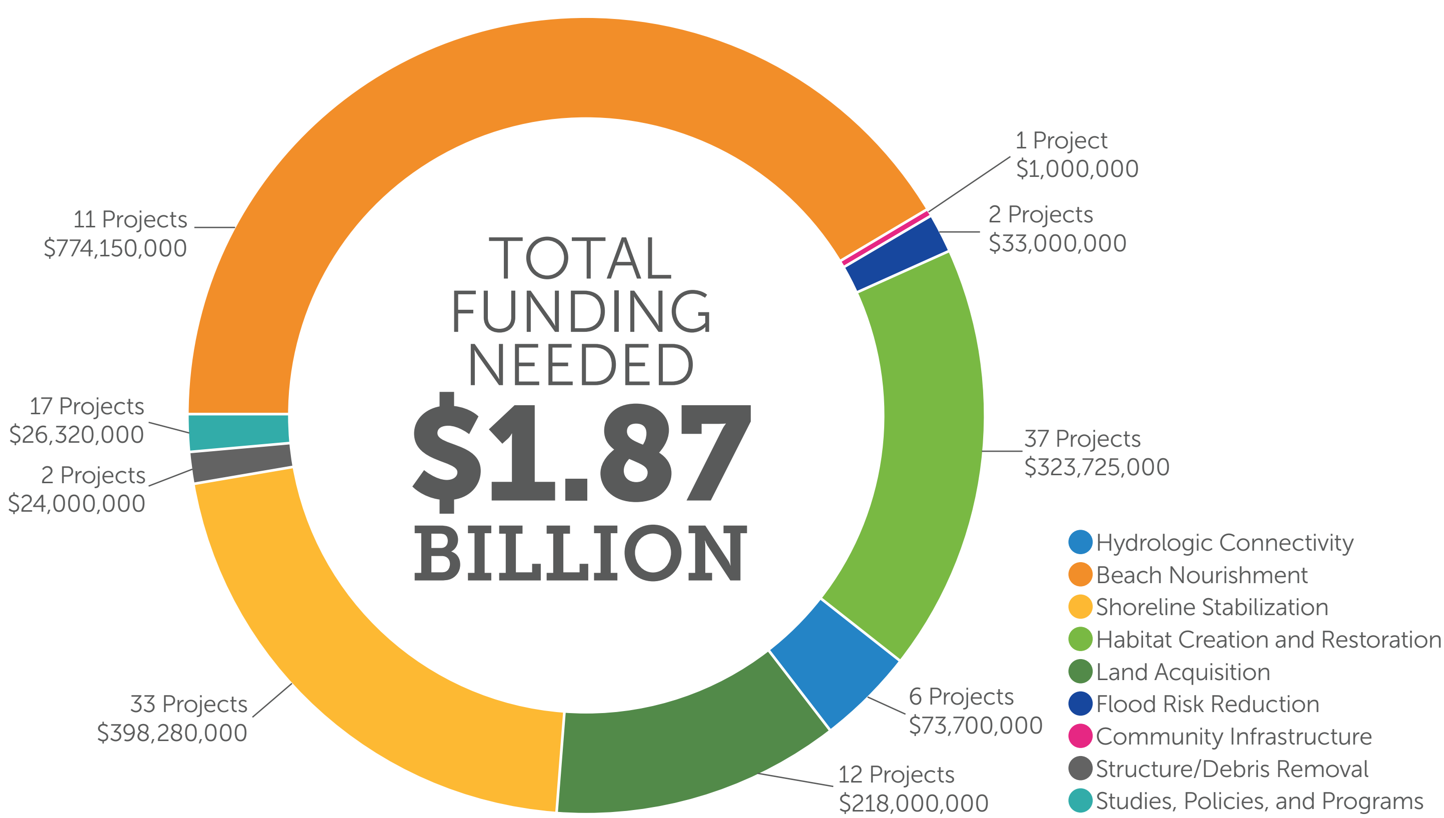
Implementation and Path Forward

Now issuing its third iteration of the Texas Coastal Resiliency Master Plan, the GLO has established a robust process for identifying, supporting, and implementing Tier 1 coastal resiliency projects. Funding awarded to coastal resiliency projects in Texas have generally been increasing since 2005, largely in part to coordinated state and federal funding efforts under disaster-specific funding opportunities, like the RESTORE Act funding made available in the wake of the Deepwater Horizon Oil Spill, and long-term programs, like the Coastal Erosion Planning and Response Act and the Gulf of Mexico Energy Security Act. In 2022, the GLO and other funding partners administered $124 million in state and federal funds to benefit coastal resiliency, an $18.3 million increase from 2021. This funding, while significant for advancing the cause of coastal resiliency in Texas, is just over 11% of the funding needed to fully enact the vision of this 2023 Plan.

The 121 Tier 1 projects presented in this Plan reflect a careful consideration of the complex characteristics of the Texas Coastal Zone by the GLO and the Technical Advisory Committee, including coastal pressures and vulnerabilities, updated flood and storm surge modeling, socioeconomics, and the needs of coastal communities. Moving forward, the GLO will continue to be proactive by using this Plan as part of an adaptable process that considers the changing conditions, needs, and preferences of coastal communities and their coastal environments. To inform future Plan updates and projects, the GLO will continue to rely on best-available scientific research, local expertise, and monitoring data available from completed projects, as well as strong partnerships to progress projects through implementation.

Conclusion

The vision embraced by the GLO for the future of the Texas coast is ambitious, but Texans have a history of overcoming difficult odds to achieve the unthinkable. Advancing our coastline to be more resilient in the face of future, unknown storms, and continued land change is a challenge that is being accepted by coastal stakeholders up, down, and across the great coastal state of Texas.



The Texas General Land Office recognizes and sincerely thanks the GLO Planning Team, which consists of members from AECOM, the Harte Research Institute for the Gulf of Mexico Studies and Hollaway Environmental + Communication Services, for their tireless and dedicated work on the development of the 2023 Texas Coastal Resiliency Master Plan. Creating all of the elements in this document was a true team effort.

GLO Planning Team

Cover photo credits (clockwise from top): Lee von Gynz-Guethle, Galveston Bay Foundation, City of South Padre Island, Patty Alexander, Patty Alexander, Texas General Land Office, Lee von Gynz-Guethle

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Acknowledgments

The Texas General Land Office would like to thank the Technical Advisory Committee members and their affiliated organizations (listed below) for their time and commitment to this important planning process. We truly appreciate your contributions to the development of the 2023 Texas Coastal Resiliency Master Plan.

- AECOM
- American Bird Conservancy
- Anchor QEA
- Angelina-Neches River Authority
- Aptim Environmental & Infrastructure, Inc.
- Aqua Strategies
- Aransas County
- Aransas County Navigation District
- Aransas First
- Arcadis
- Armand Bayou Nature Center
- Artist Boat
- Asakura Robinson Company
- Atkins Global
- Audubon Society
- Bayou Preservation Association
- Brazoria County
- Brazos River Authority
- Calhoun County
- Calhoun Port Authority
- Cameron County
- City of Aransas Pass
- City of Bridge City
- City of Corpus Christi
- City of Dickinson
- City of El Lago
- City of Friendswood
- City of Galveston
- City of Houston
- City of League City
- City of Port Aransas
- City of Port Isabel
- City of Port Lavaca
- City of Portland
- City of Rockport
- City of Seabrook
- City of South Padre Island
- Coastal Bend Bays & Estuaries Program
- Coastal Conservation Association Texas
- Coastal Prairie Conservancy
- Coastal Protection Engineering
- Coastal Tech
- Coastal Transplants
- Colorado River Land Trust
- Conrad Blucher Institute
- Corpus Christi Metropolitan Planning Organization
- Dannenbaum Engineering
- Diamond Coastal and Environmental Services
- Doucet & Associates
- Ducks Unlimited
- Environmental Institute of Houston
- Freese and Nichols, Inc.
- Fugro
- Gahagan & Bryant Associates, Inc.
- Galveston Bay Estuary Program
- Galveston Bay Foundation
- Galveston County
- Galveston Park Board
- Greater Caribbean Energy & Environment Foundation
- Guadalupe-Blanco River Authority
- Gulf Coast Bird Observatory
- Halff Associates, Inc.
- Harris County
- Harris County Flood Control District
- Harte Research Institute for Gulf of Mexico Studies
- HDR, Inc.
- Houston Advanced Research Center
- Houston Galveston Area Council
- INTERA, Inc.
- International Crane Foundation
- Jefferson County
- Jupiter Data Factory, LLC
- Lamar University
- Land/Water Associates
- LJA Engineering
- Lockwood, Andrews & Newnam, Inc.
- Matagorda Bay Foundation
- Matagorda County
- Michael Baker Intl.
- Mission-Aransas National Estuarine Research Reserve
- Moffatt & Nichol, Inc.
- Mott MacDonald
- National Oceanic and Atmospheric Administration

- National Park Service
- National Wildlife Federation
- North Beach Preservation Society
- Nueces County
- Nueces River Authority
- Orange County
- Orange County Drainage District
- Orange County Navigation and Port District
- Oso Bay Wetlands Preserve
- Palacios Marine Agricultural Research, Inc.
- Parsons
- Partner Forces
- Port Freeport
- Port Houston
- Port Lavaca Port Commission
- Port of Corpus Christi Authority
- Port of Palacios
- Railroad Commission of Texas
- Refugio County
- Rice University
- Rice University SSPEED Center
- Rio Grande Valley Metropolitan Planning Organization
- San Antonio Bay Partnership
- San Antonio River Authority
- San Patricio County
- Santos McBain
- Sarosdy Consulting
- Scenic Galveston, Inc.
- Scheibe Consulting
- Science and Spanish Club Network, Inc.
- Sierra Club
- Simfero Consultants
- Smart Home America
- Staff for State Senator Juan Hinojosa
- Staff for U.S. Representative Brian Babin
- Stantec
- SWCA
- T. Baker Smith
- Tetra Tech, Inc.
- Texan Engineering & Consulting
- Texas A&M AgriLife Extension Service
- Texas A&M AgriLife Research
- Texas A&M University
- Texas A&M University - Corpus Christi
- Texas A&M University - Galveston
- Texas A&M University - Kingsville
- Texas American Shore & Beach Preservation Association
- Texas Commission on Environmental Quality
- Texas Community Watershed Partners
- Texas Comptroller of Public Accounts
- Texas Conservation Partners, LLC
- Texas Department of Transportation
- Texas Division of Emergency Management
- Texas General Land Office
- Texas Parks & Wildlife Department
- Texas Sea Grant at Texas A&M University
- Texas State Soil and Water Conservation Board
- Texas Water Development Board
- Texas Water Trade
- The Conservation Fund
- The Meadows Center for Water and the Environment
- The Mitchell Foundation
- The Nature Conservancy
- The University of Texas - Arlington
- The University of Texas - Rio Grande Valley
- The Water Institute of the Gulf
- Town of Bayview
- Town of Fulton
- Turtle Island Restoration Network
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Fish & Wildlife Service
- U.S. Geological Survey
- University of Houston
- Walter P. Moore
- Water Street Restaurants
- West Consultants
- West Jefferson County Municipal Water District
- Wood Group

Abbreviations

ABNC: Armand Bayou Nature Center
ADCIRC: Advanced Circulation (Model)
ADA: Americans with Disabilities Act
BMMP: Beach Monitoring and Maintenance Program
BRIC: Building Resilient Infrastructure and Communities (Program)
BUDM: Beneficial Use of Dredged Material
CAP: Conservation Assistance Program
CBBEP: Coastal Bend Bays & Estuaries Program
CCAC: Coastal Coordination Advisory Committee
CCSC: Corpus Christi Ship Channel
CDBG: Community Development Block Grant
CDBG-DR: Community Development Block Grant-Disaster Recovery
CDBG-MIT: Community Development Block Grant-Mitigation
CDR: Community Development and Revitalization
CEPRA: Coastal Erosion Planning and Response Act
CHP: Coastal Heritage Preserve
CHRGIS: Coastal Habitat Restoration Geographic Information System
CIAP: Coastal Impact Assistance Program
CMP: Coastal Management Program
COG: Council of Governments
COVID-19: Coronavirus Disease 2019
CRMS: Coastwide Reference Monitoring System
CSRM: Coastal Storm Risk Management
CWPPRA: Coastal Wetlands Planning, Protection, and Restoration Act
DBI: Dickinson Bay (Rookery) Island
DHS S&T: Department of Homeland Security Science and Technology Directorate
DMPA: Dredged Material Placement Area
E&D: Engineering and Design
EMB: East Matagorda Bay
EPA: Environmental Protection Agency
FEMA: Federal Emergency Management Agency
FPG: Flood Planning Group
GBF: Galveston Bay Foundation
GCPD: Gulf Coast Protection District
GDP: Gross Domestic Product
GIS: Geographic Information System (Software)
GIWW: Gulf Intracoastal Waterway
GLO: General Land Office
GMSLR: Global Mean Sea Level Rise
GOMESA: Gulf of Mexico Energy Security Act
Hazus: Hazard US (Model)
HB: House Bill
HMP: Hazard Mitigation Plan
HOT: Hotel Occupancy Tax
HRI: Harte Research Institute
HUC: Hydrologic Unit Code
HUD: U.S. Department of Housing and Urban Development
IIJA: Infrastructure Investment and Jobs Act
IPMA: Indian Point Marsh Area
LLM: Lower Laguna Madre
LMI: Low- to Moderate-Income
MANERR: Mission-Aransas National Estuarine Research Reserve
MPO: Metropolitan Planning Organization
NAS: Naval Air Station
NCEI: National Centers for Environmental Information
NFWF-GEBF: National Fish and Wildlife Foundation-Gulf Environmental Benefit Fund
NHD: National Hydrography Dataset
NOAA: National Oceanic and Atmospheric Administration
NPS: Nonpoint Source ***or*** National Park Service
NRA: Nueces River Authority
NRCS: Natural Resources Conservation Service
NRDA: Natural Resource Damage Assessment
NWI: National Wetlands Inventory
NWR: National Wildlife Refuge
OSPRA: Oil Spill Prevention and Response Act of 1991
OSSF: On-Site Sewage Facilities
PA: Public Assistance
PCCA: Port of Corpus Christi Authority
PINS: Padre Island National Seashore
RRC: Railroad Commission
RSLR: Relative Sea Level Rise
SAV: Submerged Aquatic Vegetation
SETxFCS: Southeast Texas Flood Coordination Study
SLAMM: Sea Level Affecting Marshes Model
SLR: Sea Level Rise
SoVI: Social Vulnerability Index™
SRP: Statewide Resilience Plan
SSO: Sanitary Sewer Overflow
SVI: Social Vulnerability Indices
SWAN: Simulating Waves Nearshore (Model)
TAC: Technical Advisory Committee
TCEQ: Texas Commission on Environmental Quality

TCPI: Texas Coastal Prairie Initiative
TDEM: Texas Division of Emergency Management
TDIS: Texas Disaster Information System
TIG: Trustee Implementation Group
TNRIS: Texas Natural Resources Information System
TPWD: Texas Parks and Wildlife Department
TSSWCB: Texas State Soil and Water Conservation Board
TTP: Texas Transportation Plan
TWDB: Texas Water Development Board
TxDOT: Texas Department of Transportation
UofSC HVRI: University of South Carolina Hazards Vulnerability & Resilience Institute
USACE: U.S. Army Corps of Engineers
USFWS: U.S. Fish and Wildlife Service
USGS: U.S. Geological Survey
UT-BEG: The University of Texas-Bureau of Economic Geology
WHO: World Health Organization
WRDA: Water Resources Development Act
WMA: Wildlife Management Area
WWTP: Wastewater Treatment Plant

Units of Measurement

cm: centimeters
cy: cubic yards
cy/yr: cubic yards per year
ft: feet
ft/yr: feet per year
in: inches
in/yr: inches per year
km/h: kilometers per hour
m: meters
mcy: million cubic yards
m/yr: meters per year
mph: miles per hour

(Photo Credit: Texas General Land Office)


(Photo Credit: Freese and Nichols, Inc.)

1. The Planning Process

1.1. Introduction to the 2023 Plan

Texas is truly a coastal state—the Texas Gulf of Mexico shoreline stretches for 367 miles, and only Alaska, Florida, California, Hawaii, and Louisiana have longer coastlines.[5] The Texas coast is made up of more than 3,300 miles of bay shorelines and vast expanses of tallgrass prairie uplands, saltmarsh wetlands, bottomland hardwood forests, oyster reefs and fisheries, estuaries, and other ecosystems that contribute priceless natural resources to Texas. Furthermore, nearly 6.92 million people call the Texas coast their home.[1] Their livelihoods, day-to-day activities, and quality of life all depend on the health of the Texas coast. Perhaps most importantly, the Texas coast serves as the engine of the state's economy. Texans need a Texas-sized plan to protect their coast.

Threatened by both natural and human-made forces, the Texas coastal landscape also is one of the state's most vulnerable areas. Texas's coast is frequently barraged by tropical storms and disasters that have increased in number and intensity in recent years. Coastal storms bring the dangers of high speed winds, storm surges, and flooding, not to mention billions of dollars in economic damages and adverse impacts to natural resources that persist long after the water has subsided. Moreover, storms bring the incalculable loss of human life. Sea levels are on a rising trend, with even higher levels projected in the near future, and are compounding the destruction caused by these events and reshaping the coast as we know it today.

The natural disasters and other hazards that begin on the coast cause widespread economic repercussions throughout the state and nation. The Texas coast is an economic dynamo—home to oil and gas refineries, corporate headquarters, military bases, and numerous other enterprises—with seaports that connect the state and nation to the world. Highly profitable avenues of commerce such as waterborne transportation, pipelines, marine construction, ship and boat building, commercial fishing, and many others, employ upwards of 400,000 people in coastal counties and over 1.55 million people statewide.[2] During the COVID-19 pandemic, Texas ports played a pivotal role in keeping the U.S. economy afloat by delivering medical supplies, pharmaceuticals, food, fuel, and essential consumer goods.[6]

Resiliency is a guiding principle for how the GLO plans for the future of the Texas coast. For the GLO, "resiliency" means setting a high bar for itself where coastal management is concerned. It means that the GLO is being proactive in its directive to manage the Texas coast, looking at the coastal system as a whole, listening to the needs of stakeholders, identifying projects that address multiple vulnerabilities, working with nature, adapting to living with (or, at times, without) water, anticipating and planning for future threats, and capably responding to hazards and natural disasters as they arise.

The need to protect the Texas coast is never more apparent than when the effects of extreme weather events come into focus. During Winter Storm Uri in February 2021, as one recent example, coastal vegetation and wildlife were dramatically impacted; there were reports of cold-stunned sea turtles, an estimated 3.8 million fish were affected in the fish-freeze, and other wildlife lost their habitats when large swaths of black mangroves and other coastal vegetation died off due to low temperatures.[7,8,9] These incidents pose a major threat to the ecosystems present and economies dependent on the unique Texas coastal system, further emphasizing the role of coastal resiliency when considering the extreme effects of atypical climate events.

Daily activities like land conversion and upstream water use and management practices can likewise negatively impact the productivity of the state's bays. Surface waters from upstream areas can collect pollutants; such as pesticides, gasoline from roadways, and pet waste; flow downstream, and empty into Texas's estuaries, harming sensitive ecosystems. Water use practices purposed for industrial activities that divert freshwater from flowing into the bays can reduce the water and sediment flows naturally needed in bay systems. The health of these bays is important to our overall coastal system that connects the economy, society, and environment as communities use them for recreation and commercial purposes, playing a key role in the public's quality of life. To improve the state's ability to become more resilient and better withstand these and other coastal vulnerabilities, a broad and thorough plan for the coast is necessary.

The vision for the Texas Coastal Resiliency Master Plan (Plan) is to protect and promote a vibrant and resilient Texas coast that supports and sustains a strong economy and healthy environment for all who live, work, play, or otherwise benefit from the natural resources and infrastructure along the Texas coast.

The Texas General Land Office (GLO) believes it can advance toward this vision by funding and implementing the recommended Tier 1 projects in this Plan. These Tier 1 projects have been selected through a technical and stakeholder driven process, identifying them as providing broad and comprehensive benefits to the coastal system as described in this Plan.

The Texas coast functions in a complex and dynamic manner, integrating our economy, society, and environment into a single comprehensive system. This coastal system likewise requires an approach to resilience that is multifaceted in how Texas faces historical and future challenges. As a result, the Plan works to identify opportunities to implement coastal resiliency projects that benefit all three system components at an impactful scale.

1.2. Purpose

The GLO developed the first Texas Coastal Resiliency Master Plan in 2017 to guide state planning, resources, and funding to build a more resilient Texas coastal zone and defend against prevailing coastal vulnerabilities. The second iteration of the Plan was released in 2019, building upon the initial iteration and expanding its scope. With this 2023 Plan, the GLO has moved to a 4-year planning timeframe to give ample time to implement the vision (and associated Tier 1 projects) of the Plan before it is updated. Future updates to the Plan are anticipated to be prepared on a similar timeline.

The Texas Coastal Resiliency Master Plan aligns with the GLO's mission to restore, enhance and protect the state's coastal natural resources. Beginning from the foundation that had been built upon through the 2017 and 2019 Plans, the GLO progressed projects from the 2019 Plan into design and implementation phases using existing and new funding sources available to the GLO and its partners for advancing coastal projects. This Plan will continue by promoting an updated list of necessary actions, strategies, and Tier 1 projects to continue moving toward a more resilient coast.

Key updates made for the 2023 Plan include:

- A conceptual project process, which included technical assistance to project stakeholders, helped provide forward momentum to projects that were previously conceptual, leading to actionable projects that can be implemented by leveraging available funding opportunities. **(Section 1)**
- Presenting the coastal economy, society, and environment as one comprehensive coastal system interconnected in it's need for continual investments in resiliency initiatives. **(Section 2)**
- Revised vulnerability scores (previously called "Issues of Concern") for each of the four planning regions that are used to assess potential projects. **(Section 3)**
- Emerging stakeholder insights into Texas's evolving coastal priorities, such as freshwater inflow management, regional sediment management, tidal flat habitat loss, soil health and agricultural land management, and replacing aging infrastructure. **(Section 3)**
- Updated models for storm surge inundation and land cover change mapping. **(Section 4)**
- A data-driven process to define 10 ongoing coastwide actions that clarify the scope of the most needed resiliency projects in coastal Texas. **(Section 5)**
- A Tier 1 high-priority project list to direct coastal planning and funding. **(Section 5)**

(Photo Credit: Galveston Bay Foundation)

Using the priority list of Tier 1 projects identified through its planning process, the GLO will use this Plan to advance the overall mission of the GLO to safeguard the state's coastal resources and communities.

Furthermore, this Plan and its associated tools can be used by local governments and elected officials to understand and prepare for the vulnerabilities in their coastal communities, and to take action to make their communities more resilient to the next disaster.

What this Plan is	What this Plan is NOT
• A list of high-priority coastal resiliency initiatives and projects • A snapshot of the needs of the state for coastal resiliency at the time of publication • An opportunity for the GLO to align coastal resiliency priorities with feedback from stakeholders, coastal experts, and other public agencies	• An automatic funding mechanism* • A guarantee that projects will be funded or completed • A completely comprehensive list of the coastal resiliency projects that are necessary coastwide • A popularity contest for projects—projects are assessed by overall priority, feasibility, and ability to address coastal vulnerabilities

**While funding is not guaranteed for any project in this Plan, Tier 1 projects are typically prioritized for GLO funding programs with construction costs possibly fully funded with no local match requirement.*


(Photo Credit: Texas General Land Office)

1.2.1. Planning Timeline 2019-2023

Work to develop this Plan began in September 2019, several months after the 2019 Plan was published.

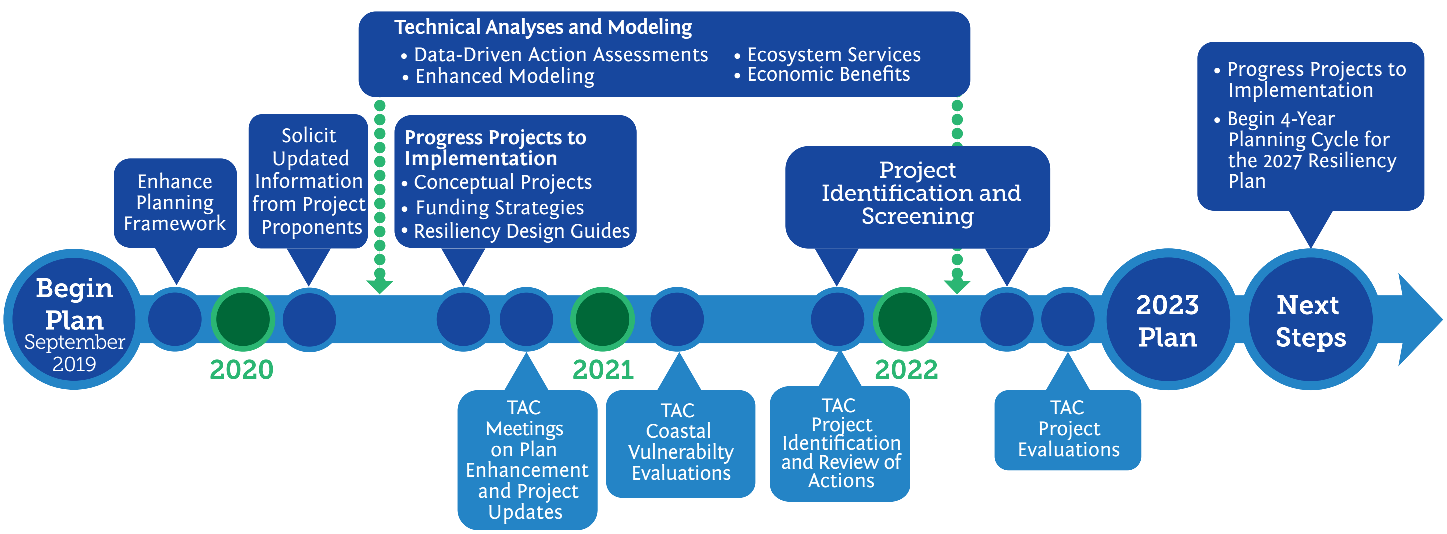


Figure 1.1: *2023 Planning Timeline (September 2019 to March 2023)*

1.3. Goals and Objectives of this Plan

Goal 1: The GLO will use this Plan to direct its authority to identify, select, and fund projects that address coastal vulnerabilities and restore, enhance, and protect the Texas coast.

- **Objective 1:** Analyze the vulnerabilities that hinder coastal resiliency along the Texas coast.
  - » Use scientific data and modeling results to characterize current and future coastal conditions.
  - » Consult with a Technical Advisory Committee (TAC) to validate the vulnerabilities along the Texas coast.
- **Objective 2:** Evaluate and select regional and coastwide projects that reduce or eliminate the identified vulnerabilities and enhance coastal resiliency.
  - » Undertake a comprehensive review and analysis of existing, relevant projects.
  - » Gather new project ideas through technical analyses and outreach to the TAC and other coastal stakeholders.
  - » Elicit input from the TAC to determine the level of benefit a project will have on addressing the vulnerabilities in its coastal region.
  - » Obtain data from the TAC to evaluate the feasibility and priority of potential projects in an objective, data-driven manner.
  - » Provide a list of recommended Tier 1 projects for funding and implementation.
- **Objective 3:** Utilize GLO authority, available funding, and partnerships to fund and implement identified Tier 1 priority projects.
  - » Seek a legislative appropriation to fund Tier 1 projects in this Plan.
  - » Coordinate with federal, state, and local entities to carry out and complete Tier 1 projects to enhance resiliency along the Texas coast.

Goal 2: Develop an adaptable plan that accommodates changing coastal conditions. This Plan will provide system-wide, multiple lines of defense solutions to restore, enhance, and protect coastal habitats, infrastructure, and communities.

- **Objective 1:** Maintain and update this Plan on a regular basis.
  - » Secure a continued funding source for future implementation of this Plan.
  - » Design and implement an adaptable update process that considers changing conditions, needs, and preferences of coastal communities and their coastal environments (natural or human-made).
  - » Maintain ongoing communication with the TAC and stakeholders throughout this Plan's development.
  - » Collect and incorporate applicable expert knowledge, research, and scientific data into Plan updates.
  - » Regularly refine and enhance strategies and actions presented within this Plan by incorporating new information and changing coastal conditions.

Goal 3: Communicate the environmental, social, and economic value of the Texas coast to local, state, and national audiences.

- **Objective 1:** Increase awareness of the benefits of investing in the recommended Tier 1 projects to restore, enhance, and protect the Texas coast.
  - » Maintain strong partnerships with the TAC and other coastal stakeholders to build upon the knowledge base utilized to develop this Plan.
  - » Continue communications with elected officials on the importance of allocating funds to implement Tier 1 projects, with an overall goal of enhancing the habitats and infrastructure in coastal communities to create a more resilient Texas and to mitigate future disasters on the coast.
  - » Coordinate with other coastal entities who fund projects to advance the purpose of this Plan.

1.4. This State-led Plan and Other Federally-led Efforts

Along the Texas coast, vital resources critical to the social, economic, and environmental welfare of the nation are at risk. When coastal storms damage homes, businesses, industry, infrastructure, and the natural environments of the Texas coast, the immediate fallout and the continued aftermath affects not only the people who live in these coastal counties, but also the entire state of Texas with cascading effects across the nation as a whole. As a result of this, several concurrent, complementary, and high-priority efforts are underway by the U.S. Army Corps of Engineers (USACE) to provide effective and comprehensive protection for the Texas Gulf coast.

The GLO is partnered with USACE to develop feasible, cost-effective, and ecologically sound projects to reduce risks to public health and the economy, restore critical ecosystems, and advance coastal resiliency. These federally-led projects are to be considered in collaboration with the Texas Coastal Resiliency Master Plan.

Complementary but Separate

Three concurrent efforts are underway to more adequately respond to Texas's coastal resiliency needs. These and future state- and federally-led efforts will be designed to work in concert with one another, using multiple lines of defense to enhance the resiliency of Texas's coastal regions, its vulnerable ecosystems, communities, industries, and the broader economy. These complementary, yet separate efforts include:

TEXAS COASTAL RESILIENCY MASTER PLAN

Texas Coastal Resiliency Master Plan
(iterative planning effort led by the GLO)

Sabine-to-Galveston Coastal Storm Risk Management Program
(led by USACE)

COASTAL TEXAS PROGRAM

Coastal Texas Program
(led by USACE)

Source: Adapted from U.S. Army Corps of Engineers[10]

For example, in the 2019 Plan, the Sabine-to-Galveston flood protection levee projects were included as Tier 1 projects; those federal projects are now moving forward into design and construction phases, but can still be considered to have the full backing and support of the GLO.

1.4.1. Sabine-to-Galveston CSRM Program

The Sabine-to-Galveston projects were initially conceptualized in the aftermaths of Hurricane Rita in 2005 and Hurricane Ike in 2008, and are being designed to reduce the risk of damage and flooding from future hurricanes. The projects include construction of a new Coastal Storm Risk Management (CSRM) levee system in southern Orange County and improvements to two existing hurricane flood protection projects at Port Arthur and Freeport. The Orange County and Freeport projects are completing the engineering and design phase, while the Port Arthur project has progressed into the construction phase.[11]

1.4.2. Coastal Texas Program

The Coastal Texas Program includes a combination of CSRM and ecosystem restoration projects that function together to reduce the risk of coastal storm surge damages to Texas's coastal communities and vitally important industries and to restore degraded coastal ecosystems. Focused on redundancy and robustness, the Coastal Texas Program provides increased resiliency along the Texas coast and is adaptable to future conditions, including sea level rise (SLR).

The Coastal Texas Program received Congressional authorization in December 2022 to advance into design and construction, pending appropriation of funding.[12] As funding becomes available, the USACE Southwest Galveston District, along with its non-Federal partners, the Gulf Coast Protection District (GCPD) and the GLO, will lead the delivery of this approximately $34.38 billion program (in today's dollars). The Coastal Texas Program is comprised of more than 15 unique projects that could take up to 20 years to build, depending on the pace of funding.[10]

The Program consists of the following projects:

- Galveston Bay Storm Surge Barrier CSRM System
- South Padre Island Beach Nourishment CSRM Project
- Coastwide Ecosystem Restoration Plan

The Galveston Bay Storm Surge Barrier System

The Galveston Bay Storm Surge Barrier System, the largest and most expensive component of the Coastal Texas Program, is comprised of eight unique projects, split into gulf defenses and bay defenses, and structural and non-structural actions, as illustrated in the figure below.

South Padre Island Beach Nourishment Project

The South Padre Island Beach Nourishment Project will include 2.9 miles of beach nourishment and sediment management activities to nourish the beaches and dunes along the highly developed South Padre Island. This project will reduce risks from coastal storm surge to businesses, residents, and infrastructure. Renourishment will occur on a 10-year cycle for five total renourishments.[13]

Coastwide Ecosystem Restoration Plan

The ecosystem restoration plan will restore degraded ecosystems that buffer communities, including eight projects along the coast to provide resilient protection to supplement the Storm Surge Barrier and South Padre Island Beach Nourishment. The projects will include constructing breakwaters, oyster reefs, beach and dune renourishment, rookery islands, and marsh habitat.[13]

COASTAL TEXAS PROGRAM

PROGRAM COST

TOTAL PROJECT COST
$34.38 Billion

ESTIMATED COST SHARE:
65% FEDERAL
35% NON-FEDERAL

FEDERAL SPONSOR
US Army Corps of Engineers
Galveston District

	Non-Federal Sponsor	Authorized Cost	Federal Share	Non-Federal Share
Galveston Bay Storm Surge Barrier System	GCPD Gulf Coast Protection District	$31.20 Billion	$19.41 Billion	$11.79 Billion
Coastwide Ecosystem Restoration Plan	Texas General Land Office	$3.10 Billion	$1.94 Billion	$1.16 Billion
South Padre Island Beach Nourishment	Texas General Land Office	$81.8 Million	$31.1 Million	$50.7 Million

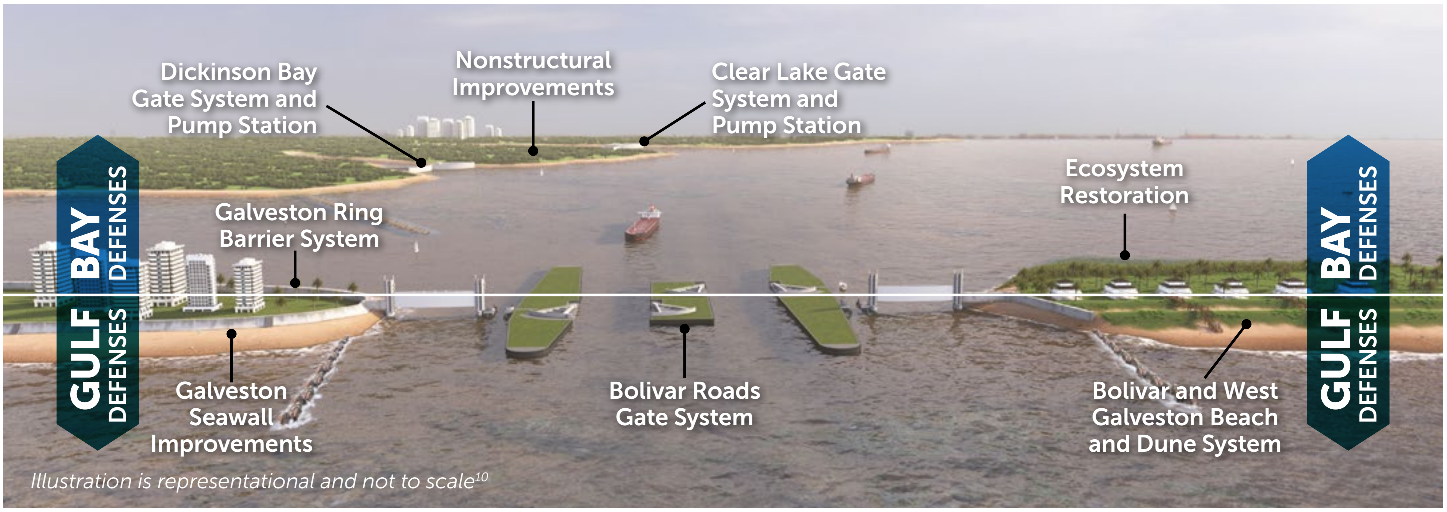


Illustration is representational and not to scale[10]

1.5. GLO Programs

The Texas General Land Office manages the state's lands and coastal resources and aids in natural disaster recovery. The GLO implements this Plan through its Coastal Protection Division and other relevant programs, operations, and divisions.

Coastal Resiliency in the GLO

Coastal Management Program (CMP)

The purpose of the CMP is to improve management of the state's coastal resources and ensure the long-term ecological and economic productivity of the coast. The CMP is a networked program linking the regulations, programs, and expertise of local, state, and federal entities managing various aspects of coastal resources. CMP grant funds may be used for: public access enhancements to coastal natural resource areas; applied research and data collection within the coastal zone boundary that supports coastal-related initiatives of at least one networked agency; resiliency enhancements to protect coastal natural resources; coastal planning and community engagement to enhance resiliency; and efforts that support the implementation of the Clean Coast Texas Program, in accordance with the conditions of the Coastal Zone Management Act.

Coastal Erosion Planning and Response Act (CEPRA) Program

Since CEPRA's inception in 1999 (via the 76th Legislature), the GLO has administered CEPRA through its Coastal Resources Division. Projects and studies funded through the CEPRA program support further understanding of the processes of coastal erosion to provide a variety of response methods that slow the impacts of erosion. Approaches such as beneficial use of dredge material, public beach nourishment, and the development of living shorelines promote the importance of barrier islands, dunes, and bays as a natural defense against storms and hurricanes. These efforts protect public infrastructure and enhance environmental quality for Texas land, water, coastal, and other natural resources. Administered using a biennial legislative appropriation from the General Revenue Fund, the CEPRA program undertakes a coordinated, needs-based approach through partnership with local communities, state and federal agencies, and non-profit entities to leverage funding toward erosion response goals.

Gulf of Mexico Energy Security Act (GOMESA) Program

Under GOMESA, the Gulf states of Alabama, Louisiana, Mississippi, and Texas receive a portion of the revenue generated from oil and gas production offshore in the Gulf of Mexico for purposes of coastal restoration, conservation, and hurricane protection projects. Funds are dispersed to these four Gulf states as well as to the individual counties along the coast in those states. Being dependent on lease sales, the amount of funding is not guaranteed and can vary on an annual basis. The GLO administers this funding for projects along the Texas coast through its CMP and CEPRA programs, with that funding highly prioritized to implement projects in this Plan.

Natural Resource Damage Assessment (NRDA)

A Natural Resource Damage Assessment is a scientific and legal process to determine damages to natural resources caused by spills or discharges of hazardous materials. In Texas, the Texas Parks & Wildlife Department (TPWD), GLO, Texas Commission on Environmental Quality (TCEQ), National Oceanic and Atmospheric Administration (NOAA), and U.S. Fish and Wildlife Service (on behalf of U.S. Department of Interior) act on behalf of the public as natural resource trustee agencies that hold responsible parties accountable for the damages and seek compensation to restore natural resources and make the public whole. To date, the Texas Trustee Council has administered more than $170 million in restoration project funds.

Beach Access & Dune Protection Program

This program works to protect public access to Gulf-facing beaches through the Texas Open Beaches Act and implements the preservation and restoration of coastal sand dunes under the Dune Protection Act. The GLO works closely with local coastal governments and shares the responsibility of balancing the public's right to use and enjoy the beach with the protection of vegetated sand dunes that serve as a natural first line of defense against storms.

Coastal Field Operations

This program provides technical field assessments and support for lease agreements for proposed and existing projects on state-owned submerged land. The assessments identify impacts on natural resources, with unavoidable impacts requiring mitigation. Leases include projects for residential, commercial, and industrial uses, as well as habitat restoration and public works. All lease agreements require authorization from the GLO and/or School Land Board, per the Texas Natural Resources Code Chapters 33 and 51. Coastal Field Operations also assists with inspections and technical support for other divisions within the GLO.

Clean Coast Texas Program

Clean Coast Texas is a coastal nonpoint source pollution program that works to ensure vibrant and sustainable fisheries, shellfish, and eco-tourism industries through sound science, collaboration, and partnership activities that focus on planning and effective management of nonpoint source pollution in Texas coastal waters. Clean Coast Texas is a collaborative effort of multiple program partners, managed by the GLO. These partners work with numerous stakeholders, state, and local agencies in ongoing efforts to protect and enhance the Texas coastal zone.

Community Development and Revitalization (CDR) Division

The GLO's CDR Division administers Community Development Block Grant-Disaster Recovery (CDBG-DR) and Mitigation (CDBG-MIT) funds purposed from the U.S. Department of Housing and Urban Development (HUD) for communities that are impacted by federally-declared disasters. This includes managing short-term housing in partnership with the Federal Emergency Management Agency (FEMA) and administering grants for housing development, infrastructure repair, mitigation, economic development, and long-term planning.

Oil Spill Prevention and Response Program

The unfortunate lessons learned during the 1989 Exxon Valdez Alaskan oil spill and two significant spills in Texas waters in 1990 prompted the Texas Legislature to pass the Oil Spill Prevention and Response Act of 1991 (OSPRA). OSPRA designates the GLO as the lead state agency for coastal oil spill prevention and response and confers upon the Commissioner the "power of the state to protect its coastal waters and adjacent shorelines." The Oil Spill Program works with deep draft cargo vessels, pipeline, and shore-based oil handling facilities to conduct audits and inspections and ensure all have plans for safe transfer of oil and spill responses. The GLO also drives efforts to remove abandoned and derelict vessels and structures and eliminate these potential pollution causes. All of these actions protect our precious natural resources and work to ensure that oil stays out of Texas coastal waters.

TAC meeting in League City (Photo Credit: Hollaway Environmental + Communications Services)

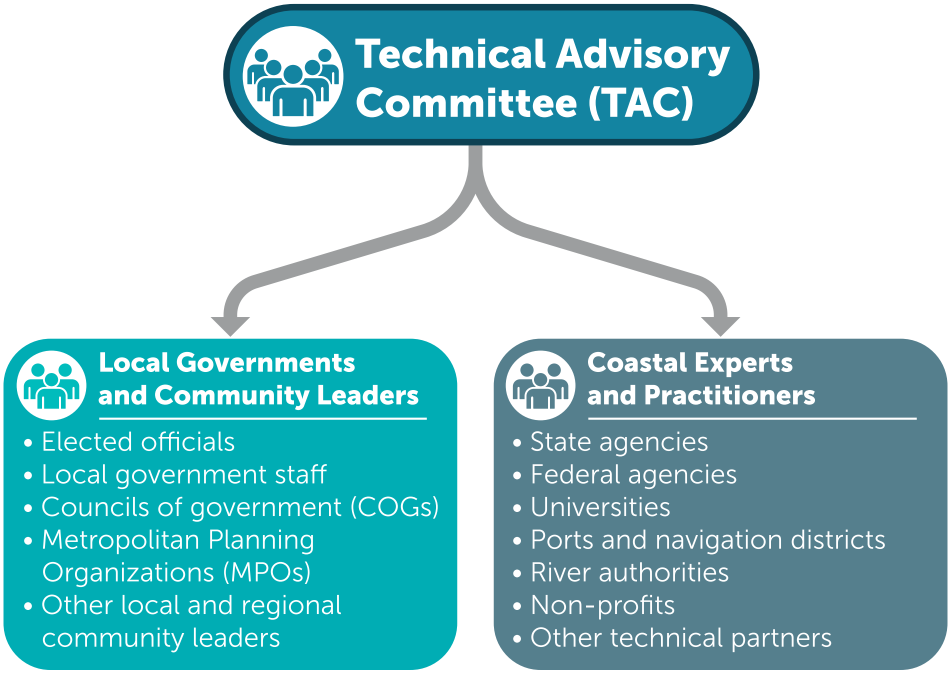
Key Term: Stakeholder-Informed Process

This Plan uses targeted feedback from coastal practitioners and experts to evaluate potential solutions, making the planning process one that is highly stakeholder informed. This icon will be used throughout this document to showcase elements of this Plan that are stakeholder informed.

1.6. A Stakeholder-Informed and Data-Driven Process

1.6.1. Technical Advisory Committee

The GLO's planning process engages a Technical Advisory Committee (TAC) corresponding to the four planning regions composed of coastwide, regional, and local decision makers, along with technical experts with insights into coastal vulnerabilities, opportunities, and unmet needs. The TAC provides invaluable input to the GLO on matters such as the current status of coastal vulnerabilities; the present state of coastal research, engineering, and science; and evaluations of prioritized programs and projects. TAC member organizations are acknowledged for their contributions to this planning process on pages xii-xiii of the front of this Plan.



TAC Meetings for this 2023 Plan Process

Spring 2020 (Virtual)

Purpose of Meetings: Two meetings were held to recap the 2019 Plan initiatives, share progress on the Tier 1 projects initiated by GLO, and share updates to the 2023 planning framework.

Data Collected: TAC members serving as project proponents gave the GLO project status updates on 2019 Tier 1 projects that had advanced since its publication.

Spring 2021 (Virtual)

Purpose of Meetings: Six meetings were held to recap the 2020 meetings, introduce the updated 2023 planning process, discuss the eight vulnerabilities for 2023 and their relevance to all regions, and discuss emerging trends and issues that needed to be considered in this Plan.

Data Collected: The TAC completed an online vulnerability assessment survey post-meeting to assess the relative level of concern in coastal watersheds for 2023 vulnerabilities by subregion.

Fall 2021 (Virtual)

Purpose of Meetings: Two meetings were held to give TAC members a presentation of the vulnerability assessment results, updates on the current progress of planning enhancements, and an overview of the 10 proposed actions for this Plan.

Data Collected: The meetings concluded with time for the TAC to provide feedback, questions, and answers.

Winter/Spring 2022 (Virtual)

Purpose of Meetings: Ten workshops each 1.5-hours in duration were held to incorporate more TAC feedback into the action development process and further refine the proposed actions. These meetings allowed TAC members to understand the proposed actions and provide notes on coastal areas that would benefit from the application of proposed actions.

Data Collected: TAC members provided spoken comments and map-based feedback on locations where actions were proposed to be situated.

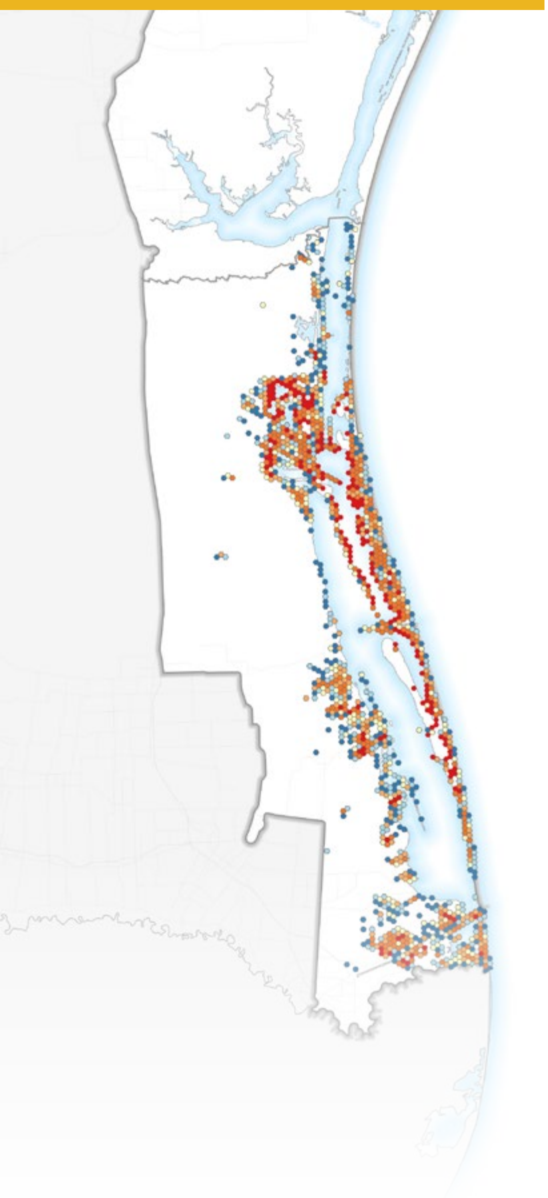
Summer 2022 (In-Person with Virtual Option)

Purpose of Meetings: Five meetings were held to obtain TAC member project evaluations for potential 2023 prioritized projects. A brief presentation of each project was given, followed by an interactive session consisting of comments, questions, and answers from project proponents.

Data Collected: The TAC completed project evaluations via online survey forms that were filled out at the meetings or shortly thereafter.

Key Term: Data-Informed Process

This Plan uses findings from best available coastal datasets to evaluate potential solutions, making the planning process one that is also highly data-informed. This icon will be used throughout this document to showcase elements of this Plan that are data-informed.



1.6.2. Coastal Datasets

Development of this Plan also follows a data-driven process. That process includes new methods to estimate the economic benefits of coastal resiliency projects (Section 3); updated coastal models for landcover change, flooding, and storm damages (Section 4); and dataset assessments that inform the GLO's 10 actions to improve coastal resiliency (Section 5).

New benefits calculations capture quantitative and spatial information about individual project impact areas relating to economic, societal, and environmental aspects. Factors such as social vulnerability are also considered. A reprised coastal modeling suite updates the Sea Level Affecting Marshes Model (SLAMM), Advanced Circulation (ADCIRC), and Hazard US (Hazus) modeling produced for the whole coast to better assist the GLO in project selections. Finally, the actions assessments in Section 5 show how the GLO is using datasets produced by its partners, including federal and state agencies and academic institutions, to put to use the exemplary work that has been done by coastal practitioners and guide management of the Texas coast in a science-backed and data-informed manner.

1.6.3. Major Stakeholders

The major stakeholders working to advance coastal resiliency in Texas are federal, state, and local governments; industry experts; academic and research institutions; and non-profits and organizations.

Coastal Coordination Advisory Committee

In 2010, the Land Commissioner took on the duties of administering the Coastal Management Program. To assist with its administration, the Coastal Coordination Advisory Committee (CCAC) was established by the 82nd Legislature in 2012. The CCAC is comprised of representatives appointed by the eight state natural resource agencies (listed over the next pages) and four individual public members representing perspectives from local citizens, governments, businesses, and the agriculture industry, appointed by the Land Commissioner. The terms of office for committee members align with five-year assessment periods of the CMP as established by the Coastal Zone Management Act §309. Members of the CCAC are noted in the following list of major stakeholders.

Federal Government

The federal government provides project permitting, disaster relief, funding, and guidance for projects.

- U.S. Army Corps of Engineers – USACE delivers engineering services and regulatory decisions to the Texas coast. For major future project initiatives, see page 7.
- National Oceanic and Atmospheric Administration – NOAA provides publicly available data related to daily weather forecasts, severe storm warnings, climate monitoring, fisheries management, coastal restoration, and supporting marine commerce. NOAA is also a partner of the Texas Sea Grant College Program (below).[14]
- U.S. Fish and Wildlife Service – USFWS is responsible for the conservation and management of fish, wildlife, plants, and their habitats. USFWS manages several national wildlife refuges (NWRs) on the Texas coast.[15]
- Federal Emergency Management Agency – FEMA coordinates within the federal government to make sure America is equipped to prepare for and respond to disasters, including coastal storms, winter storms, and floods.[16]
- U.S. Department of Housing and Urban Development– HUD administers programs that provide housing and community development assistance, including funding for disaster mitigation and post-disaster recovery.[17]

State Government

State governments can provide funding, resources, relevant information, and regulations for projects.

- GLO *(part of the CCAC)* – The GLO manages state lands, operates the Alamo, helps Texans recovering from natural disasters, helps fund Texas public education, assists veterans, and manages the coast.
- Railroad Commission of Texas *(part of the CCAC)* – The RRC regulates the oil and gas industry, natural gas utilities, and surface mining operations in Texas.
- Texas Commission on Environmental Quality *(part of the CCAC)* – The TCEQ is the environmental agency for the state that regulates air, land, water, and waste programs.
- Texas Department of Transportation *(part of the CCAC)* – TxDOT is responsible for transportation projects and planning across the state, spanning the aviation, bridge/road, rail, and navigation sectors. TxDOT included the 2019 Plan relative sea level rise planning recommendations in Chapter 15, the coastal chapter, of its Hydraulic Design Manual to help steer design engineers toward considering coastal impacts in future designs.
- Texas Parks & Wildlife Department *(part of the CCAC)* – TPWD's mission is to manage and conserve the natural and cultural resources of Texas, including those along the coast.[19] TPWD manages several wildlife management areas (WMAs) on the Texas coast.
- Texas State Soil and Water Conservation Board *(part of the CCAC)* – TSSWCB administers Texas's soil and water conservation law and coordinates conservation and nonpoint source water pollution abatement programs throughout the state, including two conservation districts along the coast.[20]
- Texas Water Development Board *(part of the CCAC)*– TWDB supports development of regional water and flood plans, provides grants and loans for water and wastewater projects, and collects data concerning the freshwater needs of the state's bays and estuaries.
- Texas Department of Agriculture – The TDA's objectives are to promote production agriculture, consumer protection, economic development, and healthy living throughout the state.[18]

Local Government

Local governments have a firsthand understanding of problems and deteriorating situations along their coastlines that would benefit the most from resilience projects.

- **Local Government Representatives** *(part of the CCAC)*– Several members of local governments along the coast have been invited to participate in the TAC. They provide key insights as to the local needs of coastal communities pertaining to coastal resiliency.
- **River Authorities** – River authorities are established by the Texas State Legislature to regulate distribution of surface water throughout the state and where rivers enter Texas's bays and estuaries.
- **Ports and Navigation Districts** – The Texas State Legislature establishes port authorities and navigation districts as political subdivisions for the state to construct and improve coastal waterways, including ship channels that facilitate trade with domestic and foreign trade partners.
- **Special Districts** – Special districts, such as drainage districts, levee improvement districts (LIDs), and the Gulf Coast Protection District (GCPD), have been established

to serve coastal-specific purposes related to resiliency, including coastal flood protection.

Industry Experts

Industry experts hold key knowledge and experience about coastal project design, project implementation, and coastal processes.

- **Local Business Representatives** *(part of the CCAC)* – Several local business representatives from industries along the coast have been invited to participate in the TAC. They provide key insights as to the needs of local industries pertaining to coastal resiliency.

Non-Profits and Organizations

Non-profits and organizations provide project concepts, local expertise, and additional funding to protect and restore coastal habitats and communities.

- **Local Citizen Representatives** *(part of the CCAC)* – Several local citizen representatives, including local interest groups, from all parts of the coast have been invited to participate in the TAC. They provide key insights as to the needs of the local citizenry pertaining to coastal resiliency.

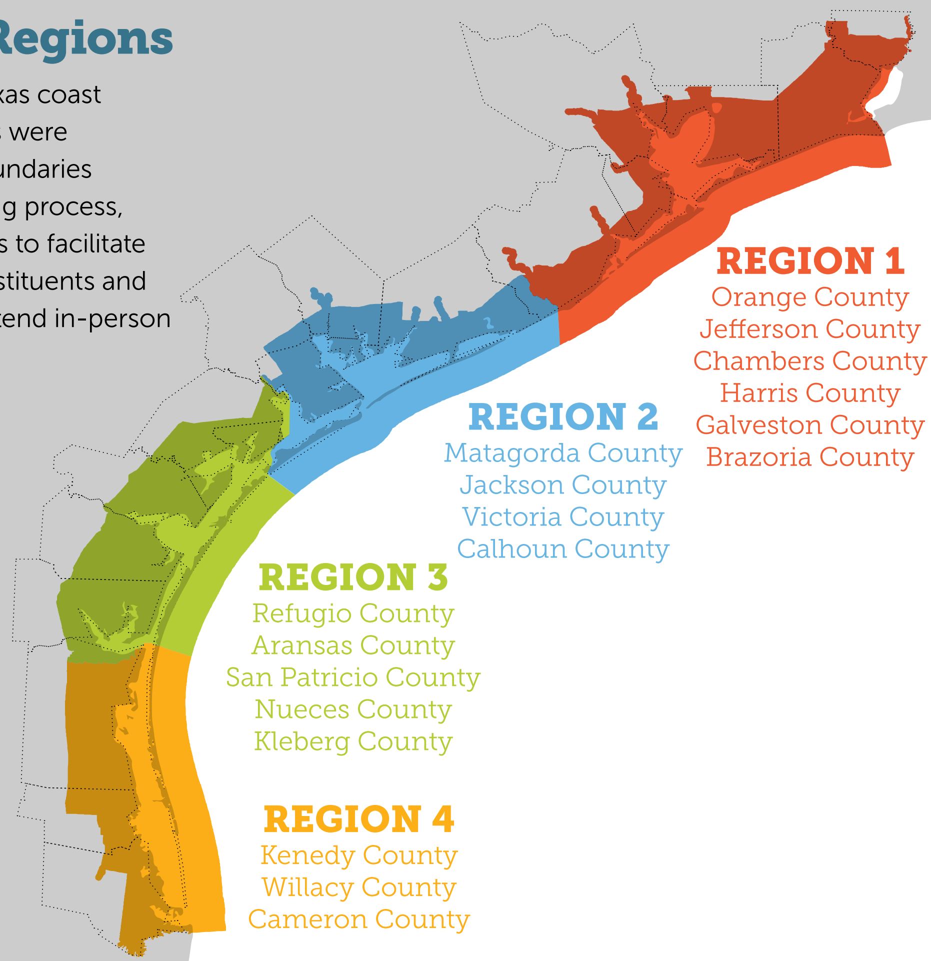
Academic & Research Institutions

Universities and research institutions work to understand coastal processes and phenomena that benefit coastal resilience projects.

- **Texas Sea Grant College Program** *(part of the CCAC)* – This program was created to advance science to support healthy coastal ecosystems, sustainable fisheries and aquaculture, and resilient coastal communities and economies.[13]
- **Texas Universities** – Texas's university system provides key academic research and scientific bases for the current and expected future state of the Texas coast. These findings are invaluable for determining projects and best practices for restoring and moving toward a more resilient coast. Several university researchers have been invited to participate in the TAC.

1.7. Four Planning Regions

For the GLO's planning process, the Texas coast is divided into four regions. The regions were developed using coastal watershed boundaries (HUC-10 level). Throughout the planning process, the GLO hosts region-specific meetings to facilitate knowledge-sharing amongst local constituents and more easily enable TAC members to attend in-person meetings in their respective regions.



1.8. The Planning Framework

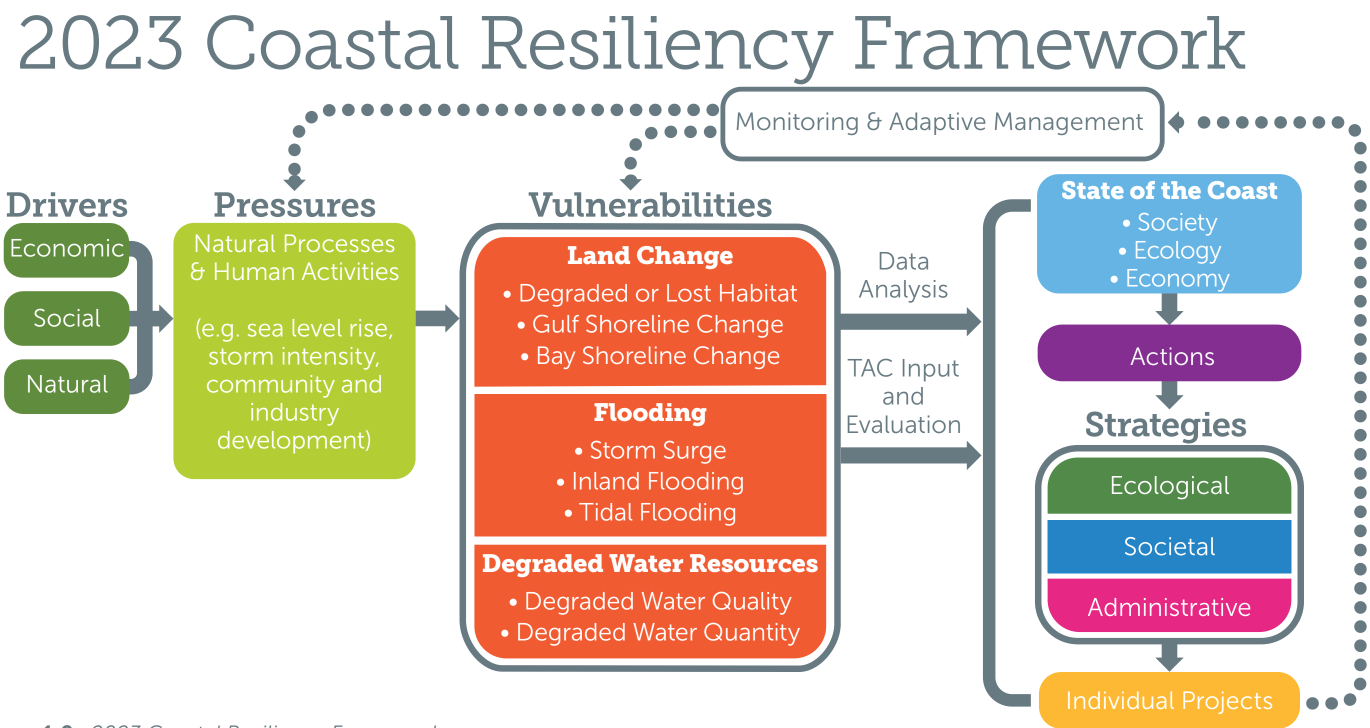


Figure 1.2: *2023 Coastal Resiliency Framework*

The Coastal Resiliency Framework is used to guide development of this Plan by relaying how economic, social, and natural drivers and pressures, such as natural hazards and human activities, lead to coastal vulnerabilities. This Plan includes eight vulnerabilities in three overarching categories: Land Change, Flooding, and Degraded Water Resources. Through data analysis and TAC input and evaluation, the actions, strategies, and individual projects are continually developed and adapted to mitigate the coastal vulnerabilities.

The data analyses completed as part of the GLO's planning process are used to ascertain the current and expected future states of the coast and recommend actions and strategies to improve coastal conditions. Engagement with stakeholders via the TAC and data analyses completed are critical for identifying and selecting the recommended priority projects presented as Tier 1 projects in this Plan.

The major elements of this framework will continue to be used throughout this Plan document, and include:

- **Drivers** – Social, economic, or natural influences on the current conditions of the coast that are largely external to the coastal system and are instigated by economic demand for food, shelter, clean water, energy, and a healthy environment.
- **Pressures** – Ongoing human activities and natural processes that result in vulnerabilities. Examples include coastal resource consumption, population growth, and relative sea level rise.
- **Vulnerabilities** – Naturally occurring and human-induced disturbances which, if left unaddressed, lead to adverse impacts on infrastructure, natural resources, economic activities, and human health and safety.
- **Data Analysis** – Refers to the GLO's review of relevant studies, models, and datasets to inform planning decisions.
- **TAC Input and Evaluation** – Stakeholder feedback is a constant source of information and is the primary basis for prioritization of resilience projects.
- **State of the Coast** – The historical, current, and future condition of the Texas coast, analyzed through the societal, ecological, and economic condition of the Texas coast, and informed through data and the TAC.
- **Actions** – Targeted long-term and ongoing approaches the state can implement that address the needs of the coastal communities and environments.
- **Strategies** – Specific ecological, societal, and administrative measures to implement actions.
- **Individual Projects** – The Tier 1 projects promoted by the GLO that offer opportunities to improve coastal resiliency that implement the actions and strategies.

1.9. A Look Back Since the 2019 Plan

The GLO first began to enact its vision to develop a coastal resiliency plan able to fit the needs of the whole state in 2016 as part of a 2-year planning cycle. The inaugural Texas Coastal Resiliency Master Plan was published in 2017. This Plan marks the third issuance of the Texas Coastal Resiliency Master Plan, and the first since moving to a 4-year process.

(Photo Credit: City of South Padre Island)

1.9.1. Plan Enhancements

Transition from a 2-year to a 4-year planning cycle: In view of the extensive volume of projects and funding required for their progress, the GLO moved this Plan to a 4-year cycle starting from 2019. This decision gives more time to fund, design, and implement projects in this Plan after a new version is released.

More funding to get projects started: The Texas Coastal Resiliency Master Plan has resulted in Tier 1 projects receiving a cumulative $597 million in total funding from the GLO and other funding partners since its inception in 2017, of which $457 million was leveraged from local and other funding sources (see Section 6). Thirty-five projects have been either fully funded and completed or are fully funded and still working toward completion, including several major coastal infrastructure projects.

Developed resiliency design guides and funding guide: The GLO developed eight resiliency design guides with recommendations on guidance for coastal resiliency project design, development, and performance after completion. The guides help project planners consider various coast-specific parameters that require assessment. The series includes design guides for *Beaches and Dunes, Delta Management, Oyster Reefs, Rookery Islands, Shoreline Stabilization, Wetland Protection,* and *Stormwater Retrofits projects, and a Funding Programs* guide to identify potential project funding opportunities.

Updated SLAMM, ADCIRC, Hazus, and with-project modeling and mapping: The GLO included additional synthetic storm scenarios of various intensities and updated its global sea level rise scenarios from those shown in the 2019 Plan. Updated geospatial data from the Texas Natural Resources Information System (TNRIS), U.S. Geological Survey (USGS), and NOAA were used to enhance the accuracy of the SLAMM and ADCIRC coupled with the Simulating Waves Nearshore (SWAN) model outputs. The GLO made significant strides to show with-project simulations to be a proof-of-concept for various resiliency project types put forward in this Plan.

1.9.2. Project Progress

Project progress from the 2019 Plan includes:

- Projects carried over into this Plan,
- Projects fully funded and complete, and
- Projects fully funded, but not yet complete.

Carryover Projects

Tier 1 projects from the 2019 Plan that have made progress toward implementation, but which are not yet fully funded will retain their Tier 1 designation for this Plan, with full description pages in the latter part of this Plan, along with the new Tier 1 projects. These projects were not re-evaluated by the TAC during the planning process. There are 50 carryover projects falling into this category.

Fully Funded and Complete Projects from the 2019 Plan

Seven projects from the 2019 Plan have been fully funded and completed; these projects, being completed, will no longer be described in detail in this Plan.

State Flood Assessment and Flood Risk Management (R0-7)

(Photo Credit: Texas Water Development Board)

Salt Bayou Siphons (R1-41)

(Photo Credit: Ducks Unlimited)

Baffin Bay Watershed Monitoring and Management Plan (R3-25)

(Photo Credit: Sam Sugarek (Nueces River Authority))

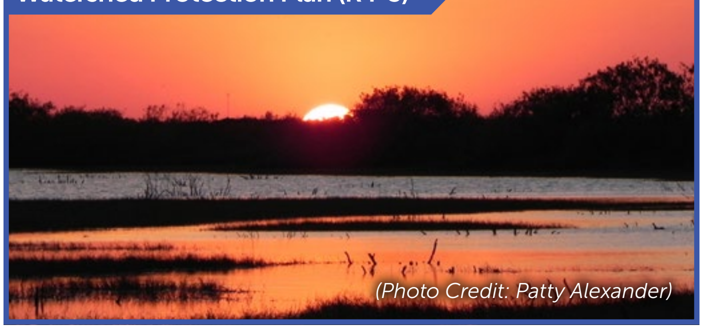
Galveston Island State Park Wetland Restoration & Shoreline Protection - Phase 3 (R1-14)

(Photo Credit: HDR)

Causeway Island Rookery Habitat Protection (R3-14)

(Photo Credit: Coastal Bend Bays & Estuaries Program)

Development of the Lower Laguna Madre and Brownsville Ship Channel Watershed Protection Plan (R4-3)



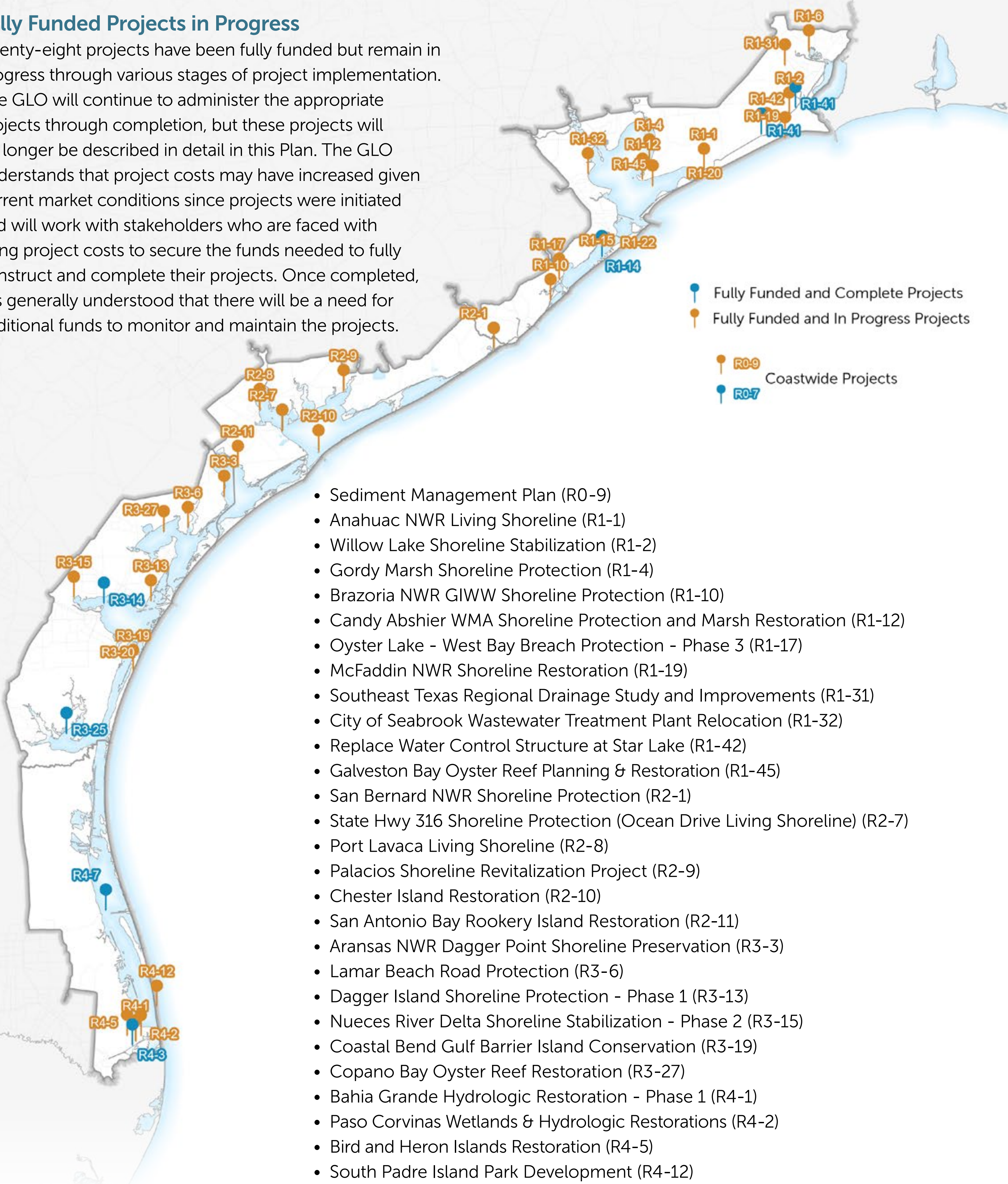
(Photo Credit: Patty Alexander)

Mansfield Rookery Island Shoreline Protection (R4-7)

(Photo Credit: Coastal Bend Bays & Estuaries Program)

Fully Funded Projects in Progress

Twenty-eight projects have been fully funded but remain in progress through various stages of project implementation. The GLO will continue to administer the appropriate projects through completion, but these projects will no longer be described in detail in this Plan. The GLO understands that project costs may have increased given current market conditions since projects were initiated and will work with stakeholders who are faced with rising project costs to secure the funds needed to fully construct and complete their projects. Once completed, it is generally understood that there will be a need for additional funds to monitor and maintain the projects.



- Sediment Management Plan (R0-9)
- Anahuac NWR Living Shoreline (R1-1)
- Willow Lake Shoreline Stabilization (R1-2)
- Gordy Marsh Shoreline Protection (R1-4)
- Brazoria NWR GIWW Shoreline Protection (R1-10)
- Candy Abshier WMA Shoreline Protection and Marsh Restoration (R1-12)
- Oyster Lake - West Bay Breach Protection - Phase 3 (R1-17)
- McFaddin NWR Shoreline Restoration (R1-19)
- Southeast Texas Regional Drainage Study and Improvements (R1-31)
- City of Seabrook Wastewater Treatment Plant Relocation (R1-32)
- Replace Water Control Structure at Star Lake (R1-42)
- Galveston Bay Oyster Reef Planning & Restoration (R1-45)
- San Bernard NWR Shoreline Protection (R2-1)
- State Hwy 316 Shoreline Protection (Ocean Drive Living Shoreline) (R2-7)
- Port Lavaca Living Shoreline (R2-8)
- Palacios Shoreline Revitalization Project (R2-9)
- Chester Island Restoration (R2-10)
- San Antonio Bay Rookery Island Restoration (R2-11)
- Aransas NWR Dagger Point Shoreline Preservation (R3-3)
- Lamar Beach Road Protection (R3-6)
- Dagger Island Shoreline Protection - Phase 1 (R3-13)
- Nueces River Delta Shoreline Stabilization - Phase 2 (R3-15)
- Coastal Bend Gulf Barrier Island Conservation (R3-19)
- Copano Bay Oyster Reef Restoration (R3-27)
- Bahia Grande Hydrologic Restoration - Phase 1 (R4-1)
- Paso Corvinas Wetlands & Hydrologic Restorations (R4-2)
- Bird and Heron Islands Restoration (R4-5)
- South Padre Island Park Development (R4-12)

1.9.3. Coastal Resiliency Successes

Building from the 2019 Plan, the GLO and its partners achieved monumental successes in the field of coastal resiliency between 2019 and 2023. While there is still work to be done, the GLO is proud to celebrate these achievements:

Dedicated Funding to Fight Against Coastal Erosion: In 2019, the 86th Texas Legislature demonstrated its long-term financial commitment to alleviating coastal erosion by allocating 2% of the revenues collected from the Hotel Occupancy Tax (HOT) to directly fund the CEPRA program. Through this House Bill (HB), dollars spent on the Texas coast will be put directly back into the economy to restore and protect the coast. At the time of this Plan's publication, disbursements to the CEPRA program from HB 6 have yet to be enacted.

Approval for Clean Coast Texas: In 2022, GLO received full, unconditional approval from NOAA and the Environmental Protection Agency (EPA) for the Texas CMP's Coastal Nonpoint Source Pollution program in accordance with §6217 of the Coastal Zone Act Reauthorization Amendments. The approval sets GLO on a 15-year implementation plan for managing nonpoint source (NPS) pollution within the Texas coastal zone. This non-regulatory program allows for GLO, TSSWCB, TCEQ, RRC, TPWD, and TxDOT to enhance coordination of NPS pollution management. The formal name remains Coastal Nonpoint Source Pollution program, but the initiative has rebranded to Clean Coast Texas for improved community engagement.

Comprehensive Flood Planning: The GLO and TWDB are both undertaking significant steps to contribute to our state's flood resilience. As of September 2020, the GLO implemented the Combined River Basin Flood Studies, which will result in detailed flood risk information and mitigation strategies for the 49 counties which received a Presidential disaster declaration due to the impact of Hurricane Harvey plus 4 counties in the Lower Rio Grande Valley that received a Presidential disaster declaration for flooding in 2015 and/or 2016.[22] This includes all coastal counties in Texas, except for Kenedy County.

Concurrently, the TWDB formed 15 Regional Flood Planning Groups statewide to conduct planning processes that will result in regional flood plans in 2023. These plans will contribute to the 2024 State Flood Plan.

The GLO's Combined River Basin Flood Studies program is a one-time planning effort, and the data and information produced by the GLO will be utilized to support current and future Texas State Flood Plans (led by the TWDB) and inform the Texas Disaster Information System (TDIS). TDIS will house critical flood risk information for the state through an accessible online dashboard. These significant steps taken by the state of Texas will result in better prepared and more flood resilient communities throughout our state.

National Wetlands Inventory being updated for Texas: The National Wetlands Inventory (NWI) received U.S. House appropriations in its draft budget to update NWI data in Texas, including in coastal regions. The NWI is an important decision-making tool and one of the primary public geospatial datasets that provides wetlands status and trends. Coastal Texas is home to close to 26.7 million acres of wetlands that need ongoing delineation and mapping. The age of the currently available data ranges from the 1980s (approximately 22% of available data), 1990s (49%), 2000s (21%), and 2010s (7%).

Local Stakeholder Capacity Building: Due to a variety of factors, not all conceptual projects from the 2019 Tier 1 list progressed toward an actualized project. Some projects stagnated due to issues like lack of stakeholder support and engagement, lack of funding, or limited avenues to pursue funding opportunities. If the listed stakeholders for the project expressed interest in continuing the project, the GLO provided non-financial technical support, insight and recommendations to (a) identify and overcome roadblocks preventing the project from moving beyond its conceptual phase, and (b) better position the projects to secure future funding to continue progressing the project toward implementation. Eleven projects were successfully progressed from a conceptual stage to a near actualized stage. Through this purposeful coordination, project stakeholders were equipped to progress the project, reach project goals and milestones, and, in some cases, achieve implementation.

(Photo Credit: Galveston Bay Foundation)

2. Texas Coastal Systems

Before large-scale development began in the late 1800s to early 1900s, the Texas coast was a mostly natural system that could naturally moderate the impact of human activities, which at that time only introduced small scale changes to natural processes like freshwater inflow and sediment transport rates. It was a less complicated, although still interconnected system that was not fully prepared to handle the level of socioeconomic activity that would develop in the proceeding decades. Along the coast, one such human activity that significantly alters these natural processes was the development of deep water ports. The naturally shallow bays and shifting inlets along the Texas coast were not easily conducive to port expansion, spurring the need to dredge ship channels and stabilize inlets with long jetties in the early 1900s. Ultimately, these activities allowed the expansion of ports and port industries, particularly the petrochemical industry. This industrial development, along with continued expansion of agriculture, housing, and tourism, caused the coastal population to reach 6.5 million in 2000, which is expected to increase to 9 million by 2050.[23] This socioeconomic activity created the built environment that is now inherently part of the coastal system, although it has altered the dynamics of the natural environment from its original state.

The Texas coastal system can be thought of as three interconnected elements—natural, social, and economic—related to one another through reciprocal effects and feedback loops that interact on multiple scales. Nowhere is the symbiotic reliance between nature, society, and economy more immediately apparent than in our coastal areas. Many economic sectors such as tourism, recreation, and resource extraction rely directly on the health of the natural systems of the state's coastal environments and estuaries. In a similar fashion, the health of our coastal ecosystems have a direct impact

(Photo Credit: AECOM)

on the economic prospects and quality of life for communities in the coastal region. These natural, social, and economic systems that form the coastal region of Texas are complex, dynamic, and act as drivers that influence the current conditions of the coast. These drivers are largely motivated by need, including economic demand for food, shelter, clean water, energy, and other resources. As represented in the Coastal Resiliency Framework, these drivers create pressures, which are typically natural processes and human activities that occur either on a long-term scale or as one-time, high impact events. Long-term pressures include continuous events, such as sea level rise, that are increasing in intensity overtime. Episodic, high impact events can range from accidental oil spills along the Texas coast to hurricanes and historically unprecedented snowstorms impacting the entire state. Increased or sustained pressures on coastal systems lead to vulnerabilities such as shifting habitats, erosion, flood events, and degrading water resources which put ecosystems, critical infrastructure, and lives at risk. Section 3 goes into further detail about these pressures and vulnerabilities, and their impacts on the coastal systems of Texas.

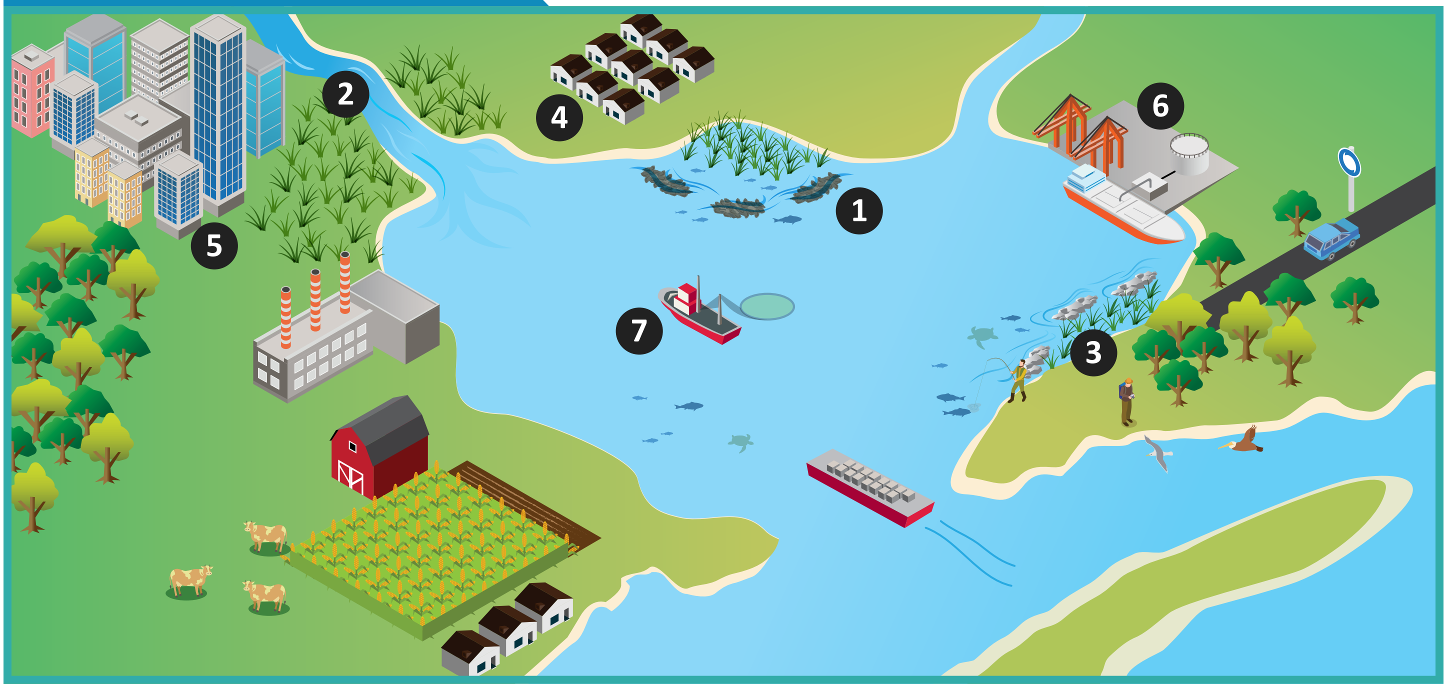
- **Natural Systems:** The natural systems of the Texas coast include a diverse swath of habitats and organisms that thrive in the unique environments that are present only along the Texas coast and nowhere else in the state, such as in its estuaries, found at the intersection of fresh and tidal waters. Texas's coastal ecosystems can adapt to the sometimes harsh and changing landscapes that exist within this coastal realm, but too much volatility can irreparably damage wildlife productivity and biological function.
- **Social Systems:** The social systems of the Texas coast include the coastal communities that support the growing population of Texans living within the Texas coastal zone. These communities include public infrastructure such as homes, schools, hospitals, and other valuable functions that sustain society. Social systems tend to change based on job availability, access to housing, and people's perception of quality of life in a given area, among other factors.
- **Economic Systems:** The economic systems of the Texas coast include the contributions of businesses and industries located in, operating on, or that use resources drawn from the coast. Industries that directly contribute to the coastal economy range from both tourism and ecotourism to commercial and recreational fishing, domestic and international maritime trade, military, and energy. These industries rely heavily on the natural resources that exist within coastal communities. Economic systems also include the infrastructure that is built to support businesses and industries that depend on the coast.

The interactions between the three systems are multi-directional, and each system can have positive or negative impacts on the others. As such, when developing solutions for a more resilient coast, each of the three should be considered all together as a unified coastal system to avoid unintended responses from one or more to another. For example, natural systems can be undermined by efforts to mitigate the impacts of coastal physical processes on human activities, such as when there are the unforeseen secondary impacts of beach erosion along a shoreline where a seawall is built to protect the adjacent community. Understanding and identifying how the natural, social, and economic systems respond to external actions can help minimize these types of negative interactions. One way to accomplish this is to use a causal chain management approach to (a) identify the point at which actions taken to support one system begin to impact the other systems, (b) consider the trade-offs and synergies of specific interactions between the systems, (c) understand the role of the human-natural environment interface within the broader landscape of the coast, and (d) indicate the scale at which actions, strategies, and projects would be effectively applied.[24]

Each system is described in further detail in the remainder of this section. Understanding how these systems interact with one another and respond to coastal pressures can highlight the vulnerabilities within the coastal system as a whole. Section 4 of the Plan will show data-driven insights into anticipated future changes to this coastal landscape and Section 5 will introduce comprehensive actions that meet natural, social, and economic needs at multiple levels to enhance resiliency and create a more robust Texas coast.

(Photo Credit: Texas General Land Office)

BAY SYSTEMS



One example of an interconnected coastal system is that of a bay system. The Texas coast encompasses eight major bay systems that support a variety of habitats, wildlife, communities, and economic opportunities. Each bay system represents a unique environment with varied hydrologic and geomorphic characteristics that respond to pressures differently. Below are example components of a typical Texas bay system. As some of these components depend heavily on location, these examples are not to be considered comprehensive.

Natural

1. Oyster Reefs - Habitats that stabilize and protect bay shorelines from erosion, filter pollutants from the water, and provide essential habitat for fish species during various stages of life. In addition, oyster reefs offer a source of food and income through commercial harvesting and provide recreational fishing opportunities.
2. Rivers and Deltas - Incoming flow from rivers is important to maintaining the balance of freshwater and sediment within the bay system. River input influences the quality and quantity of water and brings nutrients to support wetland habitats, developing critical delta habitat.
3. Wetlands - This ecosystem plays a critical function of providing habitat transition from coastal uplands to the bay. In Texas bays they perform a wave attenuation role while also serving as a water quality buffer from community drainage and outflows.

Social

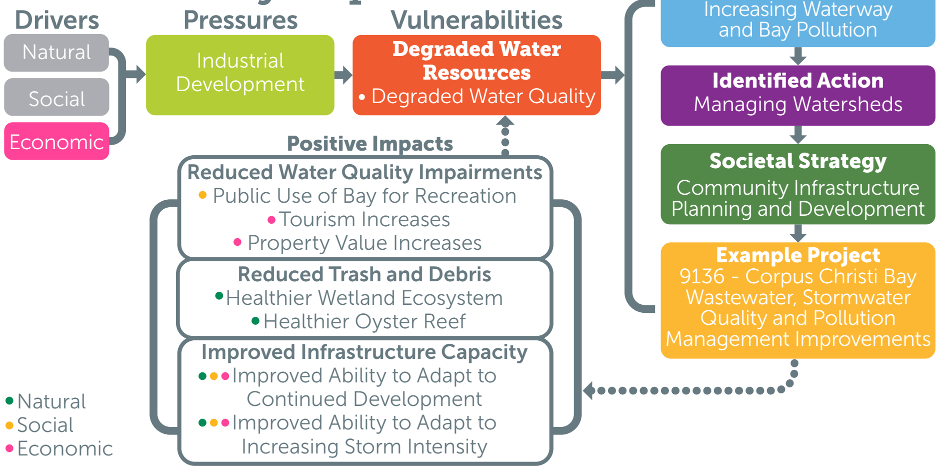
4. Residential - Bay area communities are largely populated by people making up the workforce for key coastal economic sectors, resulting in expansive suburban development with lower population zones made up of smaller, more rural communities.
5. Critical Facilities - Representing the necessary infrastructure for health and welfare of the public, these include hospitals, water treatment, police and other emergency response facilities.

Economic

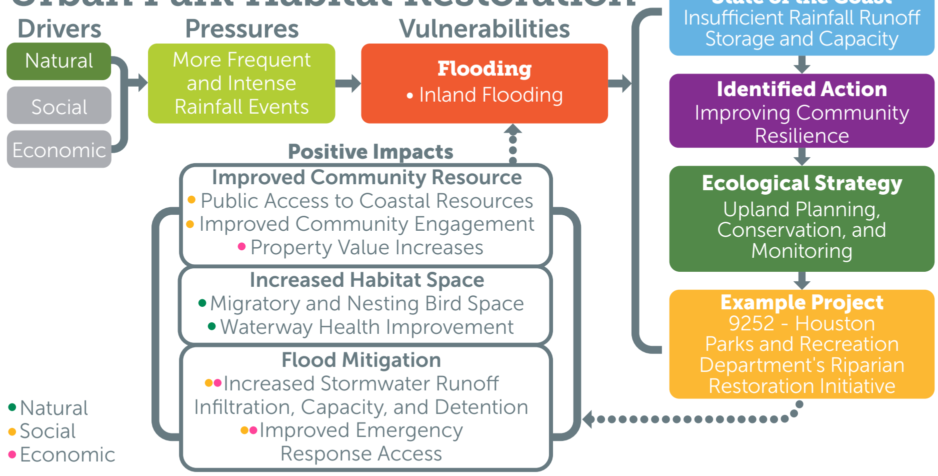
6. Energy Industry - The Texas coast is known for its robust energy sector and facilities. Home to 11 deep draft ports, our bays often facilitate access to international shipping markets.
7. Commercial Fishing - Many species of shrimps, oysters, crabs, and fish utilize the bay system during various stages of life, providing Texas with a vital and expansive economic driver.

EXAMPLE CAUSAL CHAINS

Water Quality Improvements



Urban Park Habitat Restoration



Applying the Coastal Resiliency Framework to a given system can guide users through a simple causal chain reaction. In the Water Quality Improvements example above, industrial development (i.e., the systems pressure) contributes to the degradation of water resources (i.e., the resulting vulnerability). In this example, sustained water quality degradation has altered the state of nearby waterways via increased pollution. Without taking action, this creates feedback loops between natural and social systems, as pollution degrades habitats and disrupts the ability of communities to interact with the bay. However, using actions, resiliency strategies, and projects to counteract these negative interactions can bolster the resiliency of the bay system to respond effectively to pressures. In this example, actions were taken to manage the watershed by developing community infrastructure through the Corpus Christi Bay Wastewater, Stormwater Quality, and Pollution Management Improvement project, reducing system vulnerability and leading to greater overall resiliency.

Deep Dive: Using Indicators to Inform System Health

Technical data and stakeholder input are vital to understanding the current condition of coastal ecosystems and interactions among system components. The Texas Coast Ecosystem Health Report Card is an effort led by researchers at the Harte Research Institute for Gulf of Mexico Studies (HRI), in partnership with community stakeholders, that works to provide insight into the health of the bay systems and the Texas coast as a whole. Data for a suite of indicators are rigorously analyzed to establish baseline conditions and explore change over time to inform about the health of environmental and socio-economic systems that exist within the bay through the types of relationships highlighted in these causal chains. The 2023 Report Card utilizes robust datasets on birds, habitats, fisheries, water quality and quantity, and human community characteristics in its assessment. More detail regarding the Texas Coast Ecosystem Health Report Card can be found in Section 5 of this Plan, under the "Growing Key Knowledge and Experience" action subsection.

BARRIER ISLAND SYSTEMS

A second example of a coastal system in Texas is a barrier island. Texas has extensive barrier islands along its coast with large stretches of heavily developed space as well as untouched natural coastline. These barrier islands represent a complex system with responses to changing conditions related to alterations in the natural sediment movement and increasing water levels that researchers are still working to understand. Below are example components of a typical Texas barrier island system. As these components are heavily dependent on location, these examples are not to be considered comprehensive.

Natural

1. Beach and Dune - Gulf shoreline that has the capacity to survive large waves and act as the first line of defense during tropical events. They offer habitat for sea turtles and shorebirds. They are also important for community aesthetics, tourism, and the economy.
2. Wetlands - Major storm events transfer sand from the beach and dune to the backside of barrier islands, critical to the island's long-term stability. The wetlands function as important habitat and a storm surge buffer for island communities.
3. Tidal Flats - Unique habitat within the tidal zone that are extremely sensitive to water level changes and sediment dynamics. They function alongside traditional coastal marsh grasses and mangrove vegetation.

Social

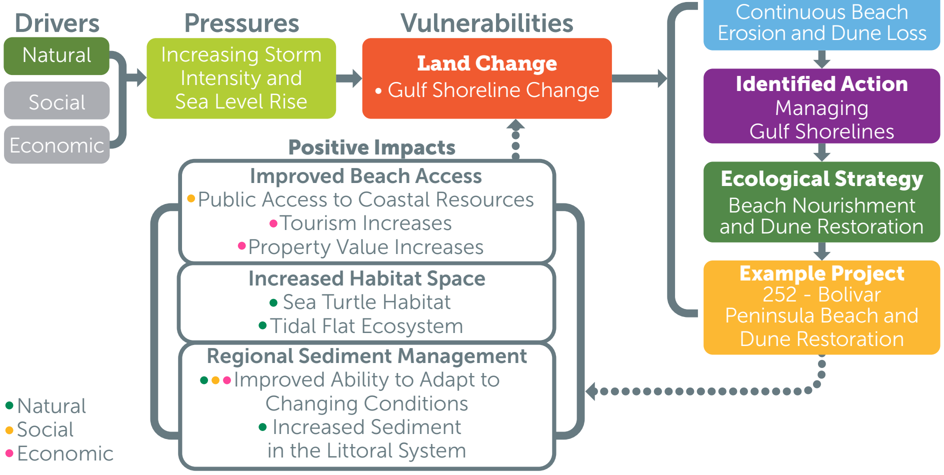
4. Residential - Barrier island communities are primarily tourism-based communities creating variable populations based on seasons. This results in a mix of rental and permanently occupied homes being common on barrier islands.
5. Critical Facilities - Representing the necessary infrastructure for health and welfare of the public, these include hospitals, water treatment, police and other emergency response facilities.

Economic

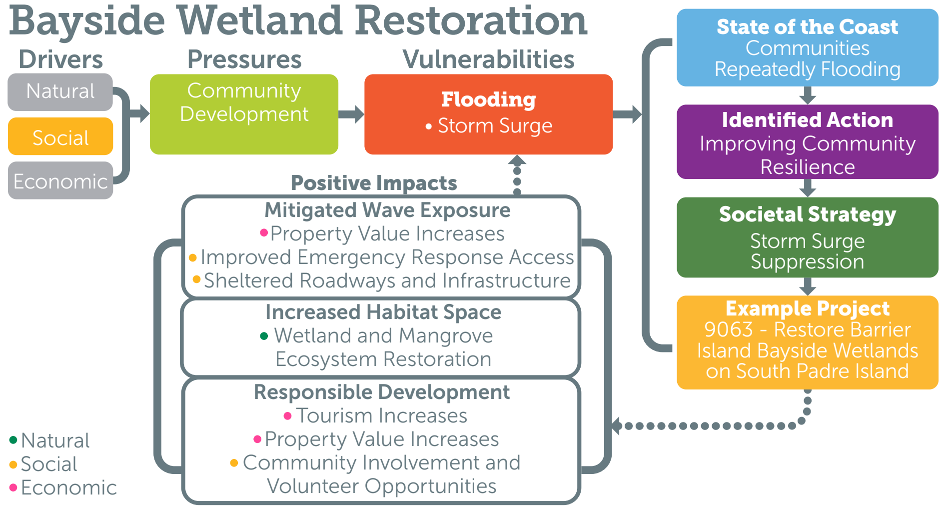
6. Tourism - Serves as a major economic driver, often realized through hotels, restaurants, and recreational venues that provide visitors access to the coastal features. On barrier islands, this has proven to be highly related to beach access.
7. Cruise Industry - With immediate access to the Gulf of Mexico, barrier islands are viable homes to ports that are reliant on international travel, such as the Galveston Island cruise terminal. This economic function also directly benefits tourism.

EXAMPLE CAUSAL CHAINS

Beach and Dune Restoration



Bayside Wetland Restoration



Applying the Coastal Resiliency Framework to the Bayside Wetland Restoration example, the causal chain reaction is initiated by community development pressure, resulting in vulnerabilities that impact the state of the coast. In this example, community development contributes to greater storm surge exposure and repeated flooding when wetland habitats that could once absorb flood waters are converted to impervious area. To address this vulnerability, actions can be taken to improve the community's resilience to flooding events by implementing storm surge suppression strategies, increasing habitat space by restoring wetlands on the bayside of the barrier island, and by responsible development and land use management. In this example, completing the restoration project creates positive impacts that reduce vulnerabilities within the system. However, these causal chain diagrams can also be used to identify the breaking points for projects that produce negative impacts or exacerbate vulnerabilities, which are not uncommon when only one of the natural, social, or economic systems is considered at the expense of the others.

Deep Dive: Geohazard Maps

Coastal systems are dynamic with physical features changing as they are driven by geomorphological processes. These processes include sea level rise, land subsidence, flooding, storm surge, and erosion and are collectively called geohazards as they may adversely affect communities and critical environments. Researchers at HRI developed geohazards maps using output from sea level rise and storm surge models. The maps outline areas prone to change and show that their vulnerability may increase as sea level rises, erosion occurs, and hurricanes continue to land on the coast. Furthermore, human actions, such as blocking upland migration of protective wetlands or dunes by development, may hasten or compound the effects of geohazards on a community.

A geohazards map shows areas that vary in their relative susceptibility to, and function for, mitigating the effects of geohazards both today and into 2100 as conditions change. This information is a guide to steering development away from future hazardous areas or enacting mitigation projects to maintain the resiliency of the human and natural landscape. More detail regarding the Geohazard maps can be found in Section 4 of this Plan.

Key Term:
Ecosystem Services

Ecosystem services encompass the direct and indirect contributions, including economic, environmental, and social effects, which ecosystems contribute to the environment and human populations, including tangible goods and benefits (such as the provision of food and materials). Ecosystem services are grouped into four main categories as follows:

- *Provisioning services* include food, raw materials, and medicinal resources provided by ecosystems that can be used by people;
- *Regulating services* are provided by ecosystems that act as regulators, such as regulating air quality, water quality, and heat, moderating extreme events, preventing erosion, and acting as biological control;
- *Supporting services* are provided by the habitats that enable flora and fauna to survive, and include supports such as food, water, and shelter. Supporting services may also include the maintenance of biogenetic diversity; and
- *Cultural services* include the recreational value of ecosystems, such as the aesthetics, tourism, and spiritual experiences provided by ecosystems.

(Photo Credit: Freese and Nichols, Inc.)

2.1. Natural Systems of the Texas Coast

The Texas coastal landscape is comprised of a multitude of natural systems and provides the foundation for a range of coastal environments, including the major bay systems, barrier islands, beaches and dunes, wetlands, coastal uplands, oyster reefs, and rookery islands. These Texas coastal environments face significant pressures related to various anthropogenic stressors, as well as relative sea level rise (RSLR) and storm surge. These environments are impacted by increased human development, fragmenting habitat corridors that are essential for birds and other wildlife species. Conserving sensitive habitats will become even more critical in the future to preserve contiguous upland prairies and forests, floodplains, natural stream deltas, and wetland migration space. Texas's coastal environments support unique and productive habitats for numerous fish and wildlife species that are important to ecosystem health and the state's economy.

The GLO seeks to better understand, steward, and manage natural resources that benefit human activities and inherently help to mitigate coastal hazards. Texas coastal environments provide economic benefits to society, and such benefits are referred to as *ecosystem services*. The economic benefits offered by natural environments along the coast are diverse and include both traditional and non-traditional factors. *Traditional economic factors* include the dollars generated for the state through profitable activities such as fishing, resource extraction, ecotourism, and recreation. *Non-traditional economic factors* are the benefits provided by the environment that support, sustain, and enrich human life. The value of ecosystem services provided by habitats along the Texas coast is dependent on the location, quality, and type of habitat. It can be difficult to fully assess and represent the extent of economic benefits that a particular ecosystem provides society, but current research justifies that protecting and restoring natural resources is immensely beneficial, and in many ways imperative, to human society.

Building on the 2019 iteration of this Plan, this update aims to better protect, enhance, and restore coastal resources that support the Texas economy and culture. Coastal resources in Texas are diverse and support a number of fisheries, migratory birds and associated habitat, and critical habitat for endangered species (e.g., Kemp's ridley sea turtle). Coastal resources contribute significantly to the Texas economy through both direct sales (i.e., costs associated with commercial and recreational fishing) and tourism. For instance, in 2020 and 2021, commercial fishing accounted for over $433 million in landings revenue, with northern white and brown shrimp accounting for the highest yields.[25] Additionally, Texas is known as an international destination for nature-based tourism, with hunting, camping, birding, and fishing as major components. As a whole, these resources are vulnerable to pressures resulting from an increasing population, natural resource extraction, habitat loss, degraded water quality, predation, invasive species, overharvesting, disease, and storms. Careful ecosystem monitoring to better understand long-term trends, future climate projections, and restoration approaches to improve and stabilize resource populations are key recommendations put forth in this Plan.

(Photo Credit: Texas General Land Office)

Deep Dive: Barrier Island Geomorphology Research

The geologic make-up and formation of the Texas barrier island system can provide insight into the response these features have to current natural and man-made processes. The upper Texas coast, mid-Texas coast, and lower Texas coast each have a unique geologic history, and therefore, may be more or less susceptible to coastal vulnerabilities, depending on the specific geomorphology. Understanding this underlying geomorphology is a key factor in identifying transgressional hotspots along the coast. Research on barrier island geomorphology is currently ongoing in order to better understand the evolution of the barrier islands in Texas and their historic response to sea level rise and other climate impacts to help inform how these features will respond to increased threats in the future. Data spanning back four decades show that the landward retreat of barrier islands is occurring at historically unprecedented rates ranging from -0.41 meters per year (m/yr) to -2.01 m/yr, creating a reversal effect of these coastal geologic formations. This retreat is likely due to the increased rate of sea level rise over the last century, as well as decreased sediment supply from rivers and offshore sources.[26] Although these systems are dynamic and constantly change and evolve over time, studies show a transition from net transgression to progradation occurs with lower rates of sea level rise and stable sources of sediment.[27] Overall, this study indicates that Texas barrier islands may become more isolated and sediment-starved in the future.[26]

DID YOU KNOW?

TCEQ assesses the state's water quality every two years in even-numbered years and releases their findings in the Texas Integrated Report of Surface Water Quality.[28] This report meets federal requirements of the Clean Water Act Section 305(b) and 303(d), which mandate that states assess waterbodies to identify and list those which are polluted. The report must be reviewed and approved by the EPA before publication. The most recent report was published in July 2022. TCEQ uses historical water quality data to determine the extent in which the waterbody meets the Texas Surface Water Quality Standards, which establish goals to maintain the quality of waterbodies throughout the state to support public health, aquatic life, and economic development.[29] These standards include metrics for dissolved oxygen levels, temperature, pH, dissolved minerals, toxic substances, and bacteria. The findings of the 2022 report suggest that a majority (56%) of the bays and estuaries along the Texas coast are impaired with a portion of these waters identified with excessive fecal indicator bacteria for waterbodies used for shellfish harvesting.

2.1.1. Bays and Estuaries

The Texas coastal region is characterized by eight major bay systems: Sabine Lake, Galveston Bay, Matagorda Bay, San Antonio Bay, Aransas Bay, Corpus Christi Bay, Upper Laguna Madre, and Lower Laguna Madre. Bays are bodies of water that are partially enclosed by land, separated from the Gulf of Mexico by barrier islands and peninsulas, and connect freshwater inflows and tidal waters of the open ocean through passes and inlets that allow for the ingress and egress of water. Many of the bay systems in Texas are also considered estuaries, bodies of water where freshwater from rivers and streams empty and mix with saltwater from the Gulf of Mexico. The major estuaries are named for the primary rivers that flow into them. The freshwater that flows into the estuaries does not empty directly into the Gulf of Mexico, but is confined within the bay system by bordering mainland, peninsulas, barrier islands, or fringing wetlands that form a transition zone influenced by both riverine (inflows of freshwater and sediments) and marine (tides, waves, and saltwater) sources. These fresh and saltwater influxes provide high levels of nutrients in the water column and sediments, which supports diverse wetland habitats for fish and wildlife. As rivers empty into estuaries, sediment accumulates at the river mouth to form pockets of land that divert the river into smaller channels. These land formations, known as deltas, typically support a diversity of coastal wetlands. Upstream disruptions to river systems can have downstream impacts to deltas and their formation or maintenance over time.

(Photo Credit: Texas General Land Office)

(Photo Credit: Galveston Bay Foundation)

These environments are influenced by regional weather patterns, which vary along the coast and impact salinity gradients within estuaries and affect the types of coastal environments that exist within each region. The estuaries of the upper coast experience approximately twice the amount of precipitation than the lower coast, and tend to have lower salinity levels which allow smooth cordgrass (*Spartina alterniflora*) to thrive within coastal wetlands. Towards the south, wetlands transition from more freshwater to higher salinity environments and become sparser due to the relatively arid climate.[30] The high salinity levels in the Laguna Madre (southernmost part of the Texas coast) support a vast area of sparsely vegetated flats and mudflats.

Fisheries

Bays and estuaries also provide diverse Texas Gulf coast habitat (see Section 2.1.3 for more detailed habitat information) that supports a variety of important commercial and recreational fisheries. Commercially important species include oysters, northern white and brown shrimp, blue crab, and various forage fish.[25] Recreationally important species include spotted sea trout, red drum, groupers, snappers, and other coastal pelagic species.[31] Many of these species utilize bay systems during various stages of their life cycle, taking advantage of the protected estuarine habitats such as wetlands and seagrass beds as nursery habitats to raise their young. Approximately 95 percent of the Gulf's recreationally and commercially important fish (e.g., red drum and spotted seatrout), shellfish (e.g., crab and shrimp) and other marine species rely on estuaries during some part of their life cycle.[30] Juvenile fish, crab, and shrimp depend upon estuaries that have adequate freshwater inflows to balance salinity. This critical nursery habitat for most Gulf commercial and recreational finfish and shellfish species provides food and shelter as the species mature, before migrating out into the open waters of the Gulf. Oysters, found only in estuaries, comprise the basis for a thriving commercial harvesting industry and are dependent upon the estuary's brackish waters.[30] Fisheries are a vital natural resource to the Texas economy, particularly in the coastal region, as they provide jobs, food, and recreational opportunities. Section 2.3.1 supports the necessity of fisheries for employment opportunities that bolster Texas's coastal economy.

(Photo Credit: Texas General Land Office)

(Photo Credit: City of South Padre Island)

2.1.2. Barrier Islands and Peninsulas

The Texas coast consists of a near-continuous chain of barrier islands and peninsulas that separate the bays and estuaries from the open waters of the Gulf of Mexico. Barrier islands are long, narrow swaths of land formed by offshore deposits of sand and sediment that typically run parallel to the mainland. Similarly, peninsulas are formed in the same orientation to the mainland as barrier islands, but are still connected. These landforms are characterized by a Gulf-facing beach and dune system that gradually slopes down to the bayside shoreline. Shallow bays or lagoons divide barrier islands and peninsulas from the mainland and are generally protected from wave action in the Gulf of Mexico, allowing for the formation of estuaries and wetlands that provide critical habitat for coastal species. The Texas Gulf shoreline has two peninsulas and six barrier islands, including Padre Island, the longest undeveloped barrier island in the world.[32]

Barrier islands are dynamic systems by nature and are constantly shifting and migrating as sand is moved by waves, tides, currents, and changing sea levels.[33] The movement of sediment within the bay system provides natural beach nourishment and protection from erosive wave action as it is deposited onto the barrier islands and peninsulas. These systems are segmented by many natural and man-made passes that allow for the movement of sediment, water, and vital nutrients between the bay systems and the Gulf of Mexico. Tidal deltas can be formed within these passes as sediment is deposited at both ends of the pass. These inlets are intended and provide for the movement of goods through the Texas port system that supports thriving economic activities. Additionally, barrier islands absorb the brunt of a hurricane's storm surge force, which helps attenuate waves further inland and protect communities on the bay side.[33] Development is occurring on several of the state's barrier islands, which limits the natural movement/migration and dynamic processes and benefits that these islands provide surrounding environments. This, in turn, will make the islands themselves, the communities located on the barrier islands, and the coastal communities behind the barrier islands more vulnerable to negative impacts from storm surge and coastal flooding.

2.1.3. Texas Coastal Environments

A range of coastal habitats exist along the Texas coastline and provide important economic benefits and ecosystem services that directly and indirectly benefit human life. In an effort to better capture the value of these services provided, the GLO, alongside a Technical Working Group, evaluated the dominant habitat types that exist along the Texas coast in order to assign an economic value through the quantification of the benefits derived from ecosystem services. In addition, this information can be leveraged for funding when combined with hazard mitigation components during project conceptualization and design. More information on this process can be found in the Hazard Mitigation Funding Opportunity Approach for Coastal Resilience Projects with Ecosystem Services Methodology document on the GLO's Texas Coastal Resiliency Master Plan landing page.

The seven habitat types and their associated benefits and ecosystem services are summarized in Table 2.1 below and described further in the subsequent paragraphs. The table indicates the high-level ecosystem services provided by each habitat type that corresponds to the findings from the document described above.

DID YOU KNOW?

Beach-quality sand is an expensive commodity, and the Texas coast faces sediment deficits due to reduced sediment inflow into Texas bays caused by upstream development, as well as circulation patterns within the Gulf. Each year, however, the federal government dredges 30 to 40 million cubic yards of sediment from Texas ship channels as routine maintenance, some of which is lost from the sediment budget of bay systems.[34] Therefore, the GLO CEPRA program is currently developing regional sediment mapping surveys for the whole coast (Regions 1, 2, and 3 are completed or in process and Region 4 is upcoming). In addition, an update to the Texas Coastwide Erosion Response Plan was released in 2020, which identified areas of critical erosion along the coast and provided metrics to determine priority areas for implementation of erosion response studies. The GLO also continues to work closely with other stakeholders that are working to improve the sediment management planning process, including the Ducks Unlimited-led Beneficial Use Master Plan, that aims to provide long-term, interagency, and statewide coordination of valuable sediment materials.

Table 2.1: Habitat Types and Associated Ecosystem Services Provided

	Ecosystem Services									
	Provisioning Services			Regulating Services			Supporting Services			Cultural Services
Habitat Types	Commercial Fisheries	Cattle Grazing/ Ranching	Timber Harvest	Storm Surge/ Flood Protection	Erosion Control/ Shoreline Stabilization	Carbon Sequestration	Habitat Provision	Biodiversity	Primary Production	Ecotourism/ Recreation
Beaches and Dunes	-	-	-	X	X	X	X	X	X	X
Coastal Wetlands	X	-	-	X	X	X	X	X	X	X
Coastal Prairies	-	X	-	X	X	X	X	X	X	X
Coastal Bottomland Forests	-	-	X	X	X	X	X	X	X	X
Submerged Aquatic Vegetation	X	-	-	-	X	X	X	X	X	X
Oyster Reefs	X	-	-	-	X	-	X	X	-	X
Rookery Islands	-	-	-	-	-	-	X	-	-	X

Note: Benefits and services are reported in the table above based on rankings (either moderate or high) from the Ecosystem Services Benefits Tool for Hazard Mitigation document. See document for establishment of methodology used to indicate the results presented herein.

Beaches and Dunes

The Gulf-facing beaches and dunes along Texas barrier islands are highly dynamic systems and important habitats that are located at the land-sea interface. These systems provide valuable foraging and nesting habitat for sensitive plant and wildlife species, including threatened and endangered species such as piping plovers and sea turtles.[32] In addition, migratory birds rely on sand dunes and beaches along barrier islands as landing or resting areas as a stop along the Central Flyway migration corridor after flying thousands of miles over the Gulf of Mexico.

Beaches and sand dunes provide a resilient natural barrier to the destructive forces of wind and waves and are therefore the least costly defense against storm surge flooding and beach erosion. Sand dunes help prevent loss of life and property by absorbing the impact of storm surge and high waves by stopping or delaying intrusion of water inland. Additionally, these systems provide a first line of defense against the destructive impacts of hurricanes and tropical storms on inland development and sensitive coastal environments.

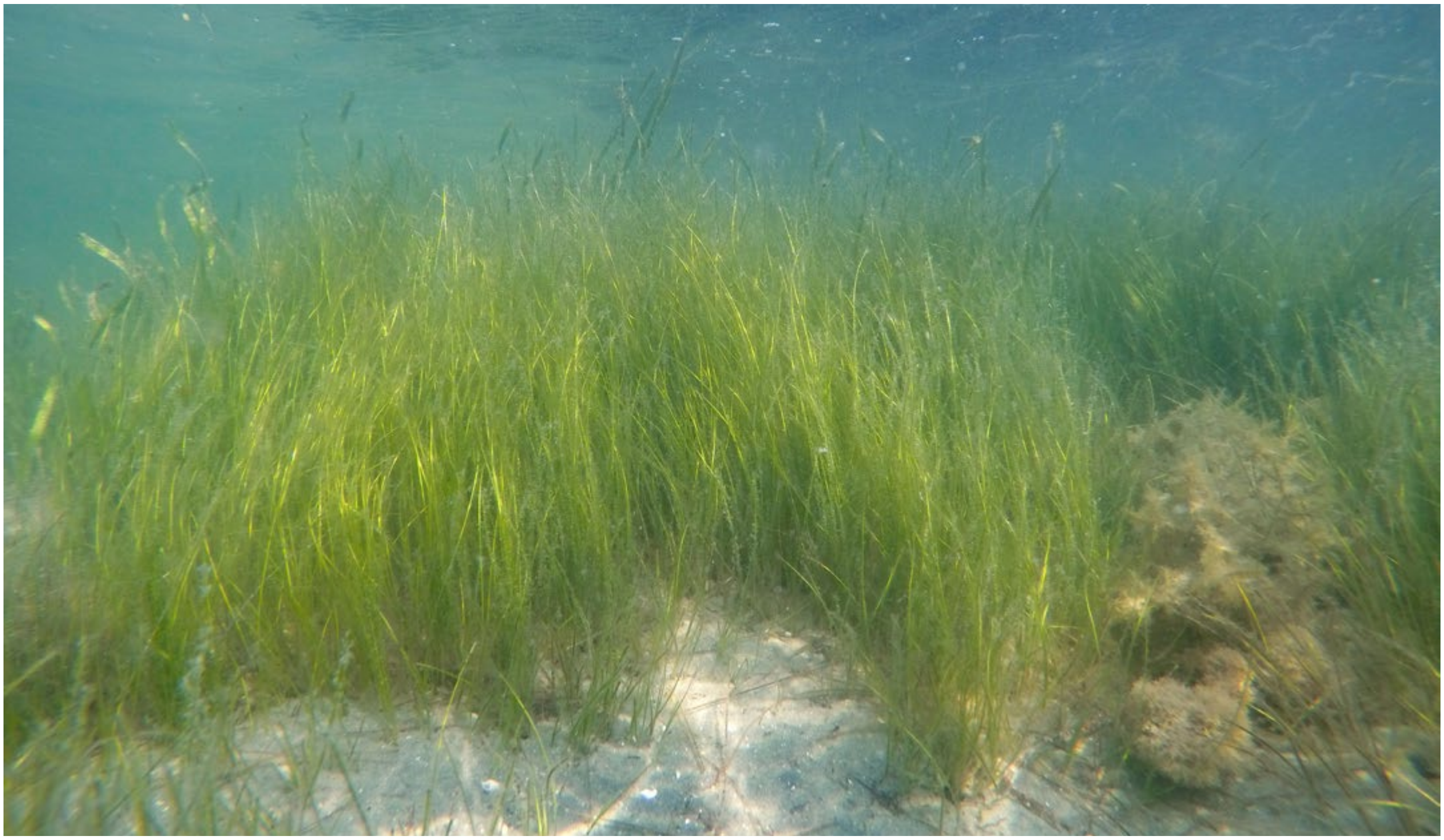
Characterizing these benefits through the concept of ecosystem services, Texas beaches and dunes can be seen as providing multiple types of ecosystem services that include: (1) the aforementioned supporting services for wildlife habitats, (2) regulating services through storm protection and erosion control, and (3) cultural services including tourism and recreation opportunities to residents and visitors which are strong drivers of economic activity throughout the Texas coastal zone.[23,35,36] In addition to these economic and social benefits, beaches and dunes provide other benefits including water catchment and purification, habitat and foraging for wildlife species, and aesthetic views.

Sea Turtles

Several species of endangered sea turtles, including the loggerhead sea turtle, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, and the leatherback sea turtle, are known to utilize the Texas Gulf coast. In particular, many individuals prefer the remote and expansive beaches along the Padre Island National Seashore.[37] Although turtles are typically only seen on shore during nesting activities, they can also be found within the bay areas, feeding on seagrasses and algae, and in offshore areas, feeding on jellyfish. Sea turtle populations have been in decline over the last century, due to historic overharvesting of the species, incidental capture in fishing gear, and loss of nesting habitats coupled with the relatively slow maturation of the species. However, in 2022, a Kemp's ridley nest – one of the most endangered of the sea turtles – was found on Babe's Beach in Galveston, a renourished beach that has historically not been a preferred nesting site for turtles.[38] Although unintentional, this success highlights the importance of maintaining and restoring natural habitats such as barrier island beaches and dunes to support vulnerable species.

(Photo Credit: Patty Alexander)

(Photo Credit: Texas General Land Office)



(Photo Credit: Hollaway Environmental + Communications Services)

Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) is a crucial part of the Texas coastal ecosystem and includes rooted aquatic plants, such as seagrass and a variety of macroalgal species. These habitats can be found in both freshwater and saltwater systems and are particularly important in estuarine environments, as SAV is a preferred habitat for some species of fish, marine invertebrates, and other aquatic organisms in various stages of life.[39,40] Further, seagrass beds are considered one of the most productive habitat types and play an important role in the greater Texas coastal ecosystem.[41] Currently, along the Texas coast, this habitat is primarily located along the mid-to-lower Texas coast, where the water is warmer, more saline, and contains less suspended sediment; however, the historical distribution of SAV included areas around Galveston Bay as well.[42] Much of the SAV that once flourished along the upper Texas coast has been lost through both natural and anthropogenic causes and very few remnant populations remain.

The benefits and ecosystem services that SAV habitats provide include: (1) provisioning services as an important cultural and economic resource for coastal populations, and contribute to human welfare by providing fishing and bait collection grounds, substrate for seaweed cultivation, medicinal resources, and food, (2) regulating services from carbon sequestration and shoreline stabilization capabilities with extensive root systems to reduce water currents and help trap sediment, (3) supporting services through sustaining biodiversity in coastal ecosystems, hosting countless species of fish, waterfowl, and sea turtles, and aiding in coastal nutrient cycling processes, and (4) cultural services with the extensive recreational activities that SAV systems can provide (e.g., snorkeling, SCUBA diving, fishing, and non-motorized boating).[41,42]

Due to their high productivity, SAV and other aquatic plants have the capacity to capture and sequester carbon dioxide in the rich, anoxic soils in which they reside. This "blue carbon" (carbon sequestration occurring primarily underwater) is considered to be a key factor in providing a solution to the increasing carbon dioxide levels in the atmosphere.[43] With growing interest in harnessing the power of the natural biological environment to capture excess carbon, protecting aquatic vegetation is a high priority in Texas.

Coastal Wetlands

Wetlands are naturally occurring or restored lands, including marshes, tidal flats, and mangroves that are transitional zones between terrestrial and aquatic systems and, therefore, are periodically inundated with saline water. Wetlands are generally characterized by herbaceous (non-woody) plants that can withstand temporary salt water inundation and are adapted to wet soil conditions, whereas mangroves are characterized by woody stands of salt tolerant trees that grow in dense thickets in the intertidal coastal zone in areas with low-oxygen soil.[44]

In this Plan, coastal wetlands are typically classified as either estuarine (intertidal) wetlands, including mangroves, or freshwater wetlands.

Estuarine Wetlands

Estuarine wetlands are found along the bay shorelines within an estuary and on the backside of barrier islands. These estuarine ecosystems support unique plant and wildlife communities that have adapted to brackish water, requiring tidal and freshwater exchange. Salt marshes are the most prevalent of estuarine wetlands and are characterized by salt-tolerant plants such as smooth cordgrass, glasswort, and saltgrass. Of wetland ecosystems, salt marsh has one of the highest rates of primary productivity, the rate at which green plants (and some bacteria) convert solar energy into biomass, due to the influx of nutrients from surface and tidal waters.[44]

Freshwater Wetlands

Freshwater wetlands are areas that receive periodic or permanent influxes of freshwater to support plant life, and often are inundated or completely covered with freshwater. These wetlands derive most of their water from surface waters, including floodwater and runoff, but also receive some groundwater input. In the coastal zone, freshwater wetlands typically exist where rivers and streams merge with other bodies of water, including the initial outflows of rivers to estuaries and lagoons.[44] They can also be found in the coastal upland areas along stream banks, lakeside meadows, or low-lying areas that receive adequate overland flow of rainwater or stream overflow. These freshwater wetlands support many species that depend upon consistent access to water that is neither too deep, nor too brackish. This ecosystem type provides diverse and ample resources for birds, reptiles, amphibians, mammals, and insects.

(Photo Credit: Texas General Land Office)

(Photo Credit: Patty Alexander)

Mangroves

Black mangroves (*Avicennia germinans*) are a species of woody shrub that are typically found in tropical or subtropical climates. These shrubs comprise a unique habitat, as they are able to tolerate a wide range of environmental conditions including saltwater, freshwater, brackish water, and periods of inundation.[45] Along the Texas coast, black mangroves are usually found in the south, along the Laguna Madre and in the salty, sandy, or clay tidal flats of coastal marshes.[46] In recent years, the warmer climate and milder winters along the Texas coast have allowed the black mangrove species to thrive, quickly becoming a dominant wetland plant displacing salt marsh species in some coastal Texas environments.[47] In areas with a warmer climate, black mangroves can grow up to 50 feet tall. However, in Texas, winter freezes occur frequently enough that prevent the shrubs from growing beyond three feet.[46] Although the two environments provide similar benefits to coastal species, researchers along the coast speculate that this shift may alter wetland dynamics in the future.[48]

Ecosystem services provided by coastal wetlands and mangroves in coastal Texas include: (1) regulating services via storm protection, sediment retention, water filtration, nutrient control and cycling, and carbon sequestration, (2) supporting services by enhancing biodiversity and providing habitat (protection, foraging grounds, and nesting and roosting habitat) for a wide variety of coastal species, and (3) cultural services via recreational activities such as kayaking, wildlife viewing, ecotourism, and recreational fishing.[49,50,51,52,53,54]

Coastal wetlands provide an abundance of ecosystem services, including habitat for plants and wildlife, water purification to help reduce water pollution, convey and store floodwaters, trap sediment, nutrient cycling and soil retention, and diffuse wave energy to protect coastal shorelines.

Coastal Prairies

Coastal prairies are large, open expanses of coastal uplands with continuous grassy vegetation located immediately inland of coastal marshes extending along the Gulf of Mexico shoreline.[55] The dominance of grasses in these uplands can be attributed to the heavy clay soil that makes it difficult for woody plant species to establish. Specific areas with coastal prairies include several barrier islands, and the resacas, or disconnected channels, of the Laguna Madre. The natural history of Texas indicates that most of the land surrounding bays and estuaries of the Texas coast were once a coastal prairie ecosystem and consisted of relatively flat ground with a very subtle, gradual rise in elevation. Once covering over 6.5 million acres (2.63 million hectares) of Texas land, coastal prairies now only occupy 65,000 acres (26,300 hectares), or less than 1 percent of the original acreage.[56]

The unique flat grasslands and thorny scrublands of the coastal prairie and adjacent marsh areas provide valuable wildlife habitat. Grasslands used for grazing, with some oak savannah and mesquite vegetation, provide ample habitat for the various species that utilize this ecosystem.[57]

Ecosystem services associated with coastal prairies along the Texas Gulf Coast include: (1) provisioning services such as grazing land for ranching and hunting, (2) regulating services including flood regulation, carbon sequestration, erosion control, and nutrient cycling, (3) supporting services through the creation of habitat and maintenance of biodiversity for waterfowl and other wildlife, including endangered species such as the ocelot, the Attwater prairie chicken, eastern black rail, and the jaguarundi, and (4) cultural services through aesthetics and recreational uses.[58]

Coastal Bottomland Forests

From East Texas to Brazoria County, there are large, forested areas adjacent to streambanks and floodplains called bottomland hardwood forests. The primary source of water for these forests comes from riverbank flooding, however, the soil in these systems is not as wet as swamps.[59] This habitat is rich in plant and wildlife diversity and contains resources necessary for species' survival. Common tree species found in these forested areas include bald cypress, water tupelo, oaks, hickory, elm, green ash, red maple, and black willow. These forested areas are home to endangered mammals and birds, as well as rare plants and other species.[60] Historically, bottomland forests were contiguous along river and bayou corridors, but have been fragmented by human pressures such as development and resource extraction.[58,60]

Ecosystem services associated with bottomland hardwood forests include: (1) provisioning services such as timber harvest, (2) regulating services include flood storage, groundwater supply and recharge, nutrient cycling, and carbon sequestration, (3) supporting services through habitat creation for plant and wildlife species, and (4) cultural services which provide recreational opportunities such as wildlife viewing as remnant bottomland forests are vital refuges and stopovers for migratory birds along the Central and Mississippi Flyways.[60]

(Photo Credit: Richard Gonzalez)

(Photo Credit: Bill Balboa)

Oyster Reefs

Oyster reefs are submerged colonies of oysters found in nearshore rocky areas, bays, and estuaries, especially near river mouths where waters are brackish and shallow. Oyster reefs in Texas are primarily comprised of the eastern oyster (*Crassostrea virginica*) through the settlement and reproduction of oyster larvae onto existing reef structures, creating large mounds of oysters and oyster shells.[61] Oysters also settle on hard substrates, like concrete barriers and rocks, but prefer to colonize on other oyster shells, as they cannot thrive on sandy or soft, muddy bay bottoms. As successive generations of oysters settle and grow, large reef structures can amass, comprised of many individual oysters. It is estimated that oyster reefs have 50 times the surface area of an equally sized flat bottom.

Oyster reefs help to increase biodiversity and provide valuable habitat in bay and estuarine systems along the Texas coast for more than 300 marine aquatic species to forage and spawn, creating ideal locations for commercial and recreational fishing.[61]

Ecosystem services provided by oyster reefs include: (1) provisioning services from oyster harvest, (2) regulating services such as sediment stabilization, shoreline protection and erosion control, and water filtration and circulation within estuaries, (3) supporting services include the creation of habitat and enhancement of biodiversity in nearshore ecosystems for juvenile fish and crustaceans, while providing associated species refuge from predation, and (4) cultural services such as recreational opportunities through the support of biodiversity within the fishery.[58,61]

(Photo Credit: Galveston Bay Foundation)

DID YOU KNOW?

Oysters filter water by removing pollutants and sediment, providing a vital service to some of the most impaired coastal waters. A single adult oyster can filter roughly six gallons of water every hour.[61]

(Photo Credit: Texas General Land Office)

Rookery Islands

Rookery islands are typically quite small – only a few acres or less in size – and while some naturally exist, most were formed from the placement of dredged material during the creation or maintenance of nearby navigation channels, such as the GIWW, or smaller channels and basins supporting ports and marinas. These islands form, and can be found, along the back side of barrier islands and can protect bay shorelines and navigation channels from erosion.[62]

Rookery islands are isolated from the mainland and are too small to sustain predator populations, thereby providing optimal foraging, roosting, breeding, nesting, and rearing habitats for migratory birds and a wide variety of colonial waterbirds and coastal shorebirds, including herons, terns, pelicans, egrets, and cormorants. Colonial waterbirds rely on open water, mudflats, estuarine wetlands, and seagrass for foraging. Nesting pairs on rookery islands can range from a few pairs to thousands depending on island size.[63] Additionally, rookery islands provide areas for birdwatching, ecotourism, and recreational fishing. Preservation of rookery islands becomes increasingly important as changes in the bays, such as RSLR and sediment management practices, are resulting in the loss and degradation of these critical islands. Several studies conducted in the Galveston Bay Estuary found a link between declining waterbird populations and decline in wetland area, including wetlands found on rookery islands – underscoring the need for island restoration and preservation.[62]

Ecosystem services provided by rookery islands are widely understudied, and vary by location and scale, but may include: (1) regulating services such as erosion control (though the extent of protection provided varies by location and scale), (2) supporting services through the creation of habitat and enhancement of biodiversity for mostly resident and migratory birds and waterfowl, and (3) cultural services from ecotourism and recreational activities such as wildlife viewing and bird watching and kayaking.[62,64]

Migratory Birds

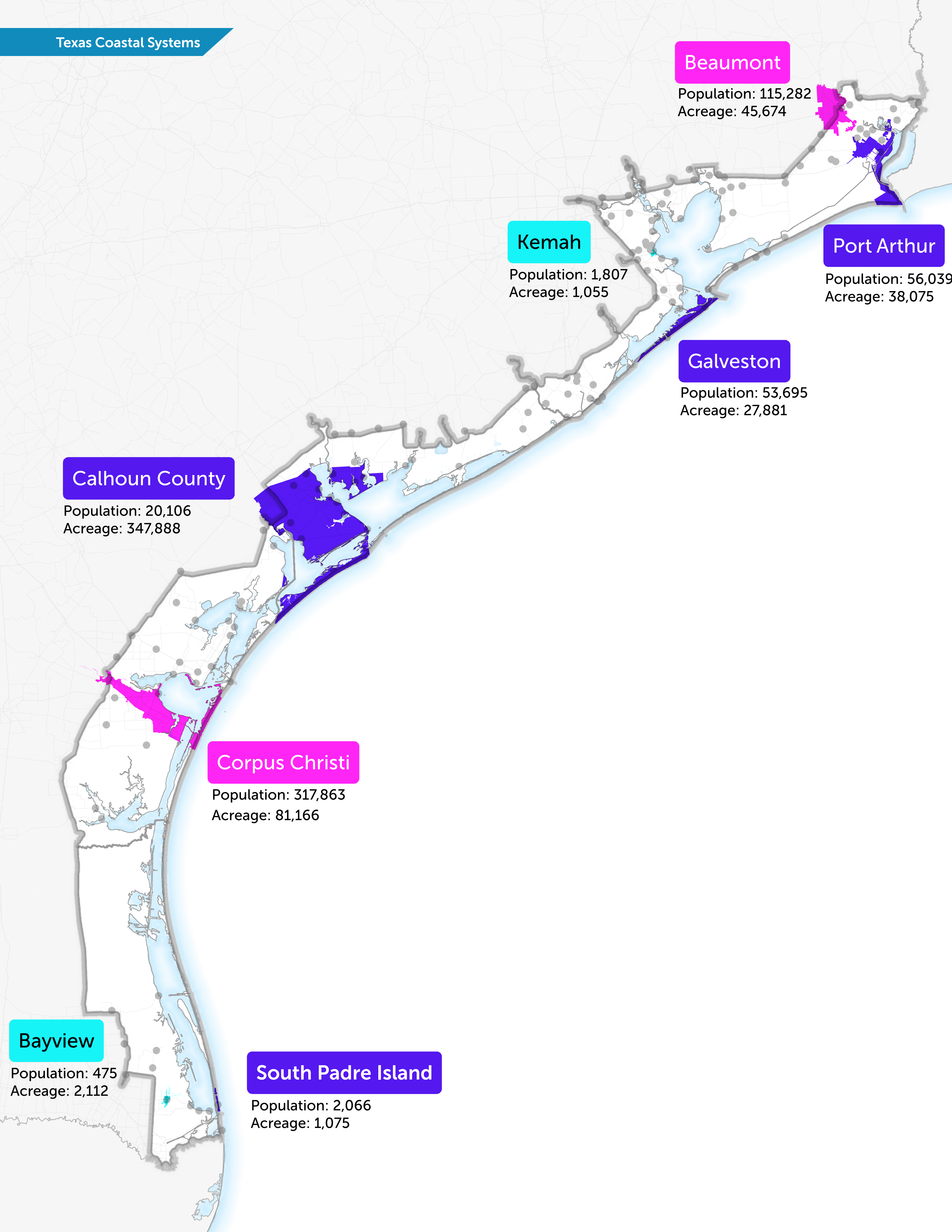
The Texas coast serves as an important stopover for many migratory birds traveling south during the winter season in search of warmer climates, abundant food sources, and additional nesting space. Texas lies in the direct path of two of the four major migratory pathways in North America, the Central and Mississippi Flyways, and birds utilizing the Atlantic and Pacific Flyways typically cross over the state as they reach the Gulf of Mexico. In total, 333 of the 338 migratory species in North America have been recorded in Texas.[65] Not only does the state provide a haven for these species during their journey, but also offers recreational birding opportunities to nature enthusiasts that visit the coast. In particular, the Texas coast boasts large swaths of critical habitat for both the endangered whooping crane and piping plover species.[66,67] Protecting these habitats is essential to a thriving migratory bird community and the associated socioeconomic opportunities.

History of Success: Shamrock Island Restoration

Shamrock Island is one of the most productive bird nesting islands in the Coastal Bend. Erosion caused by waves from wind, boat wakes, and marine debris are diminishing the viability of the island for nesting habitat. Restoration and protection work was partially completed before Hurricane Harvey, however, during the storm part of the project area was damaged and needs repair. This project, a 2023 Tier 1 project, would install 900 feet of breakwaters, fill a breach into one of the interior wetlands and lagoon, and install a feeder mound to help stabilize the beach around the rookery island. The project is partly funded, and the damaged portion of the project site is currently being reengineered to better withstand coastal storms using this funding. The beach nourishment mound is shovel-ready once full funding becomes available. The project would be monitored for three years following construction to assess its physical and ecological impacts on the coastal ecosystem. Repairing the breach and adding breakwaters to Shamrock Island would protect approximately 2,000 linear feet of prime beach nesting habitat, 12 acres of estuarine wetlands, 14 acres of seagrass, and 23 acres of upland nesting habitat from erosion.

The project will complement both on-going and adjacent restoration work now being undertaken by the Nature Conservancy, as well as, enhancing previous restoration efforts. All of which are aimed at protecting the island's eroding shorelines and providing enhanced habitat restoration for nesting birds and marine-dependent species.

(Photo Credit: Rusty Feagin)


Texas Coastal Systems
Beaumont
Population: 115,282
Acreage: 45,674
Kemah
Population: 1,807
Acreage: 1,055
Port Arthur
Population: 56,039
Acreage: 38,075
Galveston
Population: 53,695
Acreage: 27,881
Calhoun County
Population: 20,106
Acreage: 347,888
Corpus Christi
Population: 317,863
Acreage: 81,166
Bayview
Population: 475
Acreage: 2,112
South Padre Island
Population: 2,066
Acreage: 1,075

(Photo Credit: City of South Padre Island)

2.2. Social Systems of the Texas Coast

Embedded in the natural systems of the Texas coast are a variety of communities and economic activities that play a key role in the success of the coastal region and the state. Approximately 6.5 million people reside in the coastal region of Texas, representing one-quarter of the state's population, and countless more tourists travel to enjoy the wildlife, culture, and recreational opportunities.[68] Proximity to the coast supports marine related activities and shipping and logistics, amongst other sectors, which has created unique economic opportunities and activities along the coast. Texas coastal communities are key economic drivers for their locales, the broader coastal community, and the state.

The community profiles outlined in this section, demonstrate the range of communities located in the Texas coastal region and are intended to highlight how social and economic systems interact. Each of these communities and their economies are vulnerable to a range of threats and their ability to respond to and recover from storm events is, in part informed by the social makeup and vulnerability of the community, economic sectors represented, how diversified their economy is, and how effectively these sectors can respond to the impacts they may face. This can impact overall population growth, property appreciation, and commercial investments. The community profiles are categorized by:

- Large Communities > 60,000 population
- Medium Communities between 2,000 and 60,000 population
- Small Communities < 2,000 population.

Proximity to the coast supports marine related activities and shipping and logistics, amongst other sectors, which has created unique economic opportunities and activities along the coast. Texas coastal communities are key economic drivers for their locales, the broader coastal community, and the state.

(Photo Credit: Richard Gonzalez)

2.2.1. Social Vulnerability

In the context of coastal resilience, social vulnerability is the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood.[69] Social vulnerability is commonly evaluated in resilience planning using social vulnerability indices (SVIs). The SVI measures social vulnerability factors to support in understanding a community's ability to prepare for, respond to, and recover from hazards and is often used in planning to identify areas for investment. The SVI is a comparative metric that can be used to identify the differences in vulnerability across communities.

An understanding of historical investments provides the opportunity to identify communities and populations that have been underserved by resilience investments, exacerbating their present-day vulnerability to natural hazards.

Historical underinvestment in infrastructure in frontline and underserved communities creates disproportionately high social vulnerability, which includes higher cost-burdens for energy and transportation, high rates of poverty and pollution, and reliance on weak and outdated infrastructure, exacerbating risk and exposure.[70] Underserved communities refer to geographic communities and populations sharing a particular characteristic that have received less investment historically and been less successful in securing grant funding. An understanding of historical investments provides the opportunity to identify communities and populations that have been underserved by resilience investments, exacerbating their present-day vulnerability to natural hazards.

2.2.2. Critical Infrastructure

Studies show that the risks associated with building and rebuilding on the coast using less resilient standards are increasing and the negative impacts from the coastal vulnerabilities are becoming more severe. The coast remains, however, critical to the economic advancement of Texas and important to the livelihoods of many who live and work in the region. Considering the importance of the coast to work, leisure, and Texas culture, the GLO seeks to support and improve responsible development along the coastline that will safeguard the people, coastal resources, and natural and man-made environments. Responsible development can lead to investing in storm-hardened infrastructure, relocating homes, and rebuilding infrastructure that has been damaged in previous storms back to stronger codes. It also can mean using new research on ecosystem services to move from a "least cost" requirement to a "best value" solution that balances cost, human health and safety, and coastal stewardship.

Responsible development means that when people work to modify the coastal environment, they do so in a manner that: (1) avoids unnecessary risk to life and protects human health and safety, (2) proposes to avoid or manage disruptions to the natural environment, (3) considers future expected climatic conditions, (4) does not disenfranchise vulnerable social or economic groups (e.g. the elderly), and (5) utilizes current technology and best engineering practices.

The employment of military, port, oil and gas exploration and drilling, petrochemicals, fishing, tourism, and other coastal-oriented professionals necessitates that some infrastructure and communities are situated near the coast, despite the inherent risks of developing along the coast. These communities require roadways and emergency access, critical facilities (hospitals, police and fire stations, schools), service buildings, and other infrastructure to support industry and quality of life for coastal residents. The technological progress and improving coastal research of the past several decades can help advance responsible development into the future for communities that guides needed improvements to existing infrastructure. Across state and federal agency efforts, coastal roadways and other infrastructure at risk were assessed to determine facilities of critical need related to coastal resilience. Recommendations range from watershed-level drainage studies to statewide inflow planning, from utility upgrades to facility relocation, and from roadway protection to data collection. An overview of the critical facilities and coastal infrastructure impacted by coastal flooding is shown in the regional overviews beginning on page 180 of this Plan.

(Photo Credit: Port of Beaumont)

2.2.3. Large Communities

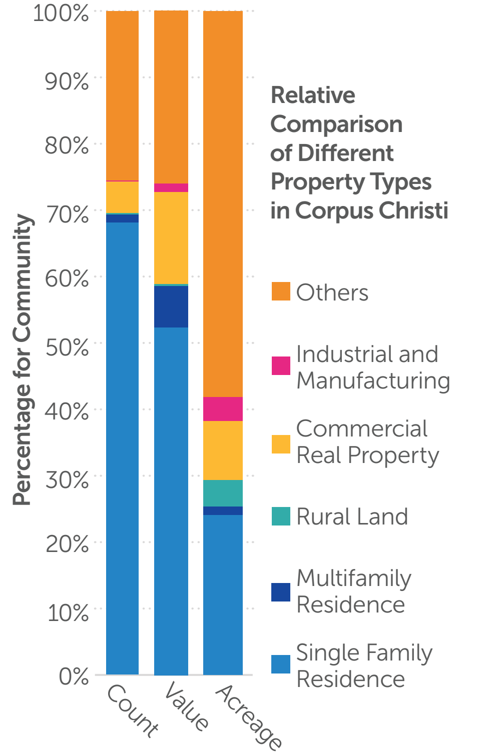
Corpus Christi

Corpus Christi is the county seat and largest city of Nueces County. Its boundaries encompass Nueces Bay and Corpus Christi Bay. With a population of 317,863 in 2020, Corpus Christi is the 8th most populated city in the state of Texas. In the last ten years, its population grew on average, 0.4% per year.[73]

Of Corpus Christi's 138,778 properties, more than half of the property value was represented by single family residences followed by commercial properties.

Much of the local economy is driven by the oil and gas industry. The Port of Corpus Christi has been in operation since 1926 and has since become the second largest export port in the United States, based on Vessel Custom Value, and one of the nation's largest in energy trade.[74] In 2020, the Port traded 159,713,040 tons, of which more than 90% were related to petroleum and crude oil.[75]

The majority of the population is employed in the services, wholesale, and retail trades. Tourism is the second largest industry sector in Corpus Christi and critical for its economic development. With more than 24,000 hospitality employees, tourism contributed more than $1.5 billion into its local economy and generated 26% of sales tax collections for the city in 2020.[76]

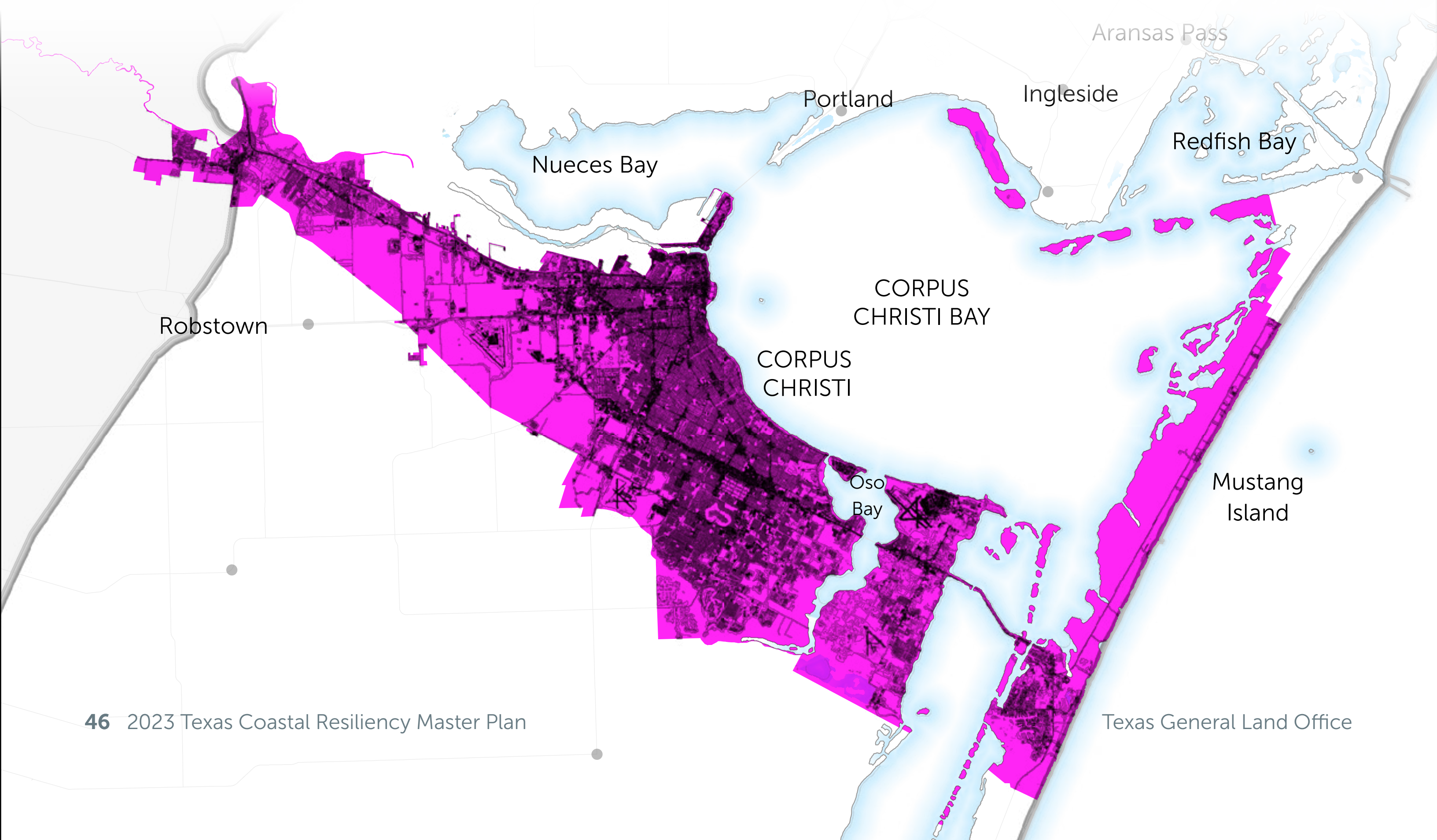


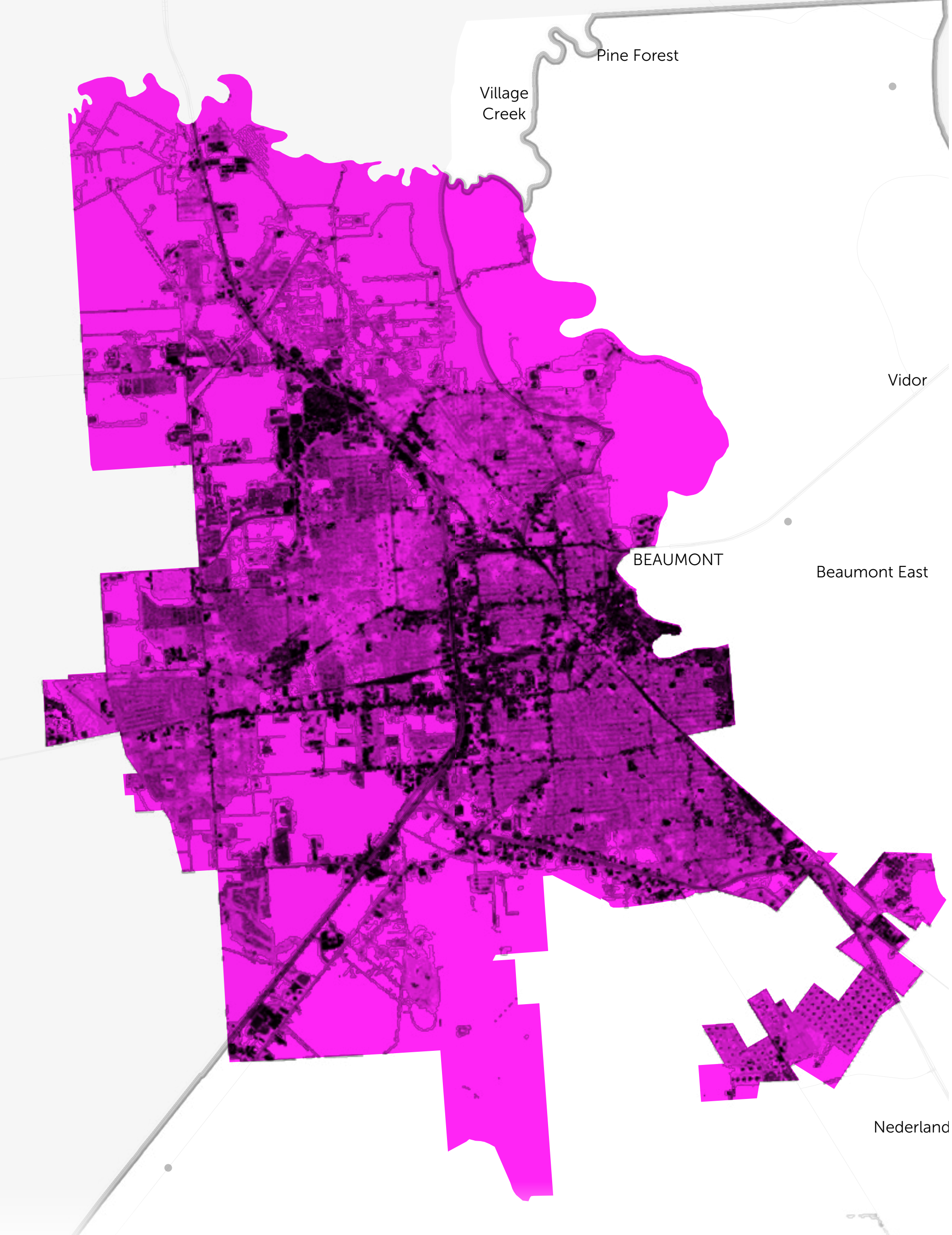
Source: Nueces County Appraisal District, 2021[77].

$57,387 MEDIAN HOUSEHOLD INCOME[73]

57% OWNER-OCCUPIED HOUSING UNIT RATE[73]

22% BACHELOR'S DEGREE OR HIGHER[73]





$48,168
MEDIAN HOUSEHOLD INCOME[78]

54.5%
OWNER-OCCUPIED HOUSING UNIT RATE[78]

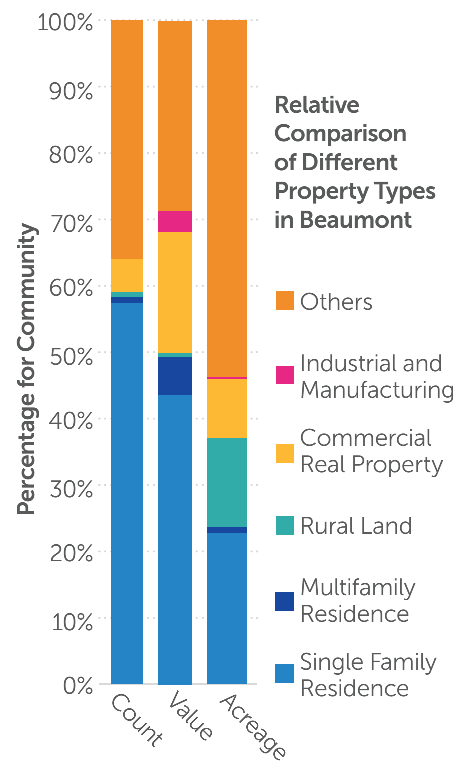
20.4%
LANGUAGE OTHER THAN ENGLISH SPOKEN AT HOME[78]

Beaumont

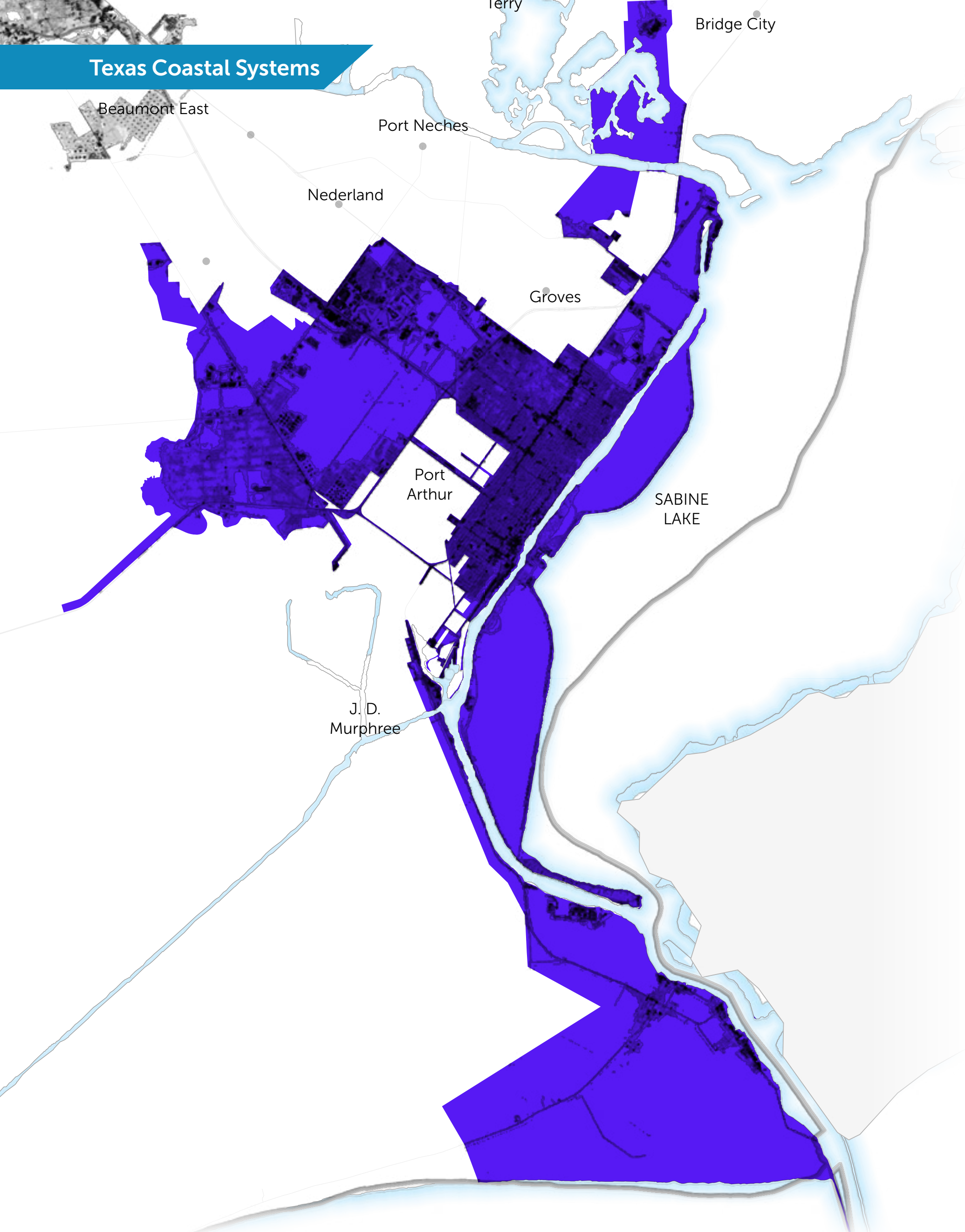
Beaumont is a coastal city and the county seat of Jefferson County. The population of Beaumont was 115,282 in the 2020 census, down from 118,296 in the 2010 census. Beaumont's poverty rate is 18.9%, which is higher than the state of Texas.[78]

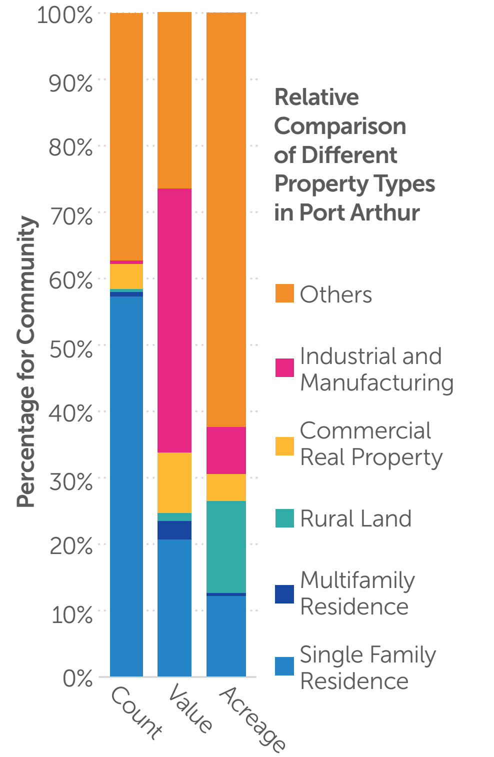
With 64,764 properties, close to half of the total property value is represented by single family residences followed by commercial properties with 18% of property value.

A significant element of the City and surrounding region's economy is the Port of Beaumont. Based on the Comptroller's 2018 estimate, trade through the Port of Beaumont affected about 84,000 jobs in Texas and contributed $12.6 billion in gross domestic product (GDP) to the state's economy.[79]



Source: Jefferson County Appraisal District, 2021.[80]





Source: Jefferson County Appraisal District, 2021.[80]

$37,794
MEDIAN HOUSEHOLD INCOME[81]

56.6%
OWNER-OCCUPIED HOUSING UNIT RATE[81]

11.2%
BACHELOR'S DEGREE OR HIGHER[81]

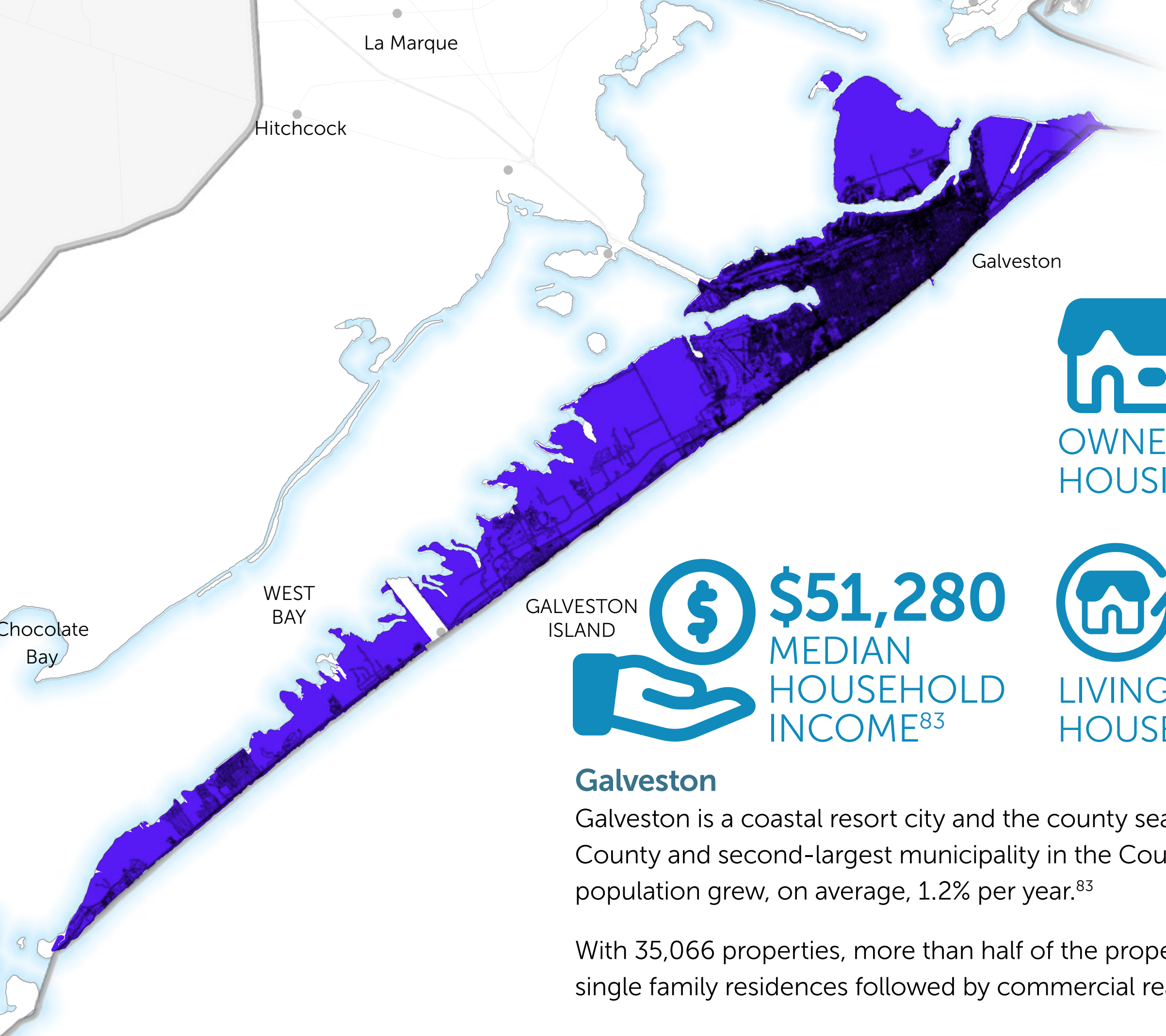
2.2.4. Medium Communities

Port Arthur

Port Arthur is a city located in Jefferson County. A small, uninhabited portion extends into Orange County. In the last ten years, its population grew, on average, 0.4% per year.[81]

With 30,148 properties, approximately 40% of the property value is represented by industrial and manufacturing properties followed by commercial real estate properties with 33%.[81]

Port Arthur is one of the major Texas fishing ports. Overall, in 2020, Port Arthur commercial fishermen landed 14.1 million pounds of seafood valued at over $29 million, which is lower than the 2017 peak of 17.1 million pounds valued at over $37 million.[82]



45%
OWNER-OCCUPIED HOUSING UNIT RATE[83]

$51,280
MEDIAN HOUSEHOLD INCOME[83]

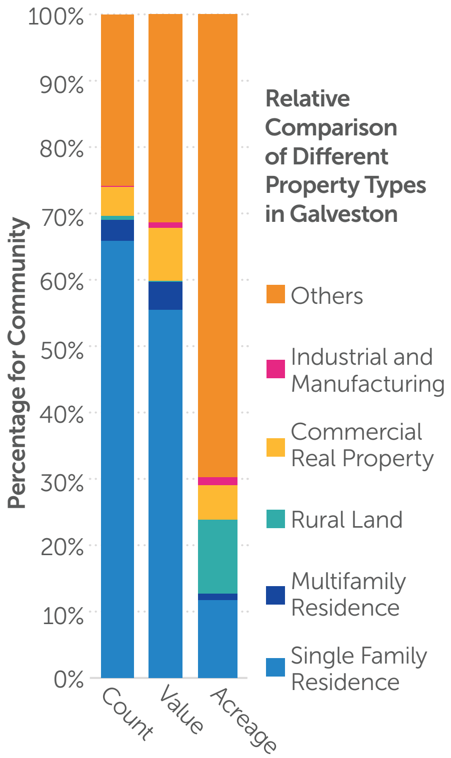
77%
LIVING IN THE SAME HOUSE 1 YEAR AGO[83]

Galveston

Galveston is a coastal resort city and the county seat of surrounding Galveston County and second-largest municipality in the County. In the last ten years, its population grew, on average, 1.2% per year.[83]

With 35,066 properties, more than half of the property value is represented by single family residences followed by commercial real property with 8%.

Much of Galveston's economy is centered in tourism, health care, and shipping. The Port of Galveston is ranked as the nation's fourth-largest cruise market based on embarkations, with an unprecedented number of cruise ship calls (297), representing a 10.8% increase on the previous record of 268 calls in 2018. Cruise activity generated $71.5 million in passenger onshore spending and another $23.4 million in services in 2019.[84]



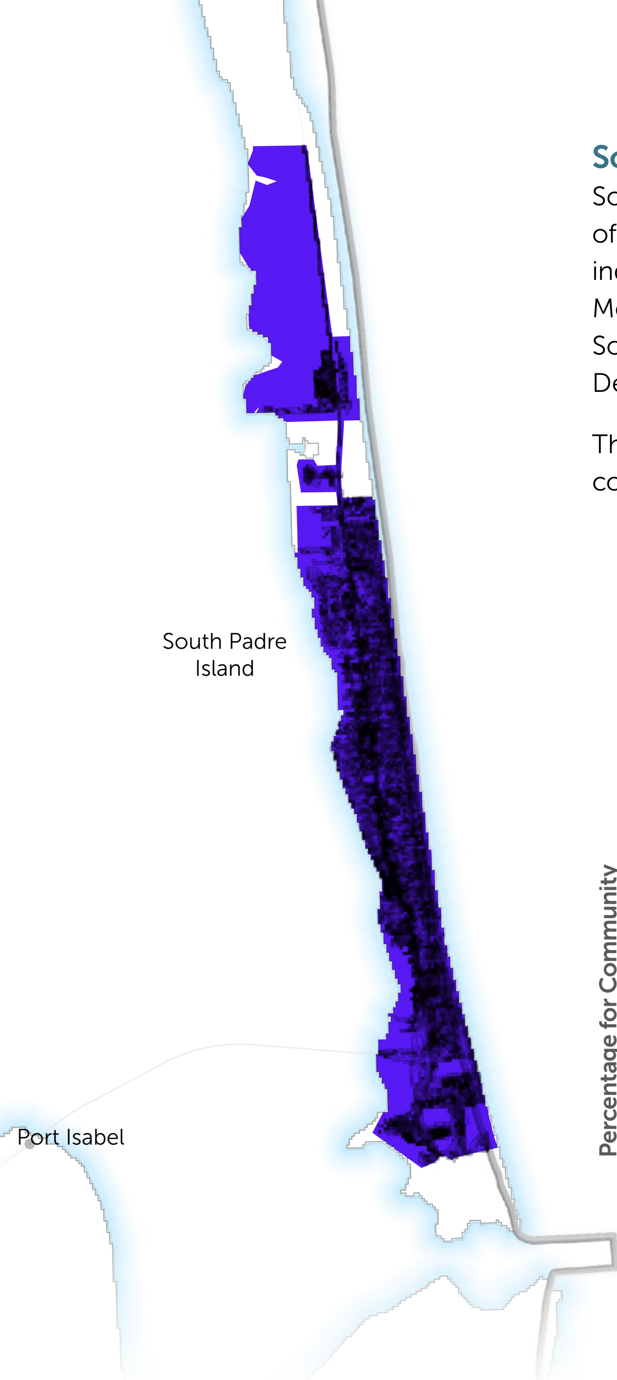
Source: Galveston County Appraisal District, 2021[85].

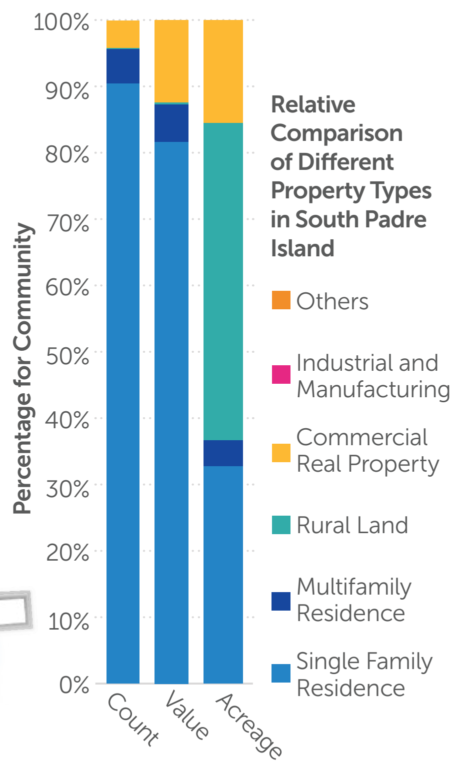
(Photo Credit: Hollaway Environmental + Communications Services)

South Padre Island

South Padre Island is a community in Cameron County with a population of 2,066.[86] Much of the local economy is driven by the tourism and marine industry. South Padre Island is part of the Brownsville-Harlingen Statistical Metropolitan area that receives over 4.3 million visitors per year.[87] In addition, South Padre Island is a designated Opportunity Zone to the US Treasury Department as of 2017 and has positioned themselves for growth.

The town's property mix includes 48% rural, 37% residential, and 15% commercial lands.





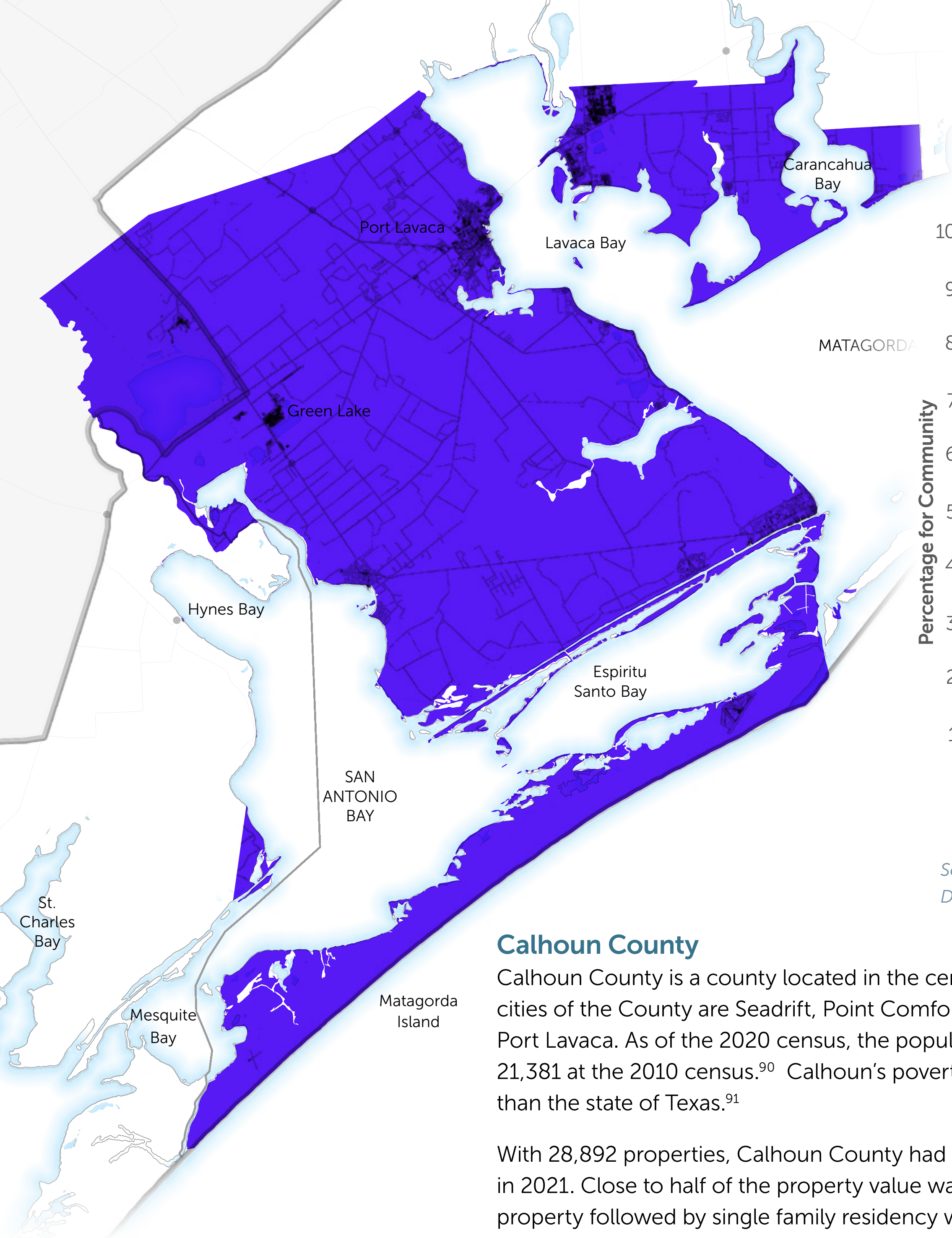
Source: Cameron County Appraisal District, 2021.[88]

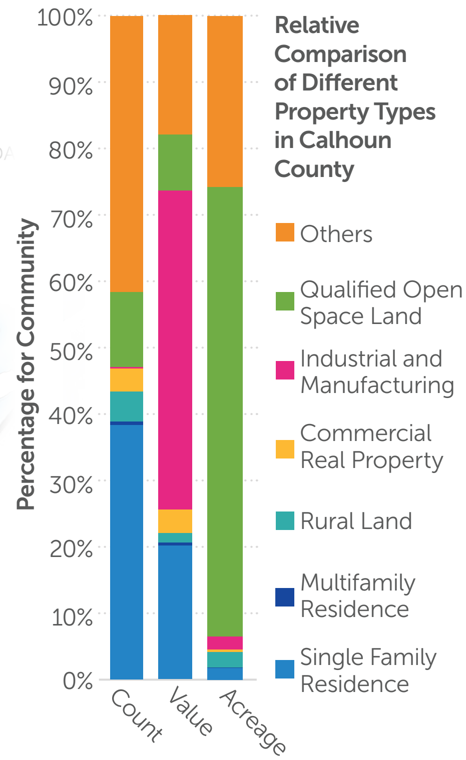
70.1%
OWNER-OCCUPIED HOUSING UNIT RATE[86]

20.6%
LANGUAGE OTHER THAN ENGLISH SPOKEN AT HOME[86]

64.6%
BACHELOR'S DEGREE OR HIGHER[86]

(Photo Credit: City of South Padre Island)





Source: Calhoun County Appraisal District, 2021.[89]

Calhoun County

Calhoun County is a county located in the central coast of Texas. The main cities of the County are Seadrift, Point Comfort, and the county seat of Port Lavaca. As of the 2020 census, the population was 20,106, down from 21,381 at the 2010 census.[90] Calhoun's poverty rate is 10.1%, which is lower than the state of Texas.[91]

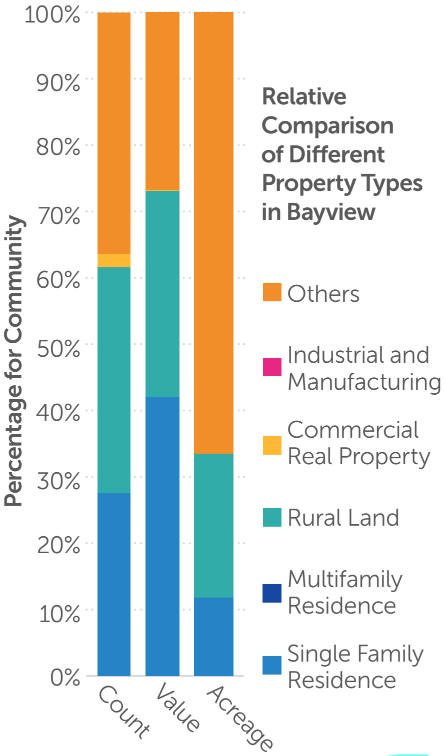
With 28,892 properties, Calhoun County had a market value of $6.2 billion in 2021. Close to half of the property value was represented by industrial real property followed by single family residency with 20%.

The economy of Calhoun County employs 10,210 people. The most common jobs held by residents of Calhoun County by number of employees, are production occupations (1,112 people), office & administrative support occupations (896 people), and construction & extraction occupations (866 people).[92]

$71,336 MEDIAN HOUSEHOLD INCOME[90]

73.7% OWNER-OCCUPIED HOUSING UNIT RATE[90]

17.5% BACHELOR'S DEGREE OR HIGHER[90]



Source: Cameron County Appraisal District, 2021.[88]

2.2.5. Small Communities

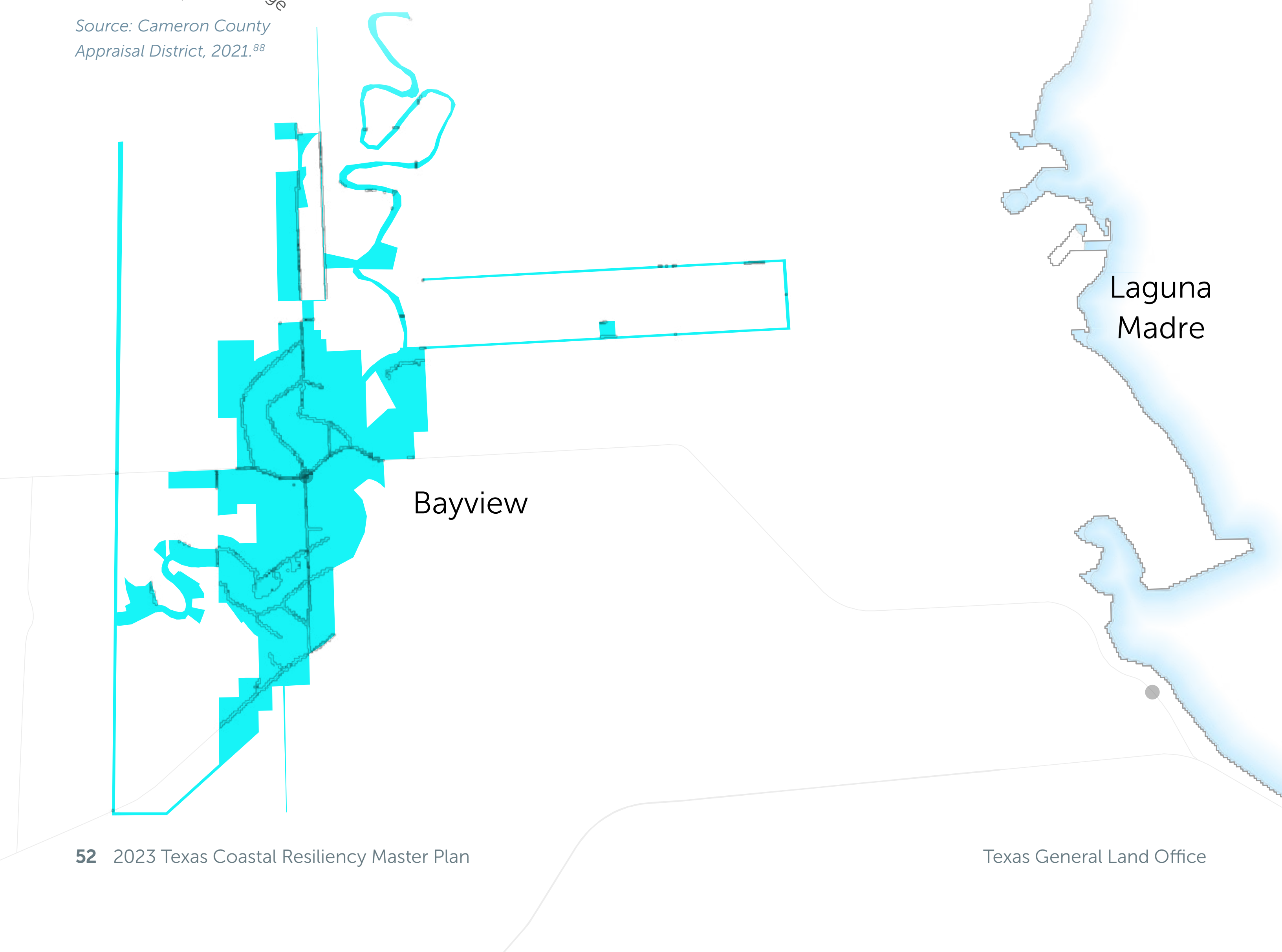
Bayview

Bayview is a town in Cameron County and part of the Brownsville-Harlingen-Raymondville and the Matamoros-Brownsville metropolitan areas. Bayview has a poverty rate of 3.2%, which is lower than the state of Texas.[93,94] The city has an unemployment rate of 15.8%.[95]

With 501 properties, single family residences represent the greatest share of total property value with 42%, followed by rural land with 31%.

$101,818 MEDIAN HOUSEHOLD INCOME[93]

95.5% OWNER-OCCUPIED HOUSING UNIT RATE[93]



Kemah

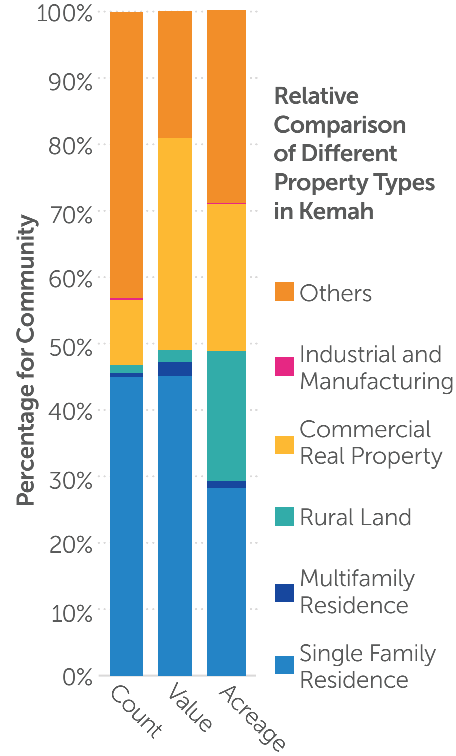
Kemah is a small city located in the northeast corner of Galveston County near Houston and part of the Clear Lake Area. Kemah has a poverty rate of 12.9%, which is lower than the state of Texas.[96] The city has an unemployment rate of 3.2%.[97]

With 1,776 properties, close to half of the property value was represented by single family residences followed by commercial real property with 32%.[85]

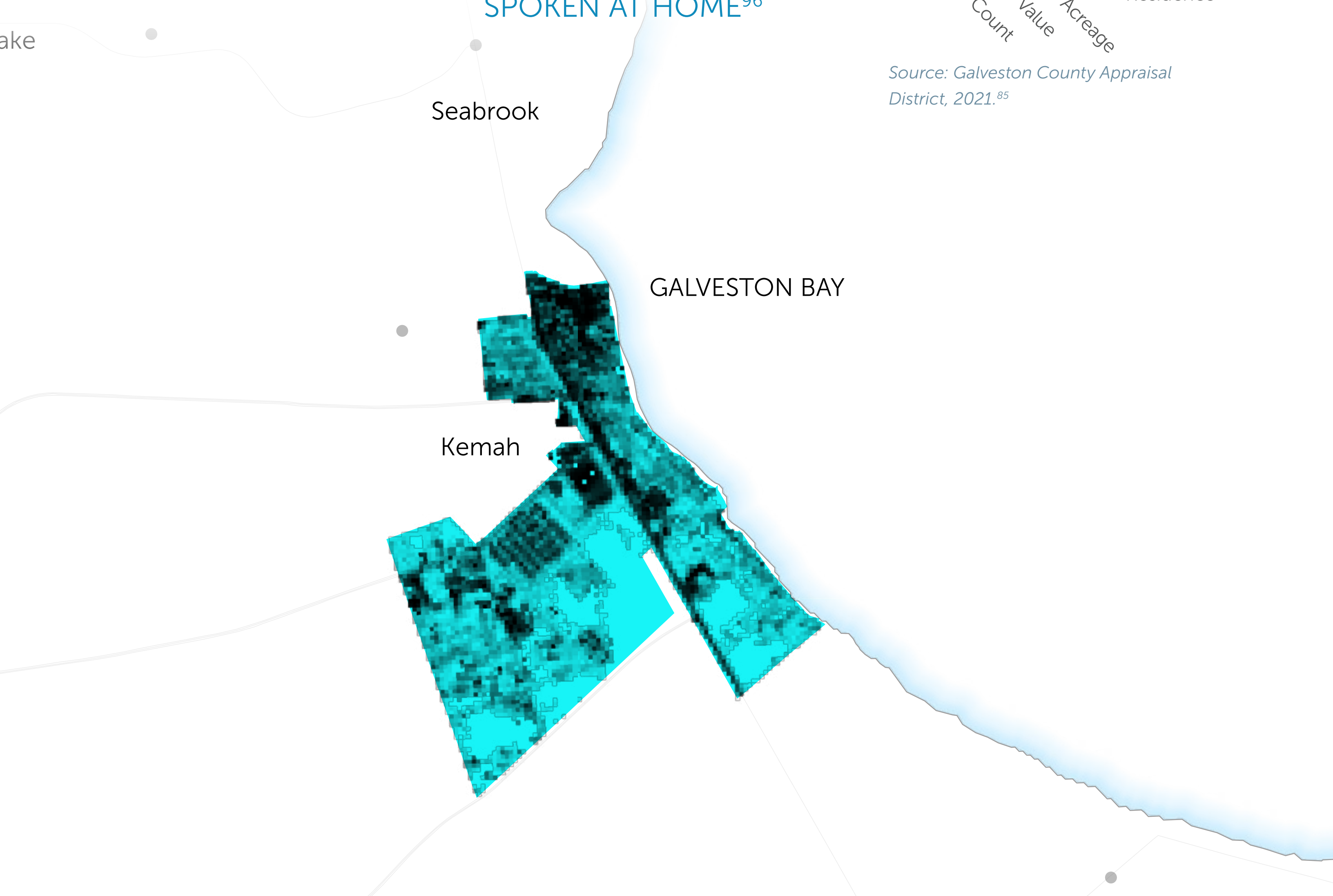
Situated on Galveston Bay, this small city has become a resort destination. Given its location on Galveston Bay, its main industry is shipping and tourism, followed by professional, scientific, and technical services, construction, and manufacturing.

$100,294
MEDIAN HOUSEHOLD INCOME[96]

19.2%
LANGUAGE OTHER THAN ENGLISH SPOKEN AT HOME[96]



Source: Galveston County Appraisal District, 2021.[85]

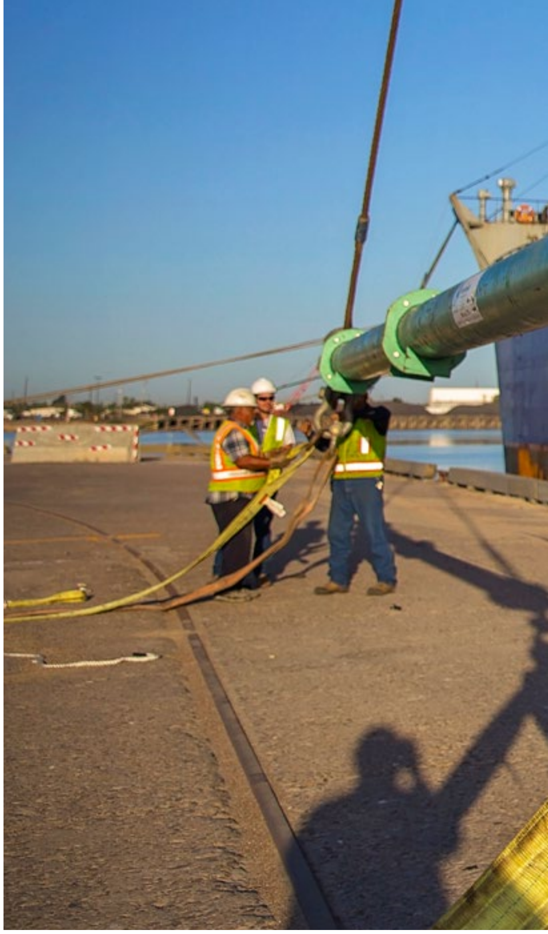


2.3. Economic Systems of the Texas Coast

The Texas ocean economy consists of enterprises that rely on coastal features, resources, and amenities. These include waterborne commerce, energy and chemical industries, military, commercial and recreational fishing, marine transportation, ship and boat building, and tourism and nature tourism. The data below represent Texas coastal counties in 2020.

Region	Annual Wages	No. of Jobs	Businesses	Avg. Wage/Employee
1	$23.3 billion	382,844	16,251	$61,000
2	$624 million	10,741	700	$58,200
3	$1.4 billion	32,039	1,725	$42,600
4	$358 million	15,744	946	$22,800

Source: Bureau of Labor Statistics, 2022.[2]



Waterborne Commerce – Ports & Waterways

Waterborne commerce is a key sector for Texas and its coastal counties. In 2021, Texas Ports' total trade revenue was $308 billion and accounted for 33% of U.S. Tonnage Export Value. Key exports include crude oil from petroleum and bituminous materials, inorganic chemical compounds, precious metals, and electrical machinery and equipment.

3 of the top 5
Three Texas ports were among the top five fastest growing U.S. ports by export revenue from 2010 to 2020: Port of Corpus Christi, Port Freeport, and Port of Port Arthur.[3]

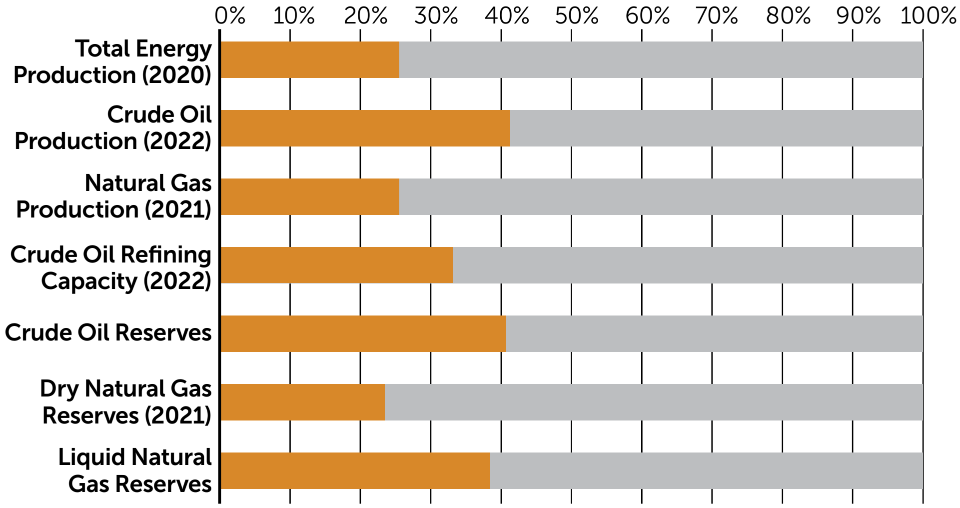
$450 billion
Economic value provided to the state by Texas ports in 2018.[3]

$72.2 billion
Anticipated public port and private investments in Texas ports between 2018 and 2023.[3]

(Photo Credit: Port of Brownsville)

Energy and Chemical Industries

In 2020, Texas accounted for 43% of the nation's crude oil production and 26% of its marketed natural gas production. The state accounts for about two-fifths of the nation's crude oil proved reserves and crude oil production and about one-fourth of the nation's proved dry natural gas reserves. The state is the largest energy-producing and energy-consuming state in the nation.[4] The industrial sector, including its refineries and petrochemical plants, accounts for half of the energy consumed in the state.



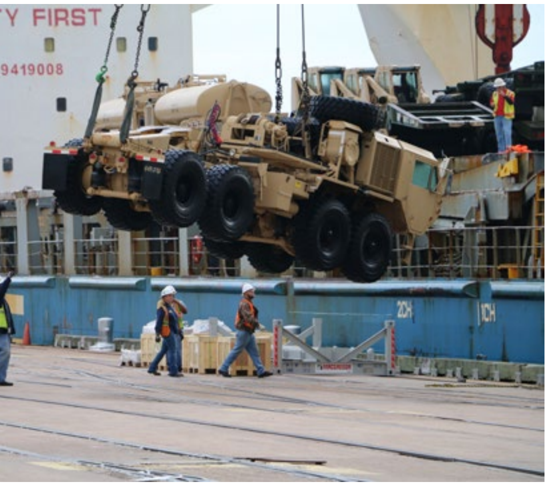
Source: U.S. Energy Information Administration, 2022.[4]

The Value of the Texas Coast

33% of the nation's total refining capacity

33% of U.S. Tonnage Export Value

$195 M of seafood production



(Photo Credit: Port of Port Arthur)

Military

Within Texas's coastal counties, the U.S. military presence employs over 20,000 persons generating $2 billion in personal income. The economic contribution of these facilities to the state is $5.9 billion and the contribution to the state's GDP is estimated at $3.1 billion. In addition to the military installations described in Table 2.7 below, the Coast Guard is another military branch that operates in Texas. While there are two Coast Guard Sectors within Texas, they include operations from multiple states and the economic impact is widespread. For example, the Houston-Galveston Sector employs 1,562 people, but this includes a station in Lake Charles, Louisiana.[98]

Table 2.2: Economic Impact of Military Installations in Texas and in Texas's Coastal Regions, 2019

	Total Employment	Output to Texas Economy (Billions)	GDP (Billions)	Disposal Personal Income (Billions)
Ellington Field JRB	2,323	$0.47	$0.29	$0.14
Naval Air Station (NAS) Kingsville	4,695	$0.85	$0.05	$0.29
NAS Corpus Christi	4,782	$2.80	$1.70	$0.91
Corpus Christi Army Depot	10,887	$1.78	$1.10	$0.70
Coastal Total	22,687	$5.90	$3.14	$2.04

Source: Texas Comptroller of Public Accounts, 2021.[99]

Marine Transportation

The Marine Transportation industry contributed 13,845 jobs to the coastal economy, across 376 businesses in 2020. Within the State, over $1 billion in wages is earned by 15,429 workers in the industry per year. Region 1 dominates the industry with 86 percent of the employment and 87 percent of the wages earned from marine transportation.

The Marine Transportation industry contributed 13,845 jobs to the coastal economy, across 376 businesses in 2020. Within the State, over $1 billion in wages is earned by 15,429 workers in the industry per year.

Table 2.3: Economic Impact of Marine Transportation in Coastal Regions of Texas, 2020

Region	Establishments	Employment	Annual Wages
Coastal Counties	376	13,845	$582,532,000
Texas Statewide	494	15,429	$1,042,108,000
Coastal Counties % of State	76%	90%	56%

Data disclosure restrictions prevented data from Region 4 from being presented publicly. As such, this value represents only Regions 1-3 data, which may not fully represent the impact to the Texas economy. Source: Bureau of Labor Statistics, 2022.[2]

Ship and Boat Building

Ship building, parts, and repairs industries support offshore mineral exploration and extraction activities as well as commercial fishing and waterborne transportation. Construction and repair of barges, ships, commercial fishing boats, towboats and offshore oil and gas floating platforms are integral enterprises of the Texas coastal economy and are part of this industrial sector.

Ship building, parts, and repairs industries support offshore mineral exploration and extraction activities as well as commercial fishing and waterborne transportation.

Table 2.4: Economic Impact of Ship and Boat Building in Coastal Regions of Texas, 2020

Region	Establishments	Employment	Annual Wages
Coastal Counties	79	497	$30,859,000
Texas Statewide	150	5,756	$396,466,000
Coastal Counties % of State	53%	9%	8%

Data disclosure restrictions prevented data from Regions 2-4 from being presented publicly. As such, this value represents only Region 1 data, which may not fully represent the impact to the Texas economy. Source: Bureau of Labor Statistics, 2022.[2]

Marine Construction

Marine construction includes construction of breakwaters, bulkheads, channels and canals, harbors, jetties, and other marine structures. Because marine construction is not differentiated among many other forms of heavy construction, the contribution of the industry to the ocean economy may be overstated for the coastal counties. Nearly one-third of the state's employment in heavy construction is found in the 18-coastal county area.

Table 2.5: Economic Impact of Marine Construction in Coastal Regions of Texas, 2020

Region	Establishments	Employment	Annual Wages
Coastal Counties	172	5,130	$439,151,000
Texas Statewide	619	17,959	$1,519,782,000
Coastal Counties % of State	28%	29%	29%

Data disclosure restrictions prevented data from Region 2 from being presented publicly. As such, this value represents only Regions 1, 3, and 4 data, which may not fully represent the impact to the Texas economy. Source: Bureau of Labor Statistics, 2022.[2]

(Photo Credit: AECOM)

(Photo Credit: Texas General Land Office)

Commercial and Recreational Fishing

The marsh systems and coastal bays along Texas's coastline and the adjacent Gulf waters provide a bounty of aquatic resources and an abundance of fishing opportunities. Commercial fishing is an important component of the coastal economy but is highly vulnerable to the health of the ecosystems that provide harvestable resources.

Overall, in 2020, Texas commercial fishermen landed 72.3 million pounds of seafood valued at over $195 million.

Table 2.6: Economic Impact of Commercial and Recreational Fishing in Coastal Regions of Texas, 2020

Region	Establishments	Employment	Annual Wages
Coastal Counties	202	558	$21,869,000
Texas Statewide	276	2,452	$96,264,000
Coastal Counties % of State	73%	23%	23%

Data disclosure restrictions prevented data from Regions 3 and 4 from being presented publicly. As such, this value represents only Regions 1 and 2 data, which may not fully represent the impact to the Texas economy. Source: Bureau of Labor Statistics, 2022.[2]

Tourism and Ecotourism

Recreational activities and tourism are important industrial sectors to the coastal economy and include sightseeing, beach-going, wildlife watching, fishing, boating, and other forms of recreation and leisure time activities.

Table 2.7: Economic Impact of Tourism and Nature Tourism in Coastal Regions of Texas, 2020

Region	Leisure and Hospitality Establishments	Leisure and Hospitality Sector Employment	Leisure and Hospitality Sector Wages
Coastal Counties	15,987	287,500	$6,881,986,000
Texas Statewide	66,778	1,178,400	$27,105,458,000
Coastal Counties % of State	24%	24%	25%

Source: Bureau of Labor Statistics, 2022.[2]

(Photo Credit: Texas General Land Office)

(Photo Credit: NASA)

3. The State of the Coast

Within the Coastal Resiliency Framework, the "State of the Coast" can be thought of as a snapshot of the Texas coastal system as it exists presently, to understand the underlying conditions as a starting point to develop a path toward improved resilience. The needs along the coast are readily demonstrated by coastal pressures, such as sea level rise and increasing coastal storm frequency and intensity, which create vulnerabilities along the coast. Working from a knowledge of today's pressures and vulnerabilities, the GLO can begin to effectively communicate where investments are most necessary and appropriate, informing how Texas can move forward to improve resilience.

This section will first walk through the pressures that impact the Texas coast, and it will do so through two lenses. The first of these include low-frequency, high impact events, which are typically unexpected and can carry costly impacts to both the natural and built environments along the coast. The second lens includes long-term pressures that are constantly present on the coast. Although their underlying causes may vary, their chronic nature allows them to be continually investigated to identify potentially mitigating solutions. This section will discuss a number of these events and their impacts since the 2019 Plan's publication.

Deep Dive: Understanding the State of the Coast

Understanding the state of the coast requires historical, current, and future perspectives. Given the range of considerations to understand all of these perspectives over time, the Plan approaches data collection and analysis from both stakeholder-informed and data-driven angles. The historical account is informed through a combination of anecdotal experiences and long-term monitoring data, which, when carried over into to the present day, reflects our current state of the coast.

Those that live on the coast can typically call up vivid memories of the last hurricane they experienced, often by stories of when they worked hand in hand with their neighbors to repair their homes and communities after hurricane force winds came ashore. These low-frequency, yet large-impact, events are major pressures on our coast that we all recognize.

After presenting an outlook on coastal pressures, this section progresses into discussion of the resulting coastal vulnerabilities. For the Texas coast, three main categories of vulnerability have been identified that this Plan is working to mitigate: land change, flooding, and degraded water resources. To better understand which of these vulnerabilities are of most concern in the four coastal regions, this Plan will provide insights directly relayed by coastal experts through TAC engagement and surveys.

Finally, this section will discuss a small number of emerging trends that the TAC has observed developing along the coast. These trends represent new variables that may need to be studied, planned for, and potentially mitigated for in the future. Key recent findings are presented in this section based on this information. The following section, Section 4, will take a deeper dive into using this information to better understand future conditions through modeling and simulations.

3.1. Pressures

When the general public thinks of coastal pressures, the first things that often come to mind are the most visible and immediate impacts they remember. Those that live on the coast can typically call up vivid memories of the last hurricane they experienced, often by stories of when they worked hand in hand with their neighbors to repair their homes and communities after hurricane force winds came ashore. These low-frequency, yet large-impact, events are major pressures on our coast that we all recognize. They tend to push natural, social, and economic systems to a breaking point, causing extreme strain. As such, these mega impact events are used to define resiliency in many ways. In addition to tropical storms and hurricanes, other low-frequency pressures, some human-induced (e.g., oil spills), and some natural (e.g., extremely low temperatures), are unique and test our personal and communal resolve in different ways.

In addition to these high-impact events, coastal pressures are also driven by long-term changes that, while less noticeable on a day-to-day basis, can have transformative effects when looked at over the timescale of decades. Systemic pressures are often more difficult to prepare for and challenging to develop solutions for, as the need to address them is frequently perceived as less urgent and the solutions less obvious than when responding to a catastrophic event. While this section covers many different pressures, both high- and low-impact, this should not be considered an exhaustive and complete list.

3.1.1. Coastal Storm Events

The Texas coastal zone is extremely vulnerable to storm surge, strong winds, and inland flooding. Texas has long been impacted by hurricanes and the more recent tropical storms have shown an increase in intensity overall. The destruction wrought by these hurricanes will continue to increase as storm intensity and frequency increase, as was observed by the extraordinarily high number of hurricanes experienced during the 2020 hurricane season.[100] Since the previous Plan was released, four hurricane seasons have passed with five storms impacting Texas, causing approximately $8.3 billion in damage.[101] Table 3.1 includes an overview of the storms that impacted Texas since the 2019 hurricane season opened on June 1, 2019.

2019 Hurricane Season

Five tropical storm systems developed in the Gulf of Mexico during the 2019 Atlantic hurricane season, tying with 1957 and 2003 for the highest number of tropical cyclones in the region in a single season. September was the most active month of the 2019 season, featuring seven named storms across the entire Atlantic coastline. Tropical Storm Imelda, which caused heavy damage to the Texas Gulf coast, is described below.

Tropical Storm Imelda

Tropical Storm Imelda moved across southeast Texas between September 17th and 19th and brought copious amounts of rainfall over the region. Several counties spanning parts of the Greater Houston metropolitan area and Beaumont recorded over 30 inches (in) (76.2 centimeters (cm)) of rain. A station 2 miles south of Fannett, Texas, recorded a maximum rainfall total of 44.29 in (112.5 cm), which made Imelda the seventh-wettest tropical cyclone in U.S. history, fifth wettest in the contiguous U.S., and fourth wettest in Texas history. Due to the high rainfall rates, flood depths in some locations exceeded those recorded in Hurricane Harvey. Where rainfall was heaviest, the total rainfall represented a 1-in-1000-year event. Approximately 8,200 homes were flooded in Harris, Jefferson, Liberty, and Montgomery counties in Texas. The NOAA National Centers for Environmental Information (NCEI) estimated Imelda inflicted $5 billion in damage.[102]

Deep Dive:
Beaumont Community Profile

The City of Beaumont is highly vulnerable to hurricanes and associated flood events. Past events that have impacted this area include Hurricane Harvey in 2017, Hurricane Rita in 2005, and Hurricane Ike in 2008, which together caused $184 billion in economic damages in the U.S.[103] In 2019, tropical storm Imelda damaged 1,818 homes and flooded 199 buildings within the City.[104] As the storm stalled over southeast Texas, a wave of rain bands moved across the I-10 corridor leaving behind dangerous flood conditions along roadways leading into and out of Beaumont. As a result of this, several vehicles were flooded and stranded along I-10 for two and a half days and two casualties occurred.[105]

Table 3.1: Storms impacting the Texas coast 2019 - 2022

Season	Storm	Landfall Date	Landfall Location	Storm Category at Landfall	Max Rainfall in Texas (in)	Direct Deaths	Damage ($)
2019	Imelda	9/17/2019	Southeast TX	Tropical Storm	44.3	5	5 billion
2020	Hanna	7/25/2020	Padre Island, TX	1	15.5	0	1.1 billion
2020	Laura	8/27/2020	Cameron, LA	4	6.7*	2	19 billion overall 975 million in Texas
2020	Beta	9/22/2020	Matagorda Bay, TX	Tropical Storm	15.8	1	225 million
2021	Nicholas	9/14/2021	Matagorda Peninsula, TX	1	10.2	0	1 billion

**Maximum rainfall amount associated with Hurricane Laura in the U.S. was 11.7 inches near Starks. LA.*

2020 Hurricane Season

During the 2020 season, our nation's entire Atlantic and Gulf coastlines, from Texas to Maine, were placed under some form of watch or warning in relation to a tropical system. The 2020 hurricane season broke the record for the highest number of tropical storms in a year. In fact, for only the second time in history, the Greek alphabet was used to name storms after the pre-determined list of 21 names was completed.[100] Texas was impacted by Hurricane Hanna (Category 1), Hurricane Laura (Category 4), and Tropical Storm Beta, described below.

(Photo Credit: Texas General Land Office)

Hurricane Hanna

In July 2020, Hurricane Hanna dumped several inches of rain causing widespread flash flooding in the Rio Grande Valley. The storm downed trees, ripped roofs from homes, and caused 194,000 residents in the area to lose power. Wind gusts reached up to 110 miles per hour (mph) (175 kilometers per hour (km/h)) and storm surge reached as high as 6.24 feet (ft) (2 meters (m)) at landfall. As Hanna moved further inland, the storm unleashed abundant amounts of rain in south Texas, with rainfall totals reaching up to 15 in (38.1 cm).

Several marinas and boats on the coastline were severely damaged and many roadways became impassable for several days following the storm as water receded. In addition, Hanna caused significant crop damage, totaling about $177 million. The NCEI estimates that Hanna caused over $1.1 billion in damage in the United States.[106]

In August 2020 Hurricane Laura caused losses estimated at over $19 billion, with Texas alone suffering $975 million in damage.

Hurricane Laura

In August 2020 Hurricane Laura caused losses estimated at over $19 billion, with Texas alone suffering $975 million in damage. Governor Greg Abbott declared a state of emergency for 23 counties in eastern Texas and mandatory evacuation orders were issued for low-lying areas of Chambers, Galveston, and Jefferson counties, and for the entirety of Orange County. Wind gusts in both Houston and Galveston peaked at 38 mph (61 km/h) and a gust of 79 mph (127 km/h) was recorded at Kirbyville Remote Automatic Weather Station site near Call, Texas. Throughout the coastal region, a multitude of trees and power lines were downed, causing damage to homes, businesses, and other community buildings.[107]

Tropical Storm Beta

Heavy surf and high waves from Beta destroyed part of the 61st Street Fishing Pier in Galveston while storm surge flooding left many areas of the Texas coast under water. Around the time of landfall, a wind gust of 48 mph (77 km/h) was recorded in Port Lavaca and parts of I-69 and TX-288 were closed due to flooding and high water. In Houston, portions of the city became heavily inundated by high rainfall totals, exceeding 9 in (22.9 cm) in some parts of the city. Dozens of streets and highways were closed due to the fast-rising water, including parts of I-69, I-45, and TX-288 and U.S. 290. Officials urged residents to stay home and avoid driving if possible. Texas Governor Greg Abbott issued disaster declarations for 29 counties. NOAA estimates that Beta caused a total of $225 million of damage in the United States.[108]


(Photo Credit: Texas General Land Office)

2021 Hurricane Season

Out of the 21 named storms of the 2021 Atlantic Hurricane Season, eight made landfall along the Atlantic and Gulf coasts of the United States, causing $70 billion in damage and one death.[109,110] Hurricane Nicholas was the only storm to impact the Texas coast.

Hurricane Nicholas

In September 2021, Hurricane Nicholas made landfall between Matagorda Bay and Sargent Beach as a Category 1 hurricane. An estimated three to six feet (1 to 1.8 m) of storm surge was observed along the upper Texas coast, with the highest surge reported around Galveston Bay. As a result, several roadways and highways were closed, including the only roadway connecting the city of Matagorda to Matagorda Beach (FM 2031). In the city of Houston, rainfall averaged 1 to 3 in (2.5 to 7.6 cm) in the north and west sides and six in (15.2 cm) locally in the south and east areas. The highest rainfall, recorded at 9.85 in (25 cm), was observed in Deer Park located east of Houston. Over 500,000 homes and businesses in the southeast Texas area, including Houston, lost power.[111]

2022 Hurricane Season

The 2022 Atlantic hurricane season began on June 1st and ended on November 30th. This season included two tropical depressions, six tropical storms, four Category 1 storms (winds up to 95 mph), one Category 2 storm (winds up to 110 mph), and two Category 4 storms (winds up to 156 mph). The 2022 hurricane season was less active than initial predictions forecasted. NOAA predicted an above-normal season, yet there were ultimately only 13 named storms in the 2022 season, compared to an average of 14 named storms per season. Three storms made landfall along the Atlantic and Gulf coasts of the United States; however, no tropical storms impacted the Texas coast.[113]

Deep Dive: Disaster Response in Orange County

Following Hurricane Laura in 2020, Orange County was left littered with debris from downed trees, power lines, and destroyed buildings, posing a safety risk to residents.[112] To aid in the clean-up efforts, the County secured contracts under the Federal Emergency Management Agency's Debris Removal Program to receive reimbursement for the cost needed to remove the debris; a total upfront cost of $15 million paid by the County. However, the reimbursement request took nearly two years to process and covered just over $10 million, leaving the County responsible for the remaining $5 million. According to Orange County Precinct 1 Commissioner Johnny Trahan, the upfront cost represented 30% of the County's annual budget and required the County to pursue a loan in order to complete the needed post-storm clean-up. Due to the delay in reimbursement of funds, the County was left to bear the cost of the debris removal, causing a difficult financial situation. Pre- and post-disaster funding challenges such as this can make it harder, and sometimes more expensive, for coastal communities to respond to disaster events.

3.1.2. COVID-19

The novel COVID-19 virus entered the U.S. in mid-January of 2020 and by early March, the World Health Organization (WHO) had declared the spread of the virus a global pandemic. Many schools, businesses, and places of work began to close due to safety concerns. During this time, the coastal communities of Texas lost approximately 174,000 jobs and the average unemployment rate rose to 8.9% in 2020, nearly doubling the 2019 rate.[114] The leisure and hospitality sector, which typically makes up a majority of the total earnings within the coastal region, lost 15% of its workforce, the greatest percentage of loss by industry along the coast.[115,116]

The leisure and hospitality sector, which typically makes up a majority of the total earnings within the coastal region, lost 15% of its workforce, the greatest percentage of loss by industry along the coast.

In addition to impacts on the state's labor force, the COVID-19 pandemic highlighted the vulnerabilities of the regional and global supply chain, such as single-source locations, little to no redundancy built into the supply chain, and just-in-time manufacturing practices.[117] Within the construction industry in particular, as supply halted, materials became less available, and the demand for construction of commercial and residential infrastructure remained, while the price of construction increased at historic rates.[118, 119, 120] From a consumer standpoint, less income was used on vacations and dining out and more was concentrated on buying goods online during the pandemic. Suppliers struggled to keep up with the increased demand. This strain on the national supply chain was exacerbated by a global disruption of container vessel shipments and bottlenecks created at ports and land entries due to the lack of available laborers and long processing times. Despite this, the Texas port system played a key role in alleviating the pressure of increased demand by moving approximately 607 million tons of cargo in 2020, more than any other state.[3]

Texas Army National Guard Soldiers process sample bags containing COVID-19 tests at a Mobile Testing Team facility. (Photo Credit: Sgt. Erin Castle, U.S. Army National Guard)

3.1.3. Winter Storm Uri

Winter Storm Uri impacted the state of Texas from February 11th to the 20th, 2021, depositing a record amount of snow and ice over all 254 counties. In some areas of the state, temperatures were recorded at or below zero degrees Fahrenheit.[121] Between February 14th and the 20th, approximately 69% of Texans were without power for an average of 42 hours in total (31 hours consecutively). In addition to the loss of power, the storm caused water mains to freeze and left 49% of Texans without running water for an average of 52 hours.[122, 123] As the temperature remained at or below freezing, roadways became impassable, leaving many Texans without access to grocery items and hindering supply chains. In addition, the state's agriculture industry suffered approximately $608 million in losses as livestock and crops could not withstand the freezing temperatures. In total, state financial losses are estimated from $80 billion to $130 billion.[122]

The sustained cold temperatures also led to detrimental impacts to coastal wildlife. At least 3.8 million fish were affected along the Texas coast, with the largest fish kills reported in the Laguna Madre. Of the total estimated number of fish impacted coastwide, non-recreational species accounted for 91% of the total loss and recreational species accounted for the remaining 9%. The top commercial species lost include Silver Perch (1,190,782 fish) and Hardhead Catfish (998,535 fish) and the top recreationally important game species lost include Spotted Seatrout (160,476 fish) and Black Drum (105,813 fish).[124] In addition, an estimated 10,000 sea turtles were cold stunned along the Texas coast.[125] Unable to regulate their body temperature in the cold water, many turtles became lethargic and were found floating on the surface of the water or washed onshore. This event is estimated as largest cold-stunning event recorded in south Texas.[126] The impact to coastal habitats such as Black Mangroves as a result of the freezing temperatures along the Texas coast is still being researched, although preliminary reports suggest a large die off of the species occurred along the mid-Texas coast, in Regions 2 and 3.[9]

Deep Dive: Nurdles in Texas

Nurdles are small (≈4mm diameter) pellets derived from materials such as polyethylene, polypropylene, polystyrene, and polyvinyl chloride used for manufacturing plastic products.[127] This microplastic is typically introduced into the environment unintentionally through transport between and during the manufacturing process and can be difficult to contain when released.[128] Aside from the aesthetic concerns of plastic waste along the coast, nurdles are easily ingested by a variety of marine species and can accumulate within an organism over time, potentially blocking intestines or causing starvation.[127, 129, 130] Nurdles and other plastic debris are commonly seen along Texas waterways and shorelines, regularly washing up on beaches and floating within bay ecosystems.[131] Nurdle Patrol, a Gulf-wide citizen science program, found that their highest nurdle counts occurred along the Texas coast, with Galveston Bay having the highest count of over 30,000 nurdles for a single survey.[127] Industrialized bays such as Lavaca Bay provide an illustration of the increasing nurdle problem within the state's waters. In the case *San Antonio Bay Estuarine Waterkeeper v. Formosa Plastics Corp. Tex.*, Formosa was found to be in violation of its state issued permit and the U.S. Clean Water Act for the discharge of nurdles into Lavaca Bay and its nearby tributaries since 2016.[132] In 2021 this case was settled for $50 million, of which $11.25 million went to forming the Matagorda Bay Mitigation Trust (MBMT).[133] This trust's goal is to fund restoration, mitigation, research, and initiatives to protect the bay systems impacted by the nurdle discharge. MBMT has since backed numerous proposals including environmental education on bay issues, restoration of bay shorelines and habitats, and research concerning Matagorda and San Antonio bays.[133]

Oil spill response boat launch. (Photo Credit: Texas General Land Office)

3.1.4. Oil Spills

The state of Texas leads the nation in energy production, accounting for 43% of the nation's crude oil production.[4] Crude oil powers homes and cars and is an important component in the production of goods used every day throughout Texas and the nation. Activities that occur under the umbrella of crude oil production, such as oil extraction, transportation, and refinement, pose an increased risk of accidental spillage. Oil spills can range from small events to large disasters, such as the Deepwater Horizon incident that occurred on April 20th, 2010. This event, the largest disaster of its kind, caused the release of 134 million gallons of oil into the Gulf of Mexico.[134] Even small quantities of oil leaked into the coastal environment can have devastating impacts on coastal habitats, communities, and economies. The Deepwater Horizon spill not only caused economic losses but led to the profound loss of marine life and marsh habitat and increased public health concerns as well. Since the 2019 Plan was released, the Texas Gulf coast has experienced 35 reported incidents involving crude oil or other related oil and gas products (i.e., natural gas condensate). An estimated amount of at least 752,142 gallons of oil were discharged along the coast or within offshore waters as a result of these incidents.[135] This estimate only includes the amount of known discharge, as some reports indicated that an unknown quantity of material had been discharged. In addition, this estimate does not include incidents involving discharge from sunken vessels. A summary of these incidents can be found in Table 3.2 below.

Oil spills can range from small events to large disasters, such as the Deepwater Horizon incident that occurred on April 20th, 2010. This event, the largest disaster of its kind, caused the release of 134 million gallons of oil into the Gulf of Mexico.

Table 3.2: Summary of Oil Spills, 2019-2022[135]

Incident	Date	Location	Material Discharged	Estimated Amount of Discharge (Gallons)
Atlas Air	February 2019	Trinity Bay	Unknown	2,291
Bayport Channel Oil Spill	May 2019	Bayport	Oil; gasoline blending stock	599,682
Corpus Christi Inner Harbor Spill	September 2019	Corpus Christi	Oil	7,030
ITC Deer Park Facility	October 2019	Deer Park	Diesel	300
Cameron County, Little Joseph Spill	October 2019	Offshore	Unknown	6,600
La Quinta Channel Spill	November 2019	Corpus Christi	Unknown	1,560
Collision between Offshore Supply Vessel and Tug and Barge	November 2019	Port Arthur	Diesel	8,000
Port Arthur Canal	January 2020	Port Arthur	Unknown	15,854
Tabbs Bay Discharge	February 2020	Baytown	Crude oil	42,000
Bryan Mound Incident	April 2020	Freeport	Oil	8,400
Tug Lee W - Barge Collision	June 2020	Port Bolivar	Condensate	13,723
Offshore Discharge – High Island 536	July 2020	Offshore	Crude oil	Unknown
Offshore Mystery Sheen – East Breaks 166*	July 2020	Offshore	Oil	Unknown
Corpus Christi Inner Harbor	August 2020	Corpus Christi	Unknown	5,600
High Island 330 Sheen	October 2020	Offshore	Diesel	2,000
San Jacinto River Spill	December 2020	Houston	Unknown	3,000
Cameron County, La Reta	January 2021	Offshore	Unknown	2,850
West Cameron 551 Discharge	June 2021	Offshore	Condensate	Unknown
Baytown Ditch Discharge	June 2021	Baytown	Crude oil	1,050
Two Barge Collision Port Isabel	July 2021	Port Isabel	Gasoline	2,803
Nueces County, Offshore Spill	July 2021	Offshore	Unknown	4,985
Abandoned Platform – High Island Block 10	October 2021	Offshore	Oil	Unknown
Oil Well Discharge into Marsh	April 2022	High Island	Crude oil	Unknown
Marsh Discharge	April 2022	High Island	Crude oil	8
Oil Discharge in Tabbs Bay	May 2022	Baytown	Crude oil	Unknown
Dark Ruby LLC Facility	May 2022	Trinity Bay	Unknown	2,940
Cedar Bayou Abandoned Tug	June 2022	Baytown	Oil	84
Oil Discharge in Marsh	June 2022	Port Neches	Oil	84
Oil Discharge into Tabbs Bay	August 2022	Baytown	Crude oil	420
West Cameron Block 498	August 2022	Offshore	Condensate	1,478
Corpus Christi Bay Spill	October 2022	Corpus Christi	Unknown	1,400
Trinity Bay Pipeline	October 2022	Anahuac	Crude Oil	4,000
Drainage Ditch Discharge	November 2022	Deer Park	Oil	Unknown
Uninspected Towing Vessel Candace Allison	December 2022	Bolivar Peninsula	Diesel	Unknown
Ingleside Dock 5 Discharge	December 2022	Ingleside	Crude Oil	14,000

**This incident was potentially related to the Offshore Discharge at High Island 536, but was not confirmed*
Source: NOAA Incident Archive

3.1.5. Historical Trends Along the Texas Coast

Determining how and to what extent coastal vulnerabilities impact long-term resiliency requires a spatial understanding of the interconnected coastal systems as they exist today, in the past, and with projections of the future given predictions of changes in the drivers and pressures. Due to the lasting effects of pressures caused in part by decades-old infrastructure as well as the occurrence of sea level rise and subsidence, it is important to study past changes to understand how the Texas coast may evolve in the future.

Relative Sea Level Rise

Coastal flooding and erosion have historically threatened lives, property, and natural resources along the Texas coastline. The risks posed to coastal communities are generally expected to increase with future SLR, and particularly RSLR. RSLR refers to how sea level rises or falls relative to the elevation of the land surface. The average global mean sea level rise (GMSLR) rate was approximately 0.06 inches per year (in/yr) over the past century. However, throughout most of the twentieth century, the rate has more than doubled to 0.14 in/yr from 2006 to 2015. The RSLR rates are different due to local factors like vertical land motion (subsidence), local wind, atmospheric pressure, and ocean circulation. The RSLR rates vary along the coast, ranging from 15 in/100 years in the lower coast to 26 in/100 years in the Galveston Bay region based on the tide gauge data. Due to this, some communities are at higher risk of being impacted than others. The graphs below depict the historical tide gauge data collected at two locations along the coast against the projected local RSLR trends developed by NOAA in 2017.[136, 137,138] Current tidal data suggests that at both locations, in Region 1 (Figure 3.1) and in Region 4 (Figure 3.2), tide levels are nearing the predicted Intermediate Low scenario.[136,137] At present, many low-lying areas along the coast are threatened during high tide and storm surge events. These trends, and the resulting threat to communities, will continue and are likely to increase if current conditions persist. Future modeled SLR trends and the anticipated impacts are discussed further in Section 4.

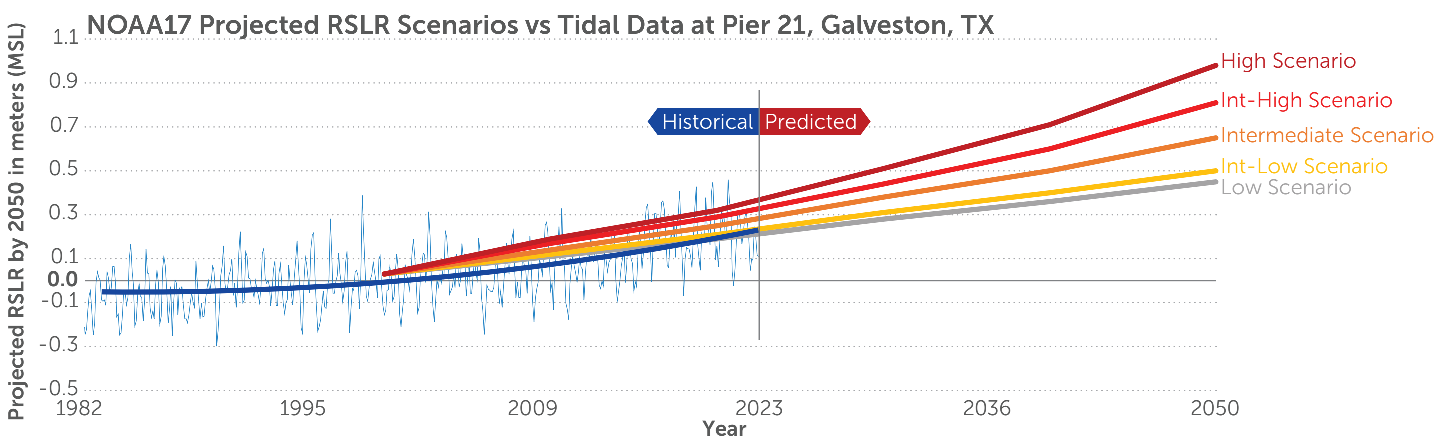


Figure 3.1: *NOAA17 Projected RSLR Scenarios vs. Tidal Data at Pier 21, Galveston, TX*

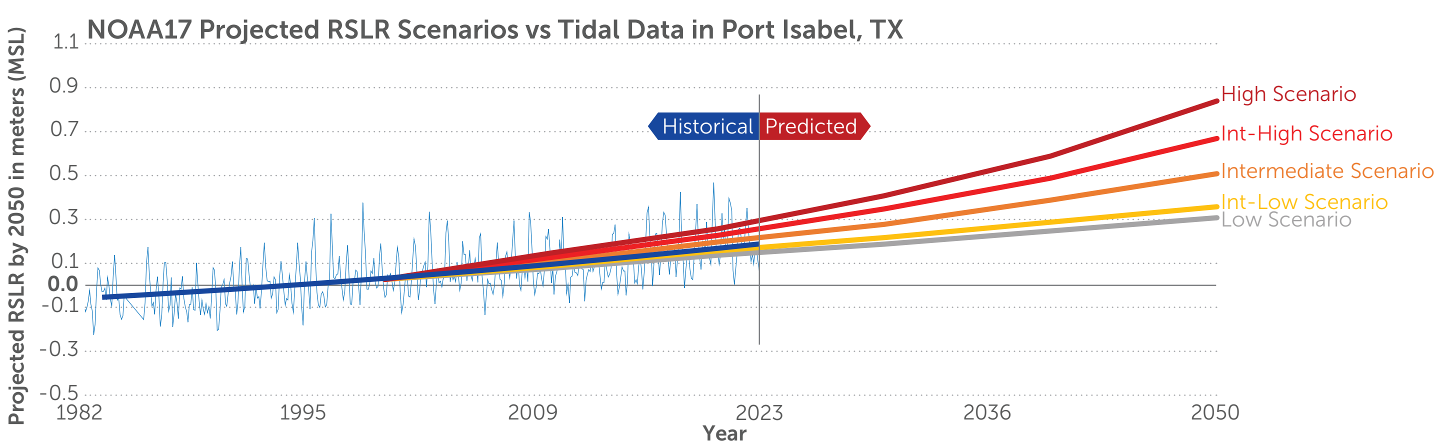
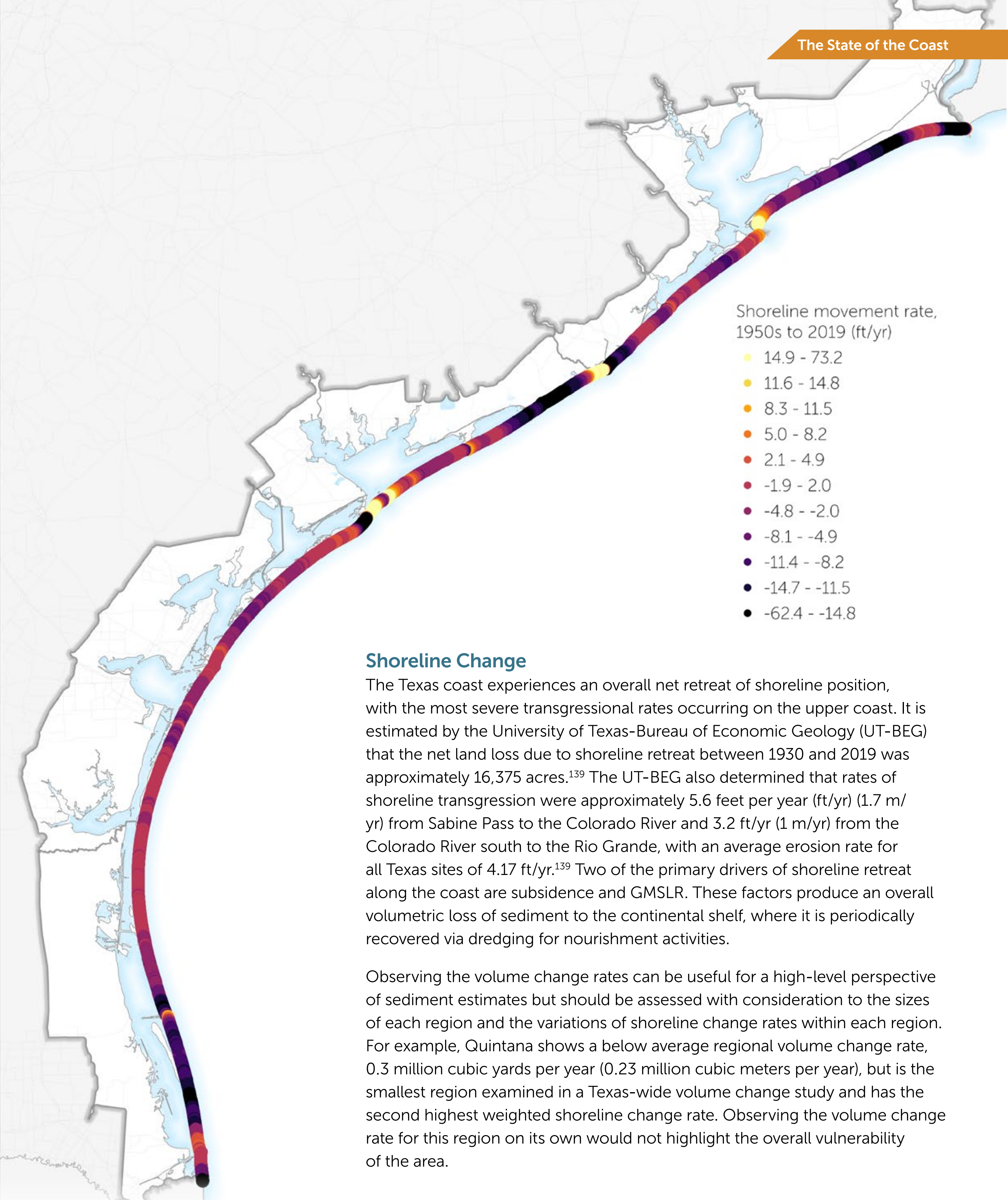


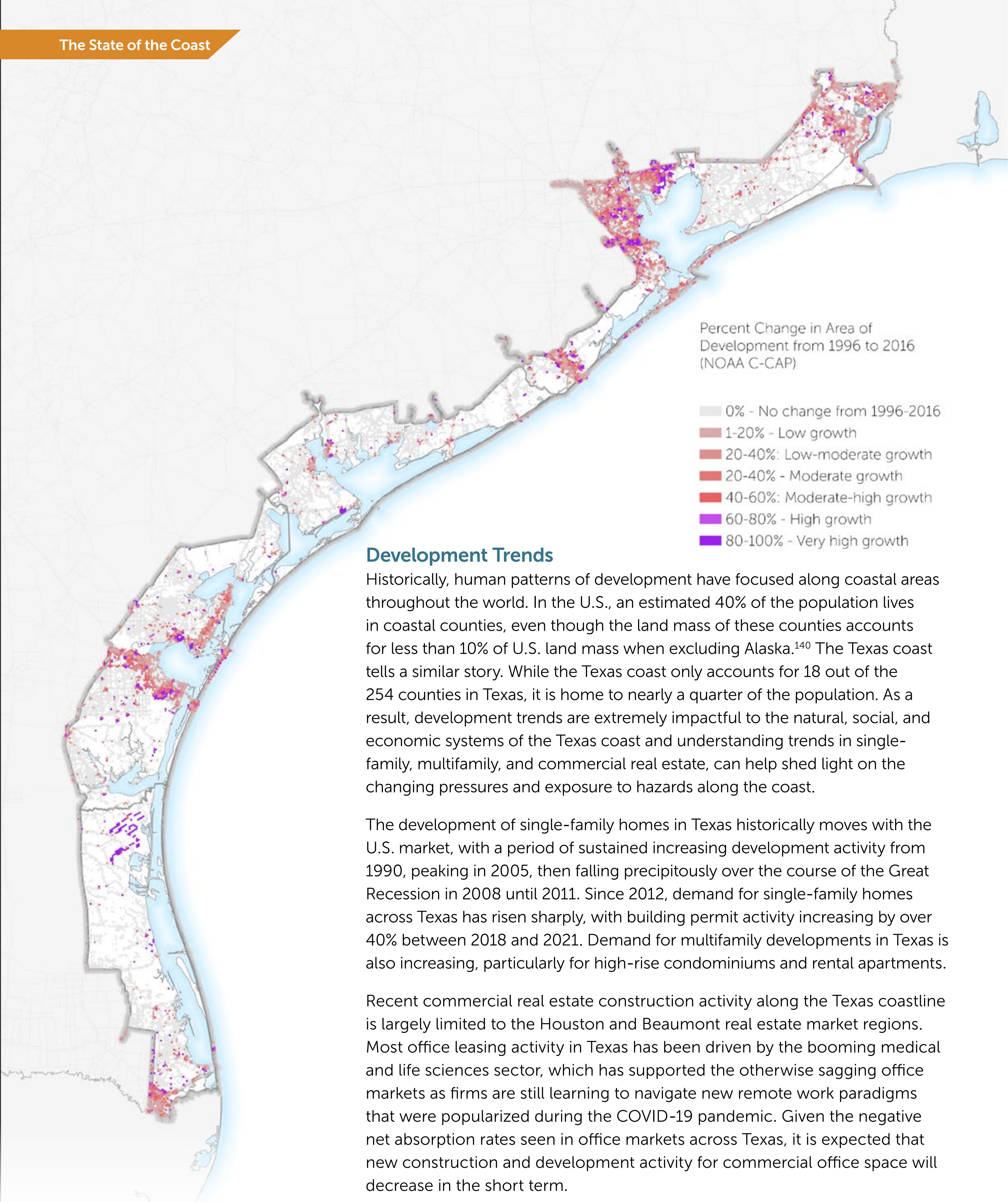
Figure 3.2: *NOAA17 Projected RSLR Scenarios vs. Tidal Data Port Isabel, TX*



Shoreline Change

The Texas coast experiences an overall net retreat of shoreline position, with the most severe transgressional rates occurring on the upper coast. It is estimated by the University of Texas-Bureau of Economic Geology (UT-BEG) that the net land loss due to shoreline retreat between 1930 and 2019 was approximately 16,375 acres.[139] The UT-BEG also determined that rates of shoreline transgression were approximately 5.6 feet per year (ft/yr) (1.7 m/yr) from Sabine Pass to the Colorado River and 3.2 ft/yr (1 m/yr) from the Colorado River south to the Rio Grande, with an average erosion rate for all Texas sites of 4.17 ft/yr.[139] Two of the primary drivers of shoreline retreat along the coast are subsidence and GMSLR. These factors produce an overall volumetric loss of sediment to the continental shelf, where it is periodically recovered via dredging for nourishment activities.

Observing the volume change rates can be useful for a high-level perspective of sediment estimates but should be assessed with consideration to the sizes of each region and the variations of shoreline change rates within each region. For example, Quintana shows a below average regional volume change rate, 0.3 million cubic yards per year (0.23 million cubic meters per year), but is the smallest region examined in a Texas-wide volume change study and has the second highest weighted shoreline change rate. Observing the volume change rate for this region on its own would not highlight the overall vulnerability of the area.



Development Trends

Historically, human patterns of development have focused along coastal areas throughout the world. In the U.S., an estimated 40% of the population lives in coastal counties, even though the land mass of these counties accounts for less than 10% of U.S. land mass when excluding Alaska.[140] The Texas coast tells a similar story. While the Texas coast only accounts for 18 out of the 254 counties in Texas, it is home to nearly a quarter of the population. As a result, development trends are extremely impactful to the natural, social, and economic systems of the Texas coast and understanding trends in single-family, multifamily, and commercial real estate, can help shed light on the changing pressures and exposure to hazards along the coast.

The development of single-family homes in Texas historically moves with the U.S. market, with a period of sustained increasing development activity from 1990, peaking in 2005, then falling precipitously over the course of the Great Recession in 2008 until 2011. Since 2012, demand for single-family homes across Texas has risen sharply, with building permit activity increasing by over 40% between 2018 and 2021. Demand for multifamily developments in Texas is also increasing, particularly for high-rise condominiums and rental apartments.

Recent commercial real estate construction activity along the Texas coastline is largely limited to the Houston and Beaumont real estate market regions. Most office leasing activity in Texas has been driven by the booming medical and life sciences sector, which has supported the otherwise sagging office markets as firms are still learning to navigate new remote work paradigms that were popularized during the COVID-19 pandemic. Given the negative net absorption rates seen in office markets across Texas, it is expected that new construction and development activity for commercial office space will decrease in the short term.

(Photo Credit: Galveston Bay Foundation)

History of Success: Protection of Salt Bayou at McFaddin National Wildlife Refuge

The 139,000-acre Salt Bayou marsh, part of the Texas Chenier Plain, is the largest contiguous estuarine marsh complex in Texas. It includes a diverse landscape of freshwater and estuarine marsh, coastal prairie grasslands, tidal flats, creeks, and provides habitat to a multitude of fish and wildlife species.[141] The marsh complex, located seaward of the Gulf Intracoastal Waterway in the upper reaches of the Texas Gulf coast, has experienced rapid erosion over the last decade primarily caused by hurricanes and other tropical weather events, vessel and shipping activity, and offshore drilling.[142] As part of a multi-phase restoration plan to restore and protect this vital ecosystem, nourishment and restoration of 17 miles of beach and dune habitat commenced in December 2021 at the McFaddin National Wildlife Refuge, which actively conserves a portion of the Salt Bayou marsh complex. This project represents the final phase of the 2013 Salt Bayou Watershed Restoration Plan and, once completed, will stabilize the shoreline from further erosion and reduce the occurrence of saltwater intrusion into Salt Bayou's fragile marsh ecosystem. In addition, native vegetation will be planted to further reinforce the dune system and ultimately enhance the resiliency of the Salt Bayou marsh complex.[143]

Beach nourishment at McFaddin National Wildlife Refuge. (Photo Credit: HDR)

Understanding historical and current development trends can highlight the asset classes that may be most vulnerable to rising sea levels and other physical or climatological changes along the coastline. Specifically, special attention should be paid to the older housing stock near or in floodplains, as those buildings and the communities surrounding them are most susceptible to flood events. While high-rise multifamily buildings are less prone to damage from floods, the bulk of lower density two- to four-family residential buildings such as townhomes and mid-rise condominiums in the Texas coastal zone were built in the 1980s. Along with older single-family homes, these buildings, which may have been constructed under outdated building codes and may be without stormwater mitigation systems, are especially at risk to future flooding. Additionally, the growing demand for more healthcare laboratories and medical office space in Texas highlights a need for newer developments to house vulnerable populations, such as the sick or elderly, that are built with resilient infrastructure systems in place.

(Photo Credit: Texas General Land Office)

3.2. Eight Coastal Vulnerabilities

The state of the coast is influenced by the natural, social, and economic drivers, the pressures brought on by human activities and natural processes, and the associated vulnerabilities resulting from tropical storms, hurricanes, extreme weather events, erosion, less accessible or degraded sources of water, environmental changes, and other nature-based or human-induced changes. Understanding the vulnerabilities and their underlying causes provides a window to the current condition of the coast and where the vulnerabilities are the greatest threat. To study the root causes of these vulnerabilities, information is gathered through data analysis and observations made by experts that work within each part of the coastal system. This stakeholder informed and data driven process is an integrated approach used to examine where and to what extent the drivers and pressures are causing vulnerabilities that negatively impact the Texas coast and to identify potential solutions to mitigate these impacts.

In many cases, vulnerabilities are brought on by multiple, compounding drivers and pressures. For instance, increased wetland degradation or loss can be influenced by both SLR and increased coastal development. For this reason, multi-faceted solutions are needed to provide long-term defense or, ideally, mitigate the drivers and pressures that create the vulnerabilities. In Section 5, the Plan recommends a list of widescale actions and further, specific strategies and individual projects that implement the needed actions. These actions, strategies, and projects take a "multiple lines of defense approach" to improve overall coastal resilience. In the Plan, this means that the recommended projects for community- and ecosystem-based implementation will work together to counteract the vulnerabilities. It also means that, where possible, these recommended solutions will aim to mitigate as many of the causes of the problems as practical, offering projects that have multiple goals. These overarching needs will be determined by assessing the coastal system as a whole.

The following sections detail the vulnerabilities that were determined to be the most relevant to the current state of the Texas coast and how they were assessed by members of the TAC.

3.2.1. Vulnerabilities Overview

This Plan considers eight vulnerabilities along the Texas coast (these were called Issues of Concern or IOCs in the previous Plans published in 2017 and 2019). These vulnerabilities include:

- Land Change
  - Degraded or Lost Habitat
  - Bay Shoreline Change
  - Gulf Shoreline Change
- Flooding
  - Storm Surge
  - Inland Flooding
  - Tidal Flooding
- Degraded Water Resources
  - Degraded Water Quality
  - Degraded Water Quantity

Vulnerability	Main Concern	Solutions
Land Change		
Degraded or Lost Habitat	Loss of beaches, wetlands, tidal flats, and other coastal environments due to erosion, development, sea level rise, or other processes.	Conservation and protection of current habitats, acquisition of land where future habitats may migrate, coastal restoration projects, policy changes
Bay Shoreline Change	Erosion of the bay-facing shoreline, increasing wind and wave exposure to landowners and habitats behind the shoreline	Shoreline stabilization, living shorelines and vegetation planting, removal of old structures
Gulf Shoreline Change	Erosion of the Gulf-facing shoreline and dune system behind it, increasing wind and wave exposure to landowners and habitats behind the shoreline	Beach and dune restoration, protection of habitats, dune vegetation planting
Flooding		
Storm Surge	Flooding of homes, infrastructure, critical facilities, and coastal habitats; erosion of dune system	Protection of beach, dune, and wetland habitats to mitigate the intensity of the surge; raising the elevation of homes and infrastructure, such as evacuation routes
Inland Flooding	Flooding of homes, infrastructure, critical facilities, and coastal habitats	Protection, conservation, and restoration of inland wetlands to capture water; elevate homes and critical infrastructure and facilities
Tidal Flooding	Flooding of homes, infrastructure, critical facilities, and coastal habitats	Elevation and/or relocation of roads, homes, and critical infrastructure
Degraded Water Resources		
Degraded Water Quality	Industrial and non-point source pollution, eutrophication, fish and other fauna die off	Agriculture Best Management Practices, working with communities to prevent pollution in runoff, monitoring and testing water bodies
Degraded Water Quantity	Flooding or drought affecting freshwater inflows	Restore freshwater inflows, drought management, water conservation practices

(Photo Credit: Hollaway Environmental + Communications Services)

TAC members were invited to share their expert feedback with fellow TAC members and the GLO during a series of committee meetings. The TAC provided critical input throughout the entire planning process with regard to scientific and specialized technical and expert local knowledge of coastal problems and possible solutions.

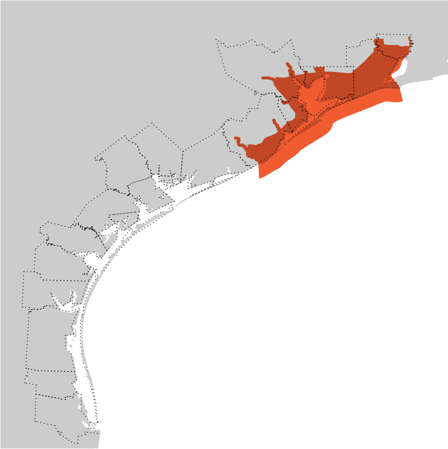
3.2.2. TAC Vulnerability Assessment Results

To understand the vulnerabilities facing the Texas coast and evaluate projects to address these coastal challenges, the GLO enlisted the assistance of the TAC. Members were invited to share their expert feedback with fellow TAC members and the GLO during a series of committee meetings. The TAC provided critical input throughout the entire planning process with regard to scientific and specialized technical and expert local knowledge of coastal problems and possible solutions.

The vulnerability discussion groups were divided into the eight vulnerabilities identified in this Plan (Degraded or Lost Habitat, Bay Shoreline Change, Gulf Shoreline Change, Storm Surge, Inland Flooding, Tidal Flooding, Degraded Water Quality, Degraded Water Quantity) where TAC members discussed the vulnerability issues and concern areas that have changed or emerged since the issuance of the previous Plan and whether there are any issues impacting their region that are not currently highlighted by the eight vulnerabilities.

From these meetings and according to TAC members' comments, summaries from each regional input meeting are as follows:

REGION 1



(Photo Credit: Galveston Bay Foundation)

DEGRADED OR LOST HABITAT

Habitats are losing migration space as development occurs on one side and sea level rise and erosion on the other, leading to the conversion of freshwater coastal wetlands to brackish/saltwater wetlands or open water.

BAY SHORELINE CHANGE

As the Gulf Intracoastal Waterway continues to increase in width to accomodate larger vessels, impacts to the bay shorelines are also increasing. Shoreline areas are eroding more often than they are accreting.

GULF SHORELINE CHANGE

The 2020 hurricane season triggered significant erosion events, wiping out beaches and dunes along Galveston Island, Bolivar Peninsula, and Follet's Island.

STORM SURGE

The City of Galveston is more vulnerable to storm surge as the dunes on the west end are diminished and properties are exposed.

INLAND FLOODING

The age of infrastructure plays a critical role during inland flooding events. Structures that were built before 1990 are the most vulnerable as they are less equipped to handle flooding from quick rainfall. Older infrastructure is typically found in communties with higher social vulnerability.

TIDAL FLOODING

Inundation of critical habitat for piping plovers and preferred habitat for other bird species, such as the eastern black rail, during tidal flooding events wipes out nests and chicks.

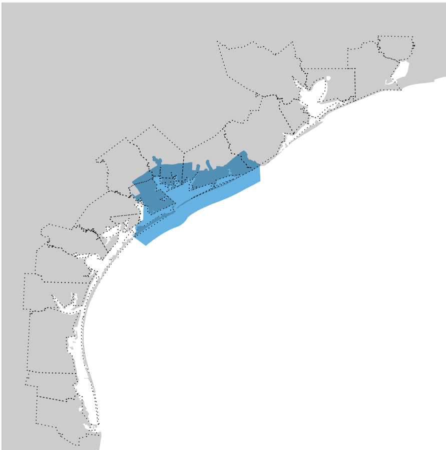
DEGRADED WATER QUALITY

Nutrient standards should be implemented within the coastal area as non-point source pollutants such as nitrogen and phosphorous are coming down the watershed. Additionally, more collaboration with upstream users is needed to manage the watershed as a whole.

DEGRADED WATER QUANTITY

Velocity and flow of water in the system is volatile. A watershed-wide management approach would balance water quantity issues (heavy rainfall, droughts, etc.) and establish flow that meets the needs of both the tributaries and the bays.

REGION 2



(Photo Credit: Texas General Land Office)

DEGRADED OR LOST HABITAT

Oyster reef habitat in Matagorda and Keller bays is in decline. This is largely due to increased use of the Gulf Intracoastal Waterway, overharvesting, and increased storm intensity leading to sedimentation on the reefs.

BAY SHORELINE CHANGE

Bays are being enlarged in this region as shorelines are changing, driven by changes to the navigational channels, among other things. This can impact tidal flow, sedimentation patterns, and salinity regimes. To fully understand these impacts, more data on bay shoreline change rates is needed.

GULF SHORELINE CHANGE

The eastern-most 5 miles of Matagorda Island is eroding rapidly, especially the tip near Pass Cavallo, and there is concern about losing this portion of the Gulf shoreline. In addition, there are several locations along the island that are in danger of breaching.

STORM SURGE

Storm surge can impact the supply of freshwater going into the bays changing the salinity levels, Other impacts of concern include toxic chemical releases, especially within Lavaca Bay, facilities at low elevations, and can contribute to the movement of toxic sediment during intense storm events.

INLAND FLOODING

This region has low-lying topography and is situated 2 feet above sea level and there are very few natural drainage options during high precipitation events, as a result. Those that do exist are blocked by roadways. This problem is exacerbated by increasing development and population growth.

TIDAL FLOODING

During regular high tide events, roadways such as State Highway 316 and FM 2031, are often underwater or are partially inundated.

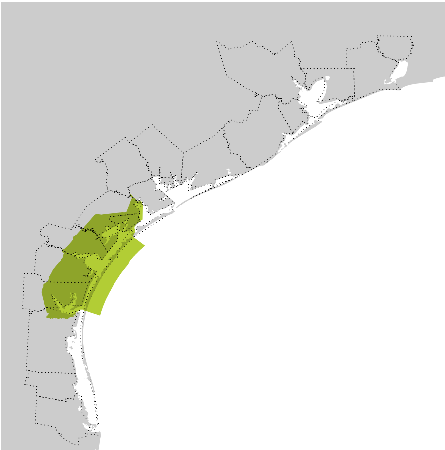
DEGRADED WATER QUALITY

Non-point source pollution is impacting Matagorda and San Antonio bays, contributing to harmful algal blooms and lowering the dissolved oxygen levels. These sources include septic tank and urban runoff from urban areas outside the coastal zone, feral hogs, and agricultural runoff.

DEGRADED WATER QUANTITY

More water is being used by industry in this region, due to increased industry interest and development. The challenge is meeting the needs of both the growing developments and existing habitats.

REGION 3



(Photo Credit: Texas General Land Office)

DEGRADED OR LOST HABITAT

At the Aransas National Wildlife Refuge, critical habitat for whooping cranes is in decline, which is a major concern as these migratory birds rely on the Refuge during winter months.

BAY SHORELINE CHANGE

Nueces Bay and the Corpus Christi Ship Channel continue to lose shoreline after Hurricane Harvey, either from the initial impacts of the hurricane or from unprotected shorelines post-Harvey.

GULF SHORELINE CHANGE

The beach and dune systems in the southern part of this region were heavily impacted during the 2020 hurricane season and have not recovered. Near Bob Hall Pier, the dunes were eroded approximately 55 feet.

STORM SURGE

During storm surge events, above ground storage tanks holding petrochemicals (i.e., crude oil) on Harbor Island and within the Corpus Christi Ship Channel are vulnerable to impacts that can cause leaking or spills.

INLAND FLOODING

Downtown Aransas Pass is flooded in knee-deep water during regular rain events, which then takes time to drain out of the area.

TIDAL FLOODING

The City of Rockport has been severly impacted by tidal flooding, but a lot of the focus has been on communities around the bay within Aransas County. Tidal flooding is a top priority for Rockport.

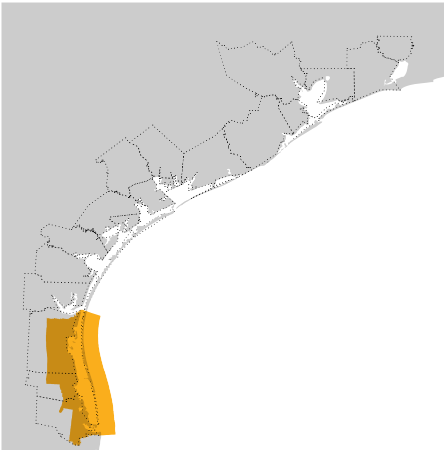
DEGRADED WATER QUALITY

The algal bloom that occurs within Baffin Bay is one of the worst in the state and is primiarily caused by Sanitary Sewer Overflows that occur during storm events and outflow into Petronila Creek.

DEGRADED WATER QUANTITY

The Nueces Delta has been declared an unsound ecological environment due to the lack of freshwater inflow.

REGION 4



(Photo Credit: AECOM)

DEGRADED OR LOST HABITAT

The tidal flats in this region, particularly on the backside of South Padre Island, are vulnerable to alterations in function and vegetative cover, driven by additional runoff, increased development, and sea level rise.

BAY SHORELINE CHANGE

Development on the Gulf side of South Padre Island impedes overwash from nourishing the marshes on the bay side of the island, contributing to degradation of these shoreline areas.

GULF SHORELINE CHANGE

The northern portion of South Padre Island is experiencing erosion of 7 to 14 ft/yr and future development plans are a concern, especially as recreational use of this area increased as a result of the COVID-19 pandemic.

STORM SURGE

The north end of the city limits of the City of South Padre Island is likely the most vulnerable area, particularly around a string of hotels located on White Sands Street that go right up to the beach where it floods during storm surge events.

INLAND FLOODING

In Willacy County, more planning is needed to manage the floodwaters where flow has been modified or altered by obstructions, such as in the San Perlita area near the recently installed windmills.

TIDAL FLOODING

Tidal flooding is contributing to erosion near the peninsula within the Bahia Grande, an area used for parking along the road.

DEGRADED WATER QUALITY

Longer lasting red tide algal blooms are occurring in the Lower Laguna Madre, likely caused by increased nutrients from treated wastewater being discharged into the Arroyo Colorado.

DEGRADED WATER QUANTITY

The Laguna Madre has too much freshwater inflow, likely due to increased storm runoff and wastewater discharge, but the Rio Grande tidal area is not getting enough freshwater inflow.

3.3. Emerging Concerns

Throughout the planning process, TAC members provide valuable insight into the intricacies of the coastal system. This includes comments made during committee meetings as well as engaging in one-on-one conversations with the GLO. During these discussions leading up to the publication of this Plan, TAC members brought up concerns that were not captured through other avenues in the planning process, either because the concern was localized or had not historically been widely addressed. The following emerging concerns are examples of the influence that the vulnerabilities have on the state of the coast. For example, declining soil health in the upstream portion of a watershed is a pressure not yet fully explored, yet it creates vulnerabilities within the coastal system such as habitat degradation, decreased water quality, and public health hazard that ultimately impact the resiliency of the coast. For some of these concerns, potential impacts to the natural, social, and economic systems of the Texas coast may not be fully understood. For others, the impacts are understood, but identifying solutions to address the pressure causing the concern has been a challenge.

3.3.1. Loss of Tidal Flats

Subject to wind-driven tidal fluctuations, tidal flats are a unique habitat, supporting a multitude of salt-tolerant vegetation, microorganisms, and shorebirds. Tidal flats are vital to the overall bay and estuary ecosystem as they provide food and shelter to protected species and provide wintering habitat for migratory birds. These habitats are typically associated with hypersaline bays, such as the Laguna Madre. As these systems are regularly to irregularly flooded, they are often covered with a mat of blue-green algae (*Lyngbya spp.*) and are home to thriving microbenthic invertebrate communities. Currently, tidal flats are at risk of being lost due to increased development, runoff, and inundation due to RSLR.[144,145] In addition, there is little understanding on successful restoration opportunities for these ecosystems. Supporting projects that grow knowledge and experience in this area of coastal restoration is key to protecting and maintaining these unique and specialized habitats.

(Photo Credit: Texas General Land Office)

An obstruction to freshwater inflow on Big Boggy Bayou, which flows into Matagorda Bay. (Photo Credit: Jake Madewell)

3.3.2. Freshwater Inflows

The state of Texas is prone to droughts that place a strain on freshwater quantities throughout the coastal region on a cyclical basis. Increasing population and industrial water usage puts pressure on this already stressed resource and the overall result is reduced freshwater inflows to Texas bays and estuaries. Inadequate freshwater inflows to coastal areas can have adverse and wide-ranging impacts to water usage by industries and households, in addition to water quality and the freshwater needs of estuarine habitats. Water rights litigation has become more prevalent as individual water rights holders can determine the use of water sources, often changing this use when the water right is transferred, potentially having downstream impacts or reducing downstream freshwater inflows. Smaller inflow quantities can lead to higher salinities, depleted nutrient levels, reduced sediment transport, and higher concentrations of pollutants and bacteria in Texas bays and estuaries. These issues can become more significant as people develop in floodplains or channelize more water sources. Expanding populations and coastal industries also can increase nonpoint source water pollution (pollution generated by stormwater runoff from residential neighborhoods, commercial sites and agricultural fields) and deplete underground aquifers. Withdrawing water from already strained aquifers can lead to land subsidence, as documented by the TWDB.

3.3.3. Soil Health, Agriculture Lands, and Saltwater Intrusion

Soil health is an emerging issue in Texas as the nutrients within the soil upstream ultimately impact downstream watersheds. Current agricultural practices rely on tilling soil and fertilizing crops, contributing to increased non-point source pollution within stormwater runoff from agricultural fields. As more soil is disturbed, increased nutrients are released into the watershed. In addition to agricultural runoff, wildlife is another source of bacteria and contributor to water quality issues. Compounding this issue on the coastal side, increased development and inundation due to RSLR is contributing to habitat squeeze, leading to a loss of marsh areas. These habitats filter out excess nutrients entering coastal waterbodies. Furthermore, increased saltwater intrusion causes the release of additional nutrients previously held within fertilized soil, due to the interaction between certain soils and saltwater.[146] Engaging with landowners or purchasing lands upstream and rebuilding natural habitats to encourage wildlife to move away from streams and waterways could reduce pollutant loads within the watersheds. Furthermore, using methods such as Bacteria Source Tracking can help coastal managers and state agencies keep monitoring the level and source of nutrients, to ultimately inform watershed management strategies.

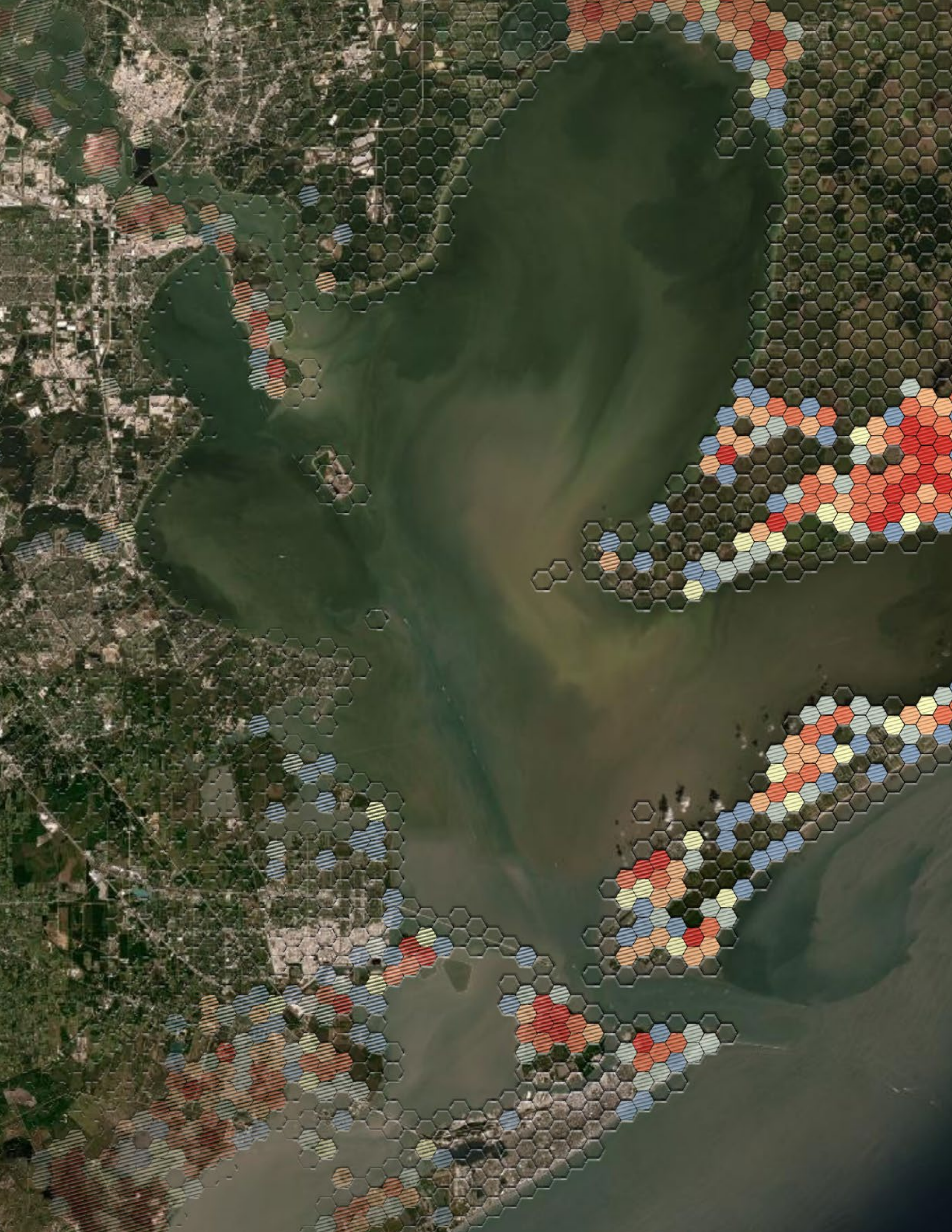
3.3.4. Wastewater Treatment

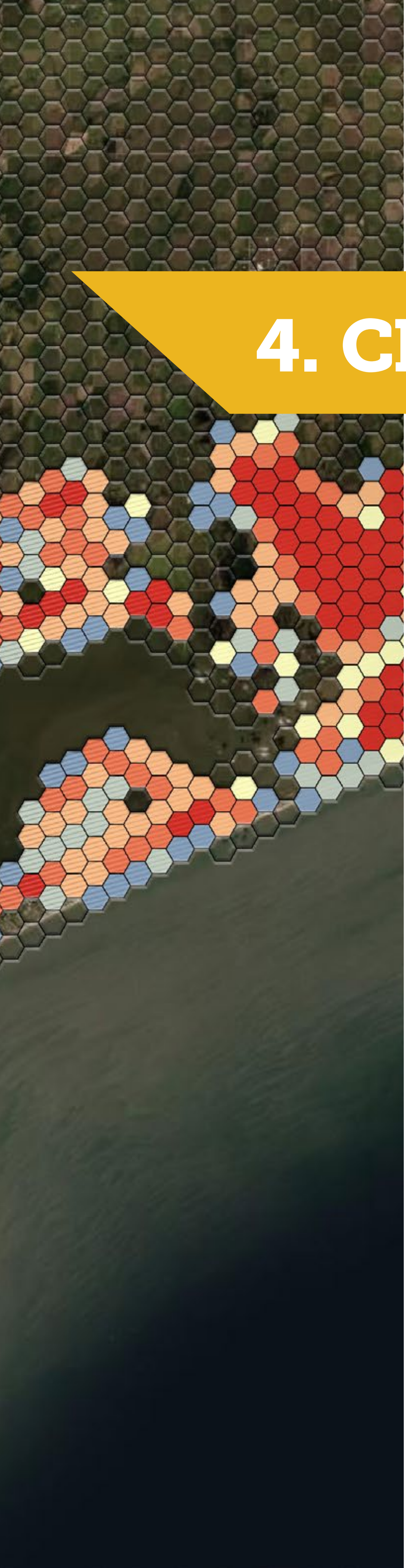
The American Society of Civil Engineers' 2021 Report Card for America's Infrastructure rated the nation's wastewater treatment plants (WWTPs) at a D+, indicating that the infrastructure is in poor to fair condition and is mostly sub-standard.[147,148] Many of the WWTPs are nearing the end of their designed 40-to-50-year lifespan, are exhibiting deterioration, and are at a strong risk of failure. In addition to WWTPs, approximately 20% of Americans rely on On-Site Sewage Facilities (OSSF), such as septic tanks, to manage household wastewater. These systems are typically designed to last 20 to 30 years but are regulated differently than WWTPs. Historically, there has been a lack of readily available data to identify coastal natural resource areas impacted by wastewater treatment systems in the coastal zone. Aging infrastructure in both WWTPs and OSSFs can lead to increased risk of Sanitary Sewer Overflows (SSOs) and other unauthorized discharges, creating a hazard to public health and safety, and the environment. Furthermore, SSOs directly impact the overall quality of water at Texas's beaches, bays, and estuaries and may influence impaired water quality designations given by TCEQ (i.e., 303(d) listings) and oyster harvesting restrictions. The GLO's Coastal Water Resources program is working to further understand and define this connection between WWTPs, SSOs, and contaminated waterbodies along the Texas coast. An overview of this analysis can be found in Section 5 of this Plan.

(Photo Credit: Texas General Land Office)

Deep Dive: Habitat Change in Texas

Understanding historical habitat changes that have occurred along the Texas coastline can provide insight into how the coast will likely transform into the future as a product of increased urban development, rising sea levels, and more frequent and severe storms events. Since 1984, approximately 18,000 acres of Texas coastline have been lost to open water habitat. This staggering loss of land has negative environmental, social, and economic repercussions for Texas. Land loss is occurring around most bay and Gulf shorelines with problematic areas including the Gulf shoreline east of Matagorda Bay, which is retreating at the highest rate on the Texas coast, bay head deltas, and the Chenier Plain of east Texas. These critical focal regions will require multiple approaches to improve resiliency including land acquisition, protection, and restoration. One notable exception to this includes northern Padre Island where longshore currents from the north and south converge to form large sediment deposits that nourish the coastline. Regions along the coast that are experiencing greater than average land loss are likely to need, and will respond favorably, to proactive restoration and nature-based designs. Land loss and habitat conversion will have irreversible and cascading impacts for the Texas coast including reduction in available habitat for species that utilize environments located at the land-sea interface, reduction in or complete loss of regulating ecosystem services benefits provided by coastal habitats (e.g., carbon sequestration, water purification, mitigation against coastal hazards, shoreline stabilization, etc.), loss of coastal recreational areas, increased financial burdens due to recovery and armoring efforts, and adverse impacts to coastal Texas economies. Future changes projected for the Texas coastline are discussed in more detail in Section 4 and the associated Technical Report.





4. Changing Landscapes

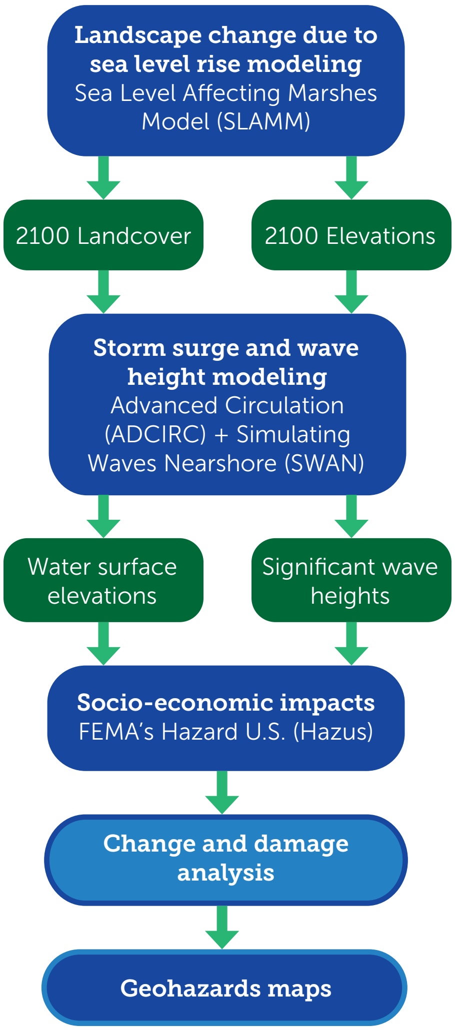
The Texas coast is a dynamic and constantly changing landscape, with natural systems that are vulnerable to hazards such as floods, storms, and storm surge. These hazards are intensified by long-term processes such as shifting habitats, erosion caused by changes in sediment supply, rising sea levels, and unpredictable weather patterns.

To effectively plan for coastal resiliency needs in the face of these hazards, the GLO uses cutting-edge science and data to guide decision-making. For this Plan, the GLO employed a variety of models, developed and vetted by experts, to understand the potential future scenarios of landscape changes and storm surges resulting from sea level rise. The models utilized in this Plan and described in the following subsections are widely used by federal and state governments for planning efforts and provide valuable insights for local and state coastal planning efforts.

The data and knowledge gained from these models is crucial for understanding the current and future vulnerabilities of the Texas coast and for developing effective solutions to improve resiliency to these vulnerabilities. As sea levels continue to rise and the potential for coastal hazards increases, it is more important than ever to have access to the best available science and data in order to make informed decisions now in anticipation of future conditions.

Combating the effects of rising sea levels and unpredictable weather patterns is a daunting task that requires the cooperation and dedication of governments, organizations, industry, and individuals. Texas has already made significant strides in understanding the potential impacts of future climate conditions on its coastal environments, economy, and communities. This work includes a wide range of studies, from climate models to storm surge assessments across the entire Texas coast. Examples of this work include large-scale projects proposed by the USACE Coastal Texas Program (see Section 1), which evaluates storm surge reduction for the Texas coast, to more localized studies that assess the impacts of hurricanes on Texas businesses.[149, 150] Additionally, various work has been done to understand the effects of these weather events on natural resources such as oysters.[151] This Plan uses the information gathered from various studies to prioritize areas along the coast that have the greatest need for improvement.

MODELING FRAMEWORK



2023 Modeling Enhancements

- ✓ Higher resolution
- ✓ Newer, better elevation information
- ✓ More sea level rise scenarios modeled
- ✓ More storms modeled
- ✓ More comprehensive project modeling
- ✓ Development of geohazards and storm surge vulnerability maps

4.1. The Modeling Framework

For this Plan, two sea level rise scenarios and nineteen storms were modeled to assess the impacts to the environments and communities on the coast. The Harte Research Institute has been at the forefront of modeling to better understand the potential impacts of sea level rise, storm surge, and wave activity on coastal environments in Texas. Through HRI's modeling techniques, the GLO has been able to quantify the environmental changes, economic impacts, and risks associated with rising sea levels and increased storm surges caused by higher water levels and changes in land cover.

Storm surge, the rise in water levels caused by a storm, is not only affected by the height of the water, but also by the composition of the coastal landscape. Coastal wetlands, for example, act as natural barriers that can reduce the impact of storm surge by slowing down the floodwaters and waves. However, these vital environments are at risk of being lost as sea levels rise. To address this, the first step in understanding and modeling the potential impact of storm surge is to predict how the coastal landscape will change by the year 2100 due to potential loss or migration of these wetlands due to sea level rise. Using the current landscape as a reference, the future landscape and elevation model outputs are then used in a storm surge model to compare and contrast the potential impacts. An economic impact model is then utilized to compare socioeconomic impacts from the storms on the present and future landscape, such as comparing the number of damaged buildings and total economic loss resulting from the storms. From all these modeling data, geohazards maps are created, identifying the most vulnerable areas and critical coastal environments that need to be protected or avoided for land conversion in the future.

These models are also used to gather evidence to support the effectiveness of large-scale coastal restoration projects as a means of reducing risk through hybrid or nature-based methodologies, such as restoring or adding protection to habitats that reduce wave damage during coastal storms. To evaluate the potential benefits of these types of projects in Texas, the models are configured to compare the impacts of storm surge under two different scenarios: one where large-scale restoration projects have been implemented ("with-project") and one where no action has been taken ("no action"). The results of these models are compared to determine if these conceptual restoration projects would provide protection from surge and waves on the current and future landscape after decades of sea level rise.

It is important to note that there are limitations to these models, which are outlined in more detail in the 2023 Technical Report. These limitations include but are not limited to the data used to initialize the model, assumptions about the rate of sea level rise, and most critically, the limited ability to model all the relevant physical and hydrodynamic processes that will occur until the year 2100. Despite these limitations, the models clearly demonstrate that without mitigating action, significant portions of the Texas coast will be at increased risk of coastal storms and land loss as current habitats and low-lying areas around communities are converted into open water through this century.

4.1.1. Improvements to the Previous Modeling in the 2019 Plan

The new ensemble of storms and sea level rise scenarios used in this Plan provides a more comprehensive understanding of the human and natural vulnerabilities within the coastal zone.

This modeling work builds on the progress made during the development of the 2019 Plan, where analysis of recent coastal change, projections of future change, and map visualizations were used to gain a deeper understanding of the dynamics of the coastal zone and how it affects ecosystem and community resilience. Compared to the 2023 Plan, the previous Plan in 2019 was more limited in scope as it only modeled six storms and one sea level rise scenario. By utilizing new scenarios, storms, and advanced geospatial data that includes information on topography, geoenvironments, and socio-economic settings, this updated modeling effort is able to provide a more wide-ranging representation of potential vulnerability scenarios. This updated modeling further enables coastwide assessments of change and vulnerability to pinpoint areas that are at risk on both the current and future landscape.

4.2. Relative Sea Level Rise Planning Ranges

Sea level is rising globally. In coordination with other federal agencies, NOAA released sea level rise reports in 2017 and 2022 that predict the global mean sea level will rise between 1 and 8.2 feet by 2100.[136, 152] These reports were used to determine the sea level rise planning ranges included and modeled in this Plan.

Deep Dive: Sea Level Rise Trends in the United States

The rate at which sea level is rising varies depending on location and is primarily influenced by vertical land movement, which can be caused by either the uplifting of land or subsidence (sinking). NOAA uses long-term tide gauges to track sea level changes across the United States. This data allows for the calculation of sea level change over time. The map below shows areas where sea level is not changing or changing at a rate similar to global sea level rise (shown in green) and areas where sea level is rising faster than the global sea level due to subsidence (shown in red). Texas is one of the states with the fastest rates of RSLR in the nation (particularly near Houston and Rockport), a fact that highlights the importance of implementing the strategies and project concepts recommended by this Plan.

Key Terms: Geohazards

What are coastal geohazards?
Coastal geohazards are geological processes causing changes in the landscape and in Texas include sea level rise, land subsidence, flooding, storm surge, erosion, or a combination of processes creating compounding effects.

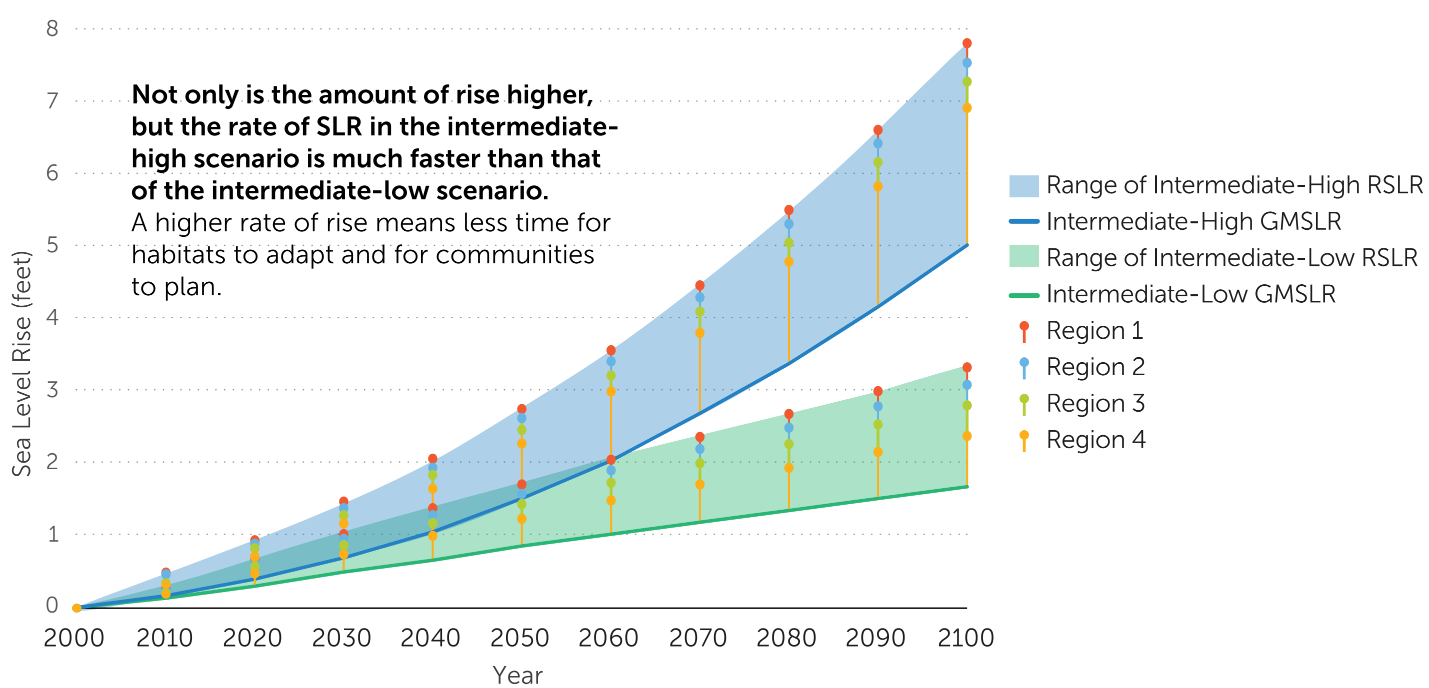
What makes an area more prone to the effects of coastal geohazards?
Areas where natural buffers, such as wetlands, dunes, and uplands, have been degraded by natural processes or human activities further exposing critical environments and communities.

The two scenarios chosen by the GLO to model for this Plan are **1.6 feet (NOAA's intermediate-low scenario) and 4.9 feet (NOAA's intermediate-high scenario) of rise by the year 2100.** This sea level rise modeling utilizes an "envelope approach" in which a lower and upper bound of likely global mean sea level rise by 2100 are modeled. For the 2019 Plan, a moderate projection of 3.3 feet (1 meter) by 2100 was used as it represented a conservative approach suitable for high-level, near-term planning needs. The new approach allows for a range of potential sea level rise scenarios to be considered in the coastal resilience planning process.

NOAA's analysis also predicts regional and local trends in sea level change, called relative sea level rise. RSLR refers to how sea level will change relative to the elevation of the land. Essentially, RSLR is a combination of GMSLR and regional processes that change the elevation of the land such as subsidence and uplift. Due to land subsidence, sea level along the Texas coast is projected to be about 2 feet higher by 2100 than the level caused by GMSLR alone. See the table below to see the RSLR planning ranges for each region for different timesteps throughout the modeling process.

Relative Sea Level Rise Planning Ranges						
	2050		2080		2100	
Region	Int-Low	Int-High	Int-Low	Int-High	Int-Low	Int-High
1	1.7 feet	2.8 feet	2.7 feet	5.5 feet	3.3 feet	7.8 feet
2	1.6 feet	2.6 feet	2.5 feet	5.3 feet	3.1 feet	7.5 feet
3	1.4 feet	2.5 feet	2.3 feet	5.1 feet	2.8 feet	7.3 feet
4	1.2 feet	2.3 feet	1.9 feet	4.8 feet	2.4 feet	6.9 feet

Sea Level Rise Planning Ranges



4.3. Landscape Change Modeling

As sea levels rise, shorelines and habitats respond differently based on their existing conditions. The shoreline can retreat towards developed areas of the coast, increasing the risk of coastal flooding for those communities and potentially disrupting industries such as farming, fishing, and tourism, as well as affecting quality of life. Freshwater wetlands may migrate inland to prevent saltwater intrusion, but if the inland space is developed and does not allow for migration, the wetlands will transition to salt and brackish wetlands. Similarly, salt and brackish wetlands will either migrate inland if given open space and enough time to build elevation, erode to tidal flats, or transition to open water if they have no other option.

The Sea Level Affecting Marshes Model (SLAMM) was used to model the two SLR scenarios to evaluate the potential impacts on the coastal landscape.[153] This land cover change model provides baseline conditions and predicts future landscape trends based on rising sea levels. The model takes into account key processes that affect the distribution of environments on the coast, such as erosion, vertical accretion, inundation, and saltwater intrusion.

Coastal wetland landscape change modeling results can be found for each region on the following pages. These maps illustrate the areas where wetlands will be lost or gained in 2100 under different SLR scenarios, as well as areas that will become new wetlands but are currently undeveloped dry land. These areas are crucial for the long-term survival of coastal wetlands as they provide migration space for future wetlands as sea level rises. Additional maps on pages 94-101 display a grid overlay of the coast, with each cell in the grid indicating the relative vulnerability to land loss under the different SLR scenarios. Vulnerability was determined by comparing the acres of land converted to open water from today to 2100 with the rest of the region. The results of the model show that in this century, with no mitigating action taken, significant portions of the Texas coast will be at risk of land loss, as current habitats and low-lying areas around communities are converted into open water.

Key Term: Land Loss Vulnerability

What is land loss?

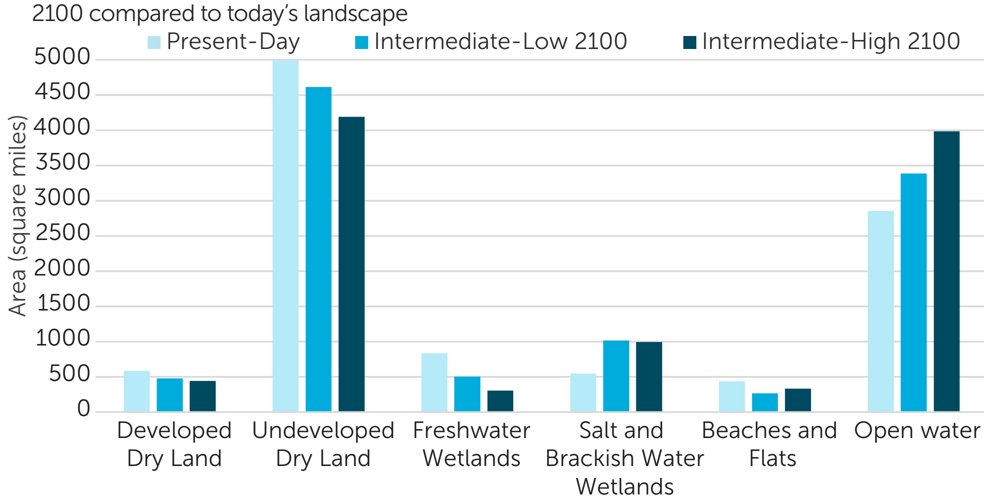
Land loss means any land cover type - such as developed land, open dry land, fresh marshes, salt marshes - that converts to open water in 2100.

How was relative vulnerability assessed in this Plan?

Relative vulnerability to land loss was determined for each region by assessing the mean and standard deviation of the acres of land loss in each hexagon-shaped cell in the grid.

2100 Landscape Change Modeling Results

The area in square miles of enviornments for both sea level rise scenarios in the year 2100 compared to today's landscape



> The results of the SLAMM model indicate that in this century, with no mitigating action taken, significant portions of the Texas coast will be at risk of land loss, as current habitats and low-lying areas around communities are converted into open water.

COAST WIDE

WETLAND CHANGE

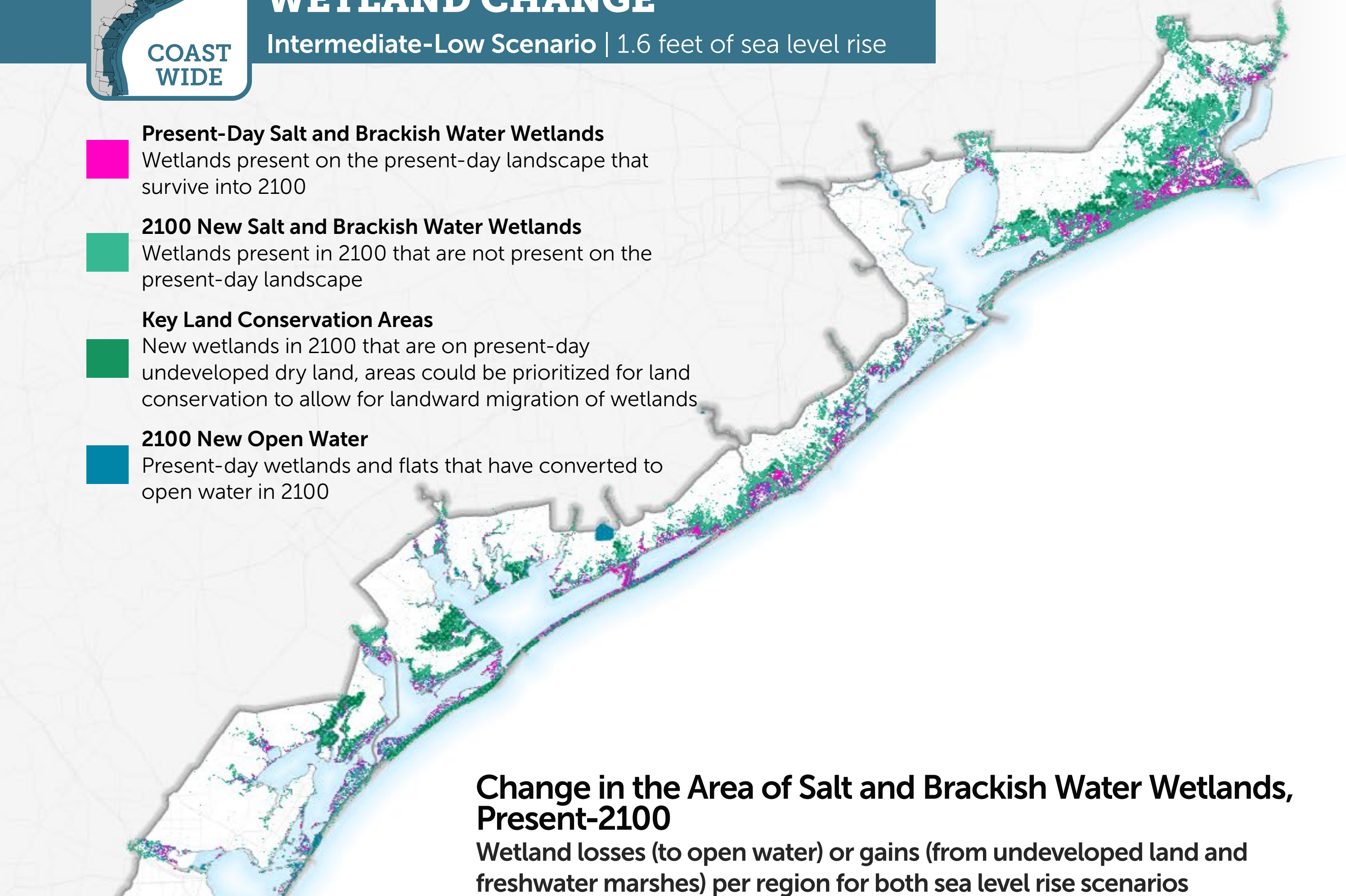
Intermediate-Low Scenario | 1.6 feet of sea level rise

Present-Day Salt and Brackish Water Wetlands
Wetlands present on the present-day landscape that survive into 2100

2100 New Salt and Brackish Water Wetlands
Wetlands present in 2100 that are not present on the present-day landscape

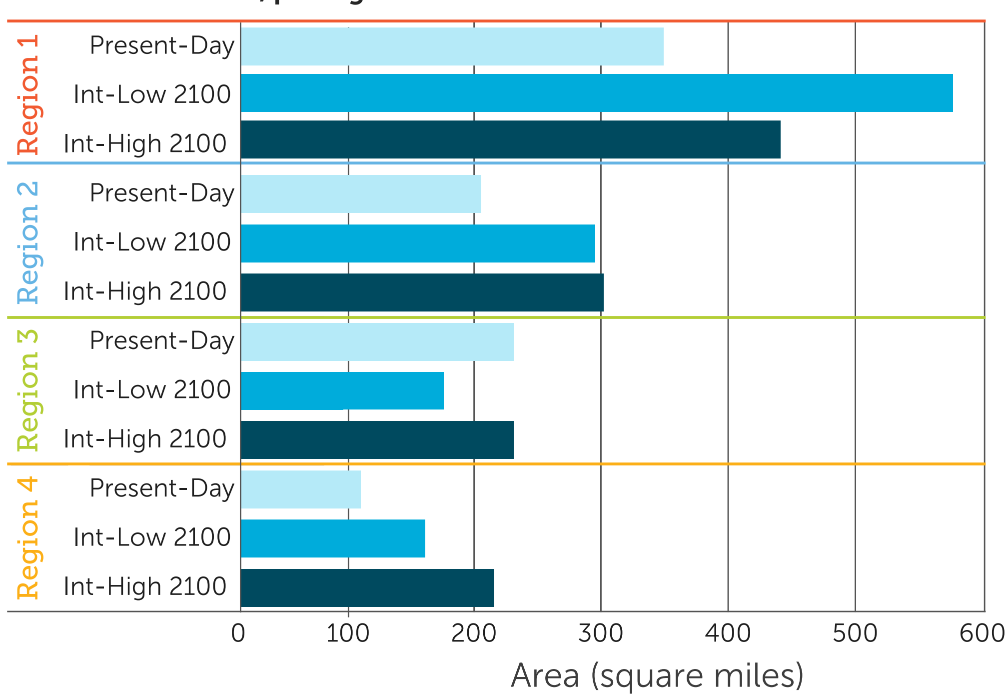
Key Land Conservation Areas
New wetlands in 2100 that are on present-day undeveloped dry land, areas could be prioritized for land conservation to allow for landward migration of wetlands

2100 New Open Water
Present-day wetlands and flats that have converted to open water in 2100



Change in the Area of Salt and Brackish Water Wetlands, Present-2100

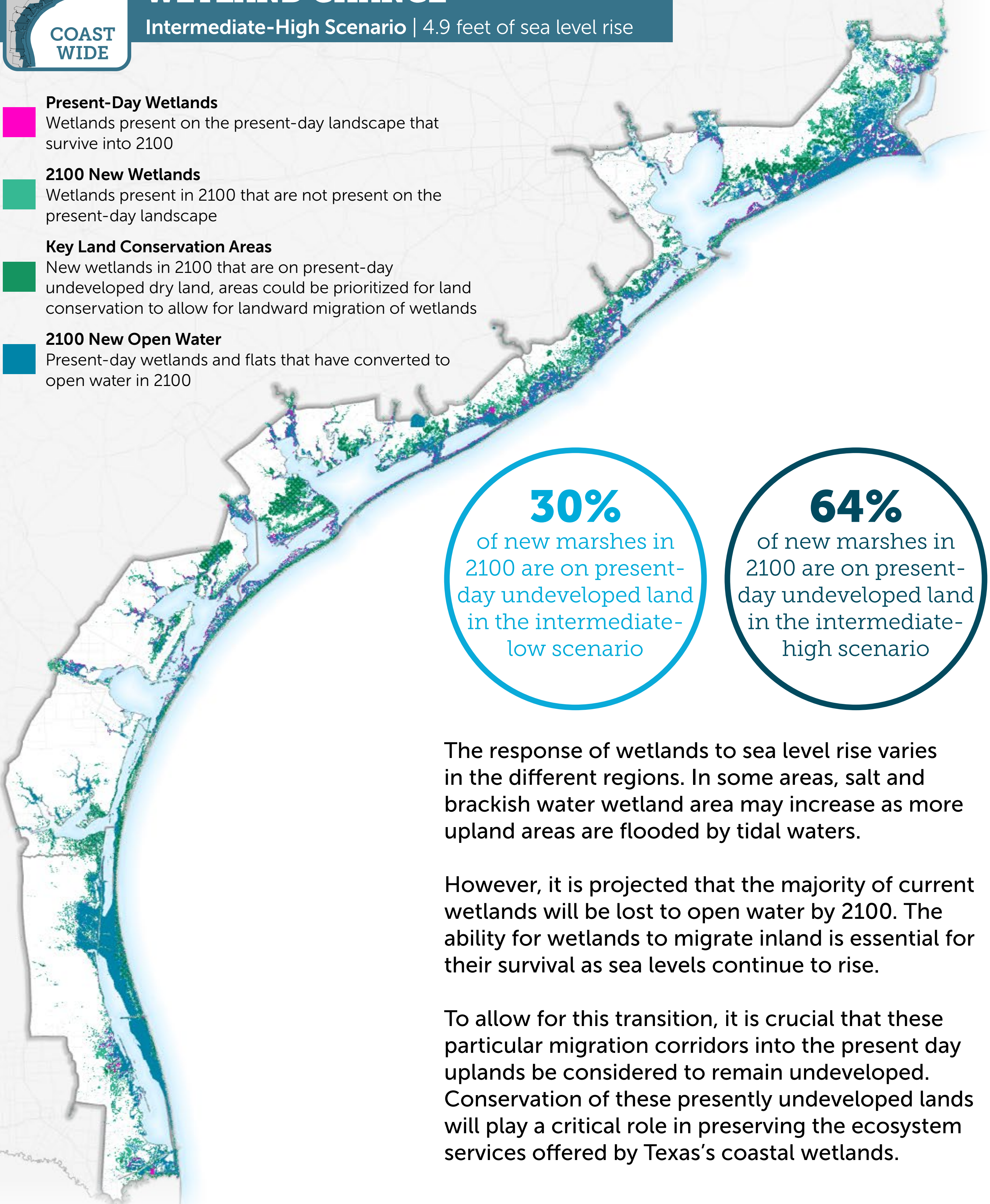
Wetland losses (to open water) or gains (from undeveloped land and freshwater marshes) per region for both sea level rise scenarios



COAST WIDE

WETLAND CHANGE

Intermediate-High Scenario | 4.9 feet of sea level rise



Present-Day Wetlands
Wetlands present on the present-day landscape that survive into 2100

2100 New Wetlands
Wetlands present in 2100 that are not present on the present-day landscape

Key Land Conservation Areas
New wetlands in 2100 that are on present-day undeveloped dry land, areas could be prioritized for land conservation to allow for landward migration of wetlands

2100 New Open Water
Present-day wetlands and flats that have converted to open water in 2100

30%
of new marshes in 2100 are on present-day undeveloped land in the intermediate-low scenario

64%
of new marshes in 2100 are on present-day undeveloped land in the intermediate-high scenario

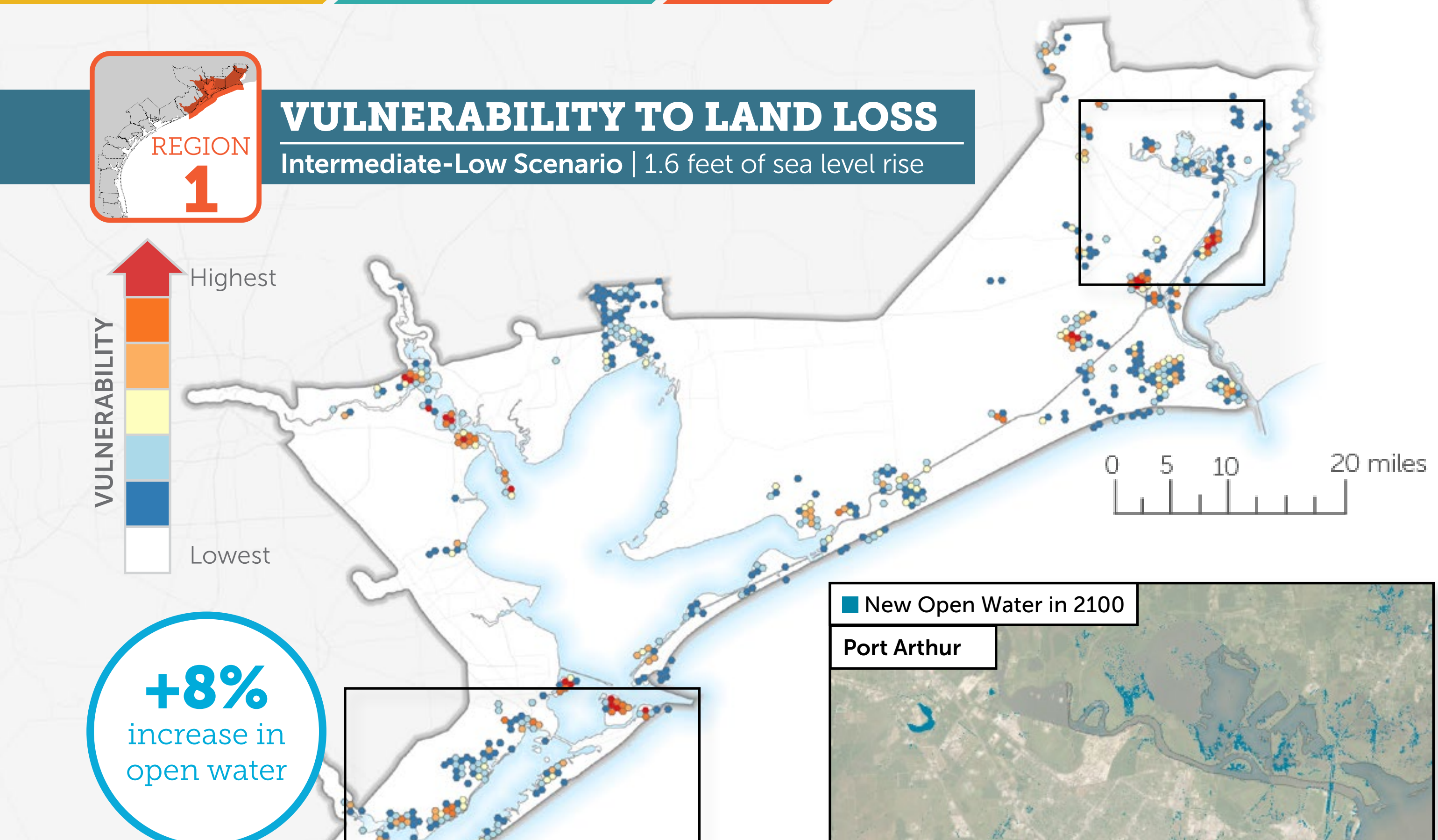
The response of wetlands to sea level rise varies in the different regions. In some areas, salt and brackish water wetland area may increase as more upland areas are flooded by tidal waters.

However, it is projected that the majority of current wetlands will be lost to open water by 2100. The ability for wetlands to migrate inland is essential for their survival as sea levels continue to rise.

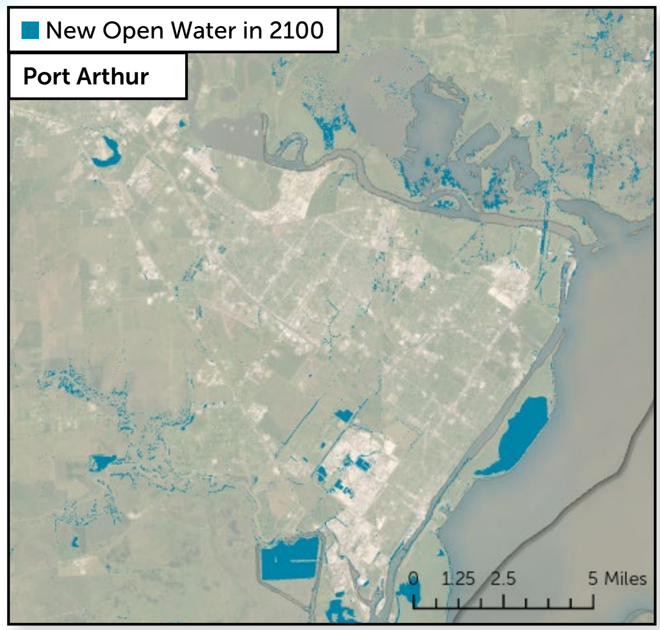
To allow for this transition, it is crucial that these particular migration corridors into the present day uplands be considered to remain undeveloped. Conservation of these presently undeveloped lands will play a critical role in preserving the ecosystem services offered by Texas's coastal wetlands.

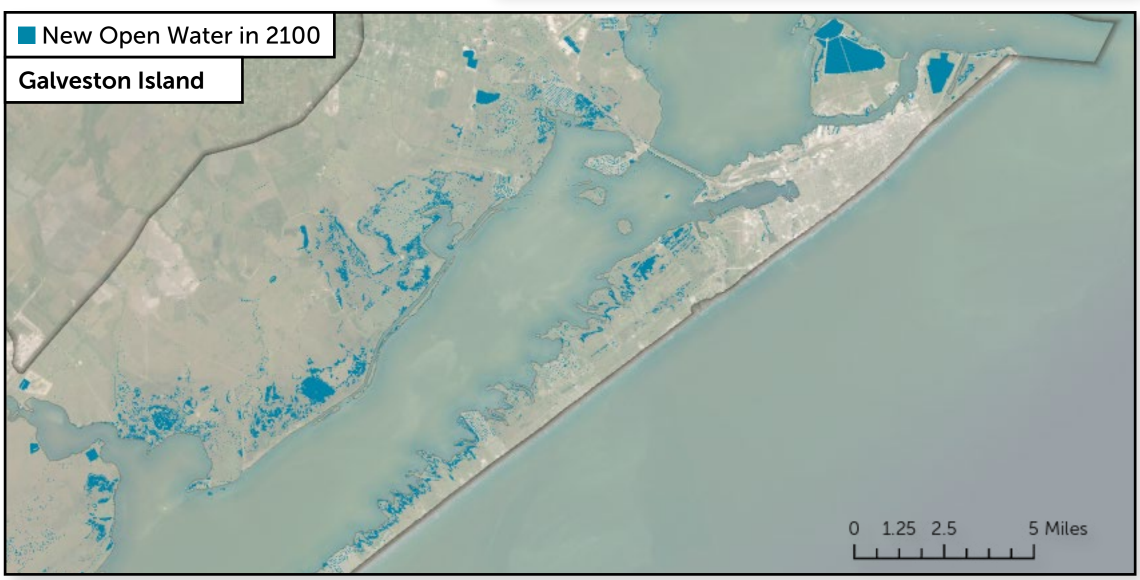
VULNERABILITY TO LAND LOSS

Intermediate-Low Scenario | 1.6 feet of sea level rise



+8% increase in open water

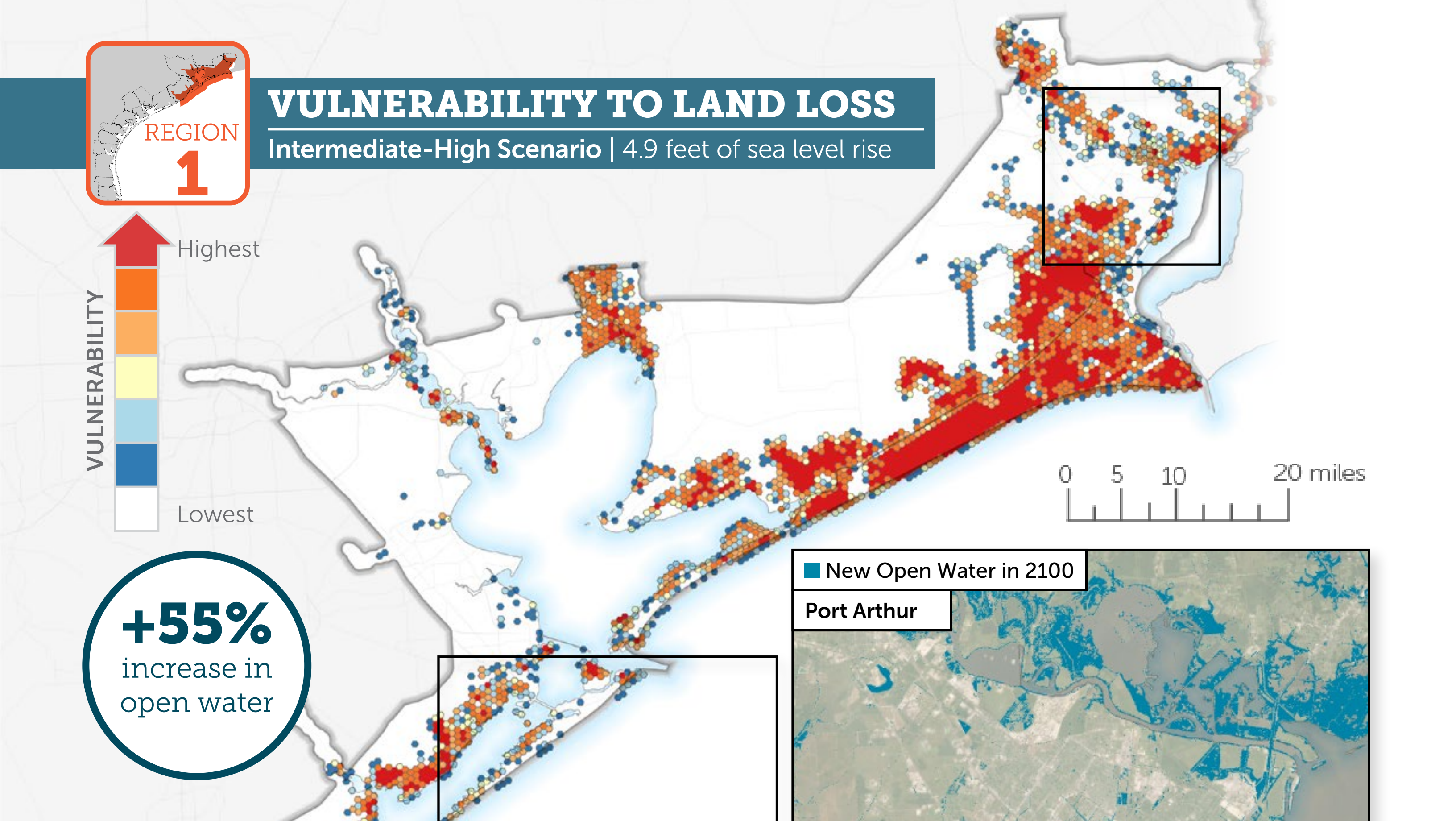




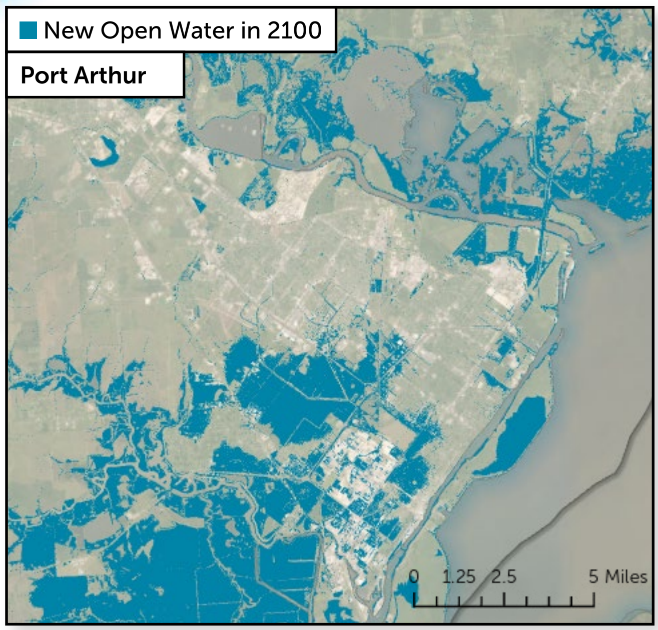
REGION 1

VULNERABILITY TO LAND LOSS

Intermediate-High Scenario | 4.9 feet of sea level rise



+55% increase in open water

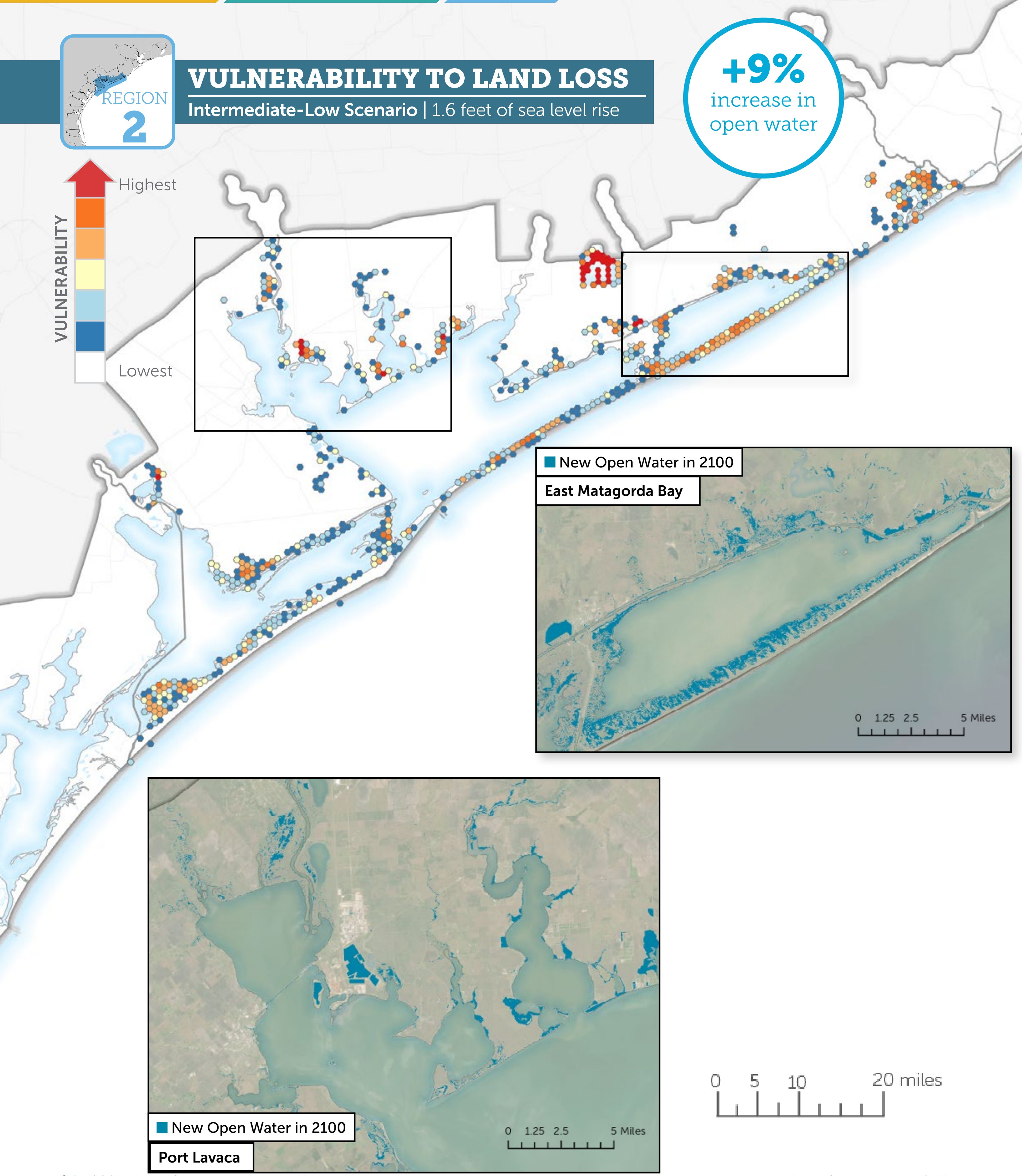


REGION 2

VULNERABILITY TO LAND LOSS

Intermediate-Low Scenario | 1.6 feet of sea level rise

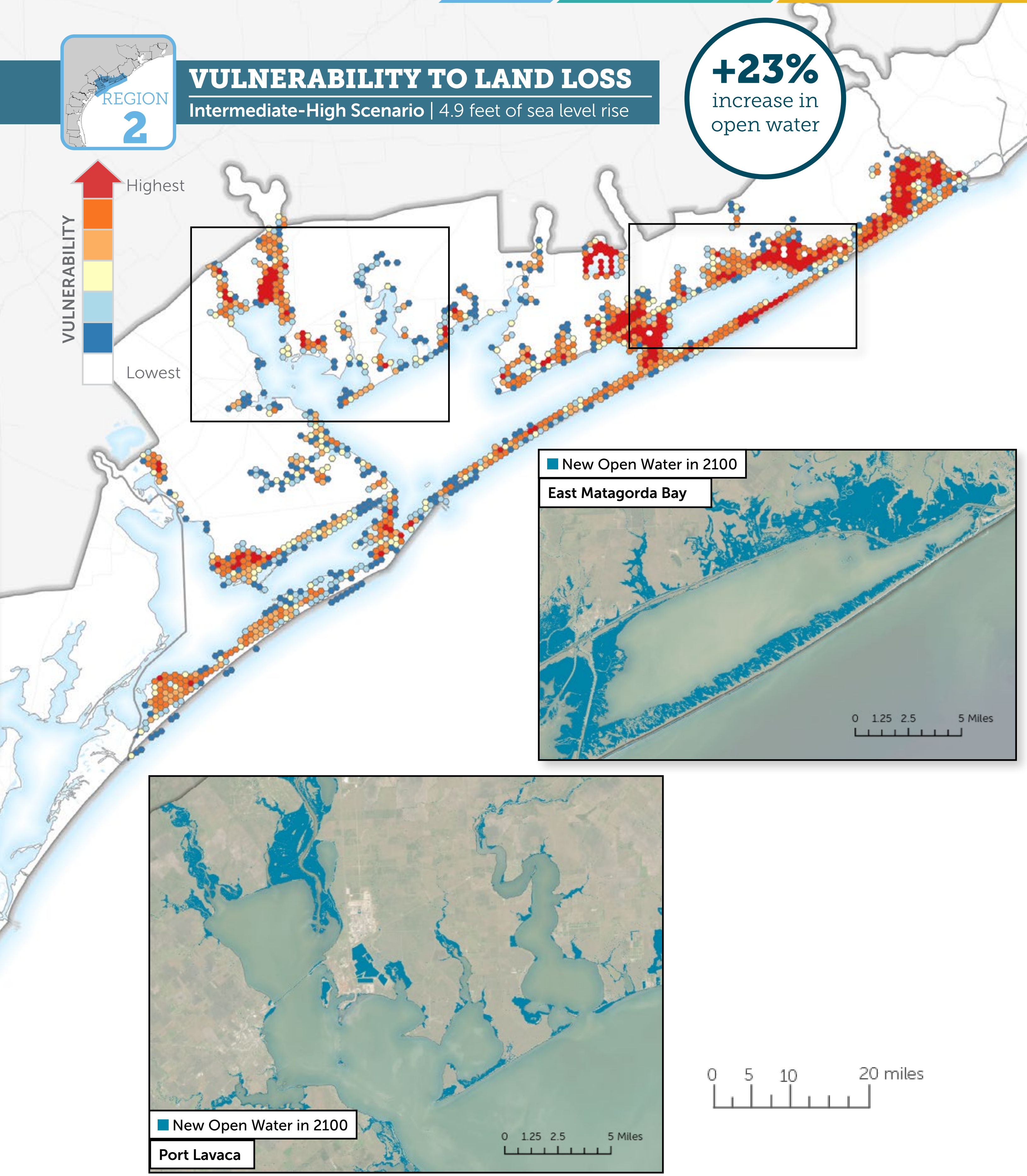
+9% increase in open water



VULNERABILITY TO LAND LOSS

Intermediate-High Scenario | 4.9 feet of sea level rise

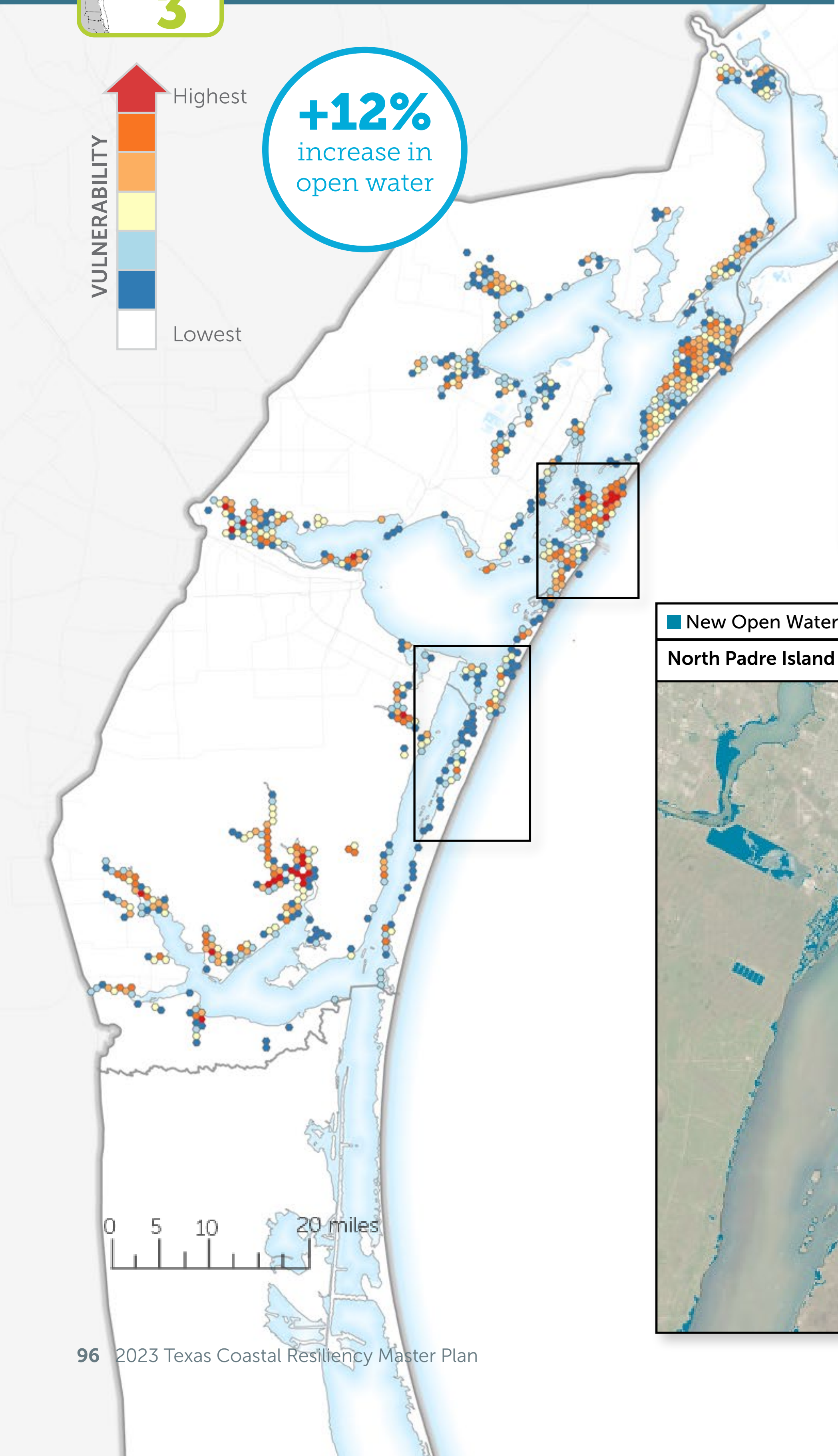
+23% increase in open water

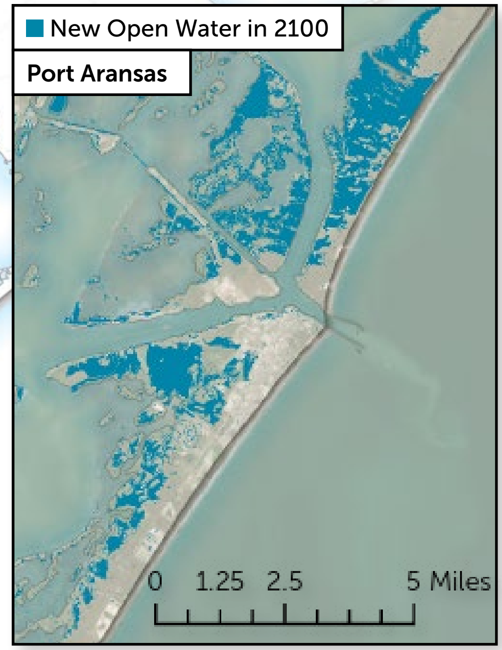


REGION 3

VULNERABILITY TO LAND LOSS

Intermediate-Low Scenario | 1.6 feet of sea level rise

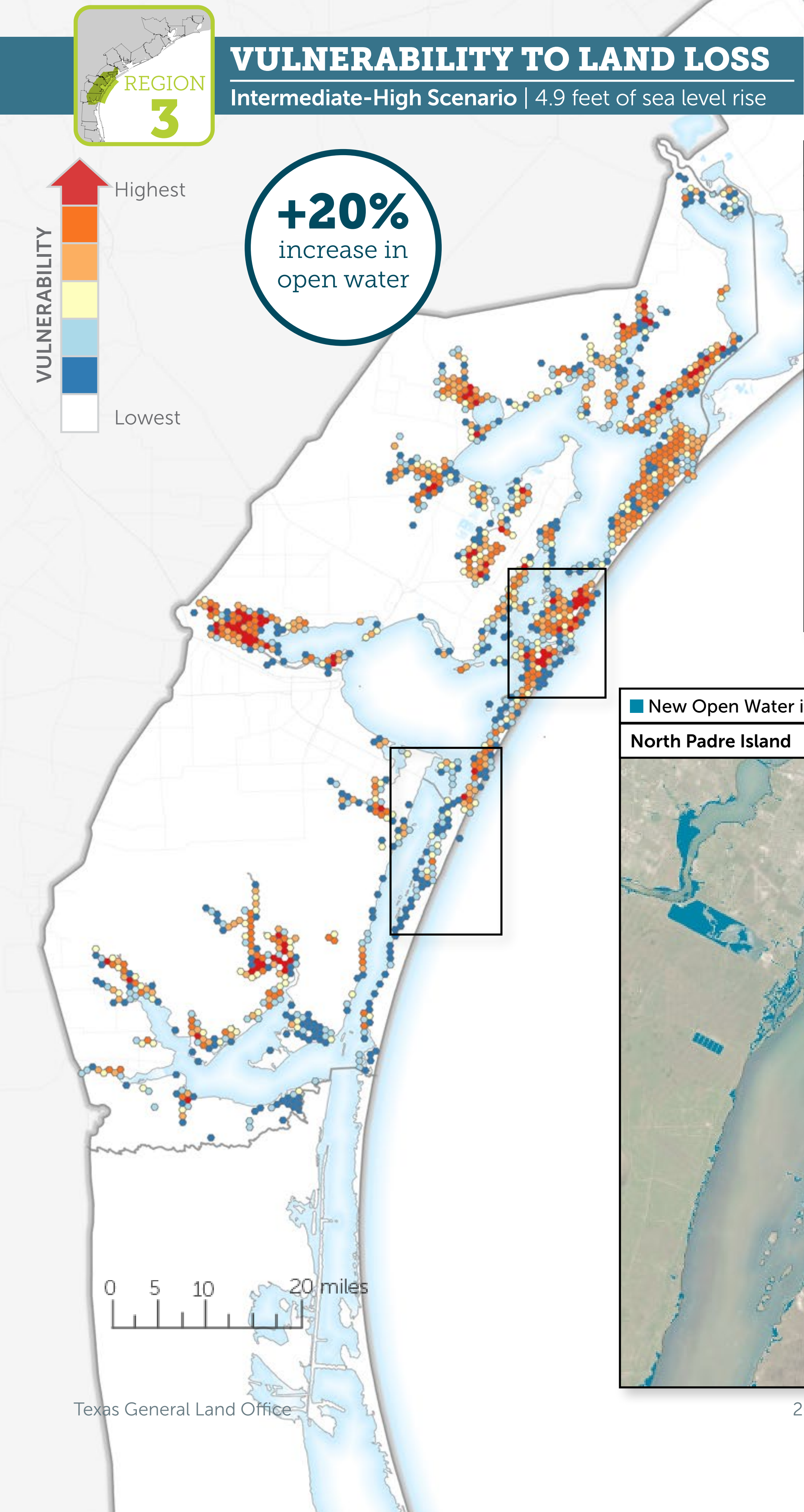




VULNERABILITY TO LAND LOSS

Intermediate-High Scenario | 4.9 feet of sea level rise

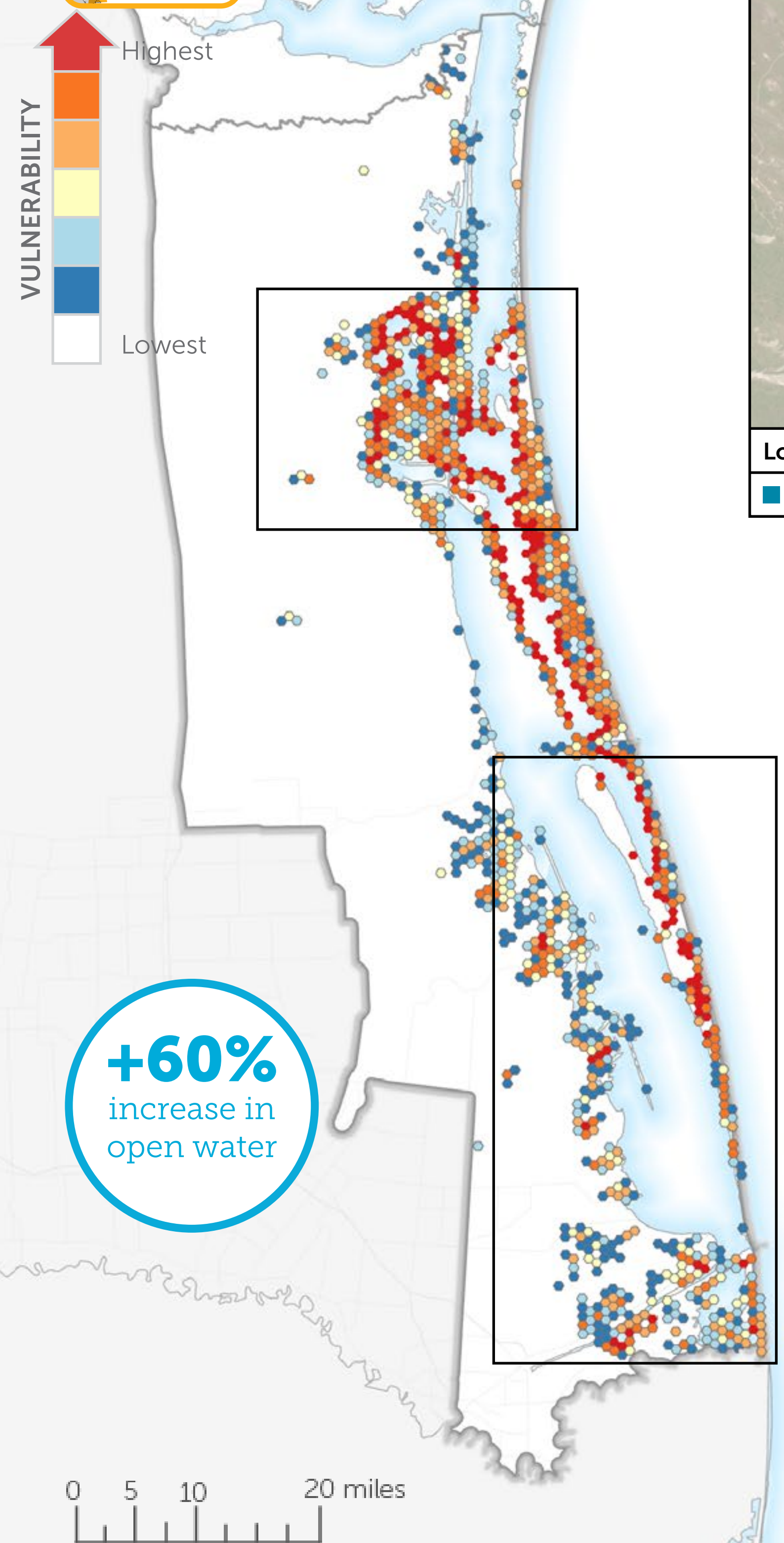
+20% increase in open water

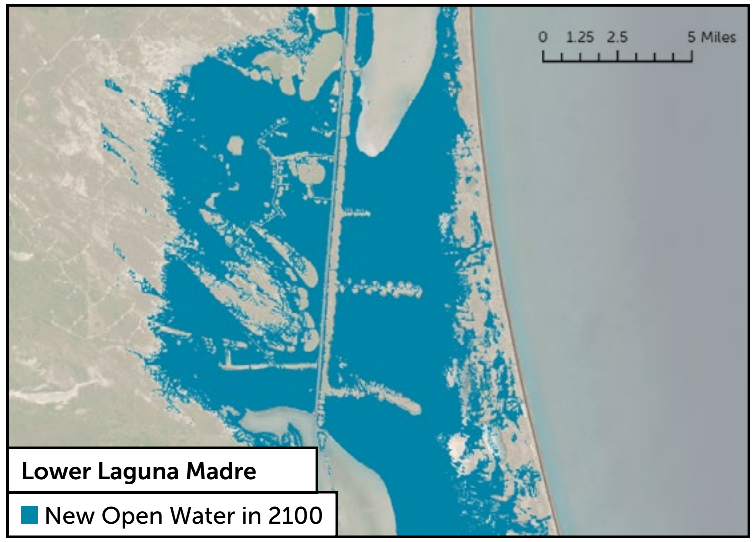


REGION 4

VULNERABILITY TO LAND LOSS

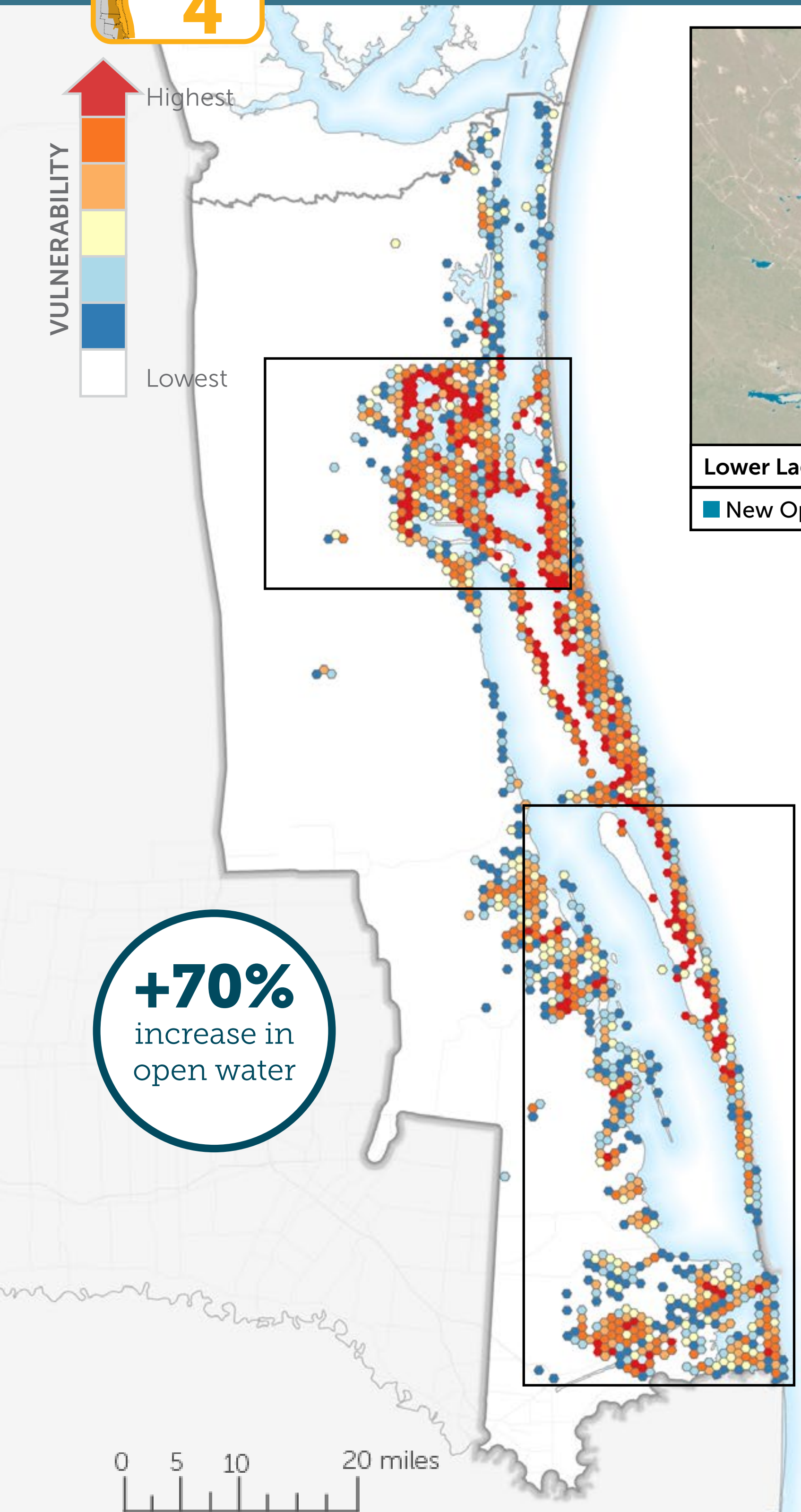
Intermediate-Low Scenario | 1.6 feet of sea level rise

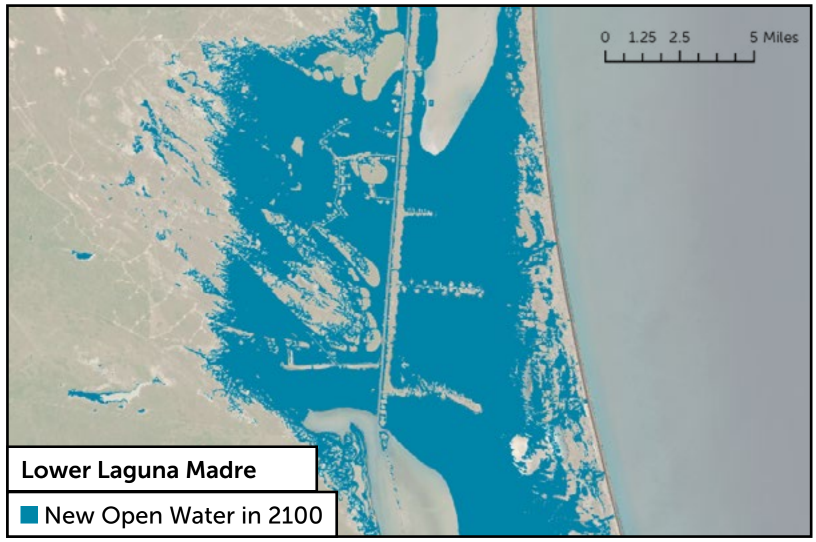




VULNERABILITY TO LAND LOSS

Intermediate-High Scenario | 4.9 feet of sea level rise





Deep Dive: Storm Surge Vulnerability Mapping

These maps show the spatial coverage of potential storm surge flooding vulnerability by considering all modeled storms in the present and future landscape scenarios. The highest vulnerability (value 1) in these maps shows an area inundated in all storm scenarios, and the lowest vulnerability (value 0) shows an area not being inundated due to the storm surge in any scenario.

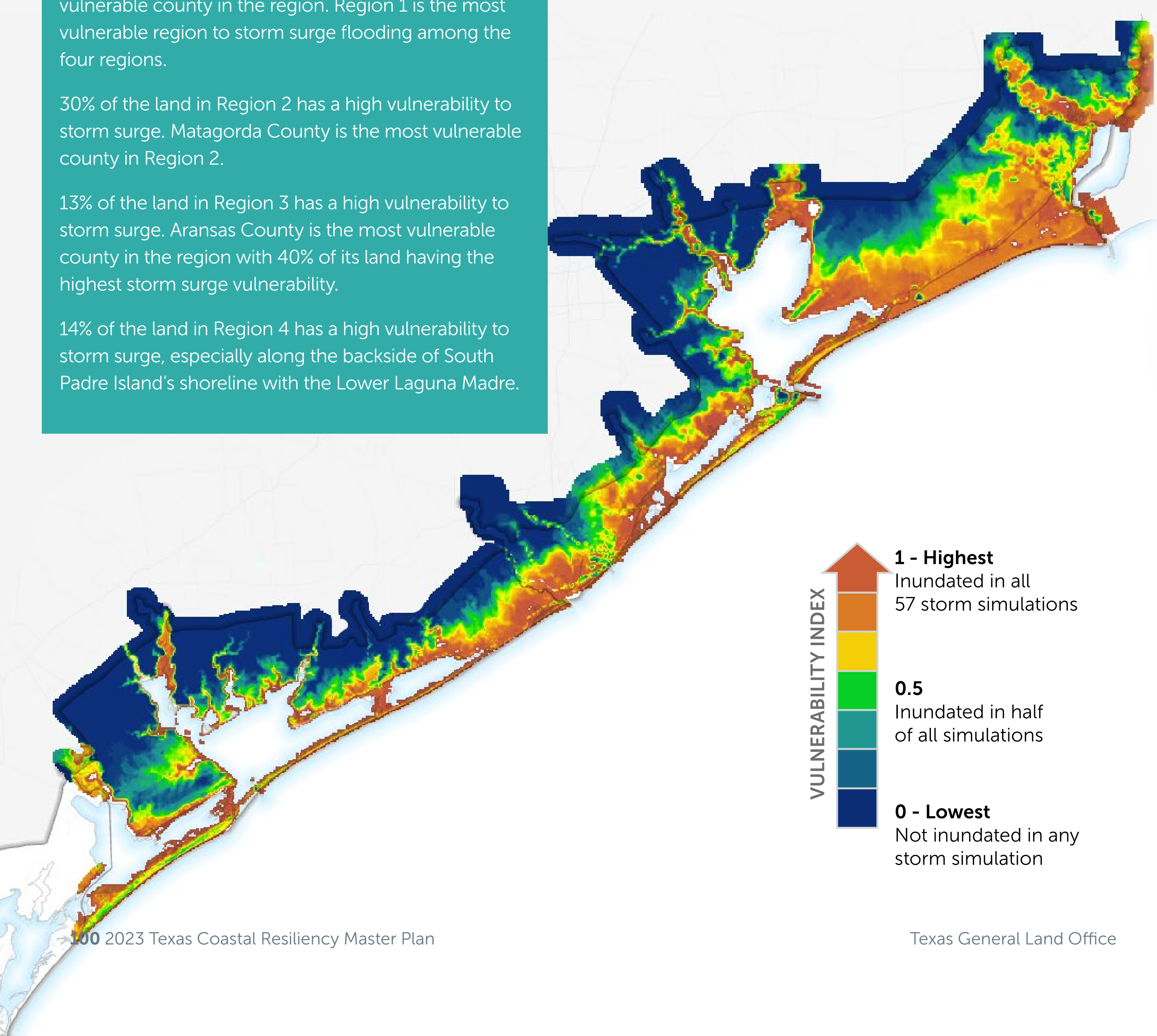
The maps show that 49% of the land in Region 1 has a high vulnerability with Jefferson County as the most vulnerable county in the region. Region 1 is the most vulnerable region to storm surge flooding among the four regions.

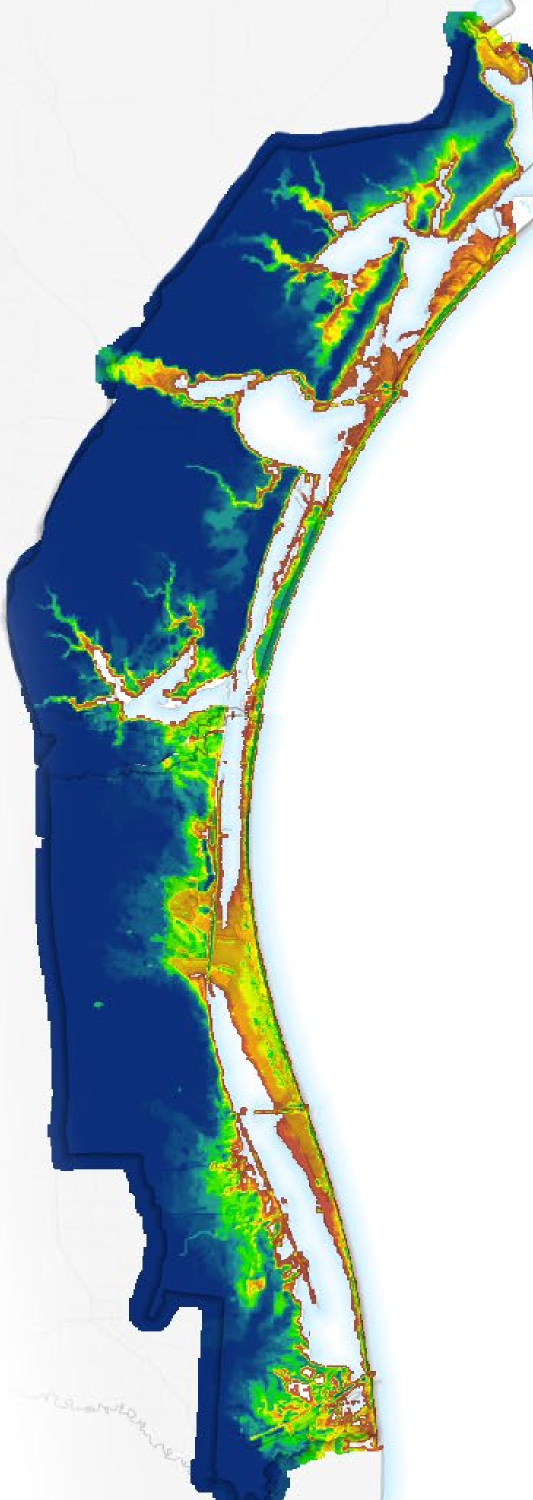
30% of the land in Region 2 has a high vulnerability to storm surge. Matagorda County is the most vulnerable county in Region 2.

13% of the land in Region 3 has a high vulnerability to storm surge. Aransas County is the most vulnerable county in the region with 40% of its land having the highest storm surge vulnerability.

14% of the land in Region 4 has a high vulnerability to storm surge, especially along the backside of South Padre Island's shoreline with the Lower Laguna Madre.

Storm surge and wave model results show that the higher sea level and landscape changes allow water to perpetuate further inland and expose new areas to inundation in the future, and significantly increase the time of inundation along the barrier islands as well as inland regions.





4.4. Storm Surge and Wave Modeling

The Texas coast is vulnerable to the destructive effects of tropical storms and hurricanes, which can take human lives, flood homes and businesses, and damage coastal ecosystems. For example, Hurricane Harvey, a Category 4 storm that made landfall near Rockport in 2017, caused storm surge damages near landfall that also caused catastrophic rainfall-driven flooding in Region 1 and resulted in over 100 deaths, displaced nearly 39,000 people, and caused $148.8 billion in damages (when adjusted for 2022 costs).

In recent decades, extreme weather events such as floods and high tides have been occurring more frequently and with greater intensity. The damages from hurricanes and tropical storms are expected to become more severe in the coming decades due to factors such as higher sea levels, land subsidence, erosion, wetland loss, development in low-lying areas, higher tide events, and higher storm surge.

To plan and adapt to these anticipated worsening conditions, nineteen hypothetical storms were simulated using a coupled hydrodynamic storm surge and wave model (ADCIRC and SWAN models).[154] These storms were simulated on the current landscape, as well as on the two future landscapes with higher sea levels (the previously referenced two modeled scenarios), resulting in a total of fifty-seven storm surge model simulations. These storms range in intensity from Category 1 to 3 and provide thorough coverage of the storm surge impact along the coast. This is an improvement compared to the 2019 Plan, which modeled only six Category 2 storms. These additional and more varied storm scenarios provide a better understanding of the relative vulnerability of the Texas coastal zone resulting from storm surge flooding. To be able to compare outcomes with the 2019 Plan, the six storms modeled from 2019 were also included in this 2023 Plan effort.

The models looked at current conditions to establish baseline and compare to future conditions to predict possible future damages if no action is taken to address sea level rise and wetland loss by the year 2100. The results of the ADCIRC and SWAN models show that the higher sea level and landscape changes allow water to perpetuate further inland and expose new areas to inundation in the future, and significantly increase the time of inundation along the barrier islands as well as inland regions. Results of the storm surge modeling can be seen on the following pages for one Category 2 storm in each region. Full results of the modeled storms can be found in the 2023 Technical Report.

REGION 1

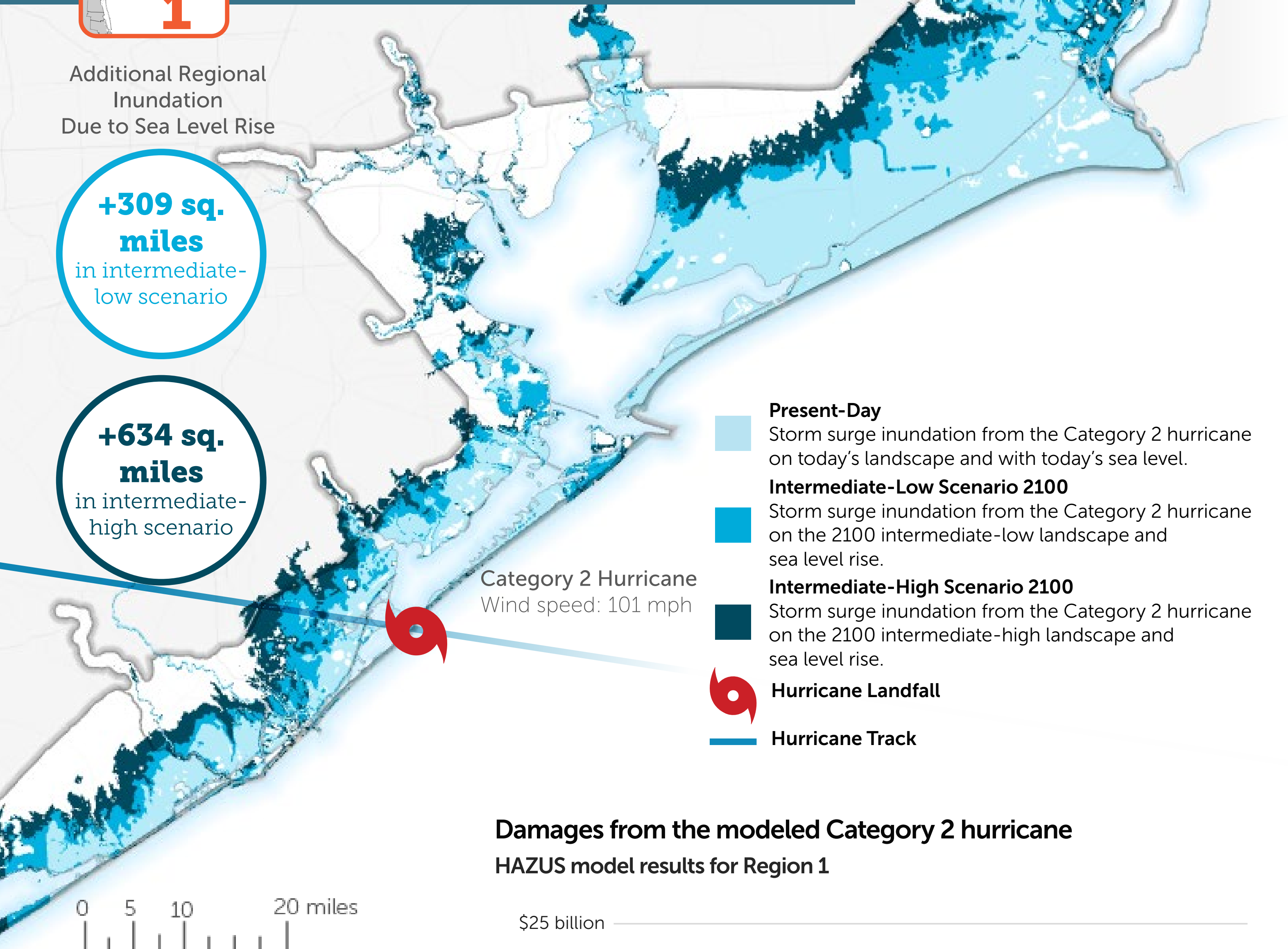
STORM SURGE AND IMPACTS

Extent of inundation and economic damages

Additional Regional Inundation Due to Sea Level Rise

+309 sq. miles in intermediate-low scenario

+634 sq. miles in intermediate-high scenario



Present-Day
Storm surge inundation from the Category 2 hurricane on today's landscape and with today's sea level.

Intermediate-Low Scenario 2100
Storm surge inundation from the Category 2 hurricane on the 2100 intermediate-low landscape and sea level rise.

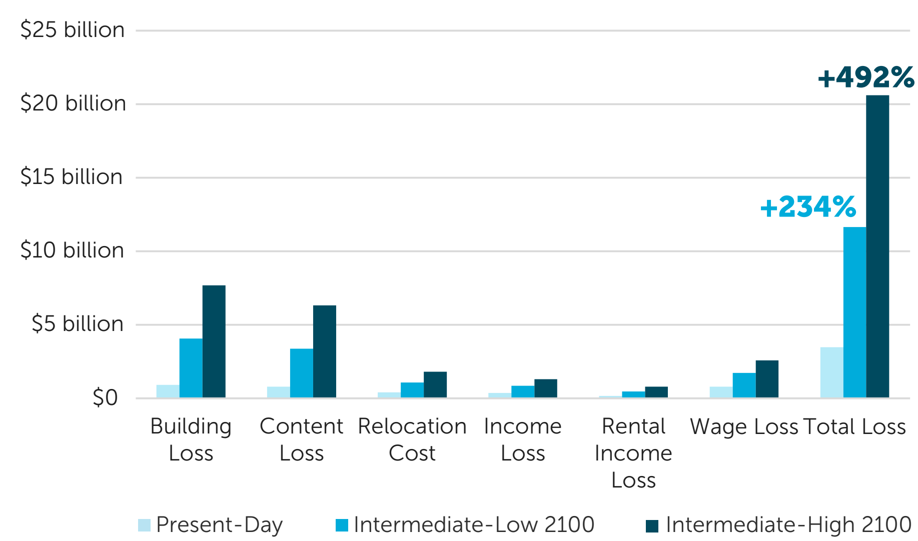
Intermediate-High Scenario 2100
Storm surge inundation from the Category 2 hurricane on the 2100 intermediate-high landscape and sea level rise.

Hurricane Landfall

Hurricane Track

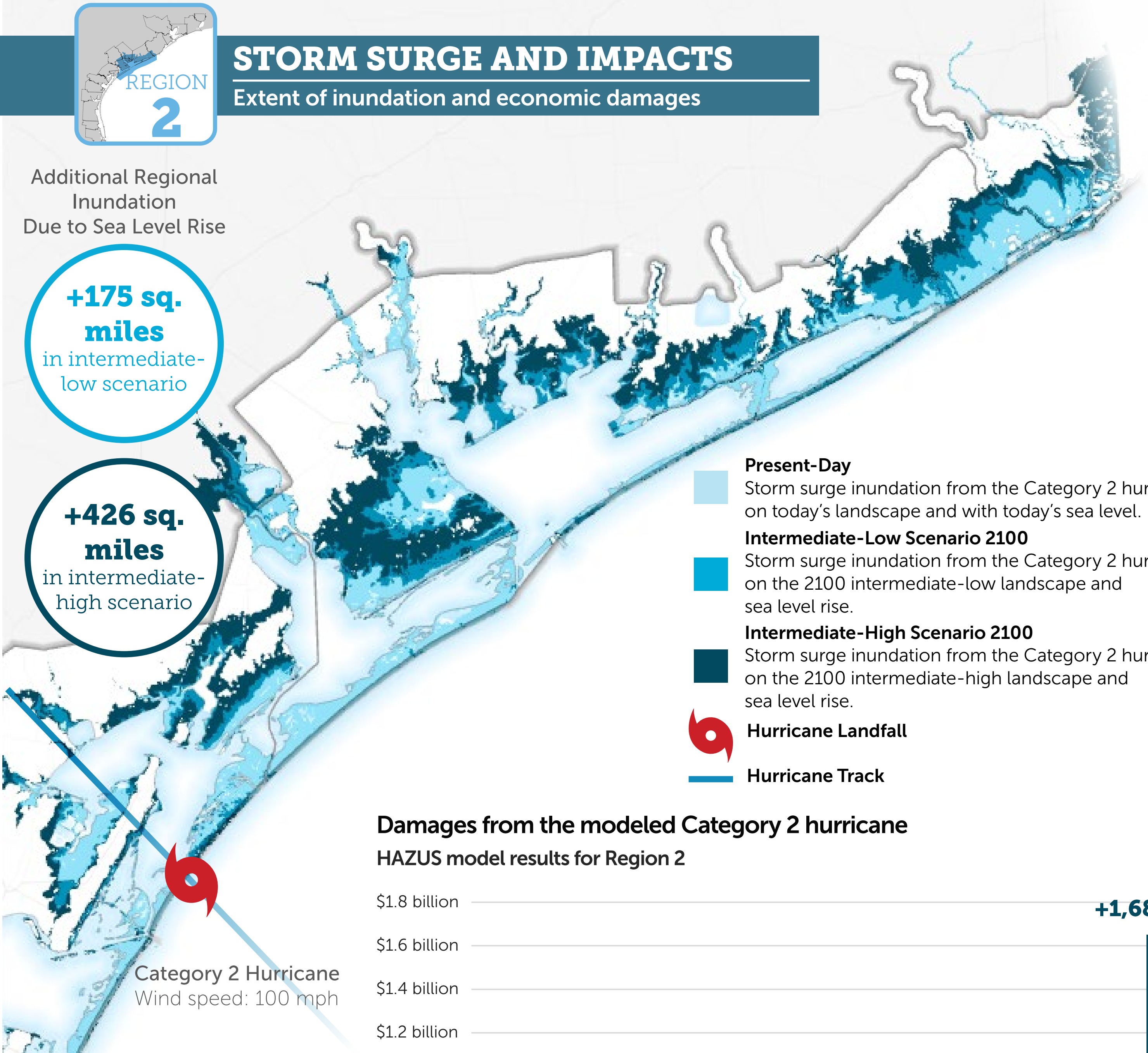
Damages from the modeled Category 2 hurricane

HAZUS model results for Region 1



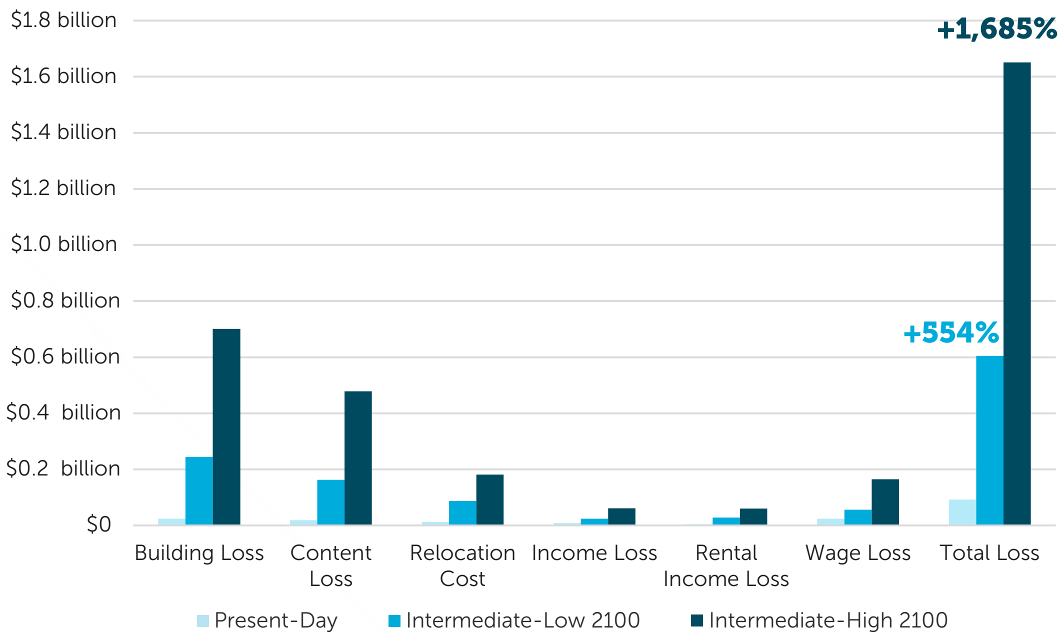
STORM SURGE AND IMPACTS

Extent of inundation and economic damages



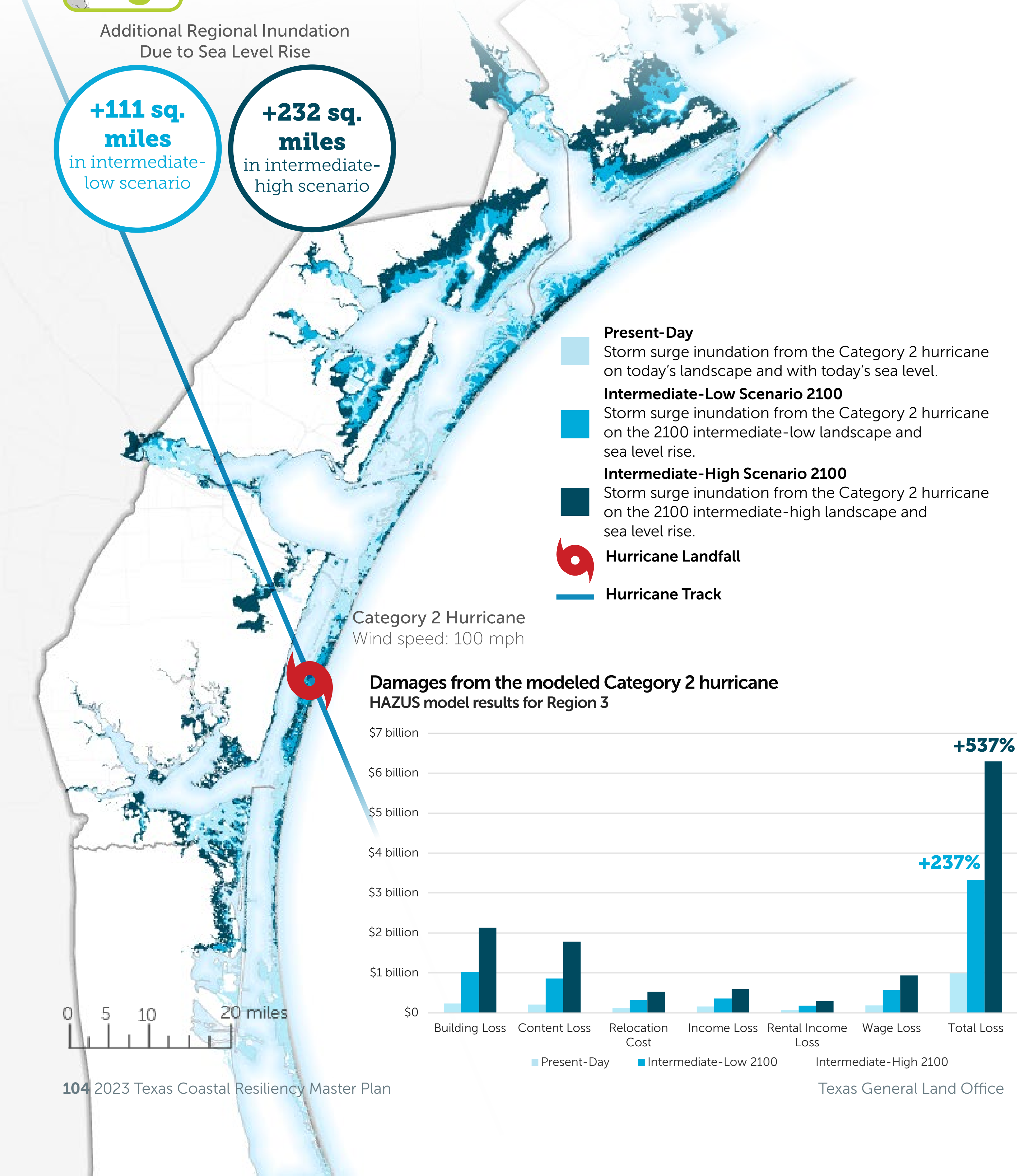
Damages from the modeled Category 2 hurricane

HAZUS model results for Region 2



STORM SURGE AND IMPACTS

Extent of inundation and economic damages



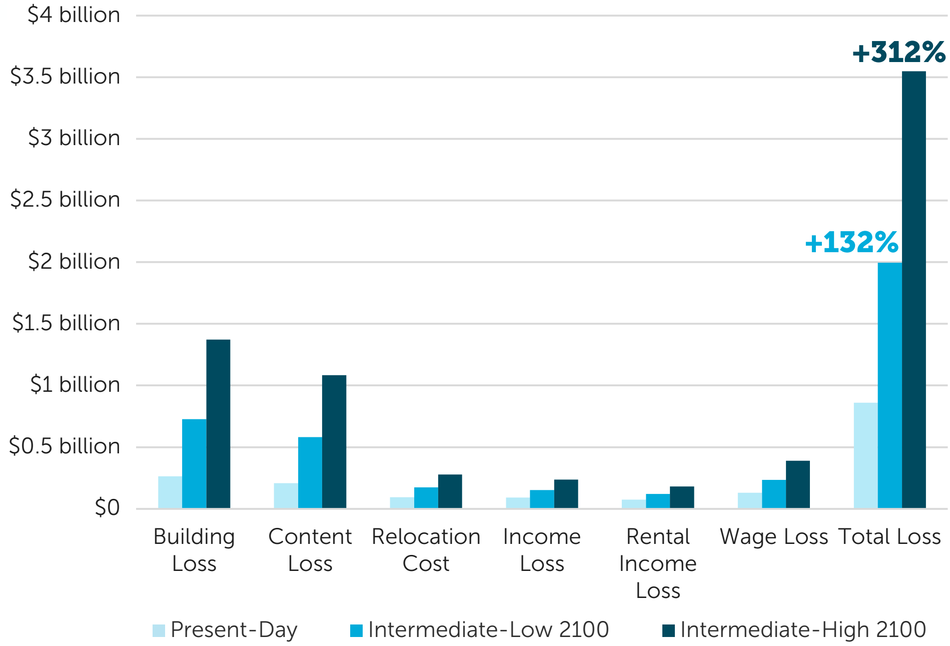
REGION 4

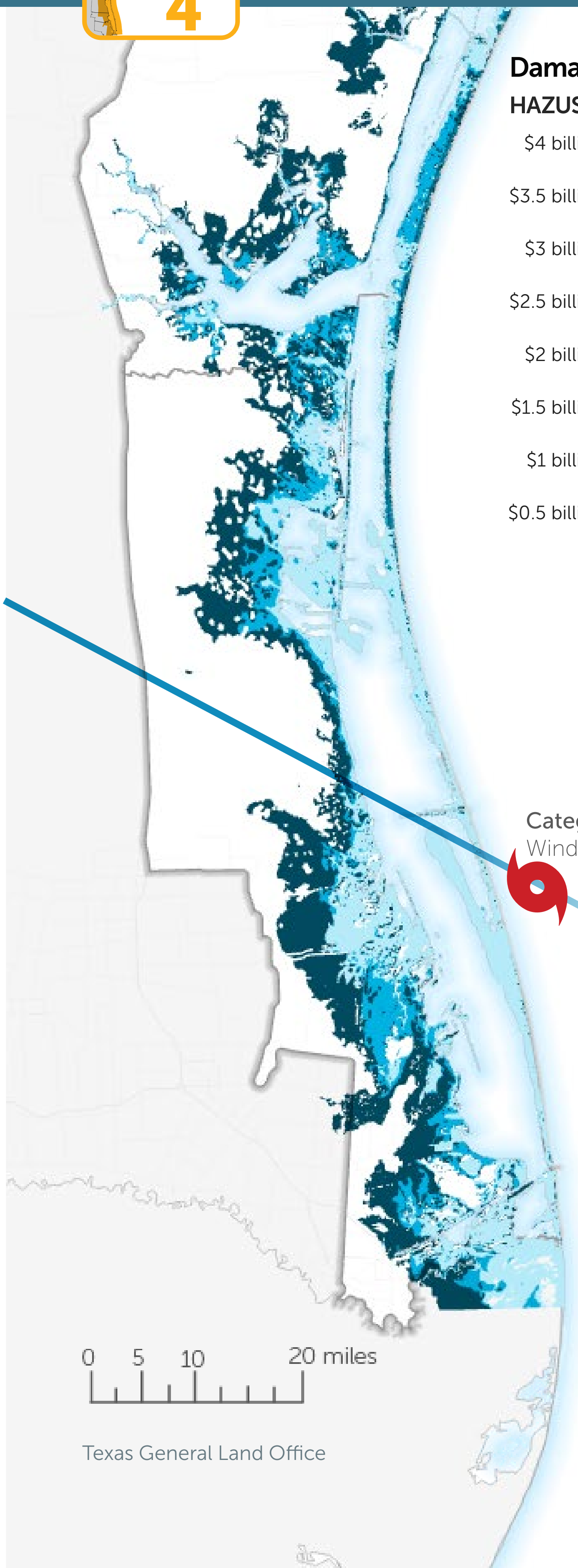
STORM SURGE AND IMPACTS

Extent of inundation and economic damages

Damages from the modeled Category 2 hurricane

HAZUS model results for Region 4





Category 2 Hurricane
Wind speed: 100 mph

Additional Regional Inundation Due to Sea Level Rise

+132 sq. miles in intermediate-low scenario

+462 sq. miles in intermediate-high scenario

Present-Day
Storm surge inundation from the Category 2 hurricane on today's landscape and with today's sea level.

Intermediate-Low Scenario 2100
Storm surge inundation from the Category 2 hurricane on the 2100 intermediate-low landscape and sea level rise.

Intermediate-High Scenario 2100
Storm surge inundation from the Category 2 hurricane on the 2100 intermediate-high landscape and sea level rise.

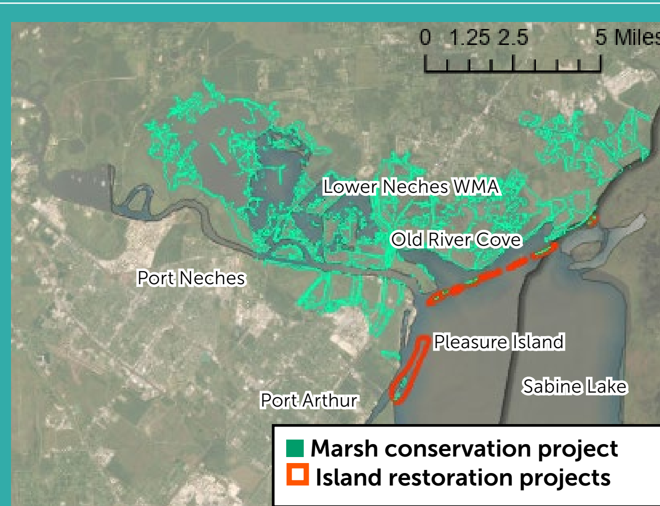
Hurricane Landfall

Hurricane Track

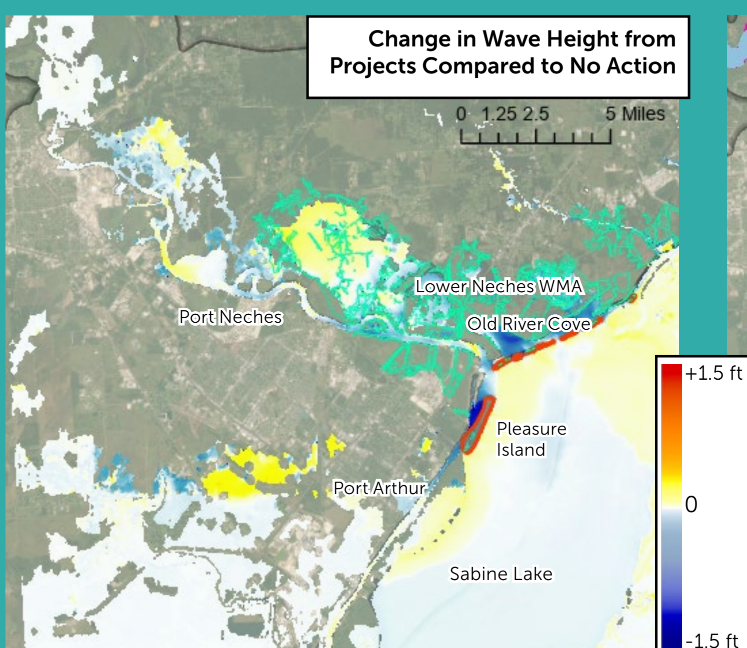
Deep Dive: Sabine Lake With-Project Modeling

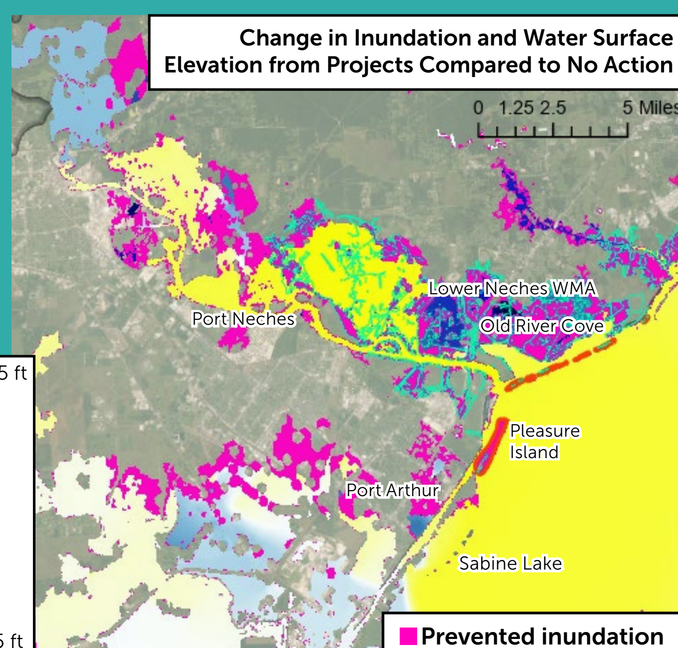
The Sabine Lake area was identified by the TAC as being especially vulnerable to coastal storms and inland flooding. Landscape change and storm surge model results also indicate that this low-lying coastal area is particularly prone to coastal hazards and conversion of land to open water. The projects modeled around Sabine Lake were therefore primarily focused on preserving wetland habitats, reducing wave energy, and reducing the depth and extent of storm surge flooding. The projects modeled here consist of restoring the islands near Old River Cove and Pleasure Island to provide protection from wave energy and storm surge. Additionally, the elevation of the wetlands surrounding Sabine Lake were boosted in the landscape change model by 0.8 feet every 25 years, an amount calculated that allows them to keep pace with the intermediate-low SLR scenario.

A Category 2 hurricane was selected to investigate the impact of storm surge with and without resiliency projects in the future landscape under the intermediate-low SLR scenario. The selected storm makes landfall on the eastward end of the Bolivar Peninsula near Rollover Pass as a Category 2 hurricane with a forward speed of 10 mph and a maximum wind speed of 100 mph. The modeling results show that the selected conceptual large-scale resiliency projects help to reduce the water depth as well as the extent of storm surge inundation.



These projects act like buffers suppressing wave energy in turn reducing storm surge impact even outside the project area. More than 38 sq. miles of land in Orange and Jefferson counties did not get inundated with these resiliency projects in place. The outcome of this analysis demonstrates that a combination of multiple resiliency projects forming a multiple lines of defense approach can help reduce wave energy thus reducing storm surge impact in the vicinity of those projects. The cool colors in the maps below show an area with reduced wave height or water levels due to the presence of projects and the purple color shows the area that is prevented from becoming inundated with the projects in place.





4.4.1. Storm Surge Vulnerability Mapping

To better understand the relative vulnerability to storm surge from the full variety of modeled storms, a storm surge vulnerability map was created by analyzing the simulated inundation caused by the nineteen different storms. The simulations determine the maximum storm surge elevation at each point in the model's domain, providing insight into the maximum flooding pattern during a storm event. A storm surge vulnerability index, ranging from 0 to 1, was calculated using the maximum storm surge elevation from all fifty-seven storm scenarios. This results in a storm surge vulnerability index map, where 1 represents an area that is inundated in all fifty-seven scenarios, and 0 represents an area that is not inundated in any scenario. For example, an index value of 0.5 means an area is inundated by half of the total storm scenarios considered. The vulnerability index map illustrates the spatial coverage of potential storm surge flooding vulnerability along the coast, and serves as a baseline for improving the resilience of the community in the present and future.

More about the uses of the storm surge vulnerability maps can be found in Section 4.5 detailing how the Geohazards maps were created.

Bolivar Peninsula after Hurricane Ike (Photo Credit: USACE Galveston District)

4.4.2. Project Modeling

The GLO ran simulations of a select number of storms on future landscapes with ("with-project") and without ("no action") certain conceptual coastal resiliency projects, to determine the potential benefits of these projects on storm damage. The modeled projects include island restoration, breakwaters and living shorelines, as well as habitat restoration and conservation projects. These project types were chosen because they could be representative of large-scale sediment planning proposed by many of the 2023 Tier 1 projects, but they are not intended to directly represent the Tier 1 projects in this 2023 Plan.

The GLO ran simulations of storms on two bay environments, Sabine Lake and Corpus Christi Bay, to determine the potential benefits of various projects on storm damage in the intermediate-low SLR scenario. These two regions were chosen because they have different risk profiles and represent different vulnerability realities. The TAC identified Region 1 as being especially vulnerable to coastal storms and inland flooding, and so the projects modeled around Sabine Lake were primarily focused on reducing wave energy and the extent of storm surge penetration. Meanwhile, the top vulnerabilities in Region 3 were identified as habitat loss and bay shoreline erosion, and so the projects modeled around Corpus Christi Bay were mainly focused on conserving habitat and stabilizing shorelines.

The modeling revealed that beneficial use of dredged material (BUDM) can be an effective way to address the impacts of SLR on habitats. Additionally, implementing living shorelines and restoring islands can help to reduce the effects of storm surge and wave damage in the immediate area. The modeling results indicate that large-scale resiliency projects can decrease water depth and storm surge inundation by acting as buffers, suppressing wave energy, and reducing storm surge impact beyond the project area. The results of this analysis suggest that a combination of multiple resiliency projects can effectively reduce wave energy and minimize storm surge impact in the vicinity of those projects. However, there are challenges in coordination of funding, dredge cycles, and interagency participation to make these kinds of large-scale projects a reality. More detail about the "with-project" modeling can be found in the 2023 Technical Report.

The results of the Hazus model indicate that the combined impact of sea level rise, wetland loss, and expanded development will increase the number of buildings at risk and magnify the negative effects of future coastal storms on human health and safety, as well as the state and national economies.

The Geohazards maps represent the present and future state of the coastal plain, highlighting areas that are most susceptible to hazards. In the intermediate-high sea level rise scenario, there is significantly more land in the higher geohazards potential zones exposing critical environments and communities. The maps show that the upper coast is more prone to the effects of coastal geohazards than the lower coast.

4.4.3. Socio-Economic Impacts of Storm Surge

The GLO used Hazus, a software developed by FEMA, to quantify potential damages due to the modeled storms.[155] Hazus model results were used to analyze the socio-economic impacts of storm surge on people, buildings, and infrastructure in Texas.

The GLO simulated one storm for one metropolitan area in each of the four planning regions on the Texas coast for three different sea level conditions: present day, 2100 in the intermediate-low scenario, and 2100 in the intermediate-high scenario. Maps on pages 104-107 show the inland extent of flooding for the same storm under each of these conditions from the storm surge and wave models described in Section 4.4.1. Accompanying these maps are graphs displaying the economic losses due to the storm under each of these conditions.

The results show a considerable increase in damaged buildings between current conditions and 2100 "no action" conditions. The impact of a Category 2 hurricane on buildings is significant, with an average increase of nearly 515% in the number of damaged structures under the intermediate-low SLR scenario. This number jumps to a staggering 1,287% under the intermediate-high SLR scenario. Furthermore, the economic losses associated with these storms also rise dramatically to 3 times higher than current conditions in the intermediate-low SLR scenario and 9 times higher in the intermediate-high SLR scenario. This highlights the importance of considering SLR when assessing the potential impact of hurricanes on communities and infrastructure. These estimates would be even greater in the event of a Category 3, 4, or 5 hurricane, since the storms modeled are only Category 2. The results of the model indicate that the combined impact of SLR, wetland loss, and expanded development will increase the number of buildings at risk and magnify the negative effects of future coastal storms on human health and safety, as well as the state and national economies. The "no action" scenario is not viable for Texas and the nation.

4.5. Geohazards Mapping

The geohazards maps are a tool developed for this 2023 Plan that helps identify areas on the Texas coast that are vulnerable to hazards such as SLR, erosion, and storm surge, as well as identifying the future distribution of critical environments. The geohazards maps are essentially a synthesis of all the modeling work done for this Plan in one product, providing detailed representation of the present and future state of the coastal plain, highlighting areas that are most susceptible to hazards, and identifying critical coastal environments to preserve or avoid. Two sets of geohazards maps were developed for the two SLR scenarios and can be found on the following pages.

The maps were created by combining multiple data layers, including topographic data from lidar surveys, land-cover data from the sea level rise model, and storm surge vulnerability data from modeled scenarios. From these data the geohazards maps illustrate the impact of ongoing geological processes on the Texas coastal plain over the next 80 years. It also depicts how critical coastal environments, such as wetlands, dunes, and beaches, may change in response to these hazards. The maps not only show areas that are presently exposed to hazardous conditions that might be generally protected by regulations but also show areas that are not protected and should receive special management consideration. The maps also show the vulnerable infrastructure that will be exposed to hazardous conditions in the future and requires special attention if progress is to be made in how we live with sea level rise. As such, the maps are designed to help planners, decision-makers, and the public understand the challenges and limitations of living on the coastal plain and make informed decisions about land use and policy.

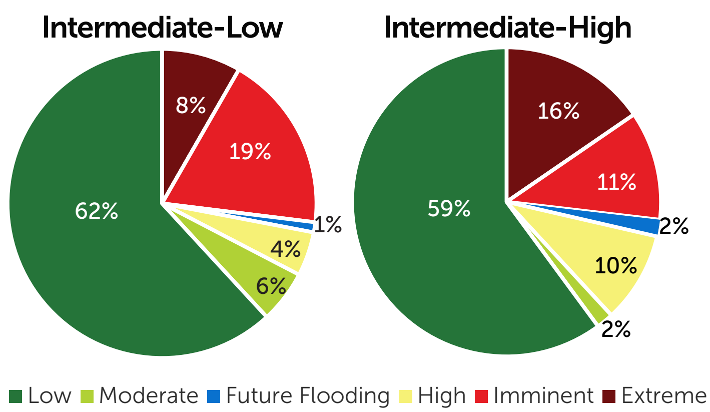
The maps are divided into six categories based on the level of hazard potential: **Extreme, Imminent, Future Flooding, High, Moderate, and Low**.

Extreme areas are currently vulnerable habitats that will be underwater in the future, based on the landscape change modeling results. **Imminent** areas are currently critical environments, such as fresh and saltwater wetlands. **Future Flooding** areas are areas of present development and roads that will flood in the future. **High** areas are presently uplands that will become critical environments in the future. **Moderate** areas are uplands that are prone to storm surge flooding and are neither currently nor expected to become critical environments in the future. The exposure to flooding is sourced from the storm surge vulnerability maps described in Section 4.4.1, where the index value is greater than 0.5, meaning the area is inundated in at least half of all modeled storms. **Low** areas are areas that are less susceptible to hazards as they are inland at higher elevations or an interior location on the island. The susceptibility to flooding is similarly sourced from the storm surge vulnerability maps, where the index value is less than 0.5.

The maps on the following pages highlight some critical areas in each region where special attention is required. In the intermediate-high scenario, there is less area in the Low and Moderate Geohazard Potential zones as they are converting to a higher hazard potential, increasing the area of the Extreme and High classification. There is less area in the Imminent threat in the intermediate-high scenario since many of those present day environments have converted to open water. These observations and maps highlight the magnitude of the situation and can help communities prepare and address the impending transformation of the Texas coastal plain.

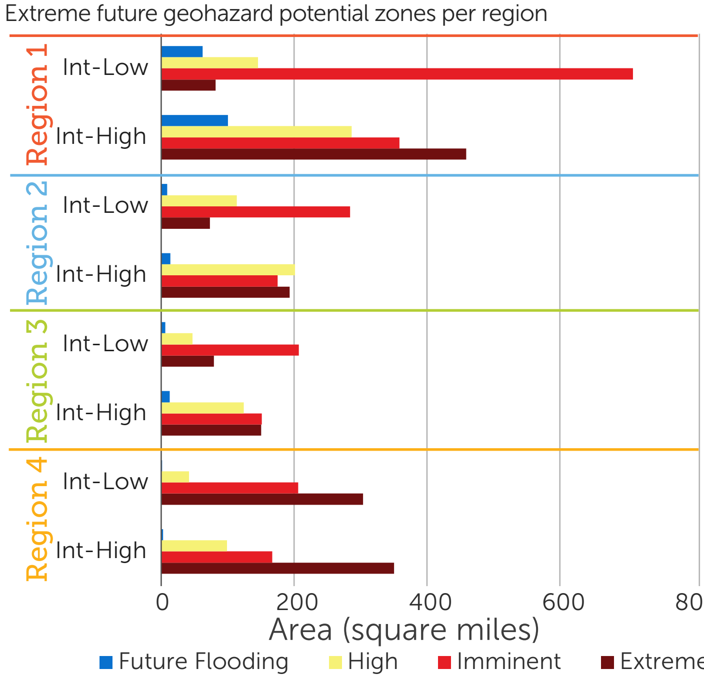
Geohazards Potential of the Texas Coast

The makeup of each Geohazard Potential class on the Texas coast for both sea level rise scenarios



Geohazards Potential by Region

The makeup of the High, Future Flooding, Imminent, and Extreme future geohazard potential zones per region



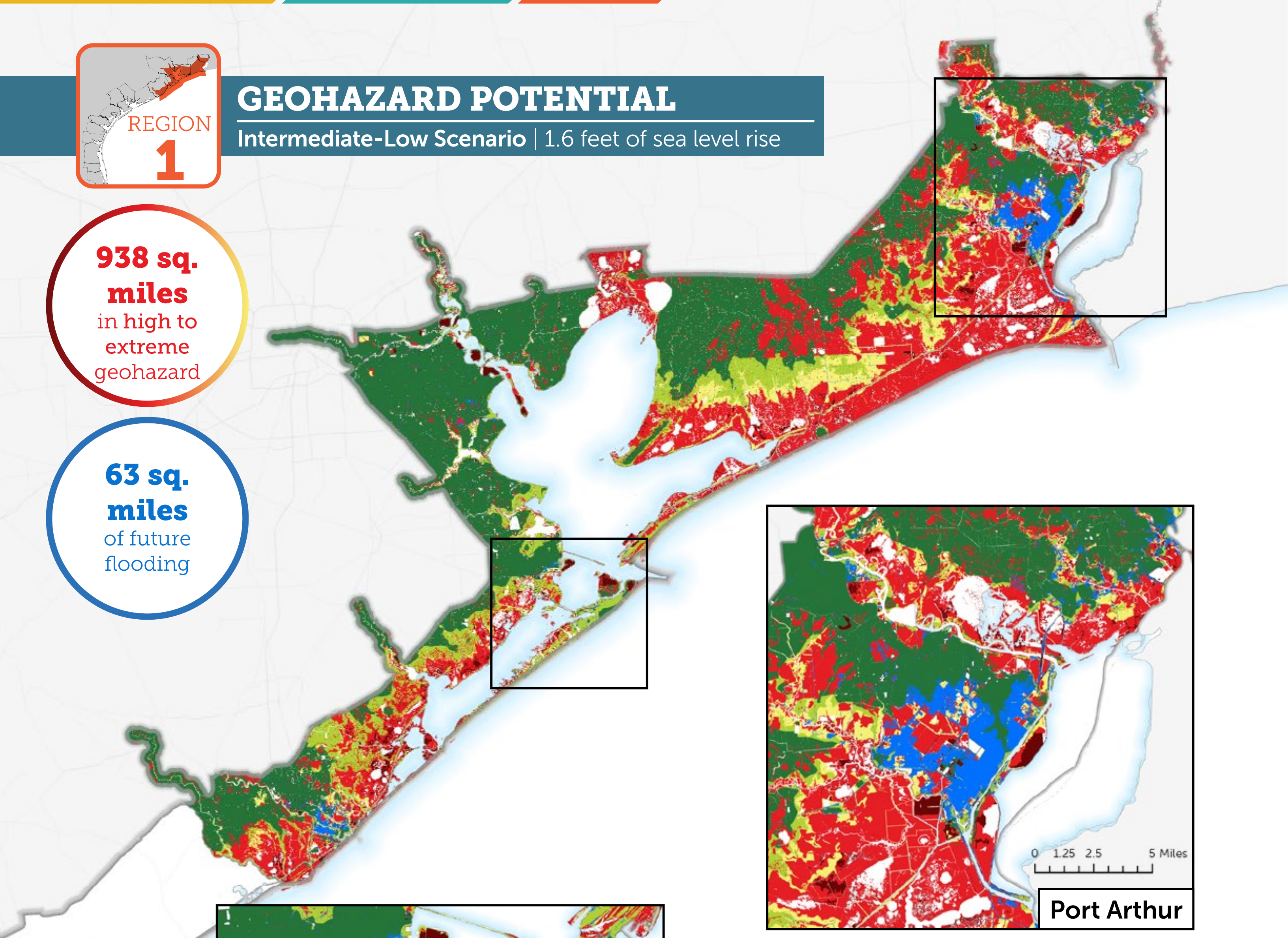
REGION 1

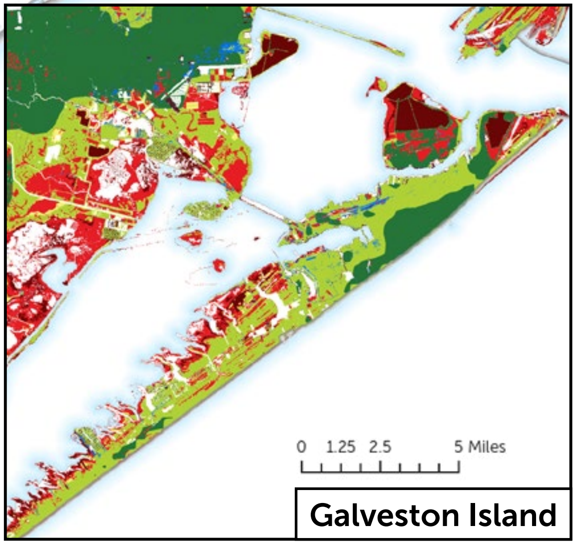
GEOHAZARD POTENTIAL

Intermediate-Low Scenario | 1.6 feet of sea level rise

938 sq. miles in high to extreme geohazard

63 sq. miles of future flooding





0 5 10 20 miles

- **Extreme:** Historic storm washover channels and future open water
- **Imminent:** Present day critical environments (wetlands, dunes, and beaches)
- **Future Flooding:** Present day urban areas and roads expected to flood in 2100
- **High:** Area expected to become future critical environments in 2100
- **Moderate:** Upland areas not expected to become future critical environments and storm surge vulnerability > 0.5
- **Low:** Upland areas not expected to become future critical environments and storm surge vulnerability < 0.5

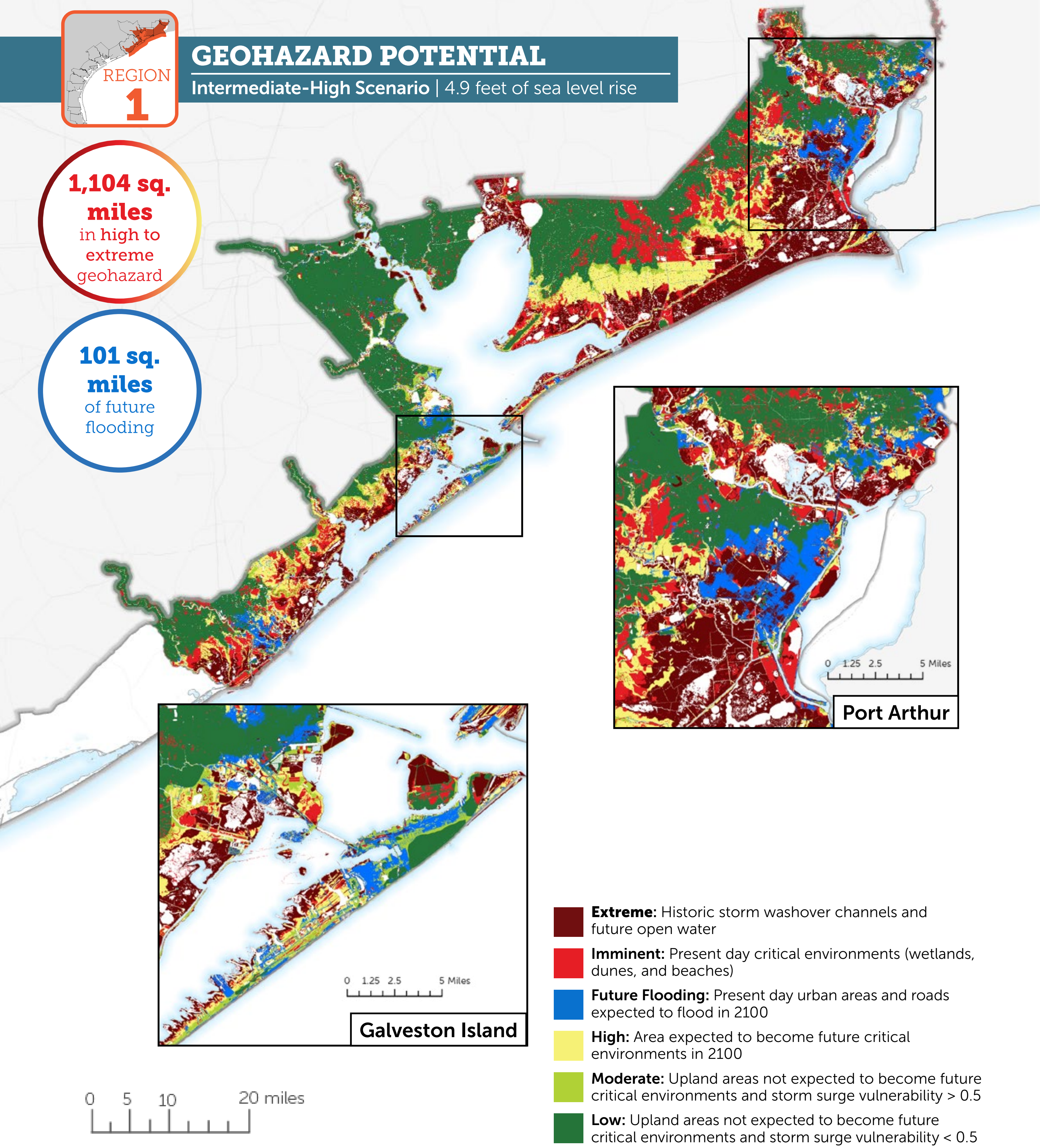
GEOHAZARD POTENTIAL

Intermediate-High Scenario | 4.9 feet of sea level rise

REGION 1

1,104 sq. miles in high to extreme geohazard

101 sq. miles of future flooding



Extreme: Historic storm washover channels and future open water

Imminent: Present day critical environments (wetlands, dunes, and beaches)

Future Flooding: Present day urban areas and roads expected to flood in 2100

High: Area expected to become future critical environments in 2100

Moderate: Upland areas not expected to become future critical environments and storm surge vulnerability > 0.5

Low: Upland areas not expected to become future critical environments and storm surge vulnerability < 0.5

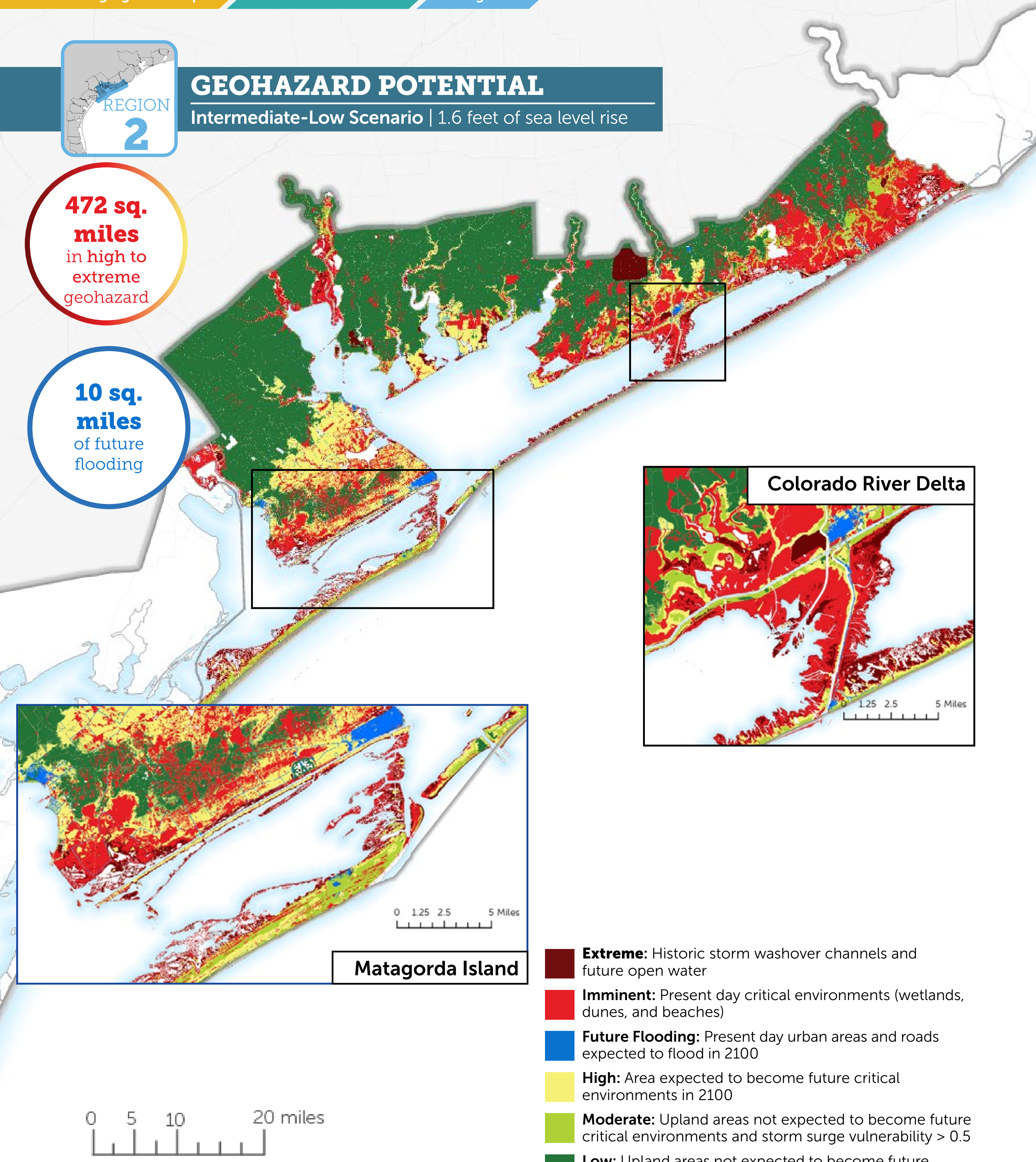
REGION 2

GEOHAZARD POTENTIAL

Intermediate-Low Scenario | 1.6 feet of sea level rise

472 sq. miles in high to extreme geohazard

10 sq. miles of future flooding



- **Extreme:** Historic storm washover channels and future open water
- **Imminent:** Present day critical environments (wetlands, dunes, and beaches)
- **Future Flooding:** Present day urban areas and roads expected to flood in 2100
- **High:** Area expected to become future critical environments in 2100
- **Moderate:** Upland areas not expected to become future critical environments and storm surge vulnerability > 0.5
- **Low:** Upland areas not expected to become future critical environments and storm surge vulnerability < 0.5

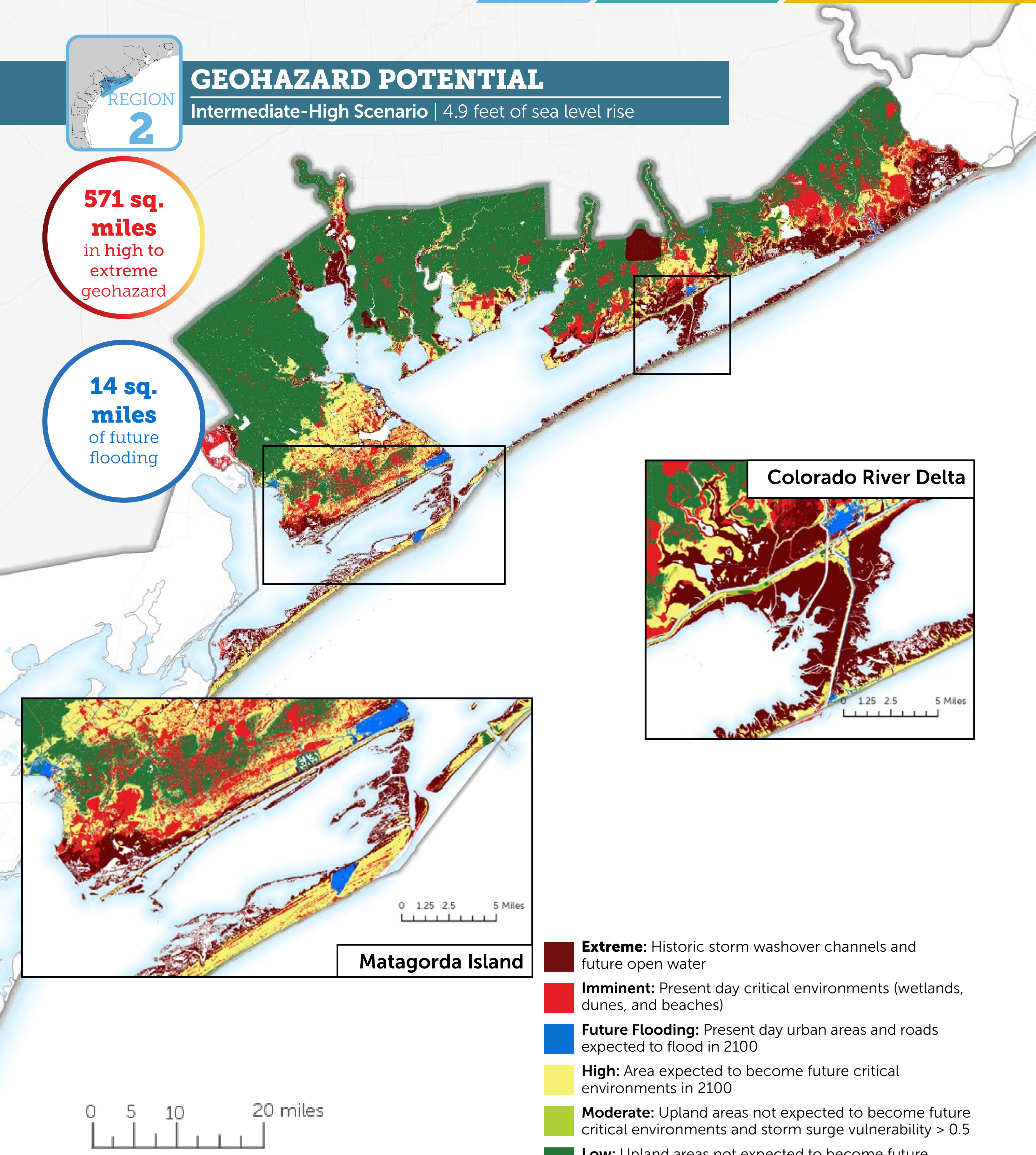
GEOHAZARD POTENTIAL

Intermediate-High Scenario | 4.9 feet of sea level rise

REGION 2

571 sq. miles in high to extreme geohazard

14 sq. miles of future flooding



- **Extreme:** Historic storm washover channels and future open water
- **Imminent:** Present day critical environments (wetlands, dunes, and beaches)
- **Future Flooding:** Present day urban areas and roads expected to flood in 2100
- **High:** Area expected to become future critical environments in 2100
- **Moderate:** Upland areas not expected to become future critical environments and storm surge vulnerability > 0.5
- **Low:** Upland areas not expected to become future critical environments and storm surge vulnerability < 0.5

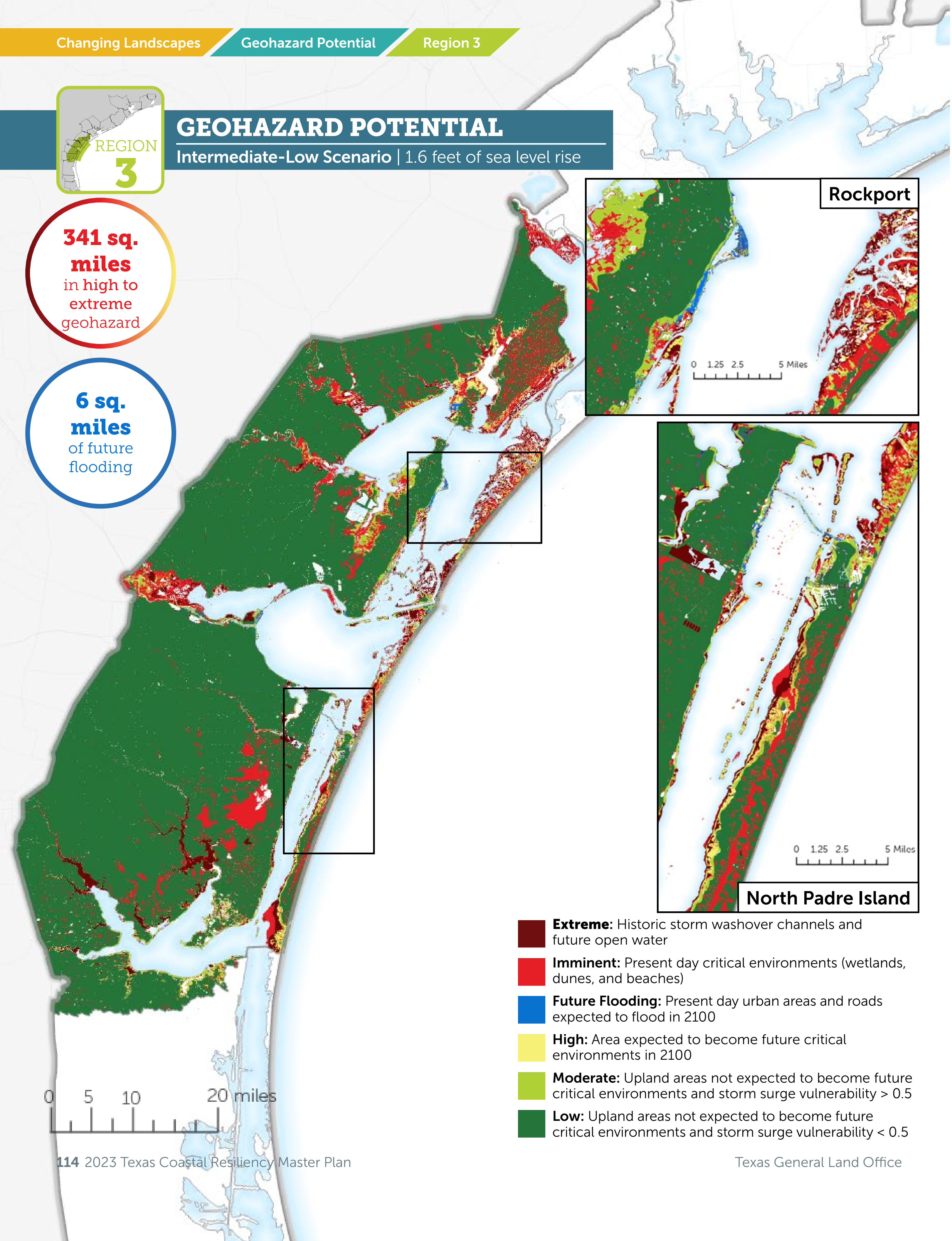
REGION 3

GEOHAZARD POTENTIAL

Intermediate-Low Scenario | 1.6 feet of sea level rise

341 sq. miles in high to extreme geohazard

6 sq. miles of future flooding



Extreme: Historic storm washover channels and future open water

Imminent: Present day critical environments (wetlands, dunes, and beaches)

Future Flooding: Present day urban areas and roads expected to flood in 2100

High: Area expected to become future critical environments in 2100

Moderate: Upland areas not expected to become future critical environments and storm surge vulnerability > 0.5

Low: Upland areas not expected to become future critical environments and storm surge vulnerability < 0.5

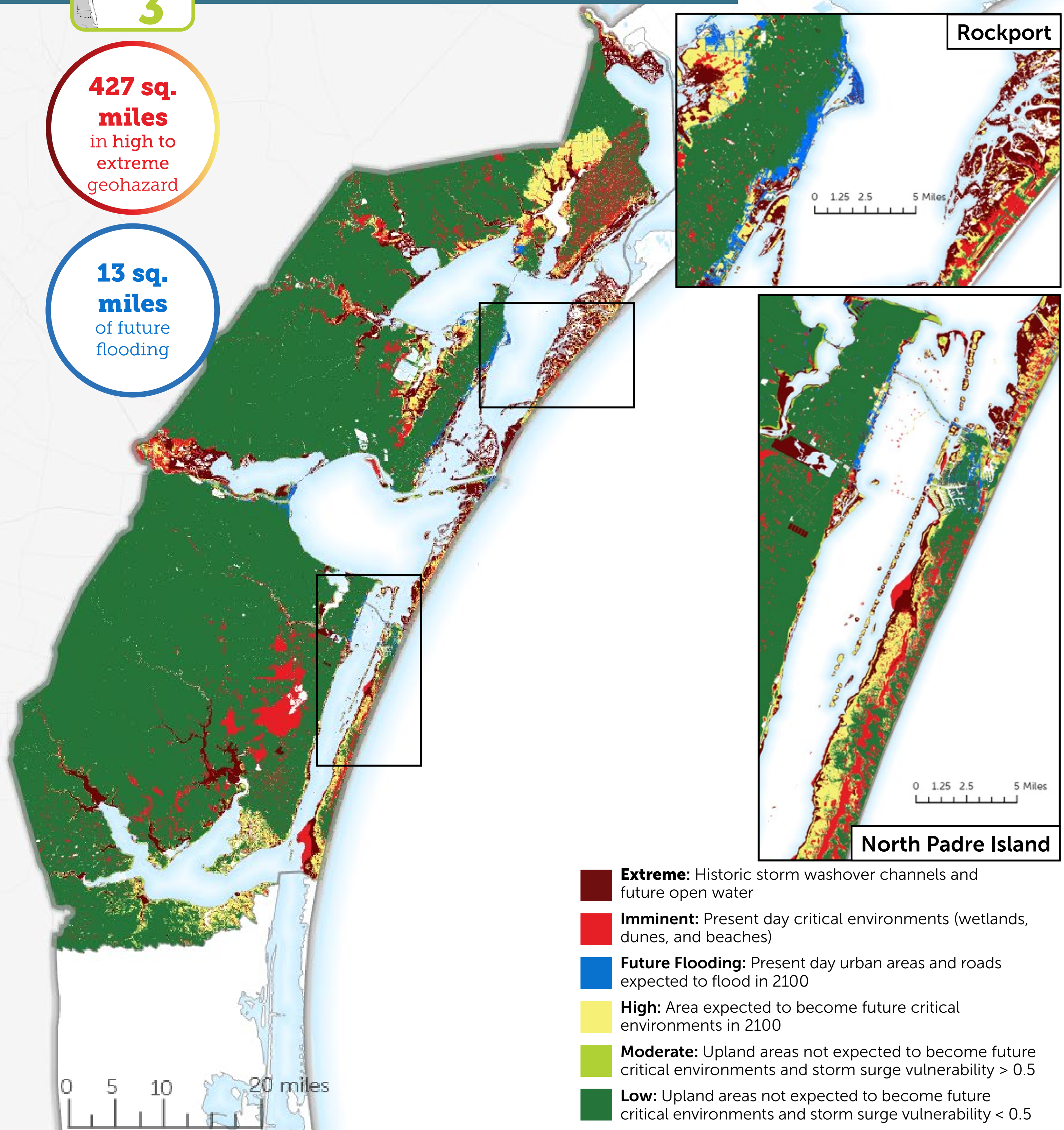
REGION 3

GEOHAZARD POTENTIAL

Intermediate-High Scenario | 4.9 feet of sea level rise

427 sq. miles in high to extreme geohazard

13 sq. miles of future flooding



Extreme: Historic storm washover channels and future open water

Imminent: Present day critical environments (wetlands, dunes, and beaches)

Future Flooding: Present day urban areas and roads expected to flood in 2100

High: Area expected to become future critical environments in 2100

Moderate: Upland areas not expected to become future critical environments and storm surge vulnerability > 0.5

Low: Upland areas not expected to become future critical environments and storm surge vulnerability < 0.5

REGION 4

GEOHAZARD POTENTIAL

Intermediate-Low Scenario | 1.6 feet of sea level rise

553 sq. miles in high to extreme geohazard

2 sq. miles of future flooding

Extreme: Historic storm washover channels and future open water

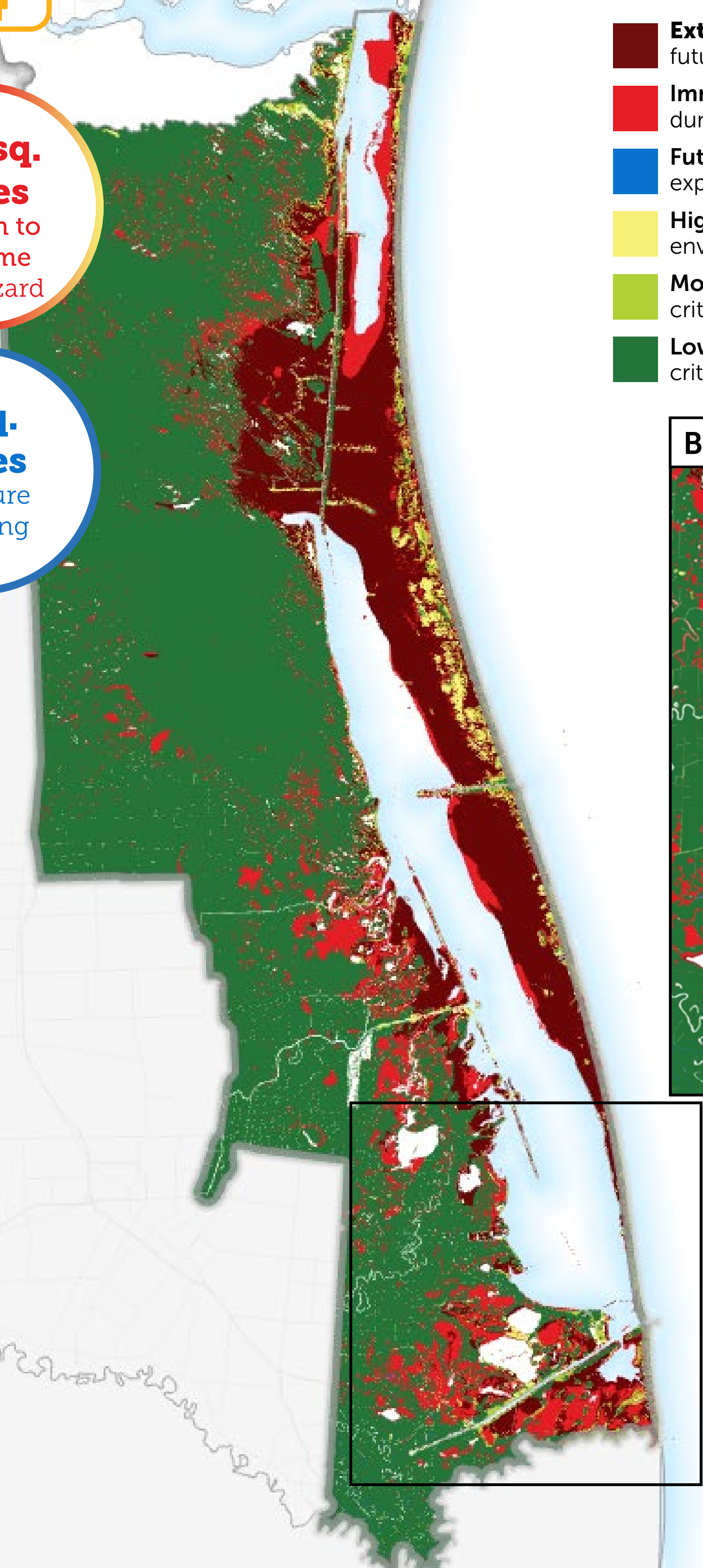
Imminent: Present day critical environments (wetlands, dunes, and beaches)

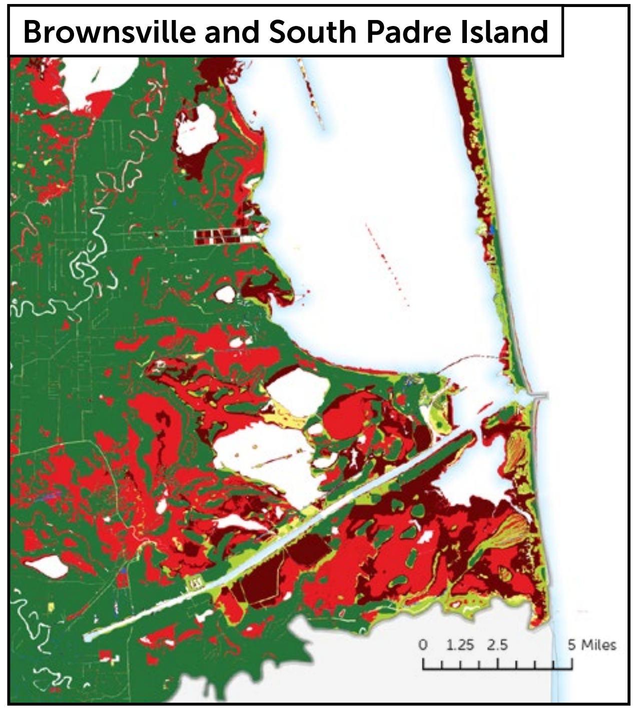
Future Flooding: Present day urban areas and roads expected to flood in 2100

High: Area expected to become future critical environments in 2100

Moderate: Upland areas not expected to become future critical environments and storm surge vulnerability > 0.5

Low: Upland areas not expected to become future critical environments and storm surge vulnerability < 0.5





0 5 10 20 miles

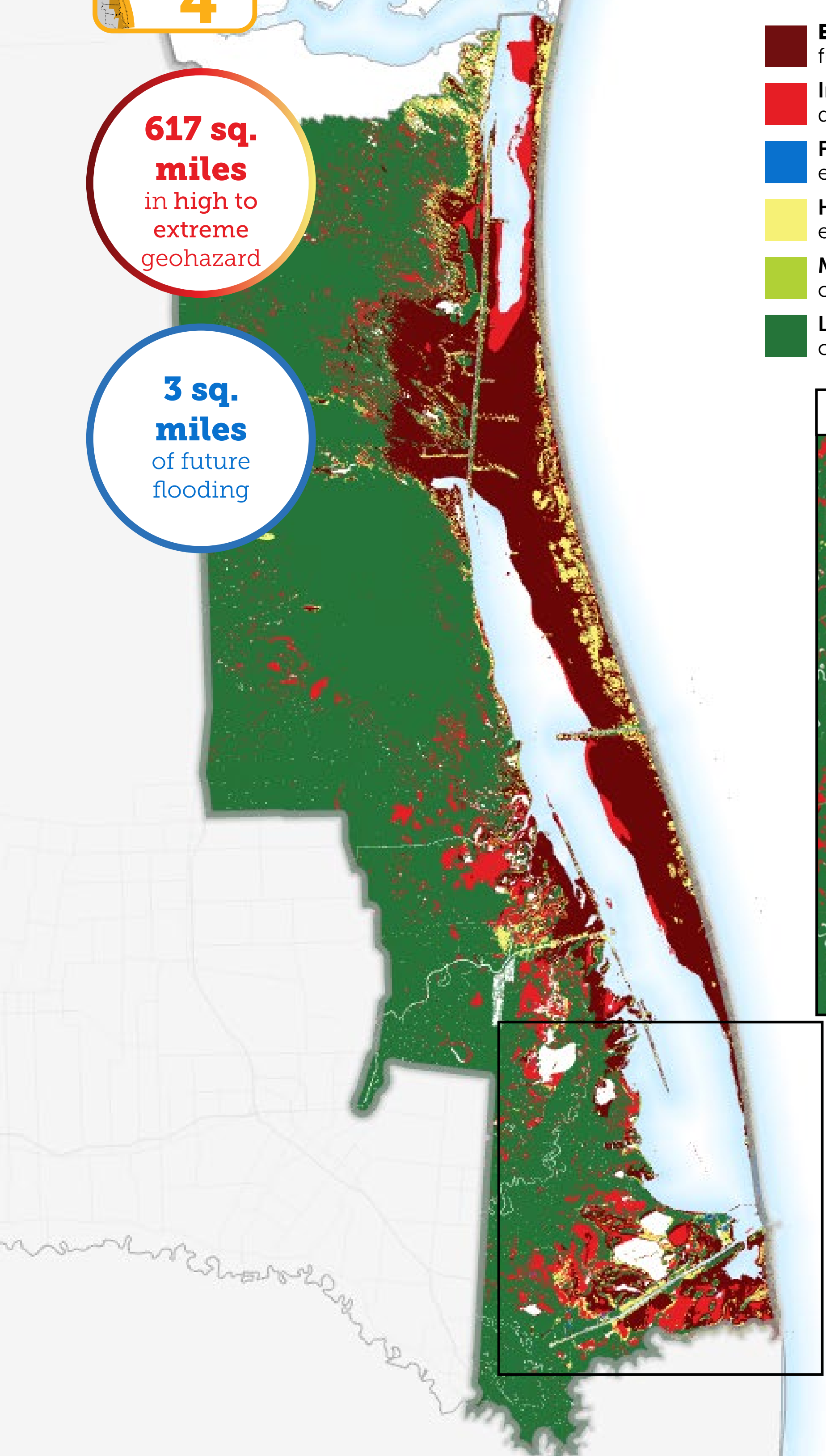
REGION 4

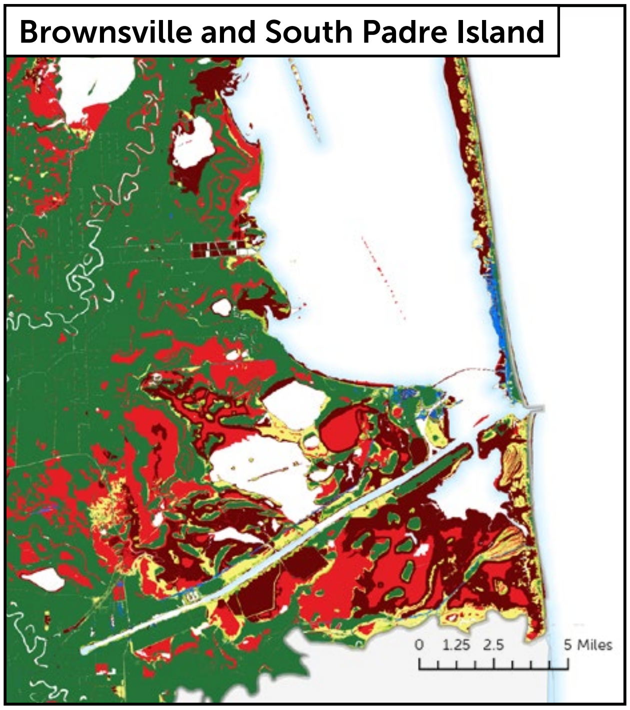
GEOHAZARD POTENTIAL

Intermediate-High Scenario | 4.9 feet of sea level rise

617 sq. miles in high to extreme geohazard

3 sq. miles of future flooding





(Photo Credit: City of South Padre Island)

5. Actions Toward Building Resilience

Implementing this Plan requires coordinated responses at multiple scales, requiring significant collaboration of funding and information sharing at the statewide and local levels. The Coastal Resiliency Framework developed for this Plan defines these needed responses as *actions*.

In the 2019 Plan, 11 actions were presented as collections of individual projects in specific geographical areas that functioned together to mitigate the coastal pressures and vulnerabilities of those areas. However, more than being tied to a specific geography, these proposed actions are intended to outline system-wide responses to systemic issues that have developed on the Texas coast. To support this approach and the concepts and ideas presented in this Plan, a series of 10 new data-driven actions are promoted through this Plan.

The purpose of the 10 actions is to propose a series of coordinated approaches that show where Texas's coastal resiliency needs now intersect with the vision that the GLO and its partners share to improve the future of the coast. With these actions guiding state and local decision-makers, the GLO hopes to champion future resiliency projects that align with one or more of the proposed actions.

2023 Plan ACTIONS

Managing Coastal Habitats

Managing Gulf Shorelines

Managing Bay Shorelines

Improving Community Resilience

Adapting to Changing Conditions

Managing Watersheds

Growing Key Knowledge and Experience

Enhancing Emergency Preparation and Response

Addressing Under-Represented Needs

Maintaining Coastal Economic Growth

(Photo Credit: Galveston Bay Foundation)

5.1. Ten Actions for Coastal Resiliency

The GLO relied on relevant, up-to-date coastal datasets and expertise from the TAC to synthesize data regarding current vulnerabilities and planning needs facing the Texas coast to formulate the 10 actions. By shifting the actions from simply being groupings of similar or related projects in a given geography toward a data-driven and stakeholder-informed approach to anticipating the future of the coast, new projects can be proposed that directly address the vulnerabilities indicated by the data. This data-driven approach will equip project stakeholders to alleviate coastal vulnerabilities and further enhance coastal resiliency in a targeted and effective manner.

The 10 actions to address coastal vulnerabilities include:

- Managing Coastal Habitats
- Managing Gulf Shorelines
- Managing Bay Shorelines
- Improving Community Resilience
- Adapting to Changing Conditions
- Managing Watersheds
- Growing Key Knowledge and Experience
- Enhancing Emergency Preparation and Response
- Addressing Under-Represented Needs
- Maintaining Coastal Economic Growth

Actions can and often do accomplish more than one resiliency goal. Each action is proposed based on the importance of the intent, the range of vulnerabilities addressed by the action, and the resiliency strategies anticipated to be most applicable for specific projects within the action. The data inputs used to inform development of the action, including TAC-provided assessment data, is documented in detail in the 2023 Technical Report.

5.1.1. An Informed Approach to Developing Actions

The actions were developed using best-available data to help define present and future areas at risk of impacts from coastal vulnerabilities.

Action Workshops

Over a course of ten workshops, held virtually in January and February 2022, the GLO worked with the TAC to discuss the proposed actions, listen to feedback about the needs pertaining to specific actions, and gain consensus from the TAC on the overall approaches and potential solutions. One 1.5-hour workshop was held for each individual action. The workshops were held prior to the TAC evaluating proposed projects for this Plan in June 2022 and were offered as a lens through which to view the anticipated projects to be proposed for evaluation.

JANUARY

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FEBRUARY

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Dataset Overview

Several types of data sources were used to inform the ten actions that were developed for this Plan, including basemap data, inventory data, monitoring data, model data, study analysis data, and TAC-provided data. The datasets were compiled from publicly available data, such as those collected by federal and state resources agencies, monitoring data assessing past project performance, and, in some cases, data provided directly by the TAC and other planning partners. A brief overview of the data included is given below by data type. The full list of data sources is provided in the 2023 Technical Report.

Basemap Data

Data includes physical features such as rivers, topography and bathymetry, navigation channels, shoreline types (e.g., hardened), impervious cover, soil attributes, land cover, wildlife refuges and management areas, critical facilities, and transportation infrastructure.

Model Data

Data includes Texas-specific models for oyster siting, bayhead deltas, sea level rise, open water conversion and marsh migration, storm surge, living shoreline site suitability, septic systems vulnerable to SLR, and future expected development.

Inventory Data

Data includes population and demographics, building stock, historical flood claims and repetitive loss properties, historical roadway inundation, economic datasets from the Texas Comptroller, grant funding by census tract, commercial fishing data, and coastal tourism statistics.

Study Analysis Data

Data includes findings from Texas-specific studies include the Texas Bay Report Card project, critical habitat ranges, regional sediment management, GIWW resiliency and segment prioritization mapping, total exposure value, 1% annual flood risk zones, wave impact index, social vulnerability, low- to moderate-income (LMI) data, future roadway planning, and port strategic planning.

Monitoring Data

Data includes extents of various habitats (wetlands, rookery islands, seagrasses, and oysters), Gulf and bay shoreline change rates, rainfall, and water quality (including freshwater inflows, harmful algal blooms, and sanitary sewer overflows).

Technical Advisory Committee Data

Data includes TAC-identified vulnerable locations along the coast and stakeholder input collected during the action workshops.

5.2. Resiliency Strategies

Resiliency strategies are the recommended methods of restoration, enhancement, and protection that have been demonstrated to be successful in the Texas coastal environment. These strategies fall into three broad categories: ecological resiliency, societal resiliency, and administrative resiliency. Most of the projects in the Tier 1 list within this Plan use one or more of the strategies to mitigate coastal vulnerabilities.

The tables below give a brief description of the resiliency strategies, as well as example approaches to implement the strategies.

Ecological Resiliency Strategies

Beach Nourishment and Dune Restoration: Renourish sediment on bay beaches and Gulf beaches and dunes to address erosion and limited sediment supply.
- Beach and dune nourishment
- Sand-catching vegetation or structures

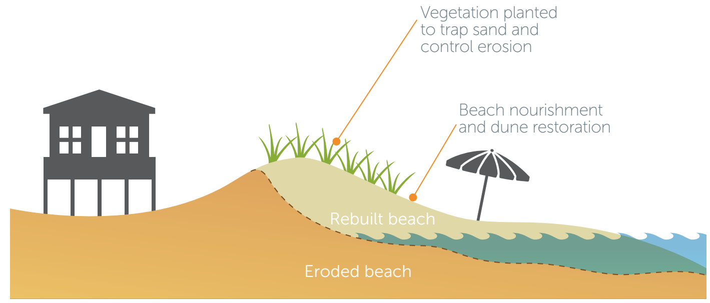
Wetland Planning, Restoration, and Monitoring: Restore, conserve, and protect ecologically significant wetlands to address habitat degradation, erosion and channelization.
- Shoreline protection and material placement
- Hydrologic restoration

Upland Planning, Conservation, and Monitoring: Restore, conserve, and protect ecologically significant coastal uplands.
- Land acquisition and conservation easement
- Hydrologic restoration

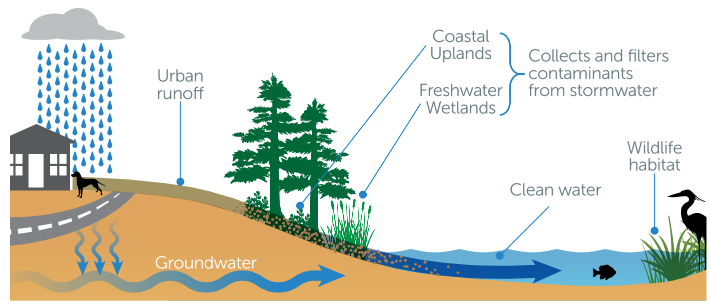
Oyster Reef Planning, Restoration, and Monitoring: Restore and/or re-establish productive oyster reefs.
- Studying optimal locations
- Recycling oyster shell or cultch

Rookery Island Protection, Restoration, and Creation: Restore and/or re-establish rookery island habitats to support colonial waterbird populations.
- Studying optimal locations
- Placing sediment and stabilizing shorelines

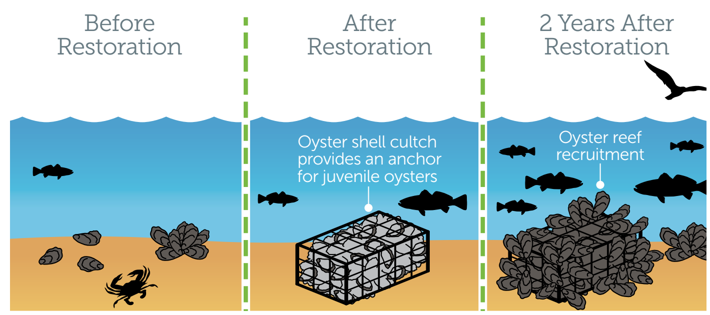
Freshwater Inflow and Tidal Exchange Enhancement: Restore and/or re-establish hydrology and inlets to mitigate water quality impairments within delta and bay systems.
- Watershed and land-use planning
- Nonpoint source pollution prevention



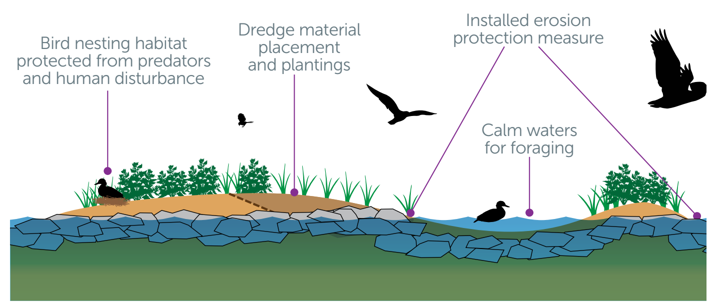
Beach Nourishment and Dune Restoration



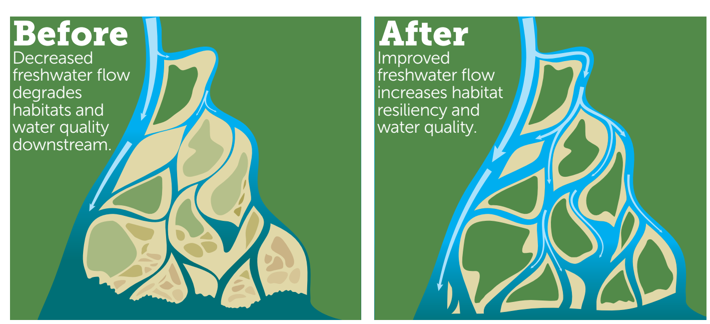
Planning, Restoration/ Conservation and Monitoring



Oyster Reef Planning, Restoration and Monitoring



Rookery Island Protection, Restoration and Creation



Freshwater Inflow and Tidal Exchange Enhancement

Societal Resiliency Strategies

Storm Surge Suppression: Implement results of federal, state, and regional storm surge suppression studies.
- Identify how projects in this Plan interact with the proposed improvements
- Acknowledge cost-share opportunities to progress project implementation

Water-based Transit Enhancement: Addresses navigation infrastructure improvement needs along the coast, including new opportunities for BUDM in state-owned waters.
- Stabilize the GIWW
- Support clean and resilient marinas
- Partner with ports for ecological and BUDM opportunities

Land-based Transit Enhancement: Addresses road, bridge, and highway infrastructure improvement needs in and around coastal communities.
- Identify opportunities to incorporate future coastal conditions and ecological considerations into final designs
- Elevate or widen evacuation routes
- Stabilize coastal roadways

Community Infrastructure Planning and Development: Proposes proactive, resilient planning in coastal communities to support current needs while considering future conditions.
- Relocate or storm-harden critical facilities
- Conduct regional studies for utility, drainage, and other infrastructure needs

Administrative Resiliency Strategies

Plan: Develop long-term recommendations and guidance for key aspects of coastal resiliency.
- Texas Coastal Resiliency Master Plan
- Coastal Texas Study (now projects for Coastal Texas Program)

Policy: Establish or update state regulations, administrative codes, standards, or guidance related to coastal resiliency goals.
- Building codes
- Setback regulations

Program: Create ongoing, structured, and regularly-funded curriculum to enhance coastal resiliency in a particular focus area.
- Beach Monitoring and Maintenance Program
- Data collection and monitoring

Study: Identify the need for additional research and/or scientific or engineering analysis to support coastal resiliency.
- Sand source study
- Oyster habitat viability assessment

Key Terms: Resiliency Strategies

Ecological resiliency strategies offer enhancements to coastal environments and species, ranging from nourishing beaches and shorelines to enhancing and supporting habitats for wildlife.

Societal resiliency strategies outline possible improvements to human and built environments, ranging from community infrastructure upgrades to planning for future development.

Administrative resiliency strategies describe opportunities to enhance policy and program-level aspects of coastal resiliency to encourage statewide and regional planning.

Leonabelle Turnbull Birding Center in Port Aransas (Photo Credit: Texas General Land Office)

Pierce Marsh (Photo Credit: Galveston Bay Foundation)

5.2.1. Resiliency Design Guides

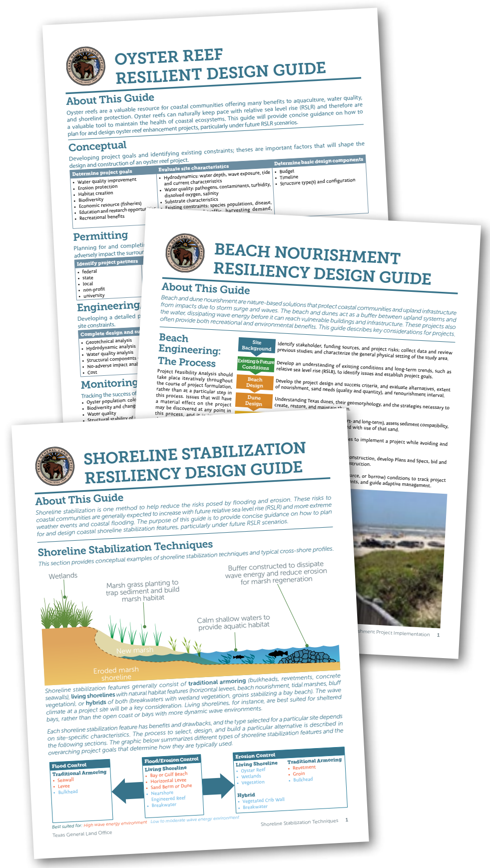
In working toward planning resiliency projects in the coastal landscape, the GLO developed a series of Resiliency Project Design Guides that feature general design guidance for stakeholders to consider when developing projects purposed toward coastal restoration, protection, or conservation. The guides are organized by project type and include considerations such as how to develop comprehensive project concepts, permitting, and recommendations for robust and adaptive design, monitoring, and maintenance for completed projects.

These guides will serve as a connection to the project types and resiliency strategies and help bridge the 2023 Planning Framework from actions to the current and future prioritized projects. The guides are available on the GLO's website.

The eight guides include:

- **Beaches and Dunes**—This guide describes considerations for beach and dune design, including sand sourcing, permitting, and monitoring.
- **Delta Management**—This guide describes structural, non-structural, ecological, study, and policy considerations for restoring and managing sensitive delta and estuarine ecosystems.

- **Oyster Reefs**—This guide includes considerations for reef enhancements, including structure type, tidal location, harvesting determinations, and cost considerations.
- **Rookery Islands**—This guide discusses wave climate, BUDM, vegetation, predation, and cost implications to consider when restoring or creating a bird-nesting island.
- **Shoreline Stabilization**—This guide presents traditional and novel techniques to prevent erosion, including armoring, living shorelines, and hybrid solutions.
- **Wetland Protection**—This guide describes challenges with wetland degradation due to sea level rise, freshwater and sediment inflows, and wave impacts, as well as potential solutions.
- **Stormwater Retrofits**—This guide describes new installations or upgrades to existing stormwater management measures where there is a lack of water quality treatment and/or management of runoff rates.
- **Funding Programs**—This guide will help project stakeholders identify possible funding sources in five general categories: conservation, disaster mitigation, research, restoration, management, and non-point source pollution reduction.



	Project Type	Project Subtypes
Nature-Based	Hydrologic Connectivity	• Freshwater Inflow • Hydrologic Restoration • River Restoration
	Habitat Creation and Restoration	• Estuarine Wetlands • Freshwater Wetlands • Oyster Reef • Barrier Islands • Coastal Uplands • Coastal Prairies • Rookery Islands • Dredged Material Placement Islands • Seagrasses • Tidal Flats • Fisheries
	Beach Nourishment	• Bay • Gulf
	Dune Restoration	• Dune
	Shoreline Stabilization	• Living Shoreline • Breakwater • Misc. Wave Break • Seawall • Bulkhead • Revetment • Jetty • Groin
	Land Acquisition	• Acquisitions • Conservation Easements • Fee Simple
Infrastructure-Based	Structure/ Debris Removal	• Structures on Public Easement • Abandoned Oil and Gas Wells • Abandoned Boats • Dock Pilings • Post Storm Cleanup
	Public Access & Improvements	• ADA* Accessibility • Walkovers • Piers, Boat Ramps
	Flood Risk Reduction	• Levees • Flood Wall • Storm Surge Barrier
	Community Infrastructure	• Drainage • Utilities • Roadway/Bridge Repair • Roadway/Bridge Elevation • Critical Facilities • Structure Raising
Studies, Policies, and Programs		

**ADA: Americans with Disabilities Act*

5.3. Projects

5.3.1. Tier 1 Project Selection Methodology

The TAC met over a series of five hybrid (in-person and virtual) meetings in June 2022 to rank and evaluate potential regional and coastwide projects for the Tier 1 list in this Plan. Each project proponent was allotted 5 minutes to verbally describe the project to the TAC and answer questions as time allowed. Written materials, a project map, and an online project dashboard that displayed social, environmental, and economic metrics in the project area were provided as supporting data to aid the TAC's review. After considering project information, the TAC assessed each project for its feasibility, priority, and effectiveness at addressing coastal vulnerabilities. In its evaluations, the TAC considered local factors and project-specific details that could indicate red flags or low feasibility for projects, and, conversely, identified promising projects with the most valued attributes.

The GLO used a three-step evaluation and ranking method, updated from the 2019 scoring process, to incorporate all the evaluation metrics gathered from the TAC and evaluate the project concepts for potential Tier 1 status. This method elicited a thorough data- and stakeholder-informed determination of 2023 priority projects. Other projects evaluated that were ultimately not prioritized as Tier 1 projects are listed at the end of this section.

- **Step 1:** Projects first had to achieve a feasibility clearance to be considered for prioritization.
- **Step 2:** Projects had to be viewed as a priority by at least 75% of the TAC members who evaluated the project (or 65% with a high vulnerability score).
- **Step 3:** Projects that passed the feasibility clearance and were viewed as a priority by at least 65% of the TAC had to show effectiveness at addressing coastal vulnerabilities equal to or exceeding the 78th percentile by TAC assessment.

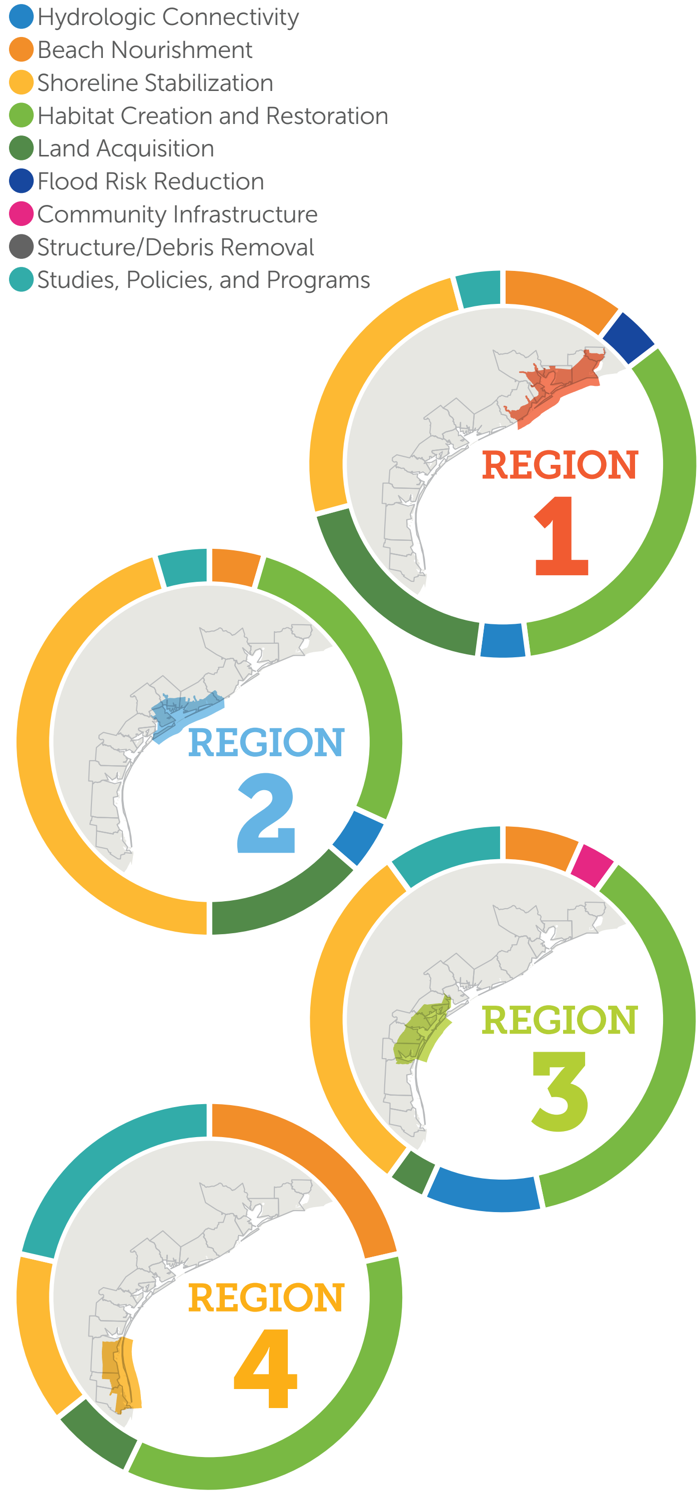
Full details of the prioritization process and a detailed list of project rankings from the TAC evaluation are included in the 2023 Technical Report.

Table 5.1: Tier 1 Projects and Costs by Project Type

Project Type	Region	No. of Projects*	Cost of Projects*
Hydrologic Connectivity	1	2	$9.8 million
	2	1	$4.3 million
	3	3	$59.6 million
Habitat Creation and Restoration	1	16	$151.6 million
	2	6	$20.5 million
	3	11	$97.7 million
	4	5	$54.9 million
Beach Nourishment	1	5	$312.2 million
	2	1	$79.6 million
	3	2	$4.55 million
	4	3	$377.8 million
Shoreline Stabilization	1	12	$154.4 million
	2	10	$146.8 million
	3	9	$86.1 million
	4	2	$11 million
Land Acquisition	1	9	$128 million
	2	3	$92.8 million
	3	1	$5 million
	4	1	$25 million
Structure/ Debris Removal	**Coastwide**	2	$24 million
Flood Risk Reduction	1	2	$33 million
Community Infrastructure	3	1	$1 million
Studies, Policies, and Programs	**Coastwide**	8	$18.7 million
	1	2	$2.9 million
	2	1	$0.25 million
	3	3	$1.42 million
	4	3	$3.05 million

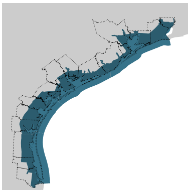
**Projects falling within multiple regions are double counted in the above tables to reflect total possible projects and cost in each region.*

Master Plan Tier 1 Project Types per Region



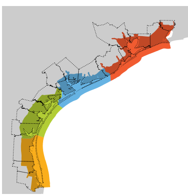
Tier 1 Project List

Projects



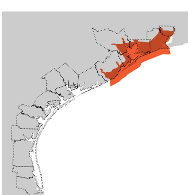
Coastwide

- 1 - Texas Coastal Resiliency Master Plan
- 2 - Abandoned Vessel Removal Program
- 1237 - Abandoned and Derelict Structure Removal Program
- 1392 - Beneficial Use Master Plan Continuation
- 2311 - Beach Monitoring and Maintenance Program
- 9097 - Longshore Transport Modeling
- 9118 - Long-Term Hydrologic Monitoring Program
- 9180 - Development of Optimal Coastwide Bathymetric and Topographic Models
- 9183 - Clean Coast Texas Program
- 10013 - Data Collection to Support Continual Updates to the National Wetlands Inventory Dataset



Multi-Region

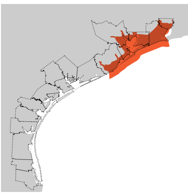
- 1284 - Columbia Bottomlands Ecosystem Preservation
- 1332 - Paired Subtidal and Intertidal Oyster Reef Restoration in Texas Bays
- 9216 - Texas Coastal Prairie Initiative



Region 1

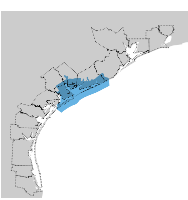
- 11 - Management of the Christmas Bay System
- 21 - Galveston Bay Rookery Island Restoration
- 240 - Coastal Heritage Preserve
- 252 - Bolivar Peninsula Beach and Dune Restoration
- 315 - Follet's Island Nourishment and Erosion Control
- 320 - Old River Cove Restoration
- 346 - O'Quinn I-45 Estuary Shoreline Protection and Marsh Restoration
- 457 - North Pleasure Island Shoreline Protection and Restoration
- 797 - Dickinson Bay Rookery Island Restoration
- 1262 - Bastrop Bayou Marsh Acquisition
- 1307 - J.D. Murphree WMA Shoreline Protection
- 1356 - Texas Bayou Water Control Structure
- 1359 - Texas Point NWR Shoreline Protection Sabine Neches Waterway and Oyster Habitat Creation
- 1387 - Lower Neches WMA Lake Street Drive Beneficial Use
- 1388 - Texas Point NWR Beneficial Use
- 1389 - McFaddin NWR Willow Lake Marsh Beneficial Use
- 1390 - Anahuac NWR East Unit Beneficial Use
- 3025 - Greens Lake Shoreline Protection and Wetland Restoration - Phase 2
- 9025 - Bessie Heights Wetland Restoration
- 9026 - Galveston Island West of Seawall to 13 Mile Road Beach Nourishment - Phase 1
- 9046 - Follet's Island Conservation Initiative
- 9066 - Dollar Bay Wetland Protection, Restoration, and Acquisition
- 9081 - Texas Point NWR Beach Nourishment Project
- 9082 - Moody NWR Conservation and Restoration
- 9101 - Brazos River and San Bernard River Restoration Strategy and Management Plan
- 9108 - East and West Galveston Bay Watershed, Wetland, and Habitat Conservation
- 9150 - Middle Armand Bayou Protection Project

Projects



Region 1, cont.

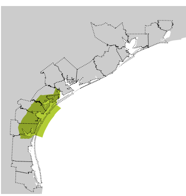
- 9161 - East Bay Living Shorelines and Wetland Restoration
- 9173 - Texas City Levee Erosion Control and Marsh Restoration
- 9192 - Lower Clear Creek and Dickinson Bayou Watershed Flood Risk Reduction Program
- 9201 - Galveston Island Nourishment and Stabilization
- 9204 - McFaddin NWR Gulf Shoreline Stabilization
- 9218 - Keith Lake Fish Pass and Baffle Repairs and Upgrades
- 9227 - West Bay Living Shorelines at Sweetwater Preserve and Maggie's Cove
- 9228 - Jones Bay Oystercatcher Habitat Restoration
- 9230 - Bay Harbor Island Stabilization
- 9248 - Highland Bayou Shoreline and Marsh Restoration Project
- 9252 - Houston Parks and Recreation Department's Riparian Restoration Initiative
- 9254 - Going to Scale: Expanding Oyster Restoration in Galveston Bay
- 9257 - Southeast Texas Flood Coordination Study - Regional Flood Sensor System
- 9276 - Chocolate Bay Preserve Shoreline Protection and Marsh Restoration
- 9277 - Pierce Marsh Wetland Restoration and Shoreline Protection
- 9279 - Neches River Forested Floodplain
- 9294 - Sydnes Island Restoration
- 9304 - Hickory Cove Marsh Restoration
- 10000 - Anahuac NWR Conservation and Restoration



Region 2

- 4 - San Bernard NWR Shoreline Protection
- 51 - Boggy Cut GIWW Stabilization
- 418 - Sargent Beach and Dune Restoration
- 430 - Carancahua Bay Habitat Preservation and Enhancement
- 600 - Half Moon Oyster Reef Restoration - Phase 3
- 644 - Mad Island Marsh Preserve Shoreline Protection and Coastal Ecosystem Restoration - Phase 1
- 922 - Oliver Point Shoreline Protection and Reef Restoration
- 1265 - Big Boggy Marsh Protection Project
- 1268 - Bird Island Restoration and Creation of Gulf Cut Island Complex
- 1342 - Hydrologic Restoration of Welder Flats
- 1391 - San Bernard NWR Sargent Unit Beneficial Use
- 9070 - Matagorda Bay Regional Inflow Study
- 9187 - Carancahua Bay Community Reefing Project
- 9215 - Shoreline Protection and Restoration at Olivia Haterius County Park
- 9224 - Lake Austin Coastal Prairie Conservation
- 9237 - Boggy Nature Park Shoreline Stabilization
- 9244 - Port Alto County Park Shoreline Protection and Restoration - Phase 2
- 9245 - Sand Point Peninsula Living Shoreline
- 9250 - Harbor of Refuge Protection and Restoration

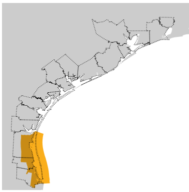
Projects



Region 3

- 70 - Goose Island State Park Habitat Restoration and Protection
- 72 - Long Reef and Deadman Island Shoreline Stabilization and Habitat Protection
- 437 - Fulton Beach Road Protection
- 443 - Nueces County Hydrologic Restoration Study
- 696 - Shamrock Island Restoration - Phase 2
- 1202 - Tern Island and Triangle Tree Island Rookery Habitat Protection
- 1375 - Dagger Island Buckeye Beneficial Use
- 1385 - Feeder Berm North of Fish Pass Beneficial Use
- 9003 - Shell Point Ranch Wetlands Protection
- 9045 - Packery Channel Nature Park Habitat Restoration - Phase 3
- 9059 - Little Bay Restoration Initiative
- 9134 - Port Aransas Nature Preserve Stabilization and Restoration - Phase 2
- 9136 - Corpus Christi Bay Wastewater, Stormwater Quality, and Pollution Management Improvements
- 9139 - Newcomb Point Shoreline Stabilization
- 9158 - Indian Point Marsh Area Living Shoreline
- 9196 - Protection of the GIWW Shoreline at the Aransas NWR
- 9199 - Bayside Wetland Resilience Study on Mustang Island
- 9209 - Farming Out Pollutants in Petronila Creek
- 9226 - Oyster Reef Restoration in Mesquite-Carlos-Ayres Complex
- 9236 - Restoration of Freshwater Inflow to Townsend Bayou
- 9253 - Going to Scale: Expanding Oyster Restoration in Aransas Bay
- 9265 - Living Shorelines and Wetland Enhancements at the Aransas NWR
- 9268 - Dagger Point Stabilization
- 9270 - Bayside Public Access and Habitat Creation
- 9271 - Austwell Water Quality and Erosion Mitigation
- 9278 - Nueces County Gulf Beach Renourishment and Protection - Phase 1
- 9287 - Rincon Reef Breakwater
- 9296 - Petronila Creek and Oso Creek Watershed Improvements
- 10005 - Shoreline and Wetland Protection on Mustang Island - Phase 1: Cohn Preserve

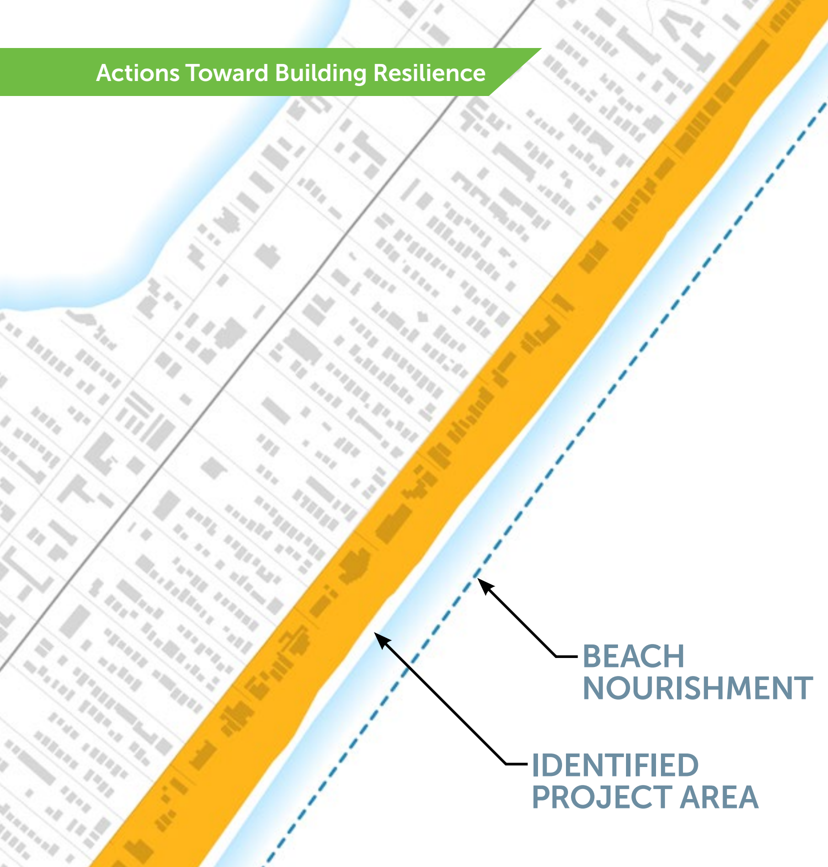
Projects



Region 4

- 145 - South Padre Island Beach and Dune Management and Restoration
- 1341 - Restoration of Sea Turtle Nesting Beach at Padre Island National Seashore
- 1393 - Protection and Restoration of Benny's Shack Islands
- 1394 - Protection and Restoration of Rabbit Island South
- 9042 - Bahia Grande Living Shoreline
- 9051 - South Padre Island Coastal Beach Protection
- 9062 - Restore Laguna Madre Rookery Islands
- 9063 - Restore Barrier Island Bayside Wetlands on South Padre Island
- 9123 - City of South Padre Island Living Shoreline
- 9229 - Adolph Thomae, Jr. Park Living Shoreline Restoration - Phase 5
- 9232 - Cameron County Beach Nourishment
- 9235 - Resaca System Restoration Project - Phase 1
- 9247 - Developing a Comprehensive Conservation and Resiliency Management Plan for the Lower Laguna Madre
- 9298 - Beach and Dune System Monitoring Program for Willacy and Cameron Counties

Least Tern (Photo Credit: Patty Alexander)



Areas around the proposed projects were evaluated for their current assets and/or assets at risk that the project could potentially help to protect. This map shows the South Padre Island Beach and Dune Management and Restoration project, which is expected to confer benefits on the urbanized area located along the shoreline.

5.4. Project Benefits

The natural, social, and economic systems that exist within the coastal region of Texas are dynamic and interconnected. Maintaining the health of these systems is vital to sustaining the Texas coast as a place for residents, businesses, and wildlife to flourish. The prioritized projects for this Plan offer a broad range of benefits to the environment, economy, and surrounding communities.

Based on data availability, a subset of benefits was quantified for the chosen Tier 1 projects, as applicable, from those listed herein. The benefits that were identified for each project were selected based on their relevance to the specific project and are presented in the Tier 1 project cut sheets. **It is important to note that these benefits do not necessarily reflect benefits offered by projects, but rather represent information about the economic, environmental, and social conditions and assets that currently exist within or surrounding the project area and that could be enhanced or supported as a result of project investment. It is also important to note that there are a number of additional benefits that these projects could offer that have not been quantified.** Some of these, as applicable, are discussed qualitatively below and in the project cut sheets. Additional information on the methodologies and data sources, tools, or references used to identify and/or quantify these benefits can be found in the 2023 Technical Report.

Economic

- Building replacement value in the project area
- Structure damage (1% storm) in the project area
- Existing jobs in the project area
- Support funding eligibility
- Avoided future flood risk

Environmental

- Number of critical habitats in the project area
- Number of endangered species in the project area
- Number of migratory bird species in the project area
- Protected habitat in the project area
- Number of Rookery Islands in project area
- Existing carbon sequestration through coastal wetlands in the project area
- Existing nitrogen removal through oyster reef restoration in the project area
- Oyster habitat protected/created in the project area
- Seagrass protected/created in the project area
- Types of wetlands in project area (freshwater and/or estuarine)
- Acres of wetlands protected/created in the project area
- Decreased wave energy

Social

- Social Vulnerability Index (SoVI) 5-classification score (county-level)
- Number of critical facilities in the project area
- Number of homes in the project area (occupied residential units)
- Number of trips on evacuation routes in project area (daily)
- Public access improvements
- Addressing data gaps
- Education and outreach

5.4.1. Economic

As noted in Section 2, Texas coastal communities are key economic drivers locally and to the state and nation. Projects can provide economic benefits in many ways.

Structural Protection: For Tier 1 projects that offer structural protection, when feasible and applicable, the building replacement value of the structures and/or the structure damages from a 1% storm in the project area are quantified based on Hazus modeling. It is important to note that this does not imply that all of these storm damages would be prevented in the area if the project were to occur, but rather to demonstrate the extent of damages given inaction and that some of these damages may be reduced with action.

Job Protection: The number of jobs currently in the project area are estimated for projects that are assumed to offer some level of protection to areas with businesses based on data from Esri Business Analyst.

Avoidance of Future Flood Risk: If the project avoids future development in an area with flood risk, such as land acquisition projects for conservation, a binary assignment was given. Effective land use decision-making is essential to building resilience and fundamental to that is considering the flood risk under both current and future conditions with changes in sea level.

Support Funding Eligibility: Projects with the "Studies, Plans, and Programs" project type may be assigned a binary benefit that they support funding eligibility if the project is intended to help develop a strategy in a way that might help future applications for funding.

There are many potential economic benefits that projects could offer that were not quantified, including a number of avoided damages from flooding—such as costs to residents and businesses to relocate after their structures are damaged in a storm, content and inventory losses to buildings, public health impacts, impacts to property values as a result of flood risk, and losses associated with public and essential facility loss of service (e.g., police, fire). Economic benefits from erosion protection, such as reduced frequency and associated costs of maintenance dredging, were not quantified. Economic benefits from habitat restoration and increased tourism were also not evaluated. Economic impacts from the investments themselves have not been quantified, such as the direct, indirect, and induced jobs that could be supported as a result of the projects.

5.4.2. Environmental

The projects in this Plan provide numerous environmental benefits including reducing hazards, creating, restoring or protecting natural habitats, and sequestering carbon.

Habitat Protected: The number of acres of wetlands in the project area, number of critical habitats, number of endangered species, number of migratory bird species, and number of rookery islands in the project area were all quantified when feasible and applicable. The types of wetlands in the project area (e.g., freshwater and/or estuarine) may also be identified for certain projects, as well as whether the project creates/protects oyster habitat, seagrass area, or protected habitat in the project area.

Carbon Sequestration and Nitrogen Removal: For more nature-based benefits, the amount of carbon sequestered for coastal wetland projects and the amount of nitrogen removal through oyster reef restoration were estimated under existing conditions, when feasible and applicable. Carbon sequestration and nitrogen removal rates were based on studies in Texas and/or the Gulf of Mexico, but it is important to note that there is wide variability between projects and project sites, and that these estimates are based on existing literature and research. See the 2023 Technical Report for more information on the values used and associated limitations.

Reducing Hazards: To capture environmental hazard reduction, it was noted whether or not the project area would decrease wave energy when applicable, which can help reduce risk from flooding and erosion.

These environmental benefits are not only fundamental to supporting the natural systems of the Texas coast, but the protection, restoration, and/or enhancement of these natural resources can reduce risk and result in a number of co-benefits. These co-benefits include supporting tourism and recreation, improving water quality, and improving human health, among others.

5.4.3. Social

Protecting and enhancing the Texas coast for all communities to continue to thrive is fundamental to this Plan. The Tier 1 projects offer a myriad of social benefits, such as through enhanced recreation opportunities, coastal storm protection, and access to essential services.

Social Vulnerability: A county-level social vulnerability index for the State of Texas was included to understand the social vulnerability of the populations in the project area. A five-score classification of the index was used: low, medium low, medium, medium high, and high. Projects were assigned one of these five scores based on the project area's county or counties.

Essential Services and Housing: Maintaining essential services is necessary for avoiding disruption and minimizing risk to human life. For projects located in an area with an evacuation route, the number of annual average daily trips for that evacuation route are identified. Additionally, if there are critical facilities in the project area, these are identified using Hazus. Critical facilities include wastewater, natural gas, electric power, and commercial broadcast facilities; port, bus, and airport facilities; railway and highway bridges; schools; police stations; medical care facilities and emergency centers; and fire stations. For projects in areas that offer protection to residential structures, the number of homes (i.e., occupied residential units) in the project area are quantified using Census data.

Recreational Opportunities: Many of the Tier 1 projects aim to protect, enhance, or expand recreational opportunities. This includes improving public access, maintaining beaches, improving fisheries, and protecting wildlife, among others. To capture these benefits, it is noted when a project increases the number of public access points. Finally, some projects provide benefits that may be difficult to quantify, such as educational benefits, local engagement, monitoring programs, and data collection tools. These projects have been tagged with a binary benefit if they improve education and outreach or address data gaps.

There are a number of social benefits that the projects might offer that have not been quantified here, such as number of visitors or recreators that might benefit from a project, public health improvements such as avoided mortality and morbidity, and others. It is important that further development of the projects includes considerations for addressing historical inequities and existing social vulnerability and improving access and opportunity.

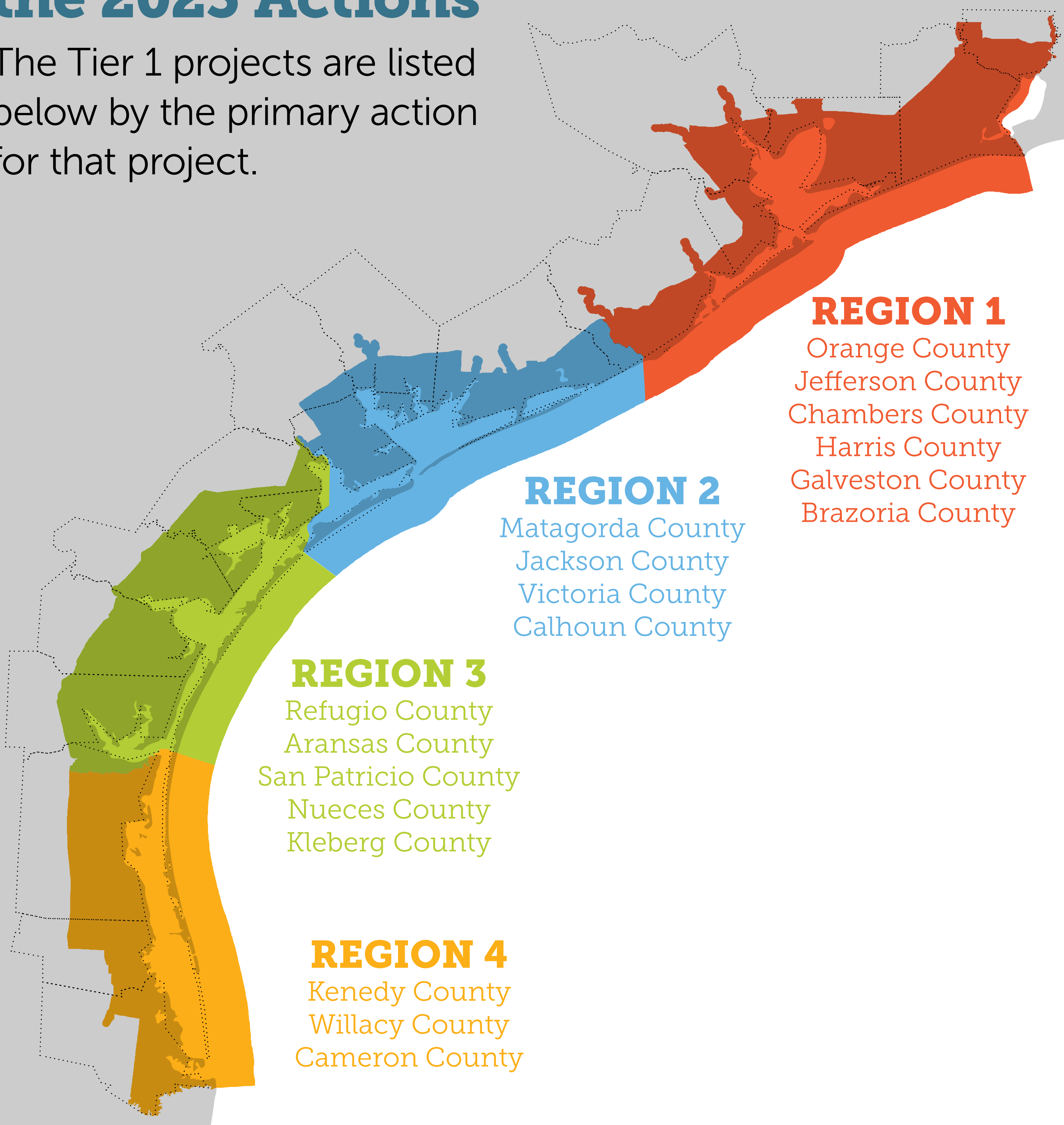
Deep Dive: CEPRA-Funded Project Benefit-Cost Analyses

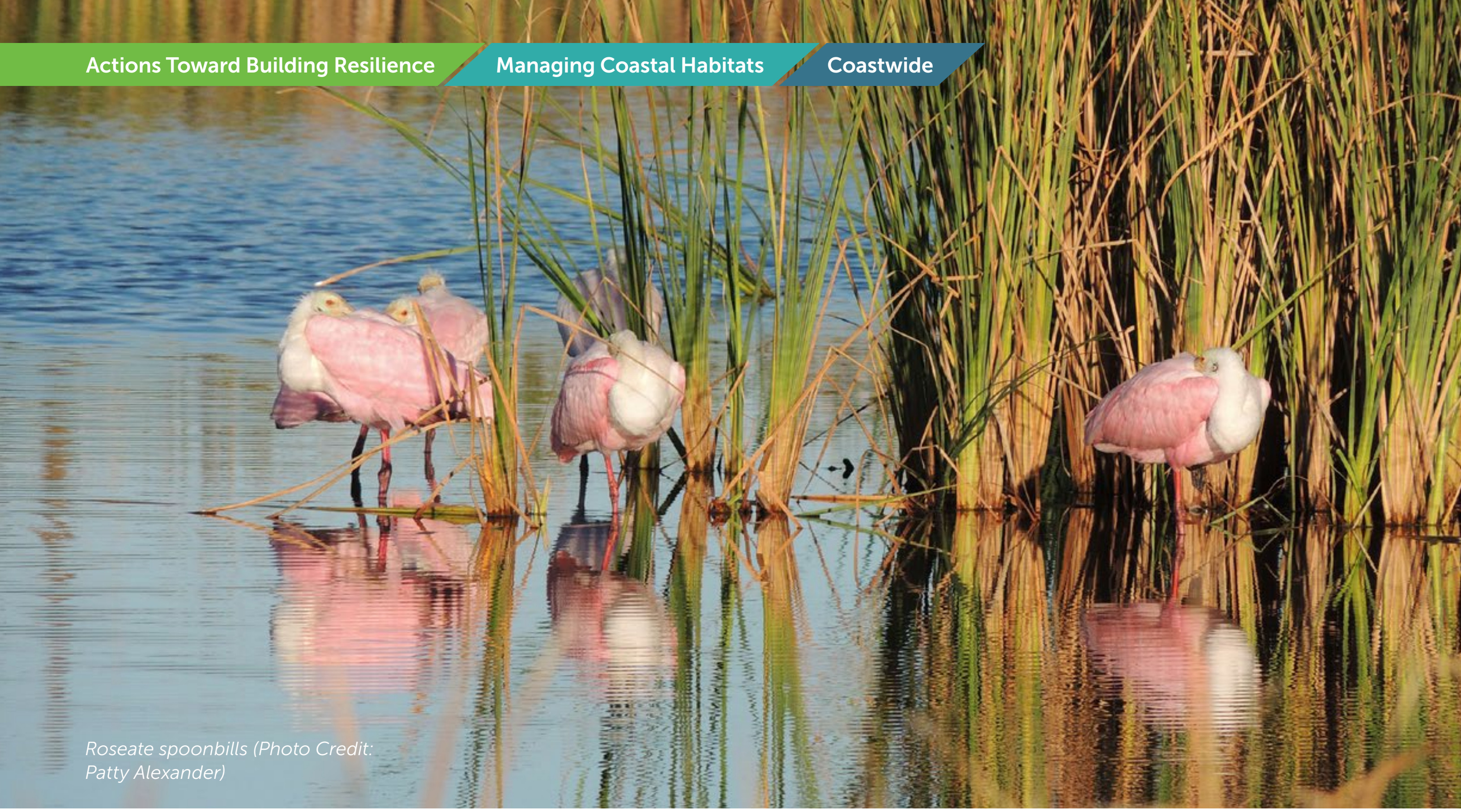
The GLO must submit a report to the Texas Legislature for CEPRA-funded projects outlining the economic and natural resource benefits that they offer. The 2019 economic study evaluated 13 projects from CEPRA Cycles 7, 8, and 9, while the 2022 economic study evaluated six CEPRA Cycle 10 and 11 project costs and benefits.[156, 157] It was found that the 13 projects in the 2019 study amounted to the state receiving $11 in economic and financial benefits per state dollar spent, while the 2023 study found that the state receives $3 in economic and financial benefits per state dollar spent, assuming a 4.75% discount rate.[156, 157] A range of benefits were quantified for these analyses, such as reduction in beach nourishment costs to the State of Texas, avoided storm damages, recreational benefits, beneficial use of dredged material, and ecosystem services benefits, among others.

Erosion along Trinity Bay (Photo Credit: Galveston Bay Foundation)

5.5. Overview of the 2023 Actions

The Tier 1 projects are listed below by the primary action for that project.





Roseate spoonbills (Photo Credit: Patty Alexander)

5.5.1. Managing Coastal Habitats

Texas's diverse coastal ecosystems contain habitats that are imperative to maintaining a healthy and dynamic coastal environment. Targeted habitats include those that are the most heavily stressed by persistent vulnerabilities and that are, according to available data, deteriorating in health, quantity, or quality. Targeted habitats also support a wide range of aquatic, terrestrial, and avian species. The resulting ecosystems provide valuable provisioning, regulating, supporting, and cultural services that encapsulate the broad benefits of coastal environments and their functionalities improve human quality of life while also serving as integral elements of the state's multiple lines of defense from the range of coastal hazards that threaten the coast.

While proper management and restoration of a broad range of natural coastal ecosystems is supported throughout this Plan, this action identifies specific and targeted ecosystems through the use of agency-collected monitoring data, habitat modeling analyses, long-term projections of ecosystem/land use changes, and local expert insight. Understanding the current and future needs of critical ecosystems will better inform preventive measures that project proponents can undertake to protect and restore coastal habitats more efficiently. It will also complement other planned mitigation and enhancement activities.

No.	Project Name	Other Key Actions
1392	Beneficial Use Master Plan Continuation	

MANAGING COASTAL HABITATS

Today's Opportunities

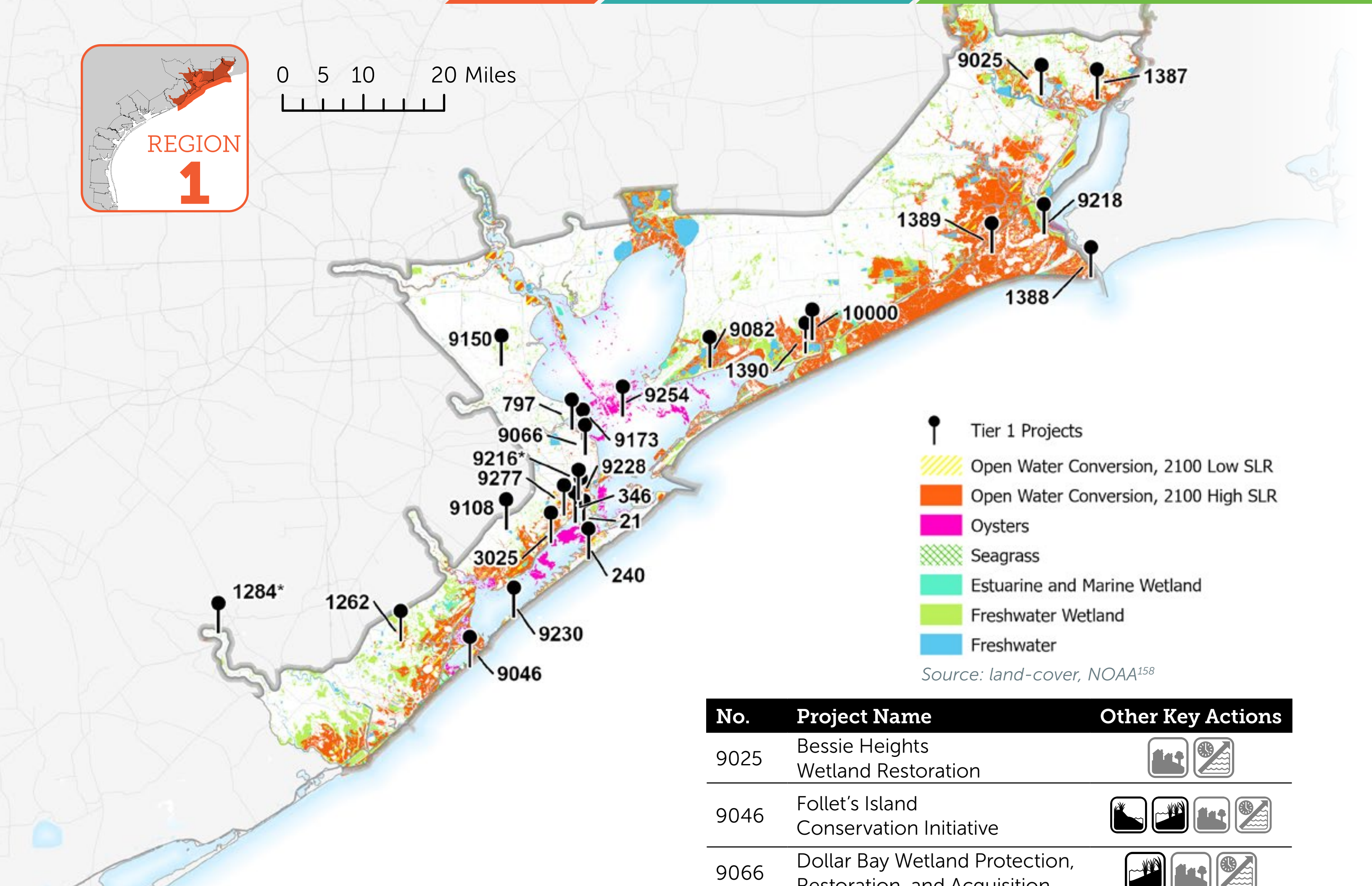
- Enable migration corridors
- Respond to RSLR
- Opportunities for BUDM
- Manage freshwater inflows

Emerging Opportunities

- Carbon sequestration and storage
- Tidal flat restoration research
- Water rights policy
- Natural capital and ecosystem services

Related Actions

- Managing Watersheds
- Managing Gulf Shorelines
- Managing Bay Shorelines

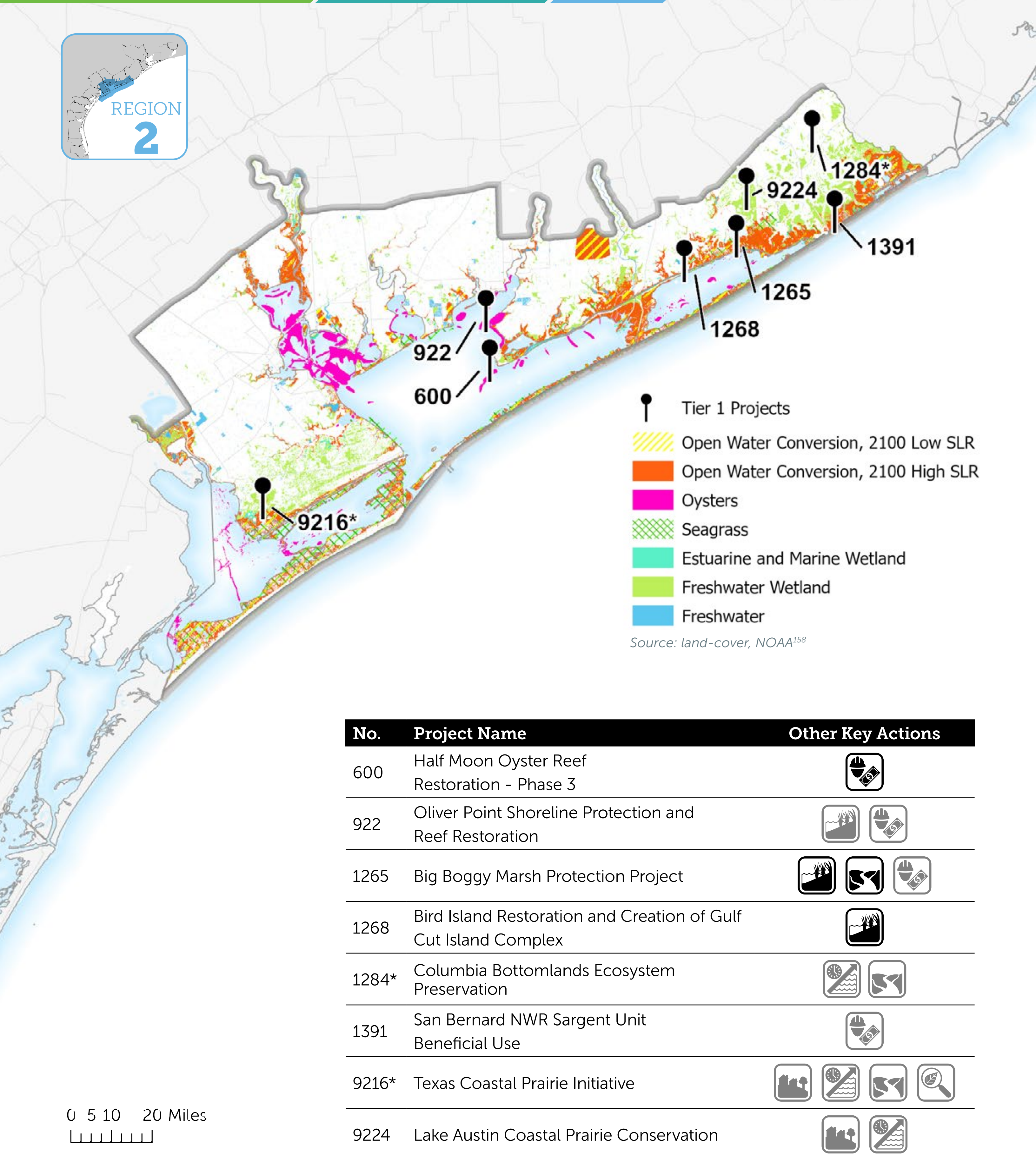


Source: land-cover, NOAA[158]

No.	Project Name	Other Key Actions
21	Galveston Bay Rookery Island Restoration	
240	Coastal Heritage Preserve	
346	O'Quinn I-45 Estuary Shoreline Protection and Marsh Restoration	
797	Dickinson Bay Rookery Island Restoration	
1262	Bastrop Bayou Marsh Acquisition	
1284*	Columbia Bottomlands Ecosystem Preservation	
1387	Lower Neches WMA Lake Street Drive Beneficial Use	
1388	Texas Point NWR Beneficial Use	
1389	McFaddin NWR Willow Lake Marsh Beneficial Use	
1390	Anahuac NWR East Unit Beneficial Use	
3025	Greens Lake Shoreline Protection and Wetland Restoration - Phase 2	

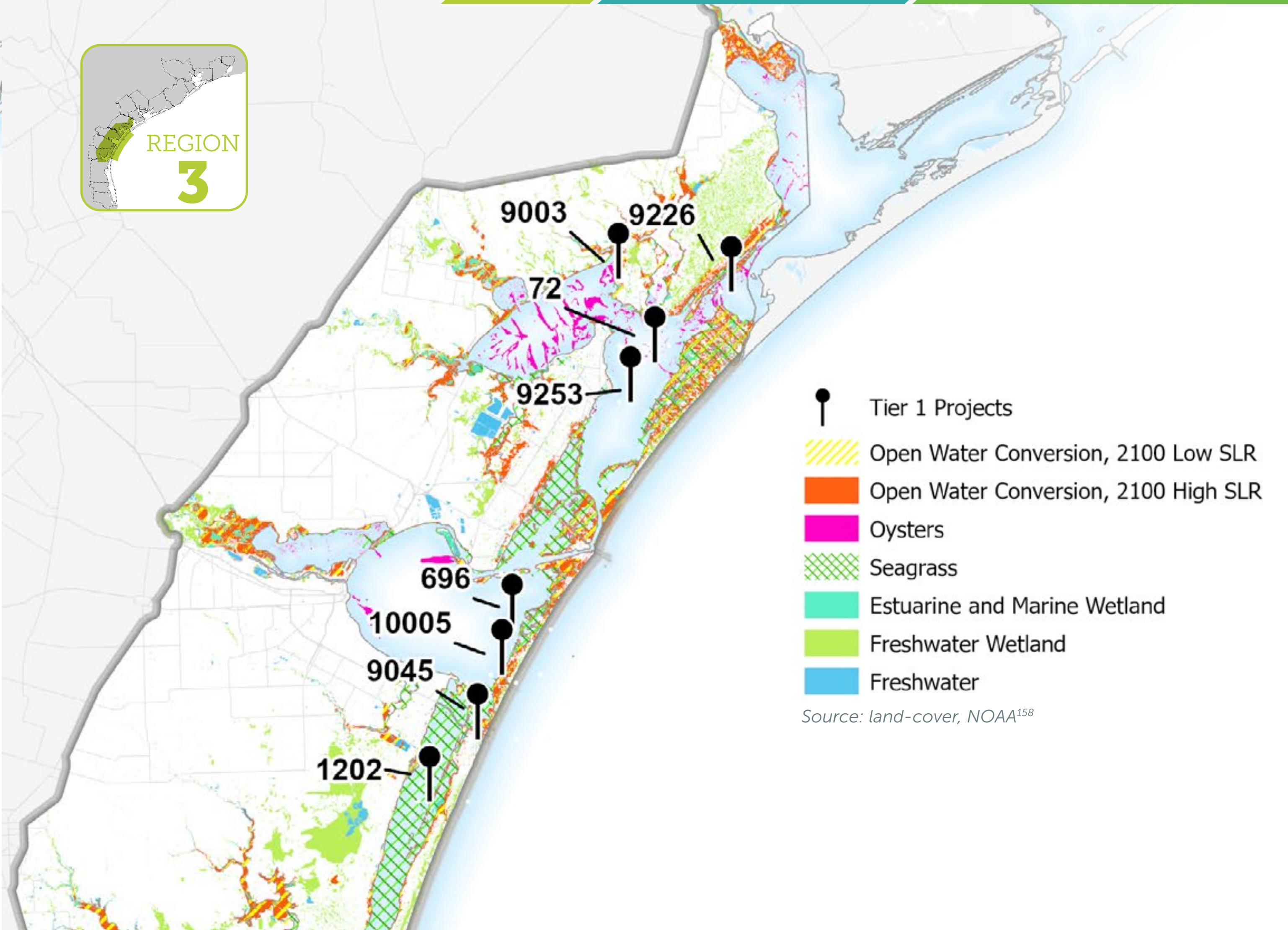
No.	Project Name	Other Key Actions
9025	Bessie Heights Wetland Restoration	
9046	Follet's Island Conservation Initiative	
9066	Dollar Bay Wetland Protection, Restoration, and Acquisition	
9082	Moody NWR Conservation and Restoration	
9108	East and West Galveston Bay Watershed, Wetland, and Habitat Conservation	
9150	Middle Armand Bayou Protection Project	
9173	Texas City Levee Erosion Control and Marsh Restoration	
9216*	Texas Coastal Prairie Initiative	
9218	Keith Lake Fish Pass and Baffle Repairs and Upgrades	
9228	Jones Bay Oystercatcher Habitat Restoration	
9230	Bay Harbor Island Stabilization	
9254	Going to Scale: Expanding Oyster Restoration in Galveston Bay	
9277	Pierce Marsh Wetland Restoration and Shoreline Protection	
10000	Anahuac NWR Conservation and Restoration	

**This project spans across multiple regions and is shown in more than one map*

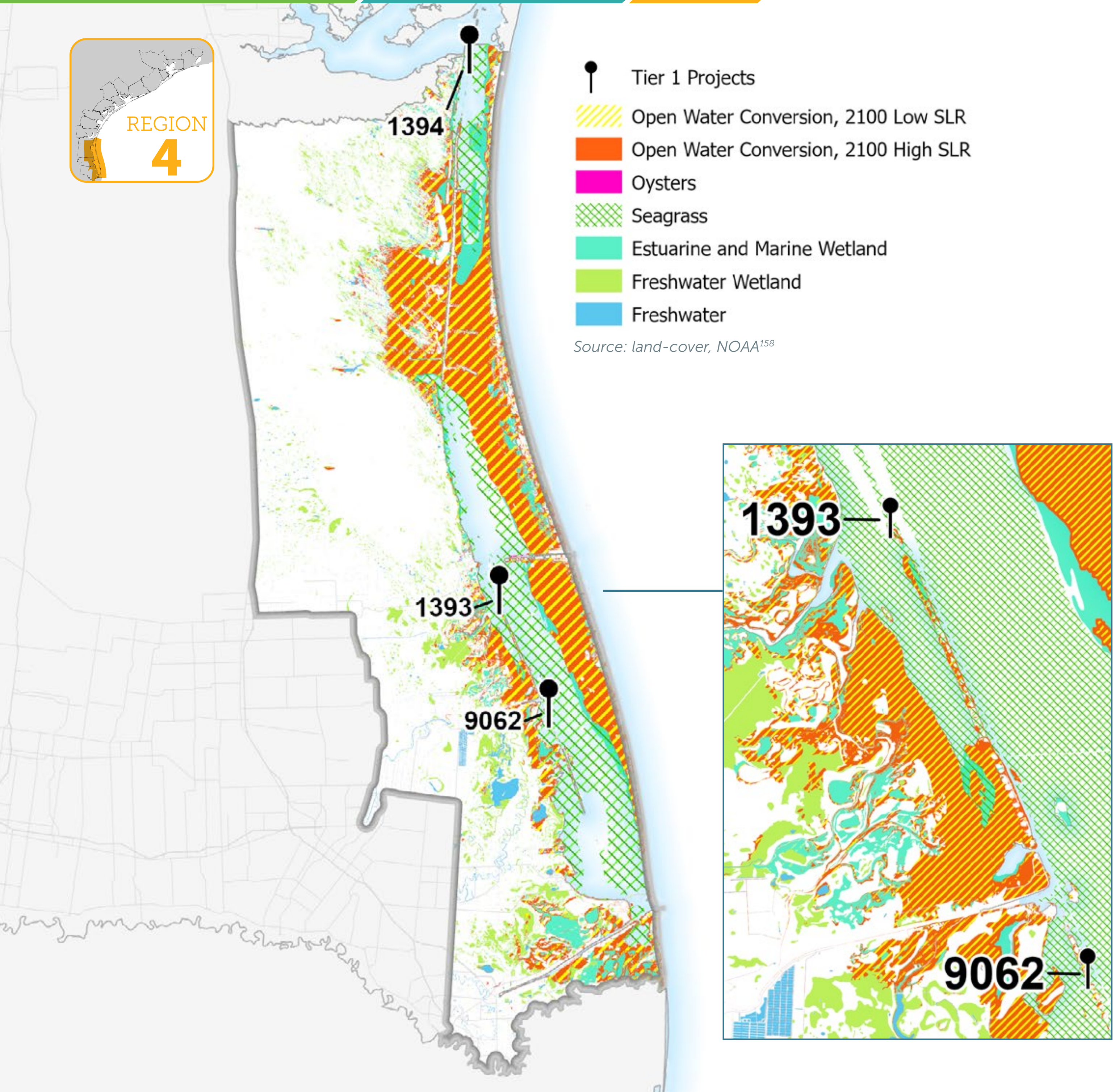


No.	Project Name	Other Key Actions
600	Half Moon Oyster Reef Restoration - Phase 3	
922	Oliver Point Shoreline Protection and Reef Restoration	
1265	Big Boggy Marsh Protection Project	
1268	Bird Island Restoration and Creation of Gulf Cut Island Complex	
1284*	Columbia Bottomlands Ecosystem Preservation	
1391	San Bernard NWR Sargent Unit Beneficial Use	
9216*	Texas Coastal Prairie Initiative	
9224	Lake Austin Coastal Prairie Conservation	

*This project spans across multiple regions and is shown in more than one map



No.	Project Name	Other Key Actions
72	Long Reef and Deadman Island Shoreline Stabilization and Habitat Protection	
696	Shamrock Island Restoration - Phase 2	
1202	Tern Island and Triangle Tree Island Rookery Habitat Protection	
9003	Shell Point Ranch Wetlands Protection	
9045	Packery Channel Nature Park Habitat Restoration - Phase 3	
9226	Oyster Reef Restoration in Mesquite-Carlos-Ayres Complex	
9253	Going to Scale: Expanding Oyster Restoration in Aransas Bay	
10005	Shoreline and Wetland Protection on Mustang Island - Phase 1: Cohn Preserve	



Source: land-cover, NOAA[158]

No.	Project Name	Other Key Actions
1393	Protection and Restoration of Benny's Shack Islands	
1394	Protection and Restoration of Rabbit Island South	
9062	Restore Laguna Madre Rookery Islands	

0 5 10 20 Miles

Deep Dive: The GLO's Commitment to Ecosystem Restoration as the Coastal Texas Program's Non-Federal Sponsor[159,160]

COASTAL TEXAS PROGRAM

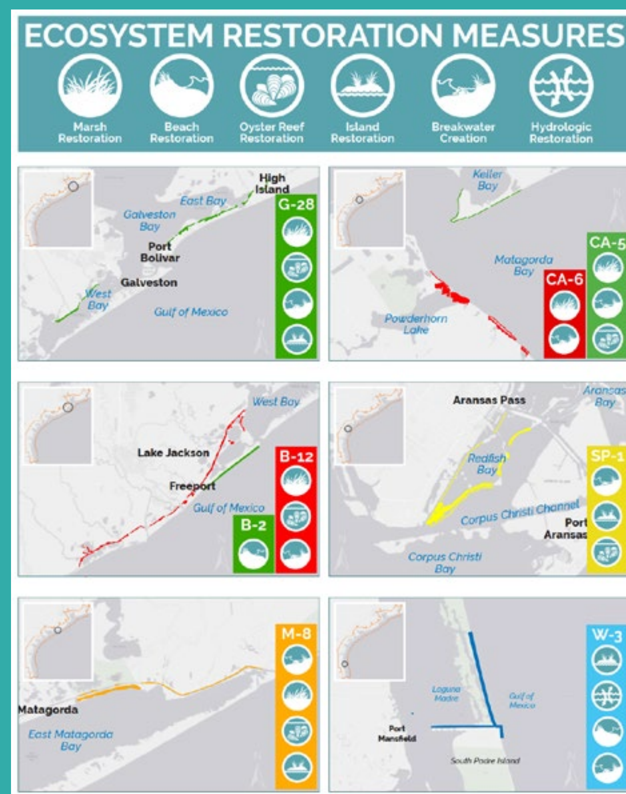
COASTAL TEXAS RESILIENCY IMPROVEMENT PLAN

As described in Section 1 of this Plan, the Coastal Texas Program resulted from a 6 year, $20.7 million comprehensive feasibility study led by the U.S. Army Corps of Engineers in partnership with the GLO as its 50/50 non-federal cost-share sponsor. The purpose of the study is to identify feasible projects that reduce risks to public health and the economy, restore critical ecosystems, and advance coastal resiliency.

The results of the engineering, economic, and environmental examinations that occurred as part of the study resulted in a final recommended plan that consists of coastal storm risk management and ecosystem restoration features. The Chief's Report for the study was submitted to Congress in the fall of 2021 and is awaiting funding for implementation of the projects.

The Coastal Texas Program envisions a 15.8-mile ring barrier around the bay side of the City of Galveston, highway and railroad gates, and a storm surge gate system for navigation and environmental flow. It also includes ecosystem restoration to address habitat loss and degradation and provide a natural buffer from storms through beach, marsh, oyster reef, hydrologic, and island restoration projects.

Once the projects receive congressional funding, the GLO will sponsor the ecosystem restoration features included in the final plan, in part through its continuing efforts on the Texas Coastal Resiliency Master Plan. Final design is expected to begin 2-5 years after authorization and construction is estimated to take 10-15 years depending on congressional funding appropriations.



Coastal Texas Program ecosystem restoration measures.[159]

Ecosystem Restoration Features:

- G-28: Bolivar Peninsula and West Bay GIWW Shoreline and Island Protection
- B-2: Follets Island Gulf Beach and Dune Restoration
- B-12: Bastrop Bay, Oyster Lake, West Bay, and GIWW Shoreline Protection
- M-8: East Matagorda Bay Shoreline Protection
- CA-5: Keller Bay Restoration
- CA-6: Powderhorn Shoreline Protection and Wetland Restoration
- SP-1: Redfish Bay Protection and Enhancement
- W-3: Port Mansfield Channel, Island Rookery, and Hydrologic Restoration of the Laguna Madre System

(Photo Credit: Texas General Land Office)

5.5.2. Managing Gulf Shorelines

The Texas Gulf shoreline is in a state of sediment starvation, and about 80 percent of the Gulf shoreline is eroding at a rate of greater than two ft/yr, leading to an overall trend of land loss.[139] This consistent trend places extreme economic and environmental pressures on several coastal communities in Gulf-adjacent areas to maintain their Gulf beaches, both for community development and ecological health. In areas where it is undeveloped, the Texas Gulf shoreline is dynamic, with beach and dune systems readily migrating to various states of equilibrium, and relatively rapid post-storm-event recovery is observed. Elsewhere in Texas, a mix of coastal and upstream development, including inlet modifications and the construction of coastal structures (e.g., jetties) have created challenges when attempting to establish stable, or even accreting, shoreline conditions for maintaining shoreline health and the wellbeing of those that live, work, or play along the coast.

The Managing Gulf Shorelines action is focused on efforts that provide the benefits of shoreline stability, whether structural or non-structural, while also working to maintain the natural beach ecosystem. In many cases, this action focuses on responsibly managing sand supplies as a critical resource.

Engineers, scientists, and researchers are still working to understand complex sediment transport patterns that characterize the Texas coast and to consider new findings alongside the demand for sand across the coastline. Despite the manifold efforts that have occurred to date, there is still significant effort needed to find workable solutions to the state's Gulf shoreline erosion problems—solutions, for example, that align permitting, dredging, and project construction timelines.

Perhaps most critically, the Texas Gulf shoreline is the state's first line of defense from violent hurricanes, storm surge, and waves. A healthy beach and dune environment has the potential to save Texans billions of dollars in damage from a single weather event, creating significant justification to invest in regional solutions and motivate community members to work together to maintain sand resources.

MANAGING GULF SHORELINES

Today's Opportunities

- Sediment management planning
- Identify sand resources
- Opportunities for BUDM

Emerging Opportunities

- Remote monitoring of overwash and other physical processes
- General permit for beach nourishment

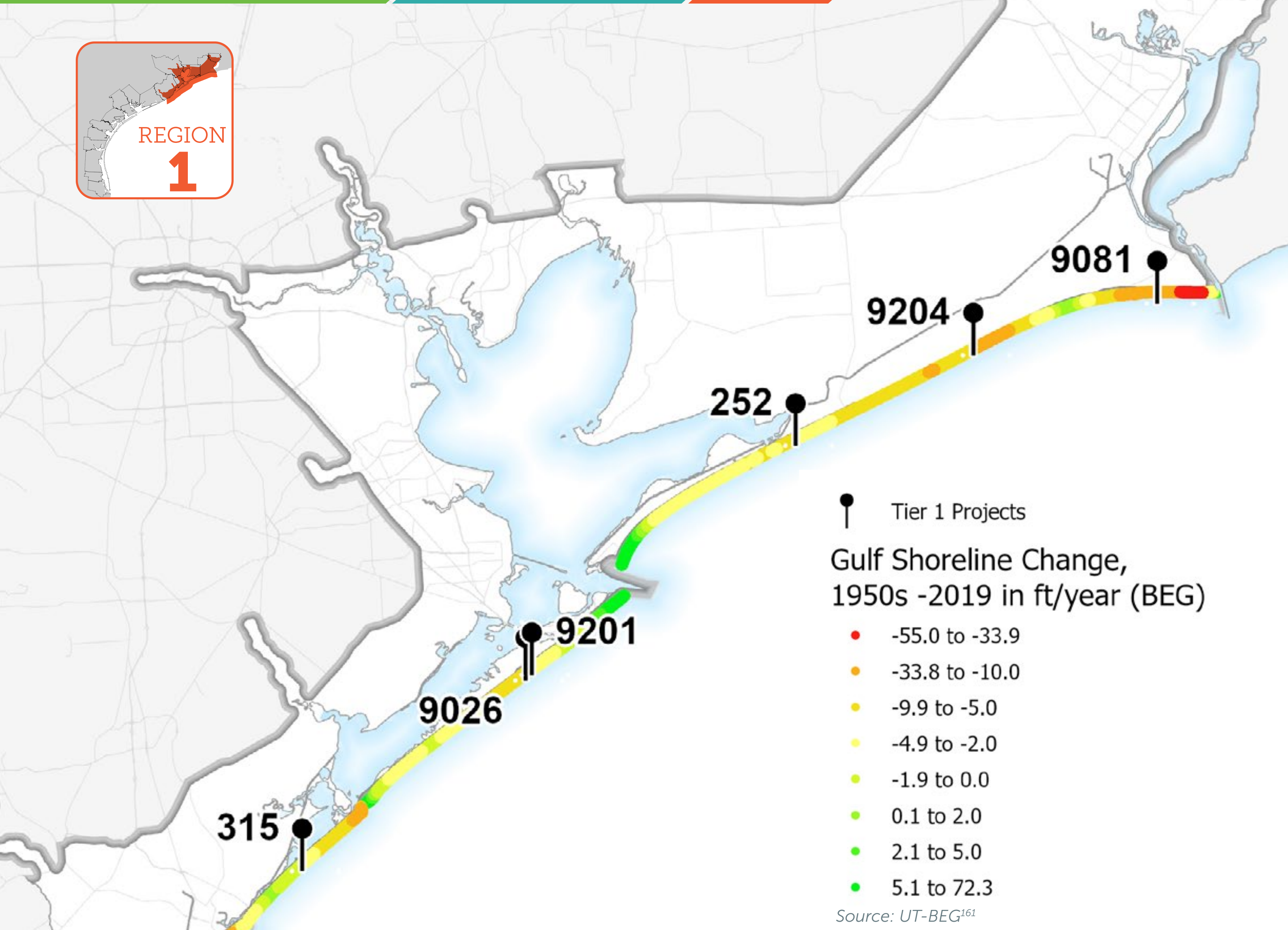
Related Actions

- Managing Coastal Habitats
- Managing Bay Shorelines
- Improving Community Resilience

	No.	Project Name	Other Key Actions
Coastwide	2311	Beach Monitoring and Maintenance Program	

Perhaps most critically, the Texas Gulf shoreline is the state's first line of defense from violent hurricanes, storm surge, and waves. A healthy beach and dune environment has the potential to save Texans billions of dollars in damage from a single weather event, creating significant justification to invest in regional solutions and motivate community members to work together to maintain sand resources.

(Photo Credit: City of South Padre Island)



No.	Project Name	Other Key Actions
252	Bolivar Peninsula Beach and Dune Restoration	
315	Follet's Island Nourishment and Erosion Control	
9026	Galveston Island West of Seawall to 13 Mile Road Beach Nourishment - Phase 1	
9081	Texas Point NWR Beach Nourishment Project	
9201	Galveston Island Nourishment and Stabilization	
9204	McFaddin NWR Gulf Shoreline Stabilization	

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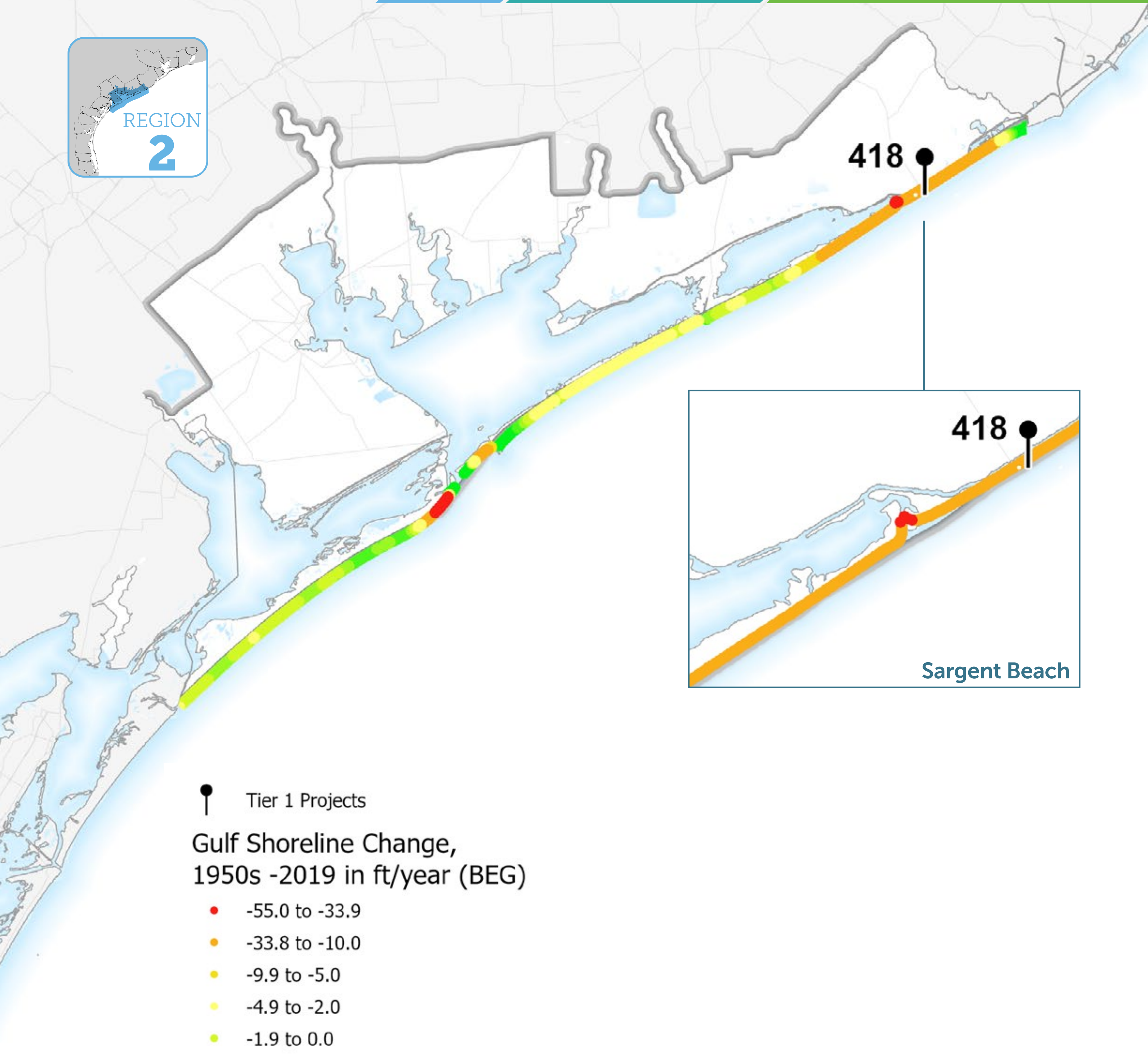
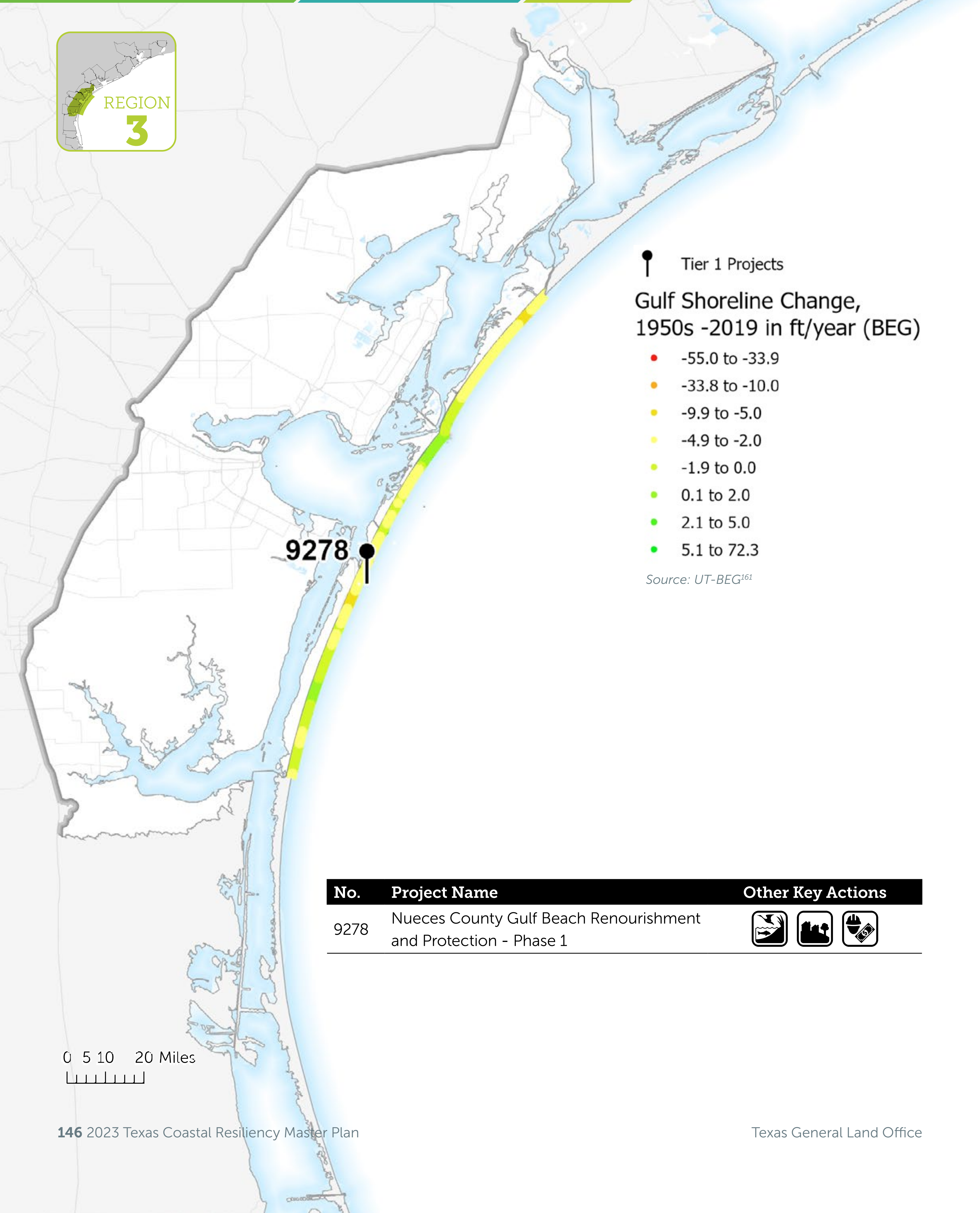
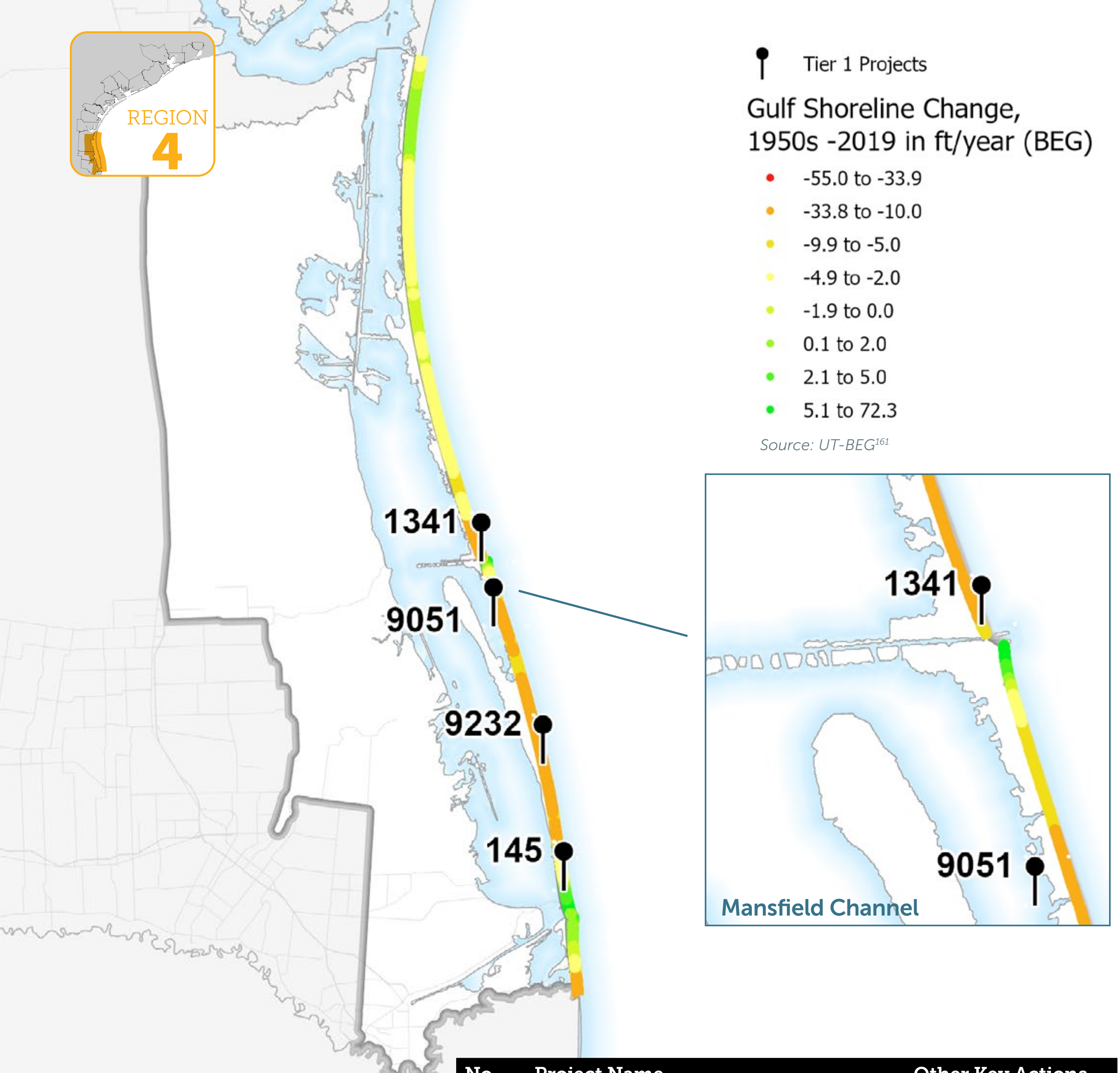


No.	Project Name	Other Key Actions
418	Sargent Beach and Dune Restoration	



Source: UT-BEG[161]

No.	Project Name	Other Key Actions
9278	Nueces County Gulf Beach Renourishment and Protection - Phase 1	



No.	Project Name	Other Key Actions
145	South Padre Island Beach and Dune Management and Restoration	
1341	Restoration of Sea Turtle Nesting Beach at Padre Island National Seashore	
9051	South Padre Island Coastal Beach Protection	
9232	Cameron County Beach Nourishment	

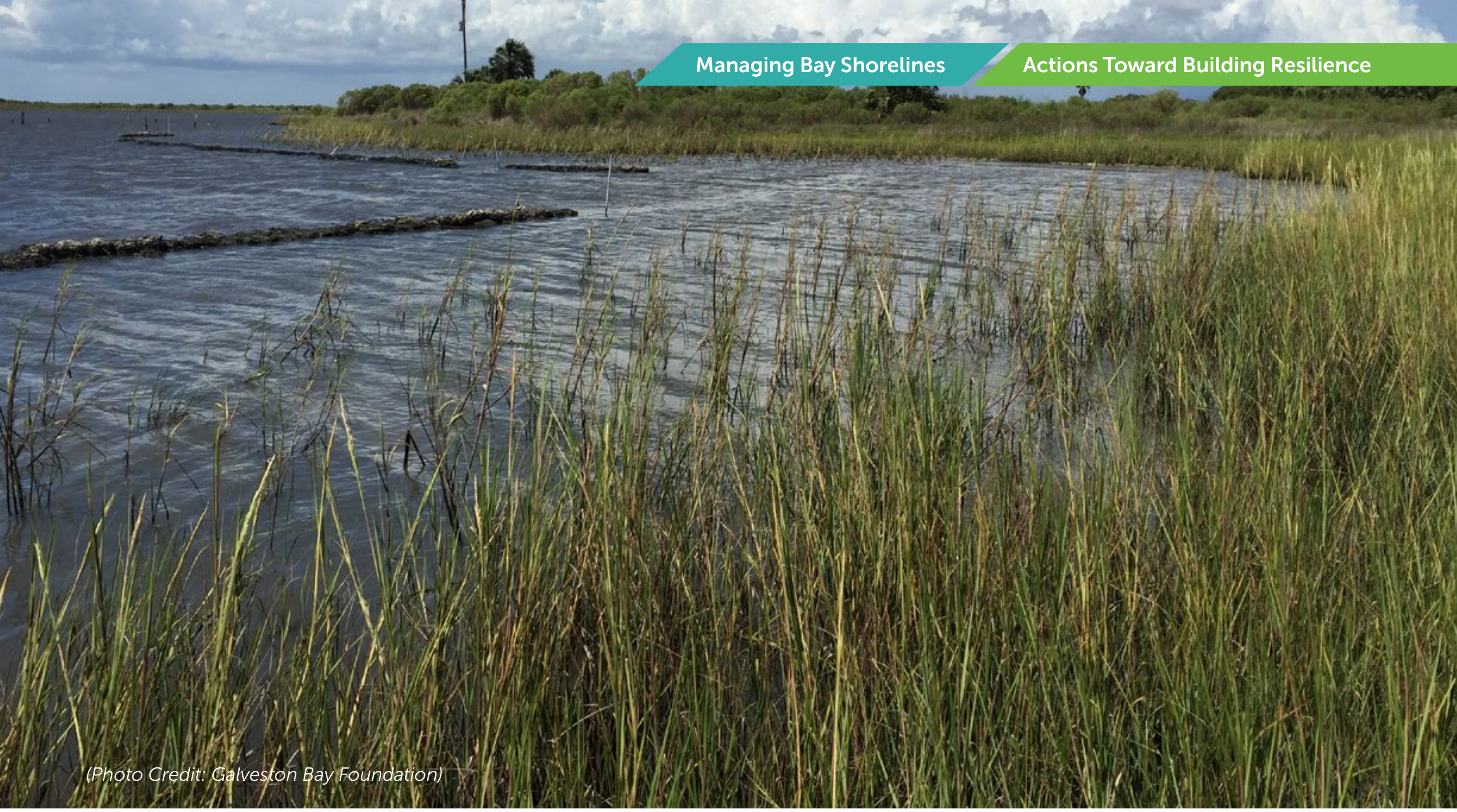
Deep Dive: Managing & Budgeting Sand Resources

Texas's coast has historically been considered "sand starved," meaning that there is not enough sand being regularly deposited into the nearshore zone to adequately replenish sand lost from the persistent wave effects that erode beaches. As a result, most of the Texas Gulf shoreline is eroding (using updated shoreline change data from 2019, the average movement rate of all Texas sites was found to be -4.17 ft/yr), and most Gulf beach restoration that occurs will need to take place through regular renourishment cycles.[139] To help understand the implications of this trend, the GLO's Planning Team investigated the volume of sand that would be required to be placed annually along segments of the Texas Gulf beach system to counteract erosion. Corrected for nourishment that has already occurred, the total volume of sand that is needed annually along the Texas Gulf coast is currently nearly 6.9 million cubic yards (mcy) to maintain shoreline equilibrium, or 27.5 mcy over the next 4-year planning cycle for this Plan.[162] The areas experiencing the most rapid erosion include South Padre Island, which loses 1.78 mcy of sand each year, followed by the McFaddin region, which loses roughly 1.35 mcy of sand each year, and North Padre Island, which loses 0.95 mcy.

These findings indicate the benefits of long-term planning regarding the identification of sand sources for the renourishment of Texas beaches and determining the frequency of large nourishment projects. The GLO recently completed sediment transport modeling studies under an ongoing Tier 1 project (ID 9097) for Regions 1 and 4 (studies for Regions 2 and 3 are ongoing) in addition to offshore regional sediment mapping surveys (see "Did You Know?" on page 33).[163, 164] The results of these studies foster an understanding of the destination of sediment lost from Texas beaches, the locations of future sand sources based on the terminus of transport, and also inform budgeting available sand resources so that the GLO and its partners can enact a robust sediment management plan that cares for all Texas beaches.

Gulf Shoreline Segment	Shoreline Change Rate[1] (ft/yr)	Annual Sand Volume Needed (cy[2])
McFaddin	-12.3	1,345,000
Bolivar	-4.2	193,000
Galveston Island	-3.3	319,000
Surfside, Quintana, and Sargent	-5.4	867,000
Matagorda Peninsula	-2.3	457,000
Matagorda Island	-2.9	450,000
San Jose Island	-3.6	307,000
Mustang Island	-2.3	193,000
North Padre Island	-2.7	955,000
South Padre Island	-8.3	1,783,000
Total	-	**6,869,000 cy/yr**
4yr Planning Cycle Total	-	**27,476,000 cy**

[1] Shoreline change rates shown are from UT-BEG shoreline change data (1930s-2019)[161] but adjusted for nourishment to estimate what erosion rates would have been if nourishment had not occurred over any shoreline segment. This gives a more complete estimate of what the sediment needs will be on the Gulf coast assuming no nourishment has already occurred for that year.
[2] cy: cubic yards; cy/yr: cubic yards per year



(Photo Credit: Galveston Bay Foundation)

5.5.3. Managing Bay Shorelines

Texas bays have a wide range of shoreline types, with geographies, geophysical characteristics, development patterns, and habitat types that vary greatly across the thousands of miles of bay shorelines. Bay shorelines are often either direct links between our communities and the coast or make up critical habitat corridors and fringe areas that provide valuable ecosystem services to a broader coastal landscape. These intrinsic functions of bay shorelines are stressed as shorelines erode, habitats become more fragmented, or land uses change due to natural, social, and economic drivers.

The Managing Bay Shorelines action will determine the most critically changing bay shoreline areas and work toward stabilizing and enhancing those areas to mitigate vulnerabilities shown in the data collected for this action. The efforts within this action are especially focused on identifying opportunities to improve the connection between built and natural systems along the coast by finding hybrid (green/gray) approaches to make shorelines more resilient.

Areas where managing bay shorelines can enhance protection of coastal communities, protect and/or restore natural ecosystems, provide economic development opportunities, and improve community access to the coast are the primary focus of this action. This action will propose sustainable solutions that are more likely to improve project longevity when considering increasing storm intensities and rising sea levels.

MANAGING BAY SHORELINES

Today's Opportunities

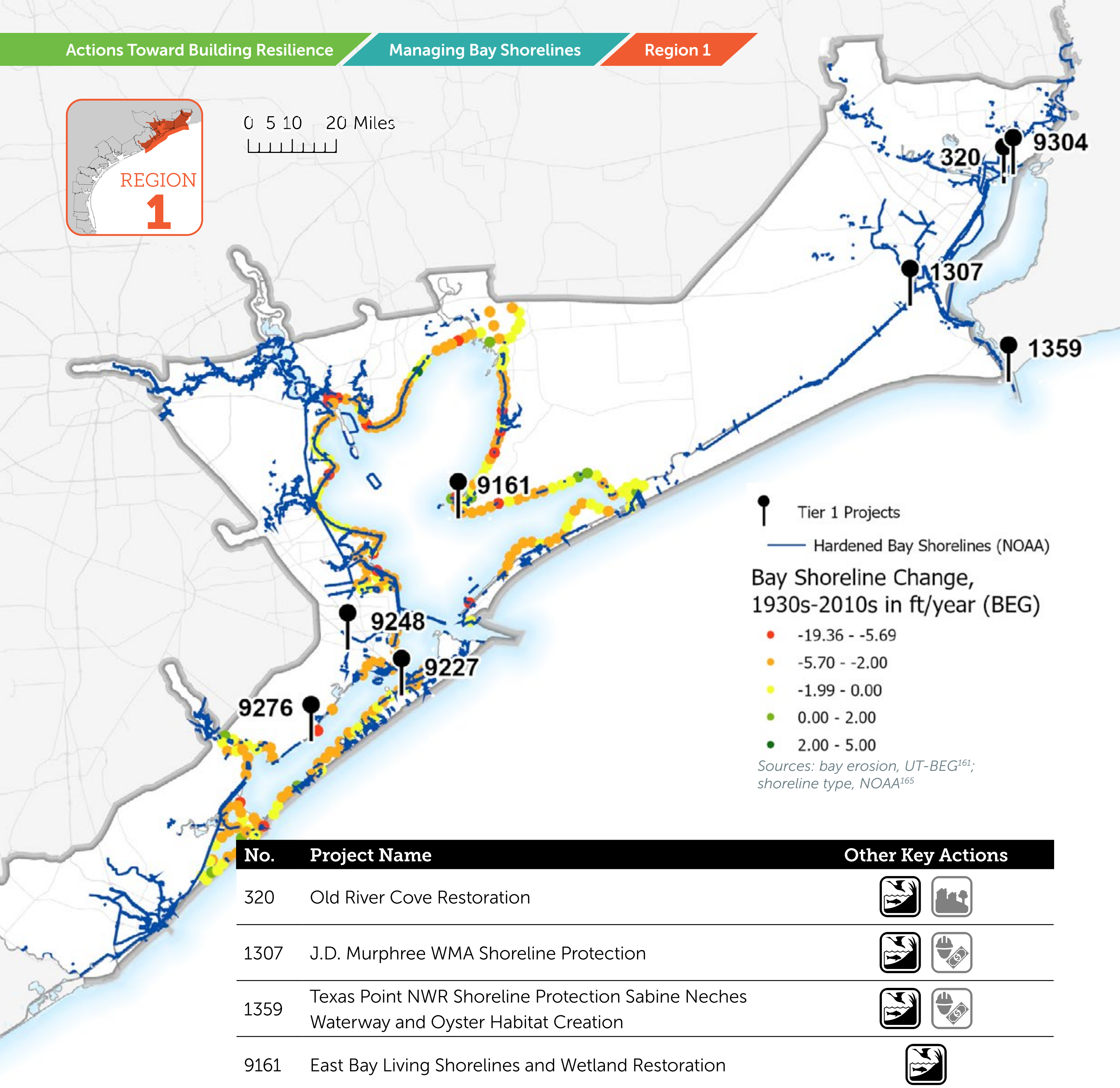
- Respond to RSLR
- Opportunities for BUDM
- Restore rookery islands
- Construct living shorelines
- Manage freshwater inflows

Emerging Opportunities

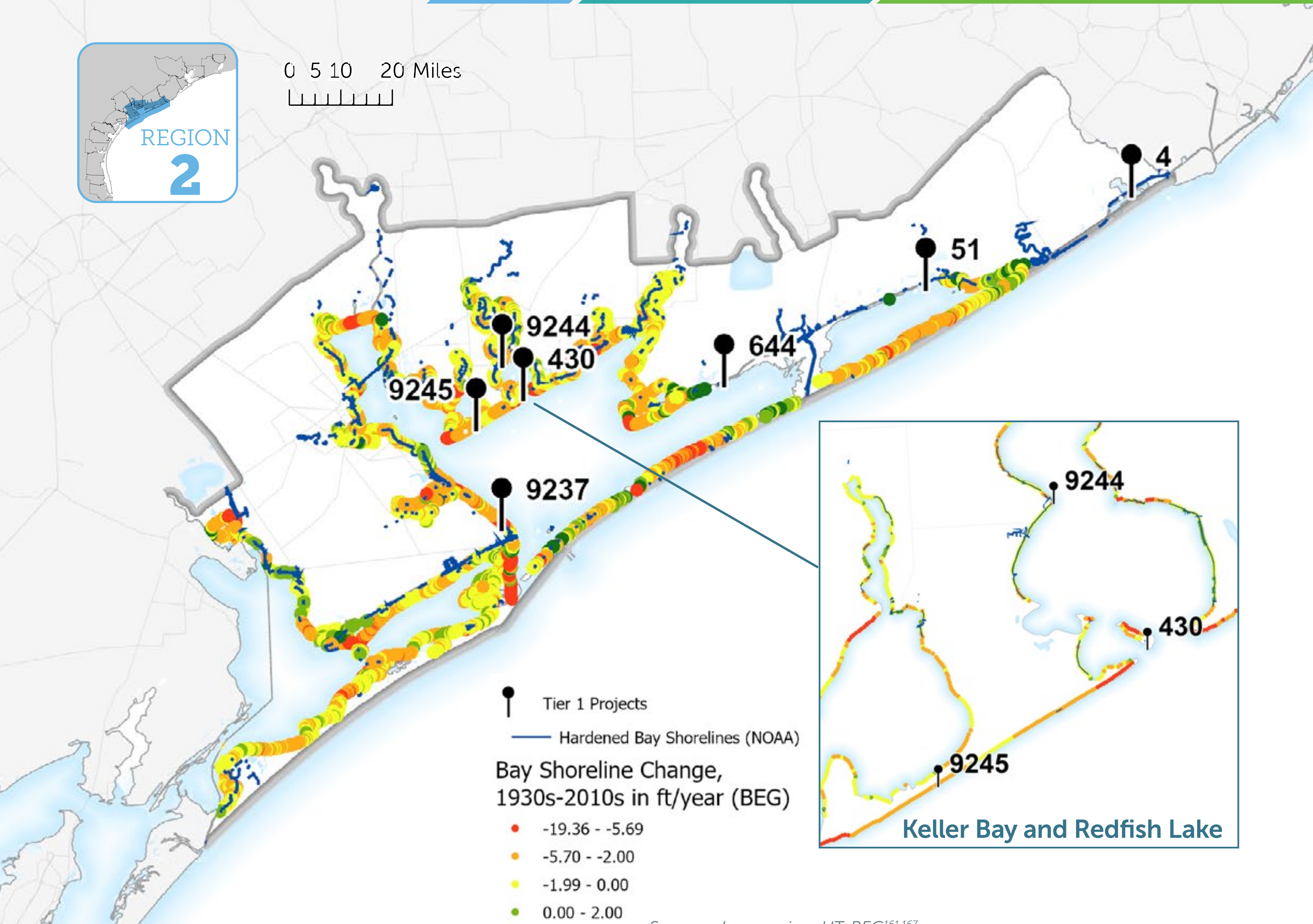
- Bay sides of barrier islands
- BUDM master planning
- Natural capital and ecosystem services

Related Actions

- Managing Coastal Habitats
- Managing Gulf Shorelines
- Managing Watersheds

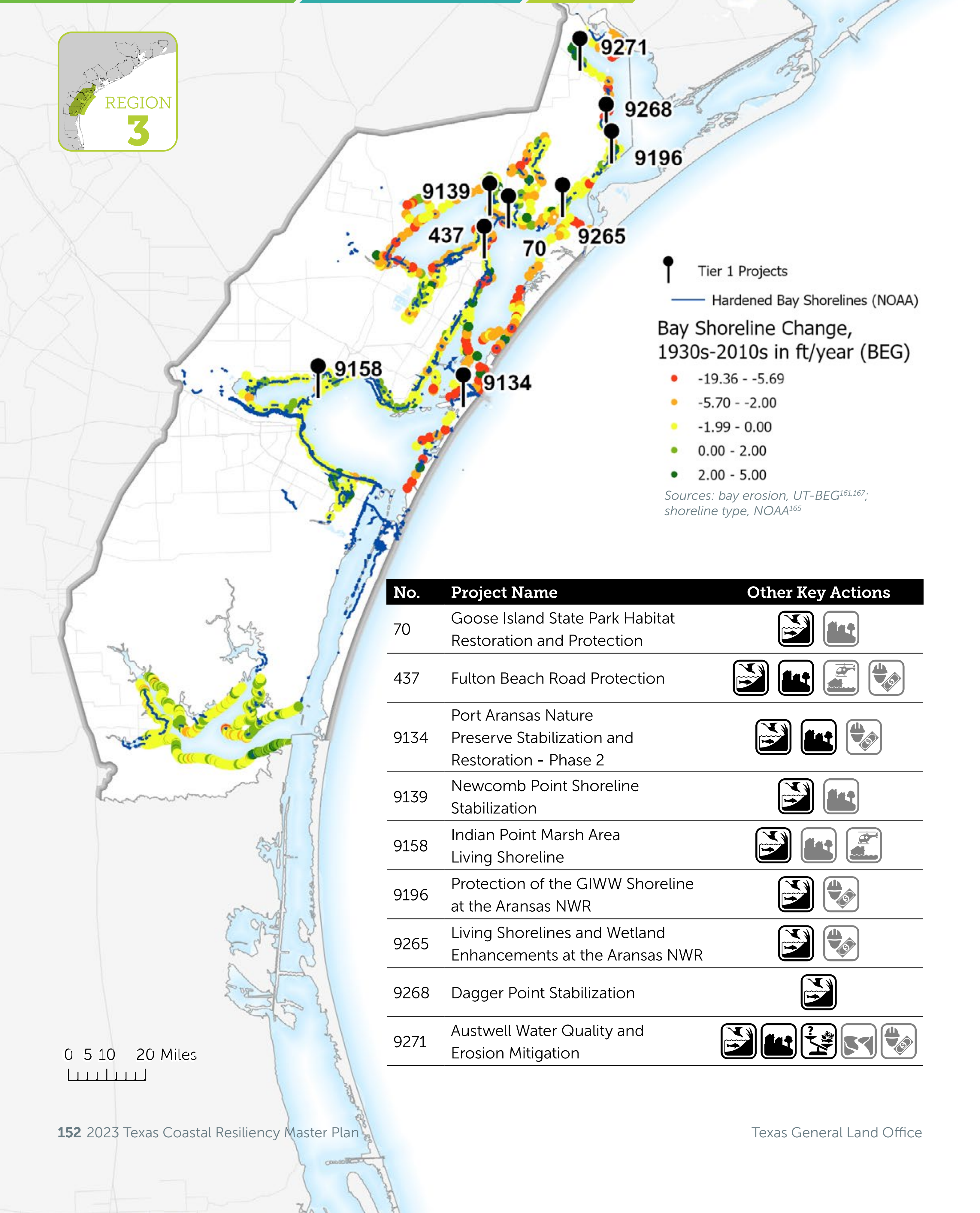


No.	Project Name	Other Key Actions
320	Old River Cove Restoration	
1307	J.D. Murphree WMA Shoreline Protection	
1359	Texas Point NWR Shoreline Protection Sabine Neches Waterway and Oyster Habitat Creation	
9161	East Bay Living Shorelines and Wetland Restoration	
9227	West Bay Living Shorelines at Sweetwater Preserve and Maggie's Cove	
9248	Highland Bayou Shoreline and Marsh Restoration Project	
9276	Chocolate Bay Preserve Shoreline Protection and Marsh Restoration	
9304	Hickory Cove Marsh Restoration	

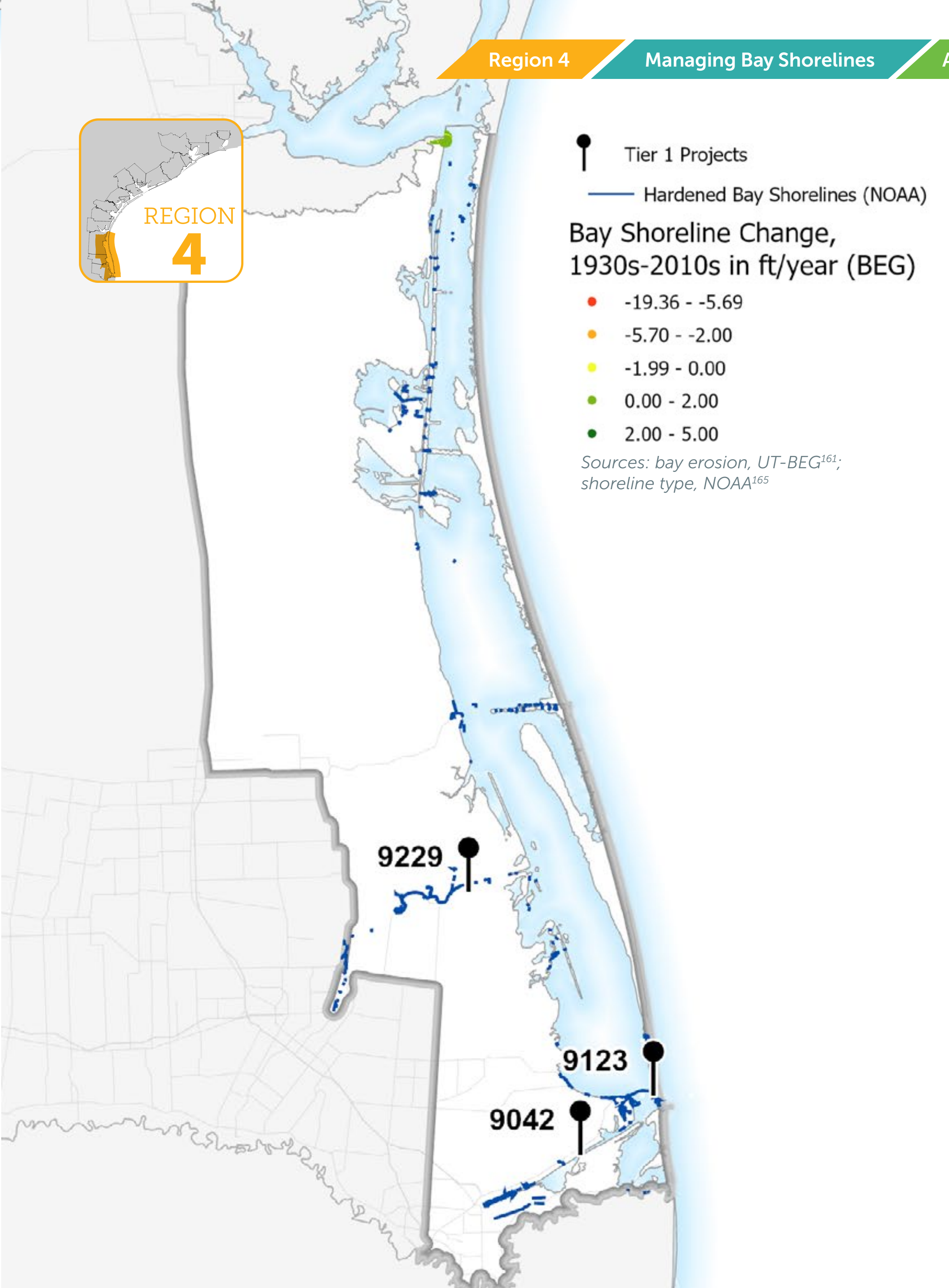


Sources: bay erosion, UT-BEG[161,167]; shoreline type, NOAA[165]

No.	Project Name	Other Key Actions
4	San Bernard NWR Shoreline Protection	
51	Boggy Cut GIWW Stabilization	
430	Carancahua Bay Habitat Preservation and Enhancement	
644	Mad Island Marsh Preserve Shoreline Protection and Coastal Ecosystem Restoration - Phase 1	
9237	Boggy Nature Park Shoreline Stabilization	
9244	Port Alto County Park Shoreline Protection and Restoration - Phase 2	
9245	Sand Point Peninsula Living Shoreline	



No.	Project Name	Other Key Actions
70	Goose Island State Park Habitat Restoration and Protection	
437	Fulton Beach Road Protection	
9134	Port Aransas Nature Preserve Stabilization and Restoration - Phase 2	
9139	Newcomb Point Shoreline Stabilization	
9158	Indian Point Marsh Area Living Shoreline	
9196	Protection of the GIWW Shoreline at the Aransas NWR	
9265	Living Shorelines and Wetland Enhancements at the Aransas NWR	
9268	Dagger Point Stabilization	
9271	Austwell Water Quality and Erosion Mitigation	



No.	Project Name	Other Key Actions
9042	Bahia Grande Living Shoreline	
9123	City of South Padre Island Living Shoreline	
9229	Adolph Thomae, Jr. Park Living Shoreline Restoration - Phase 5	

Deep Dive: Texas Living Shoreline Initiative

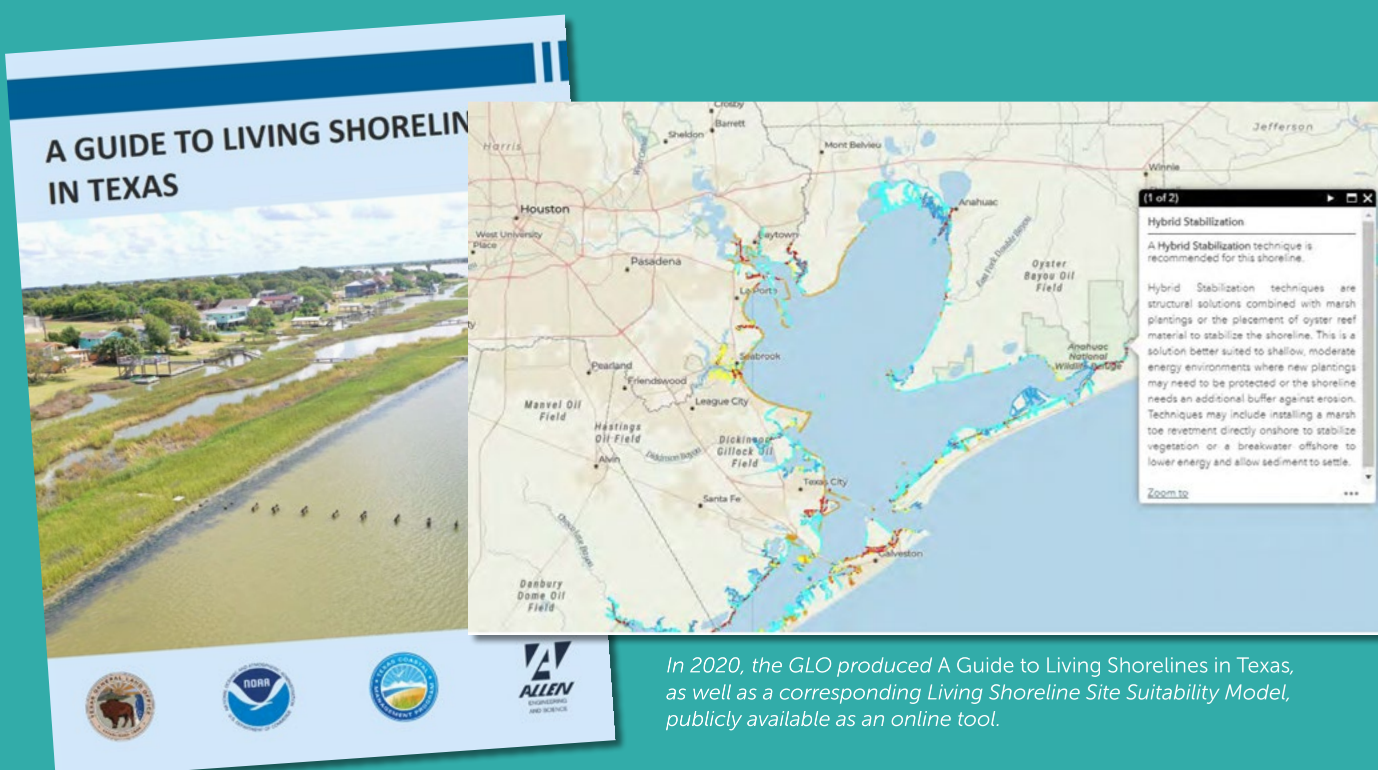
Land loss is a common concern for coastal landowners. Unprotected shorelines are at the mercy of wind, wave, and tidal energy and are vulnerable to erosion. Living shorelines can be an appropriate solution to help landowners protect their property. Living shorelines protect shorelines from erosion, are highly adaptable to SLR, require minimal long-term maintenance, enhance property aesthetics, and create habitat for terrestrial and aquatic species. Living shorelines use natural components such as upland native trees and shrubs, native tidal marsh vegetation, seagrasses, and other submerged vegetation, in combination with energy reduction structures, such as a breakwater, to combat these forces.

The GLO is working to promote the use of living shorelines as alternatives to traditional, hard shoreline stabilization techniques along public and private lands through its new Texas Living Shorelines Initiative.[168] The GLO, in collaboration with the Texas A&M Corpus Christi's Harte Research Institute and Allen Engineering, produced "A Guide to Living Shorelines in Texas" and an accompanying living shoreline site suitability model in September 2020.[169,170]

The Guide provides information on living shoreline options, installation methodology, common living shoreline vegetation, permitting requirements, and how to take the necessary next steps toward implementing a living shoreline project. The living shoreline site suitability model works in companionship with the Guide and allows stakeholders to input specific property locations and discover which living shoreline type would be most appropriate to install along certain properties. The model takes into account the type of shoreline present, shoreline slope, wave energy, salinity, erosion rate, potential for wave growth, and water depth before making a living shoreline recommendation. The Guide, suitability tool, and other helpful documents can be found on the GLO's Living Shorelines website which acts as a one-stop-shop for Texas living shoreline resources.

Guide: https://cleancoast.texas.gov/documents/guide-to-living-shorelines-texas.pdf

Online Tool:
https://gomaportal.tamucc.edu/GLO/LivingShorelines/



In 2020, the GLO produced A Guide to Living Shorelines in Texas, *as well as a corresponding Living Shoreline Site Suitability Model, publicly available as an online tool.*

5.5.4. Improving Community Resilience

Community infrastructure and water management needs along the Texas coast are wide ranging, with varying resilience concerns (often depending on the size or age of a given community) that, when addressed, can lead to significant positive impacts on the quality of life for coastal populations. For the purposes of this action, projects that are expected to significantly improve coastal community infrastructure resilience in the face of both short- and long-term hazards—including storm surge, wave effects, and inland flooding—are prioritized.

This action also incorporates other elements of water management, including urban considerations for water quality and quantity, which can often be directly correlated to rainfall events, drought cycles, stormwater runoff, and coastal storms. Long-term hazards include impacts to infrastructure caused by rising water levels from sea level rise, especially when adaptive capacity and/or retrofit measures were not considered as part of original infrastructure designs or community planning.

The Improving Community Resilience action will be used to identify local and regional project needs to mitigate water quality and quantity hazards for coastal communities, working to both reduce exposure and minimize system vulnerabilities. It is critical under this action to consider full project life cycles, including thorough infrastructure planning all the way through project implementation and adaptive management. Major future risks for this action are community development patterns and changing coastal landscapes and it will become increasingly more important to create science-based decision frameworks for community infrastructure development and improvements.

Harnessing the adaptive abilities of natural systems that make space for the functional need for engineered solutions through hybrid (green/gray) infrastructure will be important. Developing a path forward for coastal communities to exist independently of the constant threats of infrastructure damage and impacts to daily life is the ultimate goal of this action.

IMPROVING COMMUNITY RESILIENCE

Today's Opportunities

- Nature-based solutions
- Reduce flood risk
- Hazard Mitigation Funding availability (IIJA, BRIC, etc.)*
- Regional flood planning

Emerging Opportunities

- Responsible Development (managing retreat)
- System-wide planning
- Pre-disaster mitigation
- Water rights policy

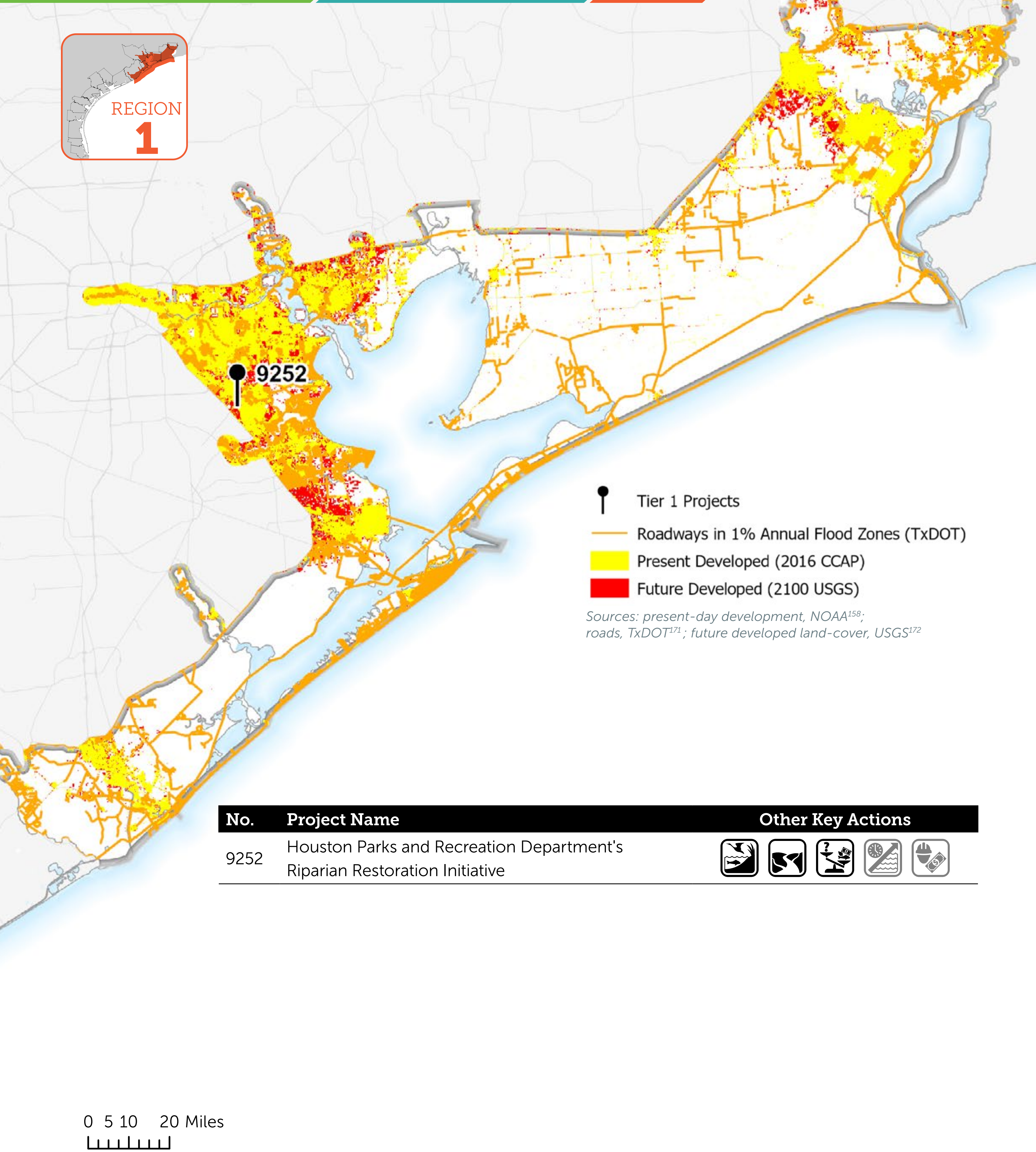
Related Actions

- Adapting to Changing Conditions
- Managing Watersheds
- Enhancing Emergency Preparation and Response
- Addressing Under-Represented Needs
- Maintaining Coastal Economic Growth

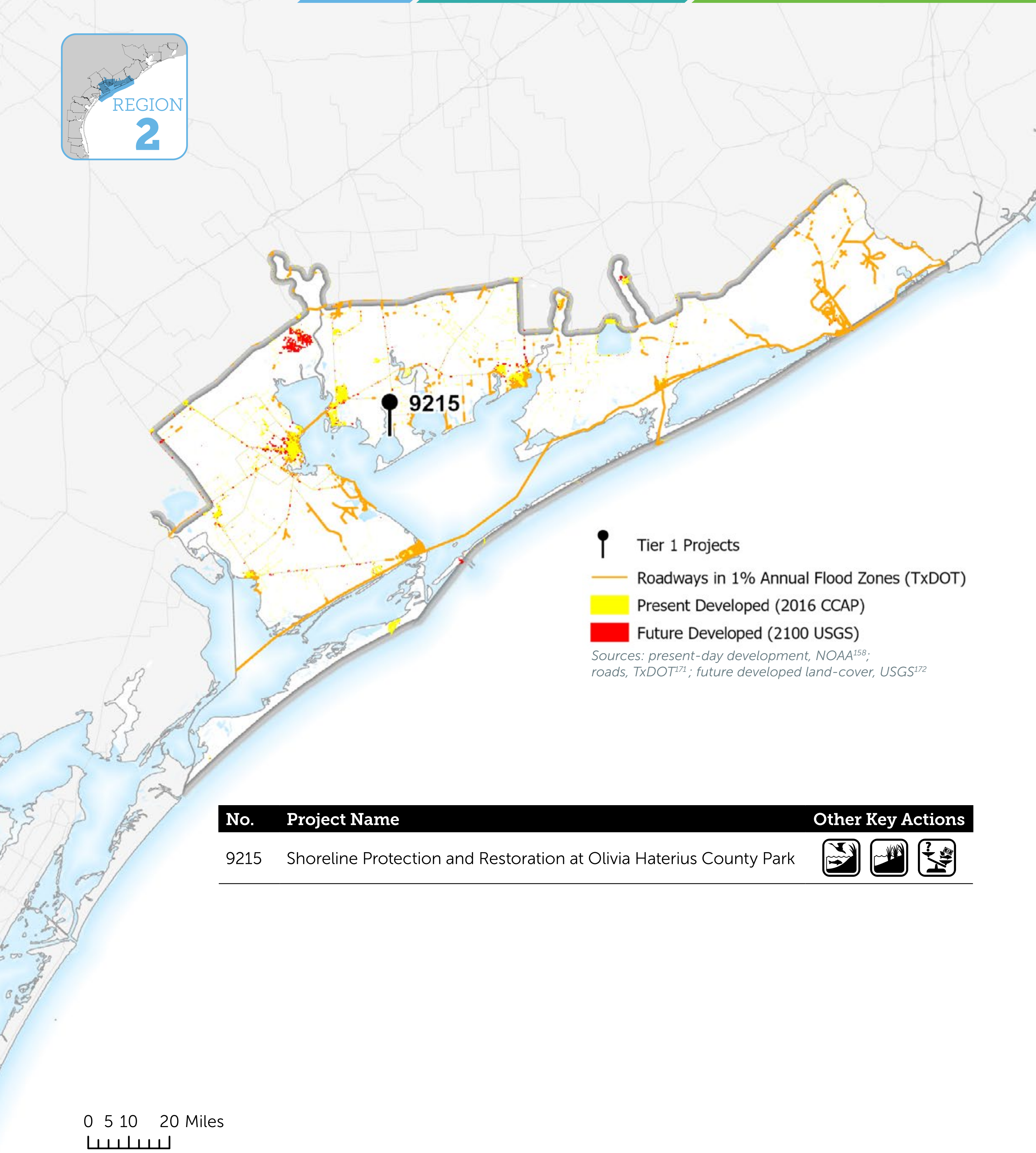
**IIJA: Infrastructure Investment and Jobs Act*
BRIC: Building Resilient Infrastructure and Communities

(Photo Credit: Port of Palacios)

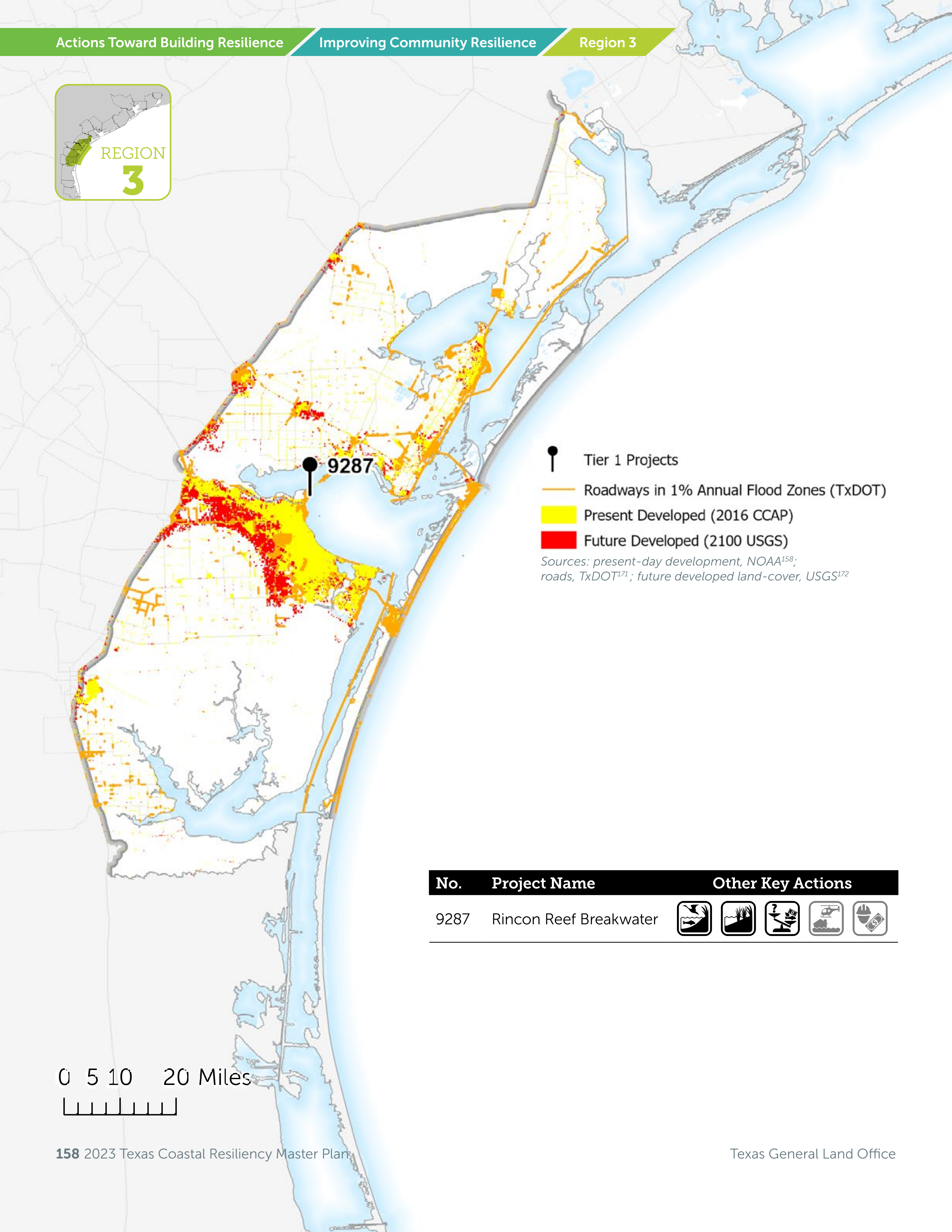
REGION 1



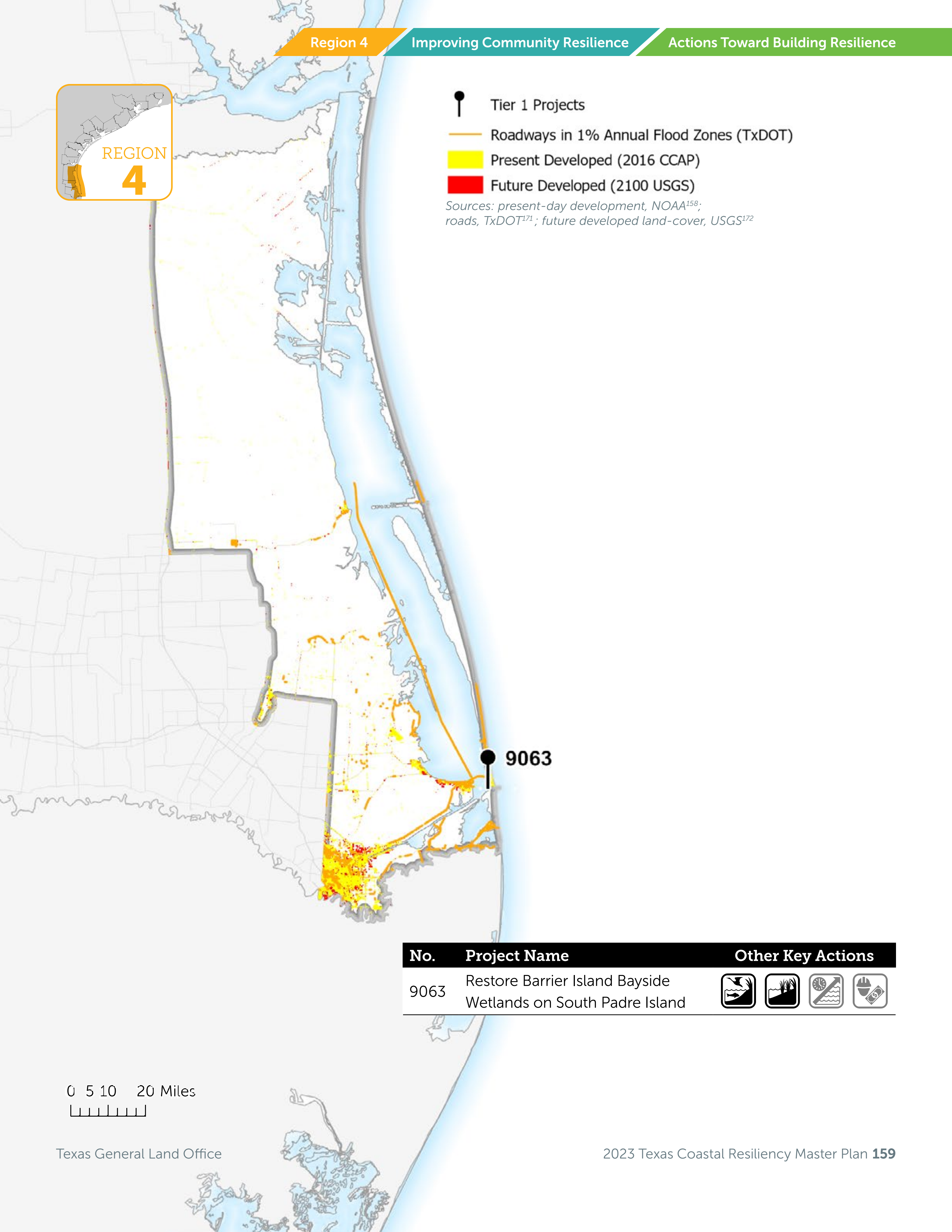
No.	Project Name	Other Key Actions
9252	Houston Parks and Recreation Department's Riparian Restoration Initiative	



No.	Project Name	Other Key Actions
9215	Shoreline Protection and Restoration at Olivia Haterius County Park	



No.	Project Name	Other Key Actions
9287	Rincon Reef Breakwater	



No.	Project Name	Other Key Actions
9063	Restore Barrier Island Bayside Wetlands on South Padre Island	

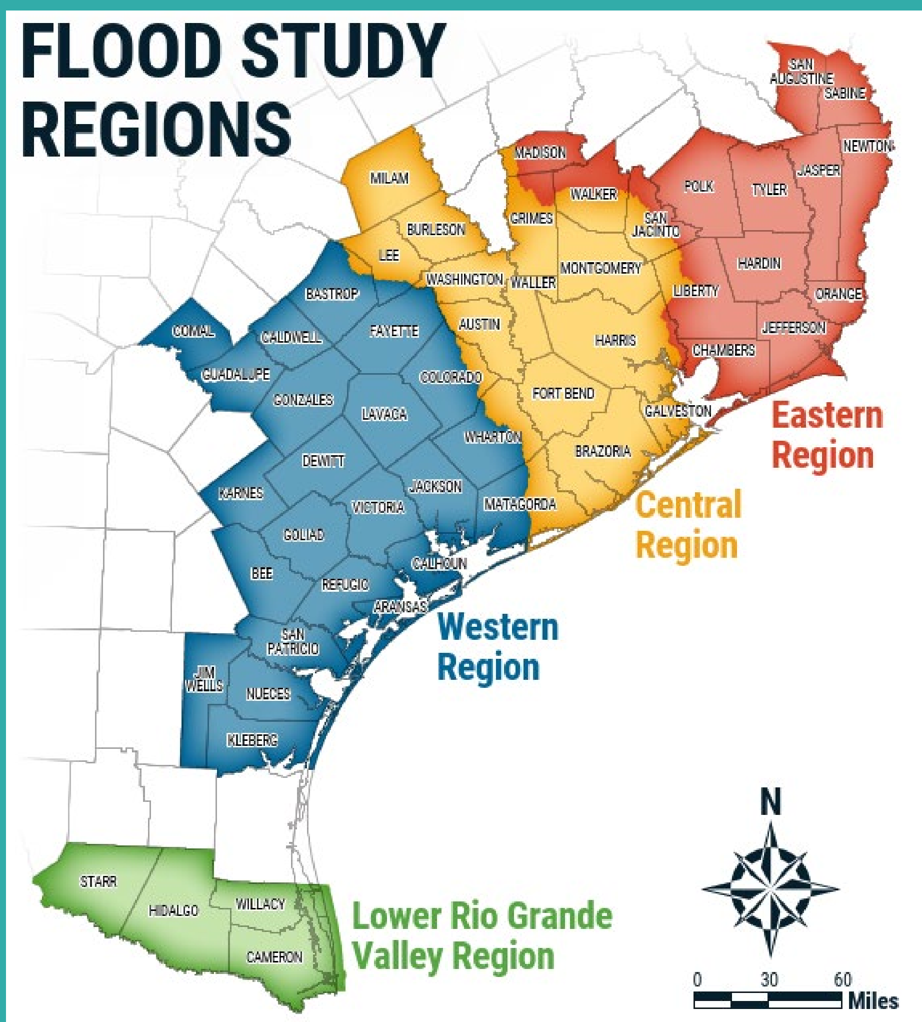
Deep Dive: GLO River Basin Flood Studies[22]

In September 2020, the GLO initiated the Combined River Basin Flood Studies to collect, analyze, and communicate flood risk information to help decision makers with protecting Texans from future floods. The goals for the flood study are to:

- Evaluate flood risks to communities
- Identify flood projects that strengthen the resilience of communities
- Identify possible funding sources for community flood projects

Led by the GLO's CDR Division, the Combined River Basin Flood Studies will analyze regional and local flood mitigation solutions to promote sound short- and long-term recovery. The study will increase the resiliency of communities most at risk of flooding by enabling them to undertake the most effective projects that reflect local priorities and needs. This effort will also maximize the use of HUD CDBG-DR and CDBG-MIT funding to build back stronger and more resilient communities.

By partnering with active federal and state efforts, the Studies seek to draw from the strengths, expertise, and capabilities of public, private, and academic centers of excellence throughout Texas. The data and information produced by the GLO from this planning effort will be utilized to support current and future Texas State Flood Plans (led by TWDB) and inform the Texas Disaster Information System, a critical tool for the State to assist communities in the development of disaster recovery and mitigation plans.



The GLO's Combined River Basin Flood Studies has been divided into four combined river basin regions: Eastern, Central, Western, and Lower Rio Grande Valley.[173]

(Photo Credit: Coastal Bend Bays & Estuaries Program)

5.5.5. Adapting to Changing Conditions

While other actions developed for this Plan point to specific concerns (for example, data needs, watershed needs, habitat needs) that are commonplace along the Texas coast, the Adapting to Changing Conditions action is formulated to provide an avenue to: a) identify a wider set of potential future measures that could be needed along the Texas coast by predicting what a future Texas coastal environment could look like and b) identify steps to implement those measures.

The coast is meaningful to Texans in a variety of ways—it drives industries that are the backbone of our state economy, is home to diverse habitats and landscapes that are unique to Texas and is home to millions of residents—but is constantly changing in response to natural, social, and economic pressures. Understanding that the risk to the Texas coast is changing over time is vital to effectively implementing resiliency measures throughout the region.

The Adapting to Changing Conditions action is focused on broad scale, proactive planning that can enhance our state's future. Historically, the majority of coastal resilience projects along the Texas coast have been reactive, aiming to address problems that had already arisen by restoring habitat, coastlines, and development to historical or other prior conditions. As a state, we must begin to think about what has yet to happen and decide what the best course of action will be to respond.

ADAPTING TO CHANGING CONDITIONS

Today's Opportunities

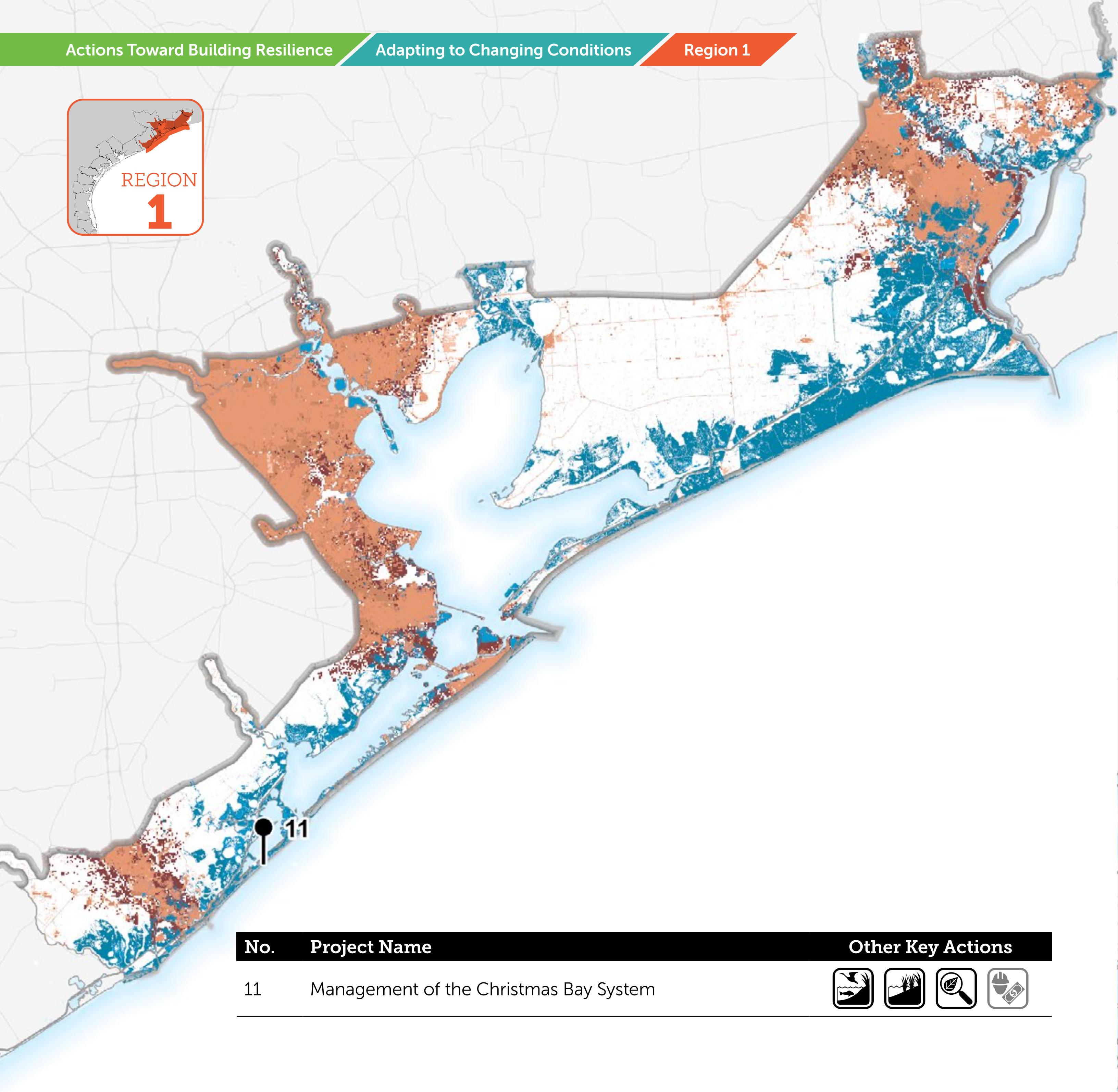
- Respond to RSLR
- Soil health practices
- Sediment management planning

Emerging Opportunities

- System-wide planning
- Pre-disaster mitigation
- Water rights policy

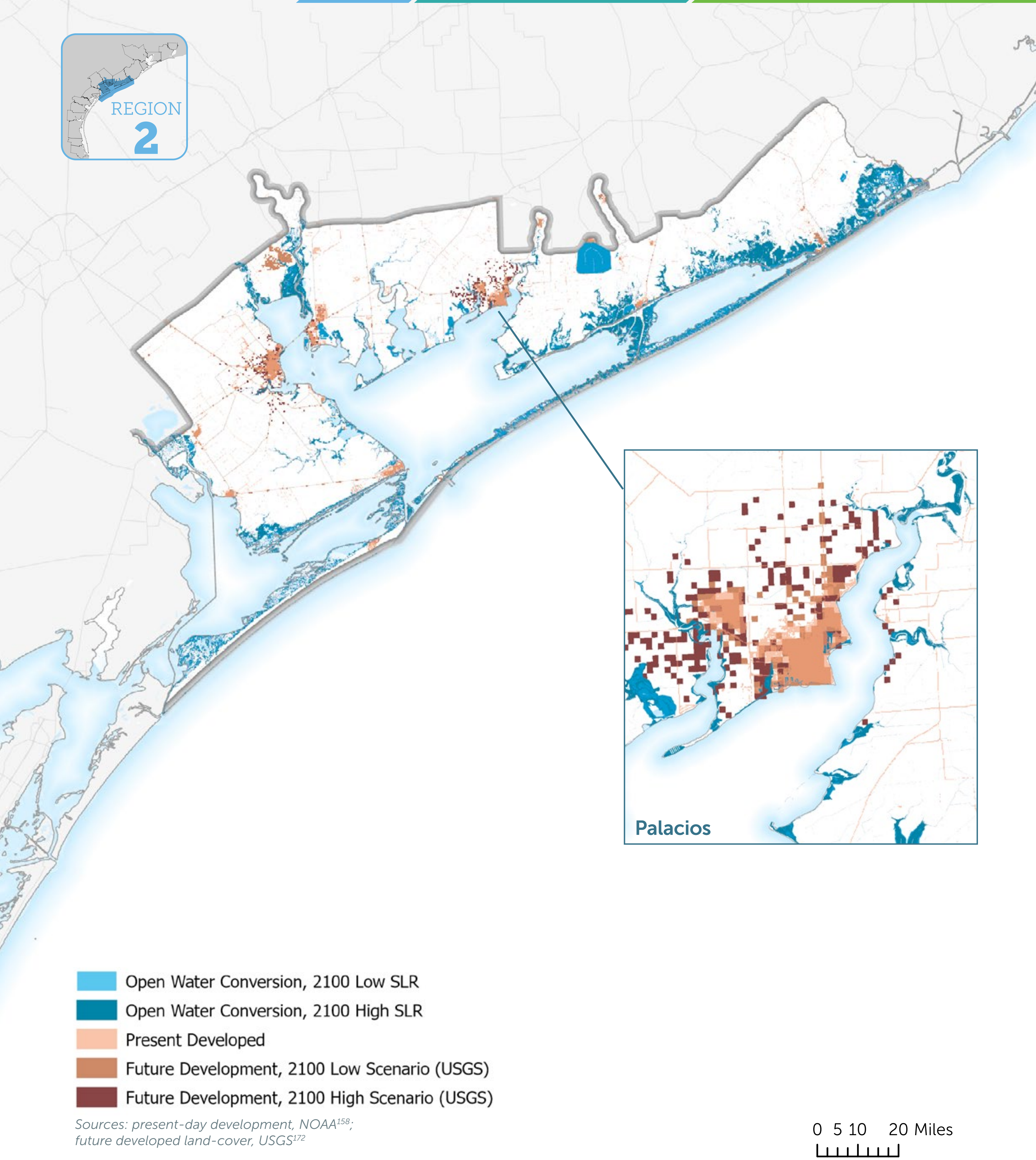
Related Actions

- Managing Watersheds
- Enhancing Emergency Preparation and Response
- Addressing Under-Represented Needs

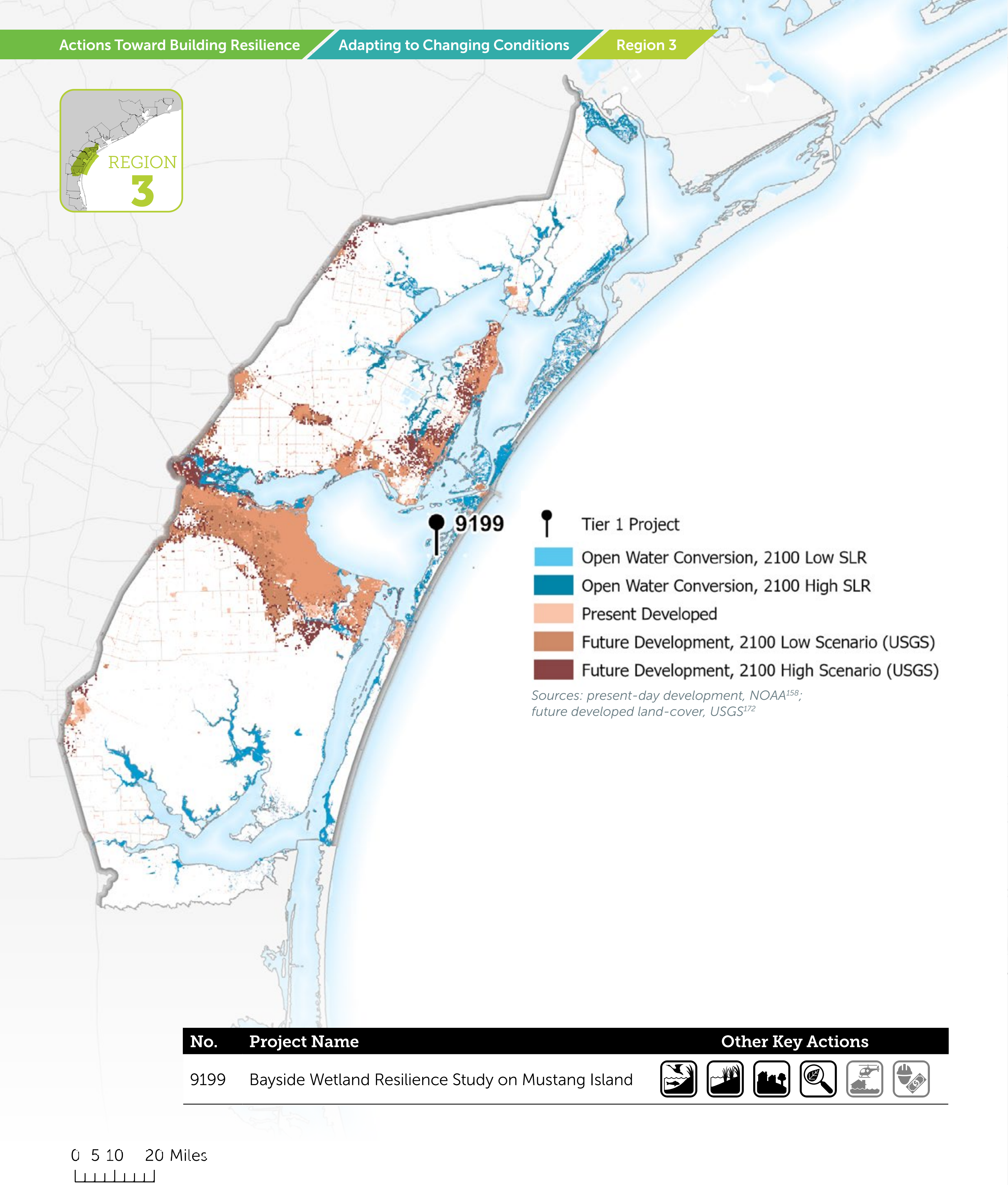


No.	Project Name	Other Key Actions
11	Management of the Christmas Bay System	

Sources: present-day development, NOAA[158]; future developed land-cover, USGS[172]

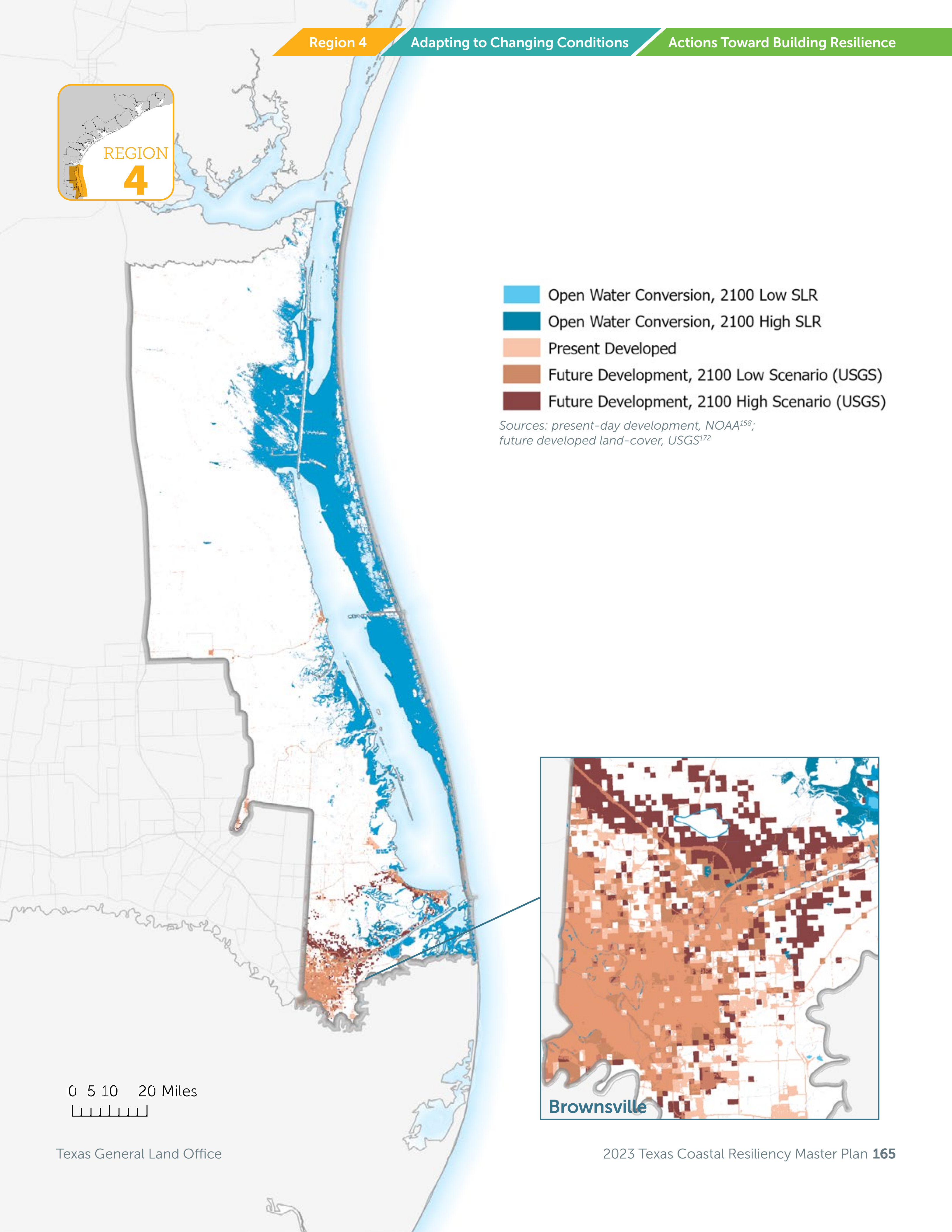


Sources: present-day development, NOAA[158]; future developed land-cover, USGS[172]



Sources: present-day development, NOAA[158]; future developed land-cover, USGS[172]

No.	Project Name	Other Key Actions
9199	Bayside Wetland Resilience Study on Mustang Island	



Sources: present-day development, NOAA[158]; future developed land-cover, USGS[172]

Deep Dive: Responsible Development

"Managed retreat" is industry terminology for buying-out or relocating coastal properties in high-risk areas that have greater exposure than more inland areas to coastal flooding, storm surge, shoreline erosion, RSLR, and similar coast-specific vulnerabilities that have high likelihoods of undermining coastal infrastructure. When coastal infrastructure is undermined, it becomes more challenging for municipalities to provide essential services, such as roadways, hospitals, and utilities to those communities and can also put lives of inhabitants and first responders at elevated risk. In Texas, our goal is to find ways to develop our coastal communities while maintaining robust levels of protection, including multiple lines of defense, from coastal vulnerabilities in the near-term and long-term planning horizons. Developing Texas's communities responsibly with this overarching goal in mind can be thought of, not as merely retreating from our coastlines, but as Texans choosing responsible development approaches as a defense from known hazards.

This kind of responsible development—development that considers a future coast with higher water levels, larger populations, greater amounts of infrastructure, more commercial and residential properties, and more frequent exposure to extreme storm events—will require legislators, decision-makers, individual people, and industry leaders throughout the state making realistic, informed decisions to both avoid developing in high risk areas and reclaim coastal lands for the betterment of the environment. This will ultimately protect Texas's natural resources and the lives of all who live, work, or

Bulkhead failure (Photo Credit: Galveston Bay Foundation)

Bulkhead failure (Photo Credit: Galveston Bay Foundation)

recreate on the Texas coast. Additionally, these efforts would need to consider and account for inclusion of low- to moderate-income households and the elderly.

Developing the coast in a responsible manner will help Texans live more independently of future natural disasters. Efforts to conserve vulnerable lands and habitats, hold a strong dune setback line, provide adequate flood storage areas, manage shoreline erosion, and remove at-risk homes and infrastructure from floodways, floodplains, and other high risk areas will allow Texans to enjoy the fruits of their coastlands without repeatedly enduring wreckage and rebuilding cycles in areas that are known to have elevated risk to hurricanes and other coastal storms. In some cases, this progress toward responsible development practices may be hard earned and may be most practicably achieved by acquiring developed land, elevating at-risk structures, and relocating repetitive loss properties.

(Photo Credit: Galveston Bay Foundation)

(Photo Credit: Texas General Land Office)

5.5.6. Managing Watersheds

Coastal watersheds have unique complications when compared to inland watersheds, which can make them more challenging to manage. In addition to the riverine conditions common to all watersheds, the intersections of riverine and bay systems that are tidally influenced have bay-specific characteristics, such as deltaic formation, fluctuating salinity gradients, and presence of tidal forces. Tidal considerations can vary significantly by coastal watershed, creating unique tidal flushing characteristics that generate watershed-wide impacts to water quality and quantity. Given the complexity of these and other, similar watershed-related concerns (e.g., large rainfall events, stormwater runoff, periods of drought), there is much to consider related to comprehensive coastal water resources management.

The Managing Watersheds action is focused on capturing the above considerations within projects that span either a single watershed or a network of watersheds. Texas coastal watersheds can vary considerably in their specific natural processes and environmental features, as noted, but also in human development within the watersheds. This action will work to establish management priorities that are suitable for both rural and urban watershed needs, ranging from best practices that can be implemented at local levels to large-scale, regional plans that can be implemented for entire systems.

	No.	Project Name	Other Key Actions
Coastwide	9183	Clean Coast Texas Program	

MANAGING WATERSHEDS

Today's Opportunities

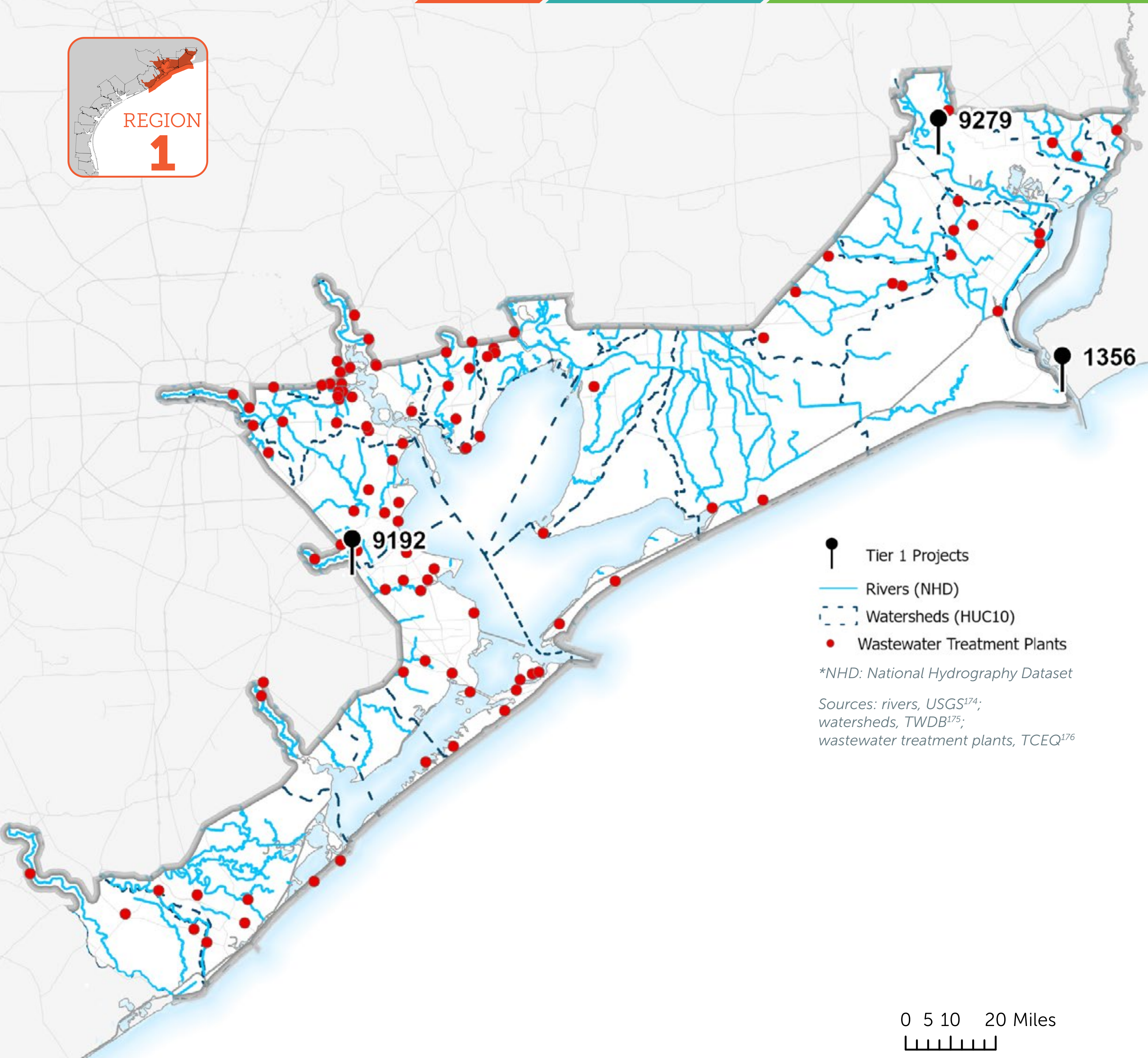
- Nature-based solutions
- Manage freshwater inflows
- Soil health practices
- Flood risk reduction
- Hazard Mitigation Funding availability (IIJA, BRIC, etc.)
- Regional flood planning

Emerging Opportunities

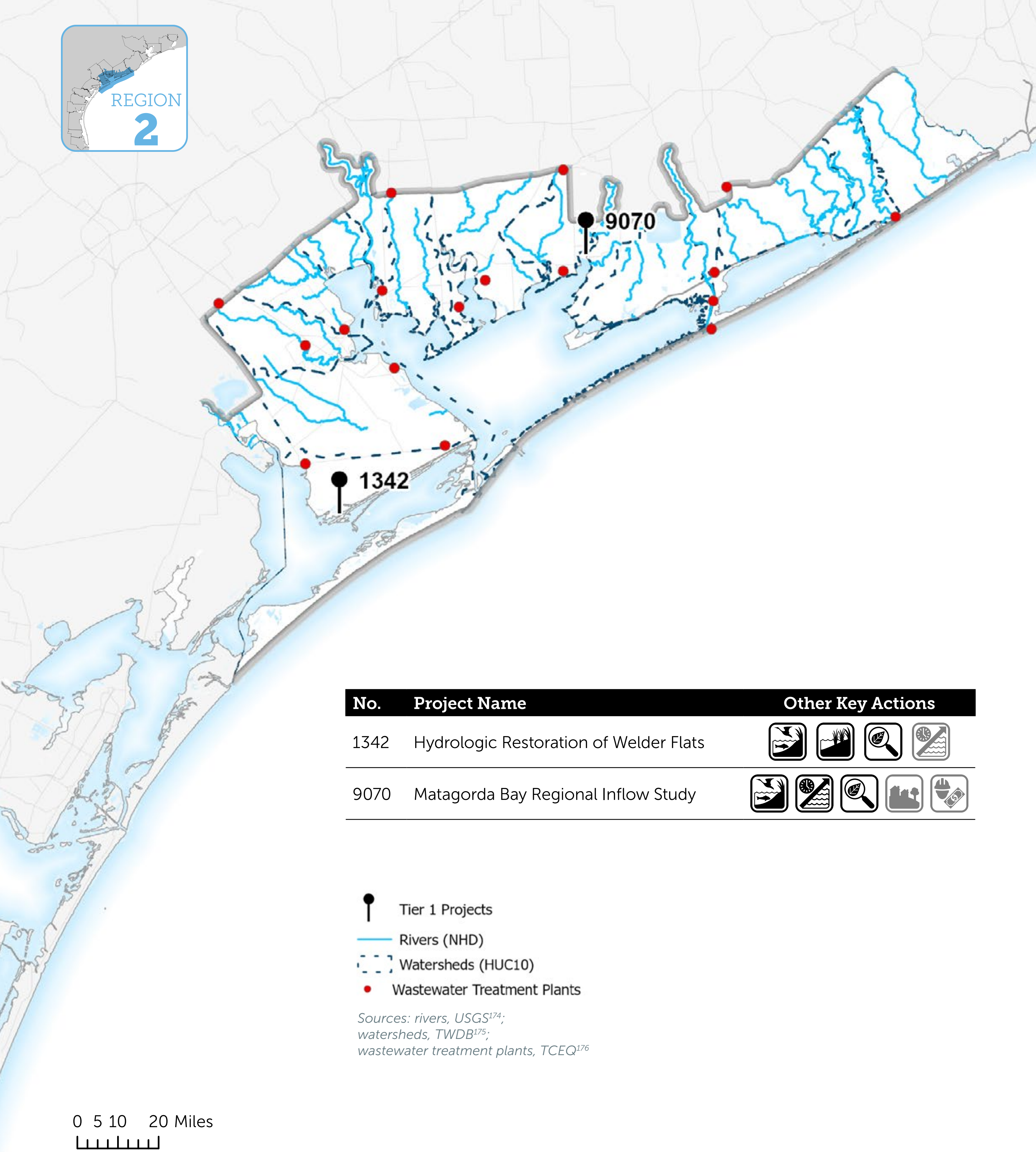
- System-wide planning
- Pre-disaster mitigation
- Water rights policy

Related Actions

- Managing Coastal Habitats
- Managing Gulf Shorelines
- Managing Bay Shorelines
- Improving Community Resilience
- Adapting to Changing Conditions
- Enhancing Emergency Preparation and Response

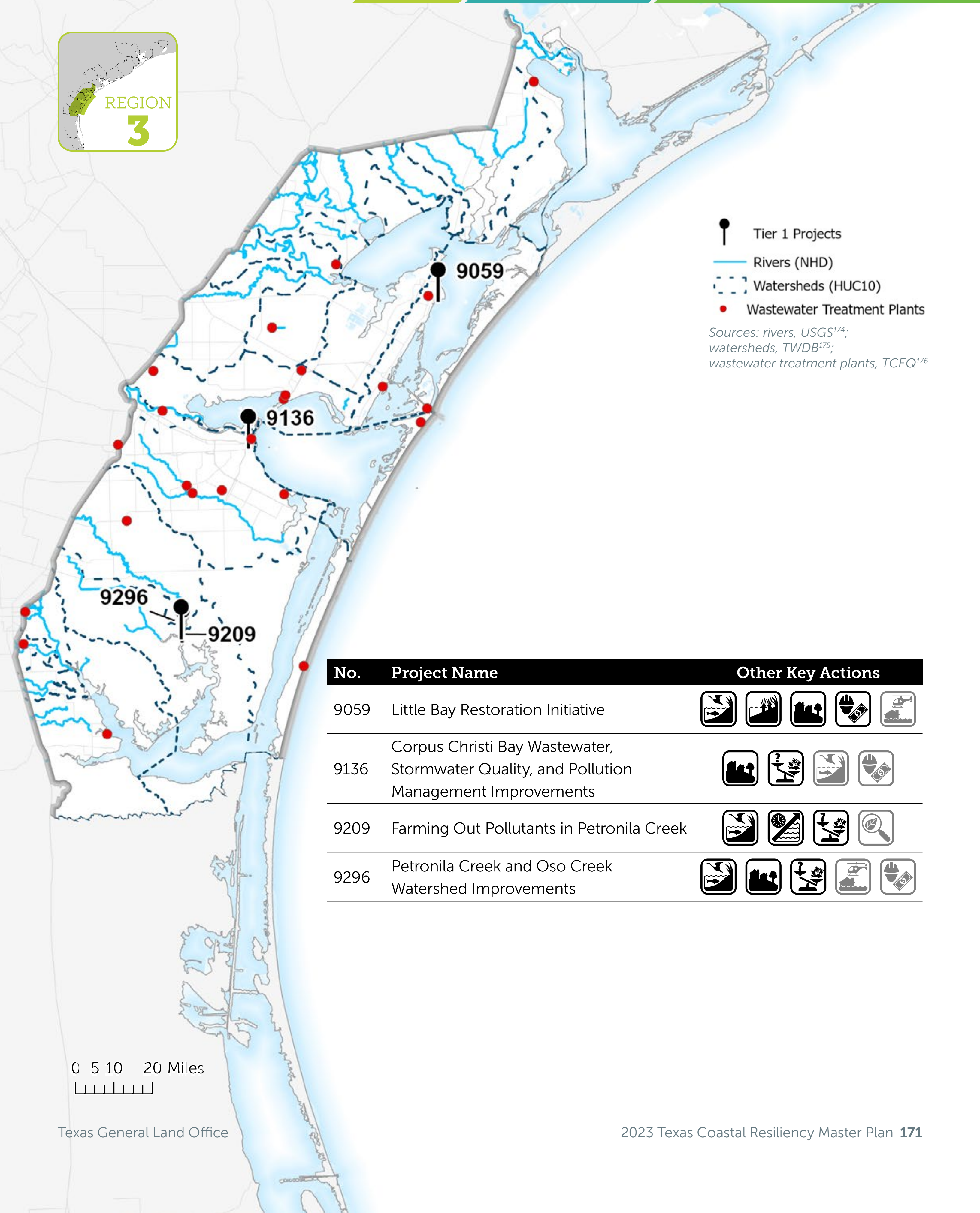


No.	Project Name	Other Key Actions
1356	Texas Bayou Water Control Structure	
9192	Lower Clear Creek and Dickinson Bayou Watershed Flood Risk Reduction Program	
9279	Neches River Forested Floodplain	

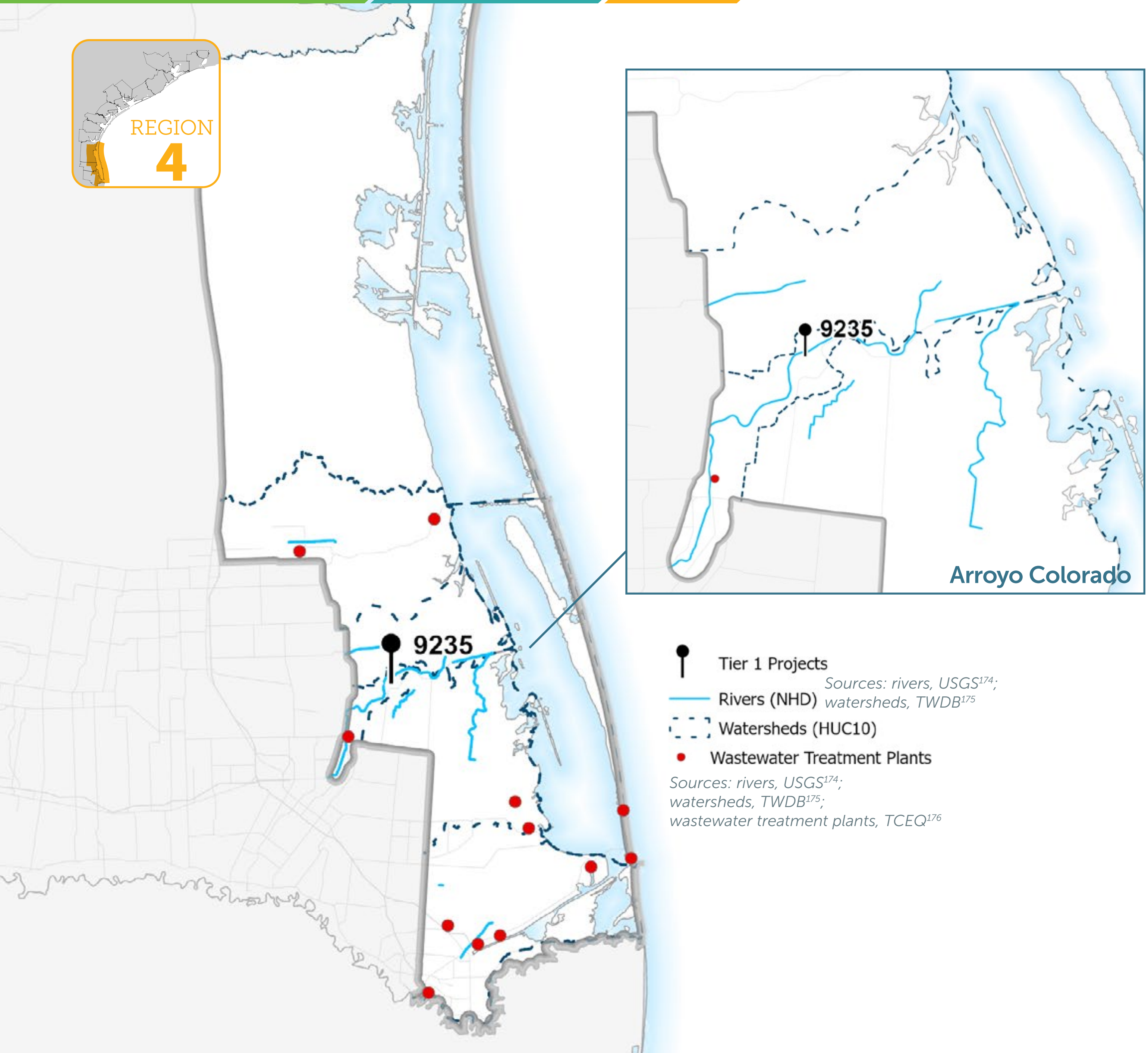


No.	Project Name	Other Key Actions
1342	Hydrologic Restoration of Welder Flats	
9070	Matagorda Bay Regional Inflow Study	

REGION 3



No.	Project Name	Other Key Actions
9059	Little Bay Restoration Initiative	
9136	Corpus Christi Bay Wastewater, Stormwater Quality, and Pollution Management Improvements	
9209	Farming Out Pollutants in Petronila Creek	
9296	Petronila Creek and Oso Creek Watershed Improvements	



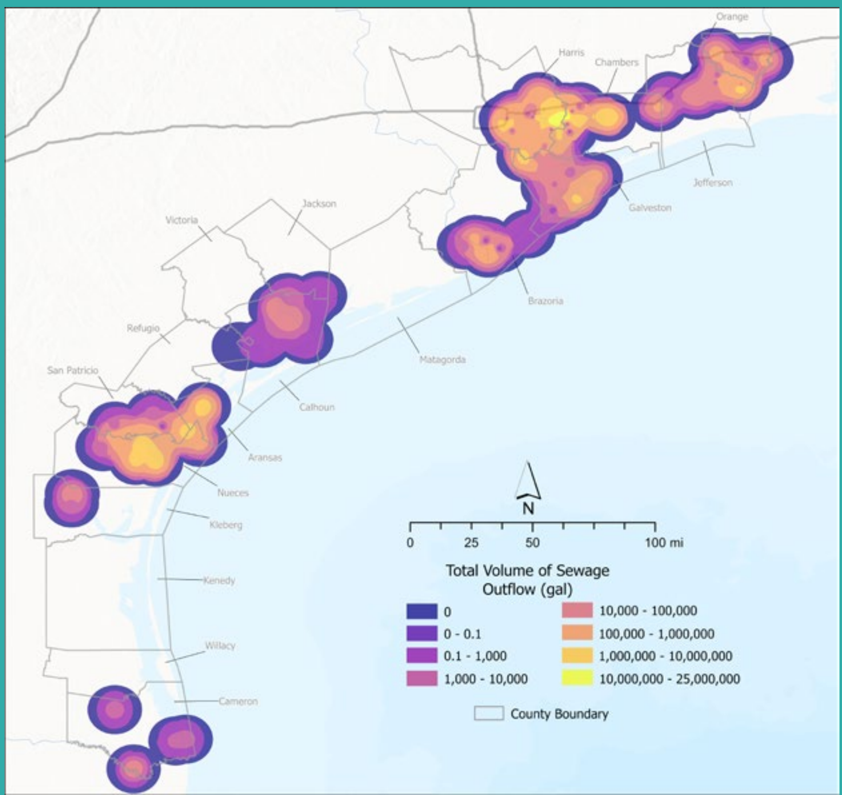
No.	Project Name	Other Key Actions
9235	Resaca System Restoration Project - Phase 1	

Deep Dive: Monitoring SSOs in the Coastal Zone

The GLO's Coastal Water Resources Program has been actively working to understand the vulnerabilities posed to coastal waters by sanitary sewer overflows from wastewater treatment plants and their collection and conveyance systems and on-site sewage facilities (OSSFs), otherwise known as septic systems. The vulnerabilities from SSOs have direct impacts to bays, coastal waters that drain to bays, and the Gulf of Mexico itself. If contaminant levels—such as increased levels of bacteria that can result from SSOs—in Texas's water bodies reach a certain threshold, the TCEQ will label the waterbodies as impaired and may initiate regulatory action depending on the severity of the impairment and the relative level of concern compared to other impaired waterbodies.

In addition to the vulnerabilities faced by inland wastewater treatment systems (flooding, line blockages, etc.), WWTPs and OSSFs in the coastal zone are also susceptible to coastal processes that may increase the likelihood and/or frequency of overflow incidents. As one example, depending on their locations relative to the shoreline and elevations above sea level, wastewater facilities (both WWTPs and OSSFs) may be at increased continued risk of overflow incidents related to RSLR. In the Texas coastal zone, at least six WWTPs and at least 2,270 septic systems are expected to be inundated by 3 feet of RSLR, which corresponds approximately with the years between 2050-2060 using the intermediate-high RSLR projections for this Plan.[162]

One encouraging finding from the initial analysis of the current state of WWTPs with reported SSOs over the past decade is that certain individual plants generate disproportionate volumes of SSOs into coastal waters compared to all the plants. In fact, 44% of WWTPs report no SSOs whatsoever. Because of this, it is possible that targeted rehabilitation efforts for certain individual WWTPs producing the greatest amounts of pollutants could lead to dramatic improvements in water quality and effluent. More detailed information pertaining to this assessment is available in the 2023 Technical Report.



Total reported volume of SSOs produced from 154 wastewater treatment plants in the Texas coastal zone boundary from July 2012 to April 2022.

5.5.7. Growing Key Knowledge and Experience

A common concern for achieving coastal resilience is a lack of up-to-date data and information that would better inform areas most at risk to coastal vulnerabilities or that would provide more insight into how to effectively perform resilience projects. While there have been and continue to be studies, monitoring and data collection efforts, and resilience projects completed up and down the Texas coast, it is still common to find subjects that are under-informed with regionally specific data. Often, resolving these needs is left to independent efforts to fill in the data gaps, which gradually happens over time. However, time is sacrificed in this approach and, as there is a lack of an overarching mission for the various data collection tasks, significant inefficiencies are created.

To help resolve this, the Growing Key Knowledge and Experience action is proposed to provide structure and vision for gathering data and information needed to improve coastal resilience in Texas. This action is intended to focus the goals of previously independent (e.g., project specific) data collection and studies and organize the efforts to fill any gaps in the current knowledge base that would be impactful for furthering the overall goals of this Plan.

In addition to data gathering and studies, there are novel techniques proposed for resilience in Texas ecosystems and communities that are not well understood or have yet to be attempted that could prove pivotal in furthering coastal resiliency goals. This action will support such techniques in the form of pilot projects or programs to provide pathways to stakeholders for future implementation. Pilot-type efforts under this action will help the GLO reduce long-term risk associated with new technologies through the understanding that while some of the pilot efforts may not return promising results, they may still be important in informing the broader picture of coastal resilience goals.

GROWING KEY KNOWLEDGE AND EXPERIENCE

Today's Opportunities

- Nature-based solutions
- Sediment management planning

Emerging Opportunities

- Bay sides of barrier islands
- Natural capital and ecosystem services
- Carbon sequestration and storage
- Tidal flat restoration research

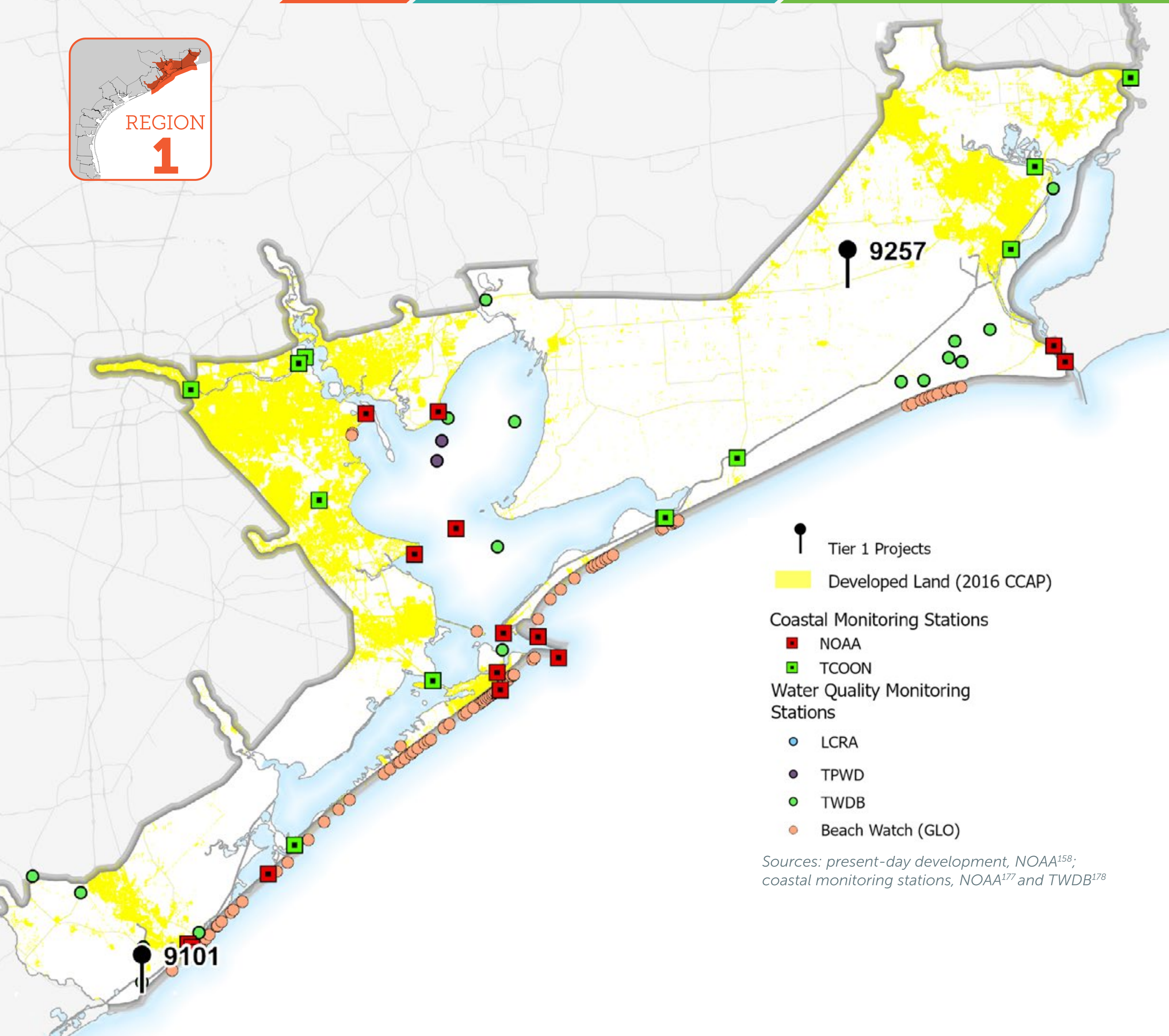
Related Actions

- Managing Coastal Habitats
- Managing Gulf Shorelines
- Managing Bay Shorelines
- Adapting to Changing Conditions
- Managing Watersheds

Example Opportunities for Future Research:

- Carbon sequestration and storage
- Tidal flat restoration
- Agricultural soil health
- Ecosystem service valuations for coastal habitats

	No.	Project Name	Other Key Actions
Coastwide	1	Texas Coastal Resiliency Master Plan	
	9097	Longshore Transport Modeling	
	9118	Long-Term Hydrologic Monitoring Program	
	9180	Development of Optimal Coastwide Bathymetric and Topographic Models	
	10013	Data Collection to Support Continual Updates to the NWI Dataset	



Sources: present-day development, NOAA[158]; coastal monitoring stations, NOAA[177] and TWDB[178]

No.	Project Name	Other Key Actions
9101	Brazos River and San Bernard River Restoration Strategy and Management Plan	
9257	Southeast Texas Flood Coordination Study - Regional Flood Sensor System	

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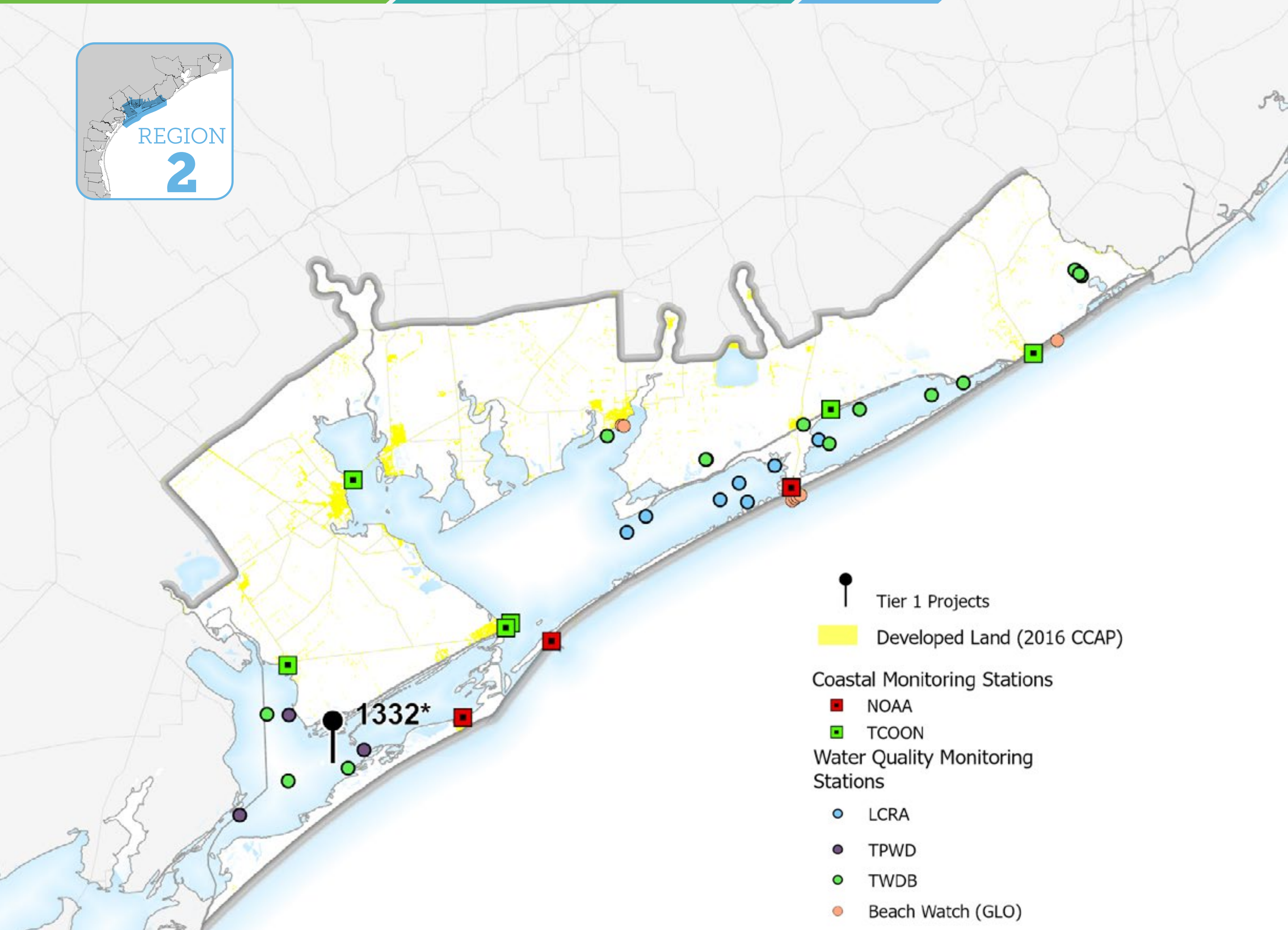
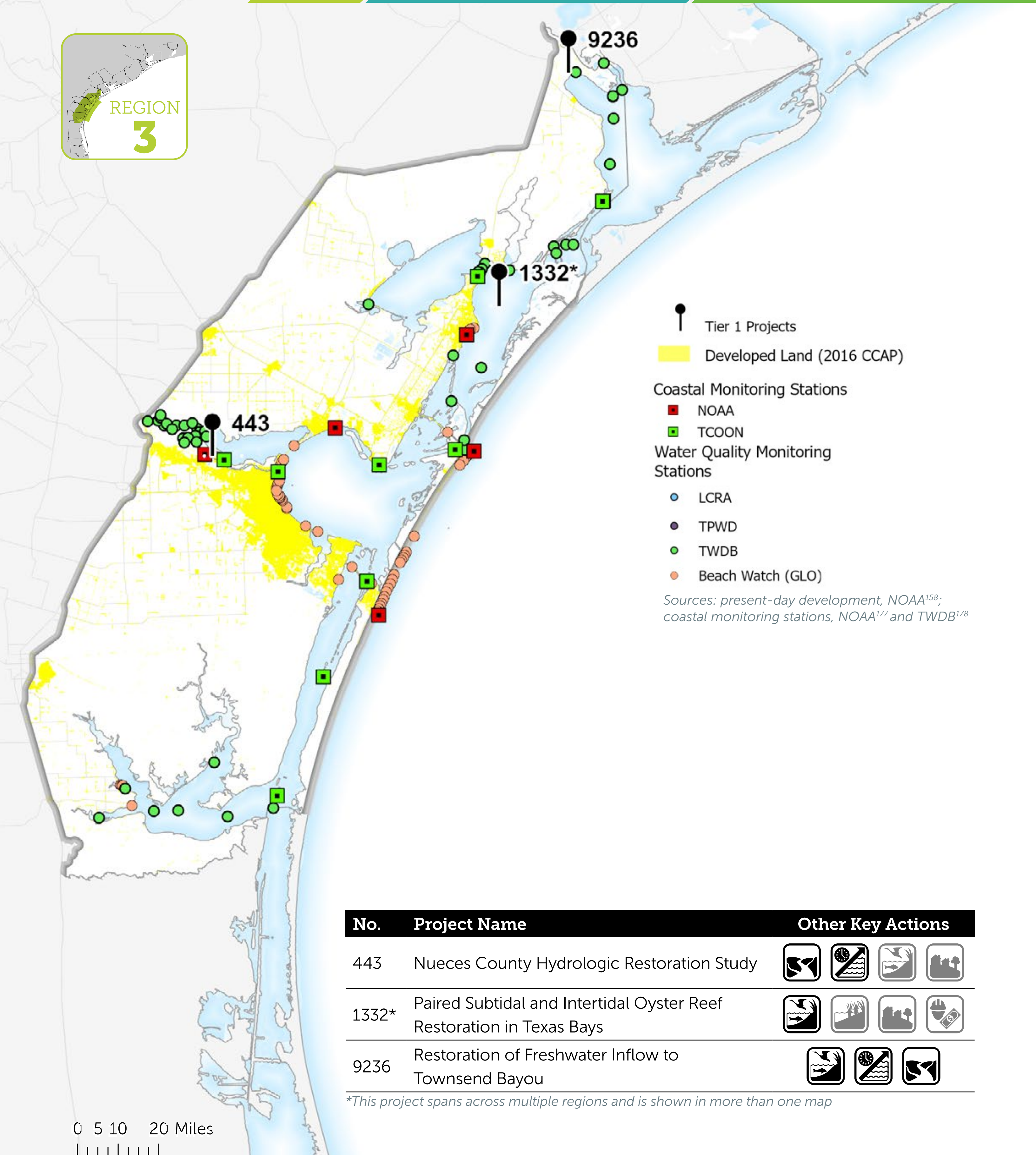


Sources: present-day development, NOAA[158]; coastal monitoring stations, NOAA[177] and TWDB[178]

No.	Project Name	Other Key Actions
1332*	Paired Subtidal and Intertidal Oyster Reef Restoration in Texas Bays	

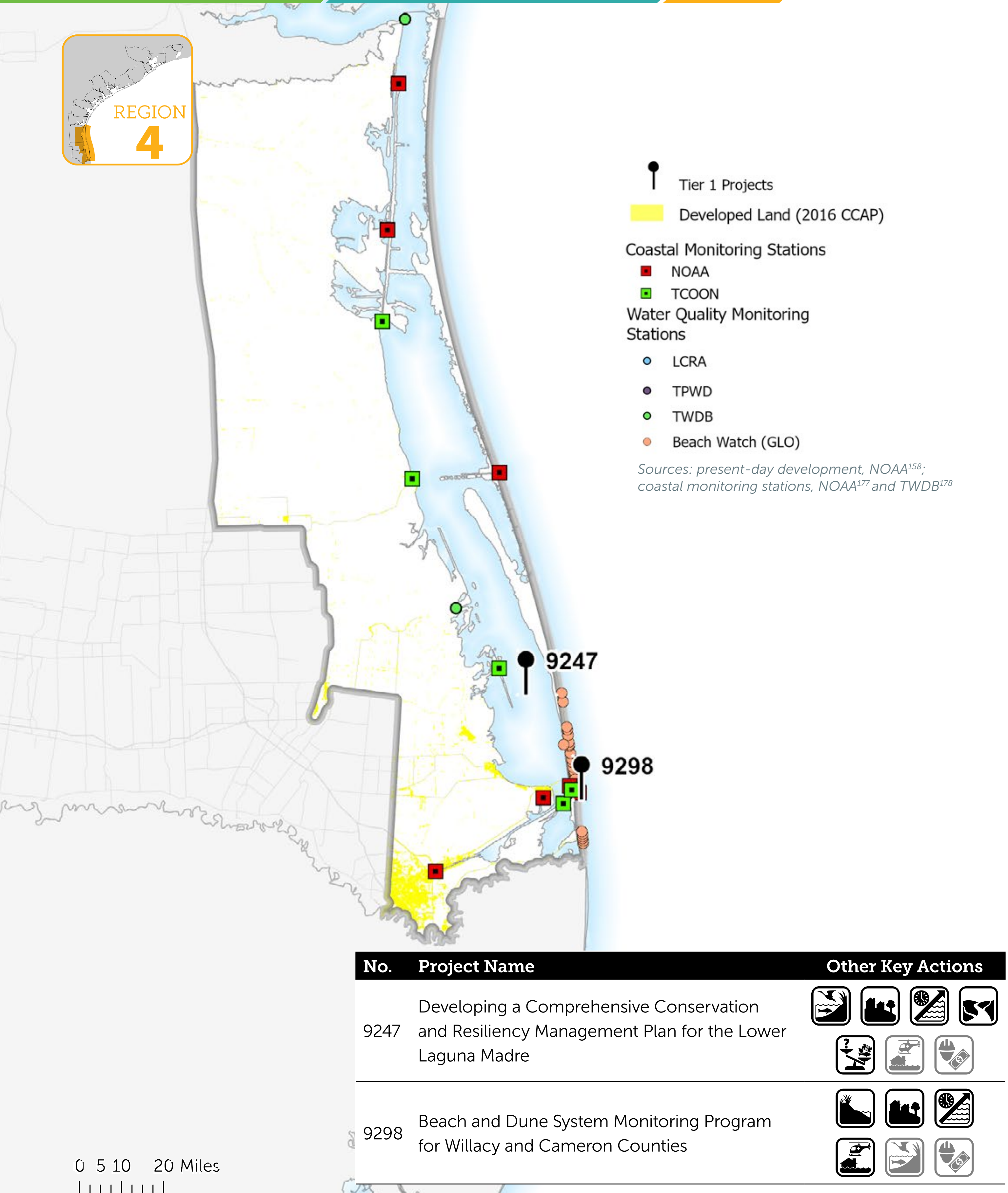
**This project spans across multiple regions and is shown in more than one map*

0 5 10 20 Miles



No.	Project Name	Other Key Actions
443	Nueces County Hydrologic Restoration Study	
1332*	Paired Subtidal and Intertidal Oyster Reef Restoration in Texas Bays	
9236	Restoration of Freshwater Inflow to Townsend Bayou	

*This project spans across multiple regions and is shown in more than one map



Sources: present-day development, NOAA[158]; coastal monitoring stations, NOAA[177] and TWDB[178]

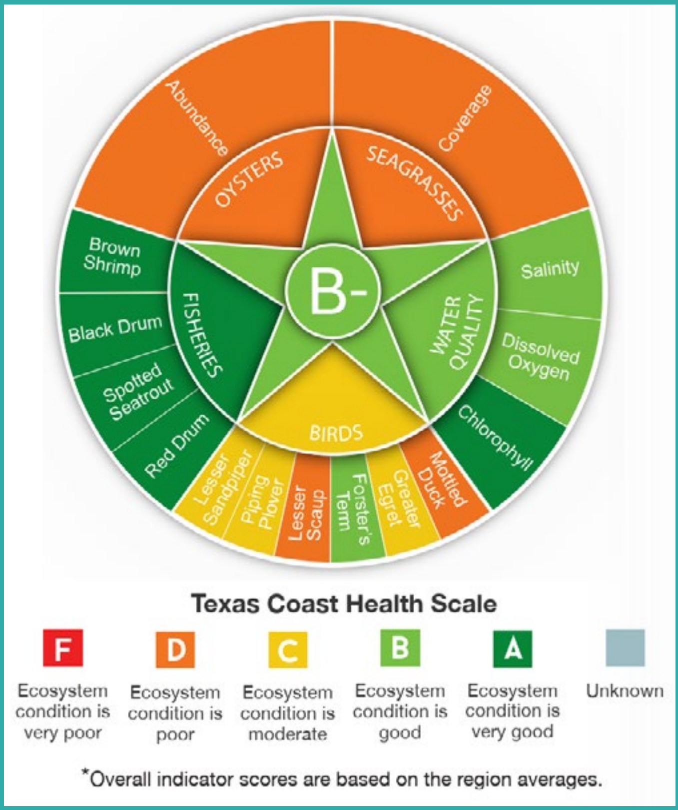
No.	Project Name	Other Key Actions
9247	Developing a Comprehensive Conservation and Resiliency Management Plan for the Lower Laguna Madre	
9298	Beach and Dune System Monitoring Program for Willacy and Cameron Counties	

Deep Dive: Texas Coast Ecosystem Health Report Card[179]

The coastal regions of Texas and associated watersheds are an interconnected system of diverse and complex ecosystems, communities, and economic interests. Researchers at the Harte Research Institute at Texas A&M University-Corpus Christi have developed a new tool to understand and communicate about the health of the Texas coast: the Texas Coast Ecosystem Health Report Card. The 2019 Texas Coast Ecosystem Health Report Card was a proof-of-concept evaluation of coastwide ecosystem health that used five ecosystem indicators, including birds, oysters, seagrass, water quality, and fisheries.[180] The Report Card team is now developing an updated assessment using a broader suite of ecological and socio-economic indicators and is working closely with regional stakeholders to better understand the challenges facing their bays and estuaries. In addition, the 2023 Report Card series will include assessments of the Texas coast as a whole, as well as bay-specific assessments. It will highlight priority funding and restoration needs and describe additional data that would be useful for ongoing assessment. It is envisioned that the 2023 Report Card sets a baseline for measuring change in future assessments.

In some cases, the data used for evaluation is not available for the Texas coast, and, in others, the data only covered certain locations and was not comprehensive. As the intent of the report is to regularly assess the health of coastal ecosystems using the best available data, the expansion of monitoring efforts and development of new data sources is vital to filling in the gaps of current knowledge and data. Understanding where these gaps may exist is the first step to accomplishing this goal. The Report Card will also support and complement prioritization efforts being conducted as part of the development process of this Plan.

This effort not only provides an opportunity to identify historical and current impacts to the health of the Texas coast, but also to emphasize the unknowns and the potential to expand current knowledge.



(Photo Credit: Petty Officer 3rd Class Johanna Strickland, U.S. Coast Guard)

5.5.8. Enhancing Emergency Preparation and Response

Emergency scenarios and hazard response are inevitable along the Texas coast. A range of hazards are possible, including those captured within other actions, but perhaps the most prevalent include major tropical storm and other heavy rainfall event response. Preparing for and responding to these hazards is important for the safety and wellbeing of coastal communities.

Many communities along the Texas coast are not well-equipped to prepare for or respond to major emergency scenarios. In many cases, this is due to increased risk caused by deteriorating critical infrastructure and facilities or lack of public awareness. Particularly in smaller communities, there may also be a lack of personnel capacity (for example, when local governments are short-staffed) to make proper preparations to prevent or reduce the impact (for instance, emergency personnel response time) of emergency situations.

Under the Enhancing Emergency Preparation and Response action, projects that increase community awareness, maintain and protect evacuation routes, improve critical data systems, enhance risk studies, and implement resiliency measures to protect critical facilities will be considered. This action is intended to promote proactive administrative planning to anticipate and respond to coastal disasters through improving vital coastal infrastructure, developing public education campaigns, and developing and enacting emergency response plans to lessen the impacts of extreme weather events and natural disasters on coastal communities.

ENHANCING EMERGENCY PREPARATION AND RESPONSE

Today's Opportunities

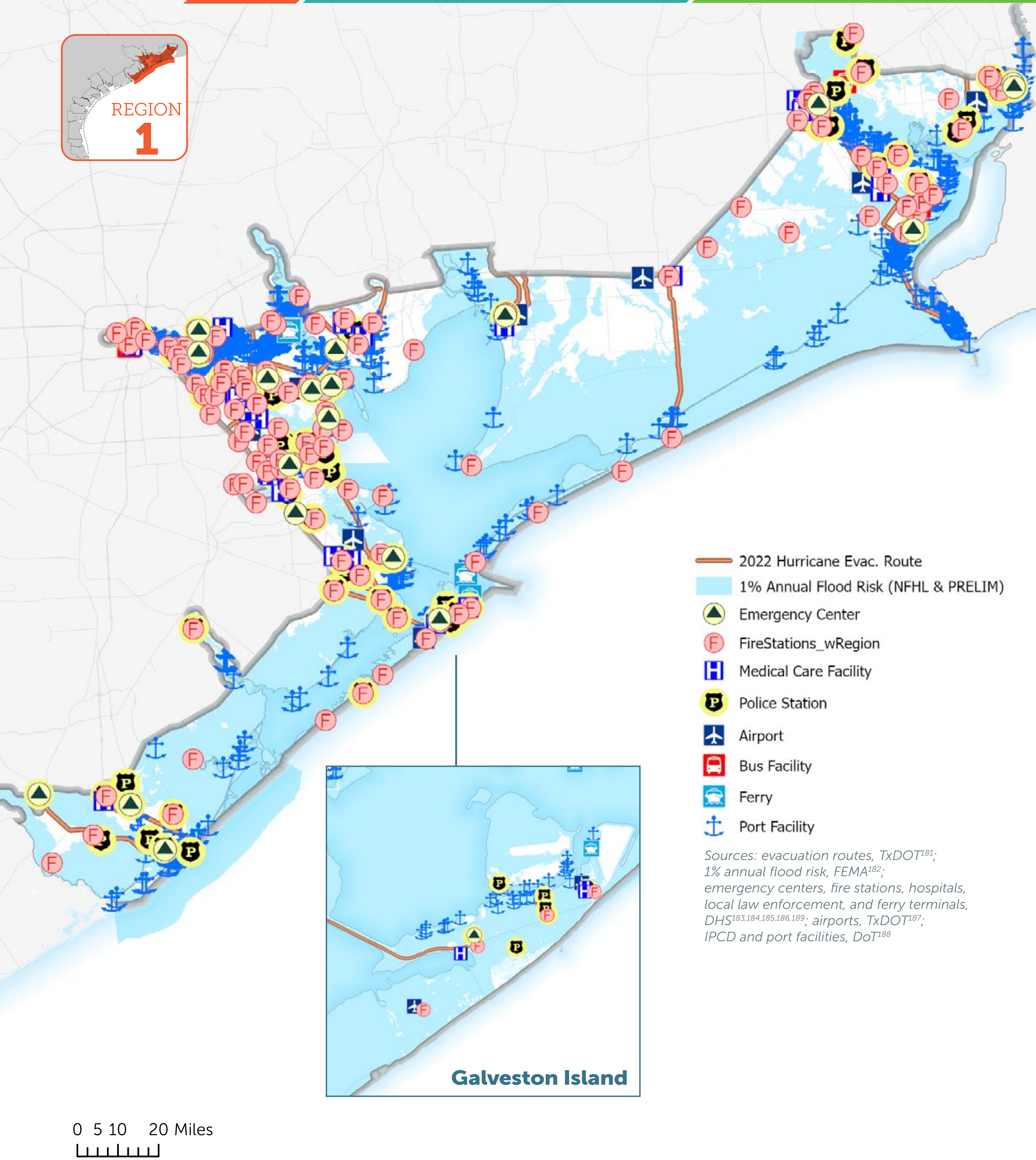
- Respond to RSLR
- Reduce flood risk
- Hazard Mitigation Funding availability (IIJA, BRIC, etc.)
- Regional flood planning
- Consider social vulnerability
- Plan for debris removal

Emerging Opportunities

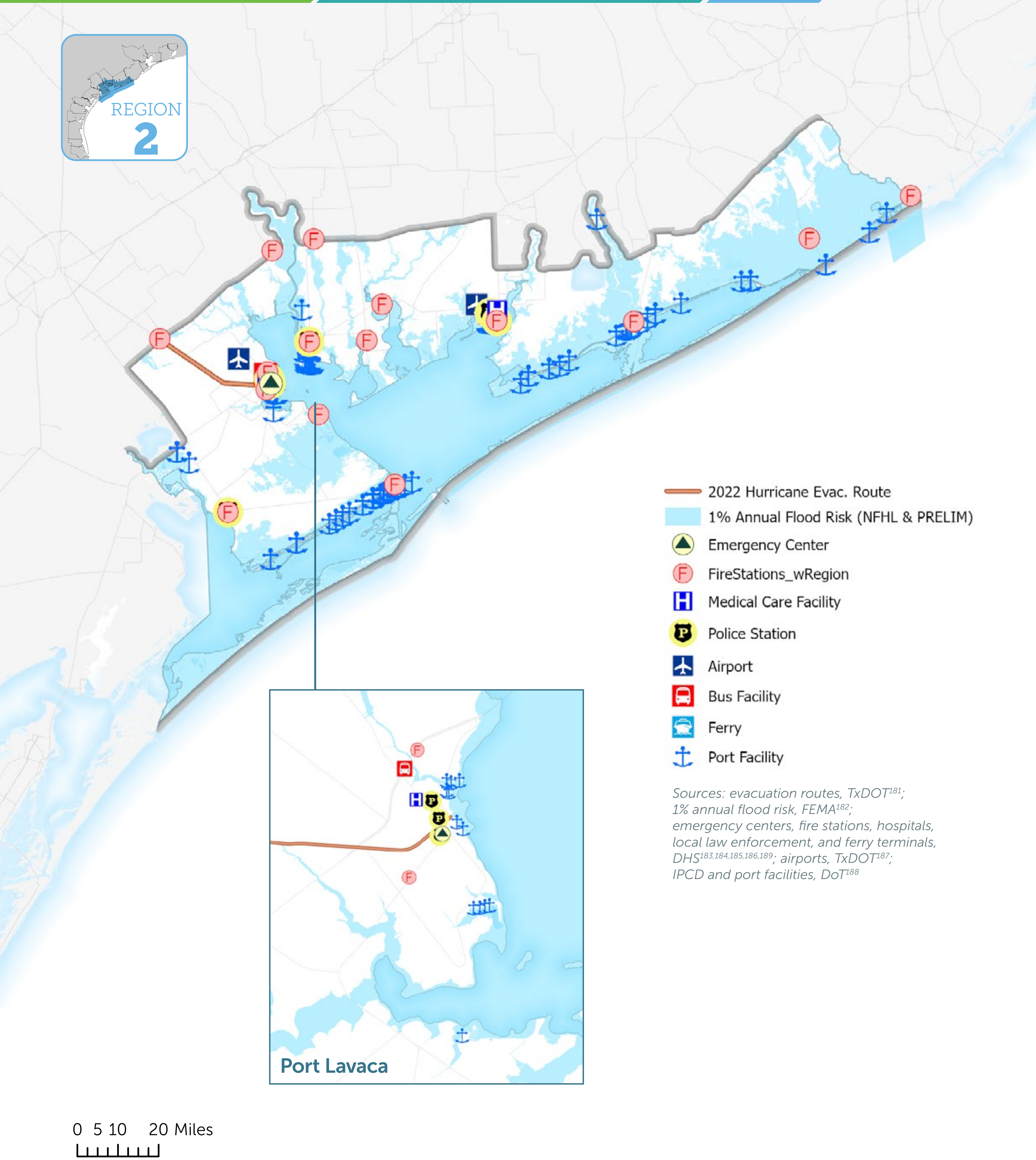
- Parametric insurance
- Responsible Development (managing retreat)
- System-wide planning
- Pre-disaster mitigation

Related Actions

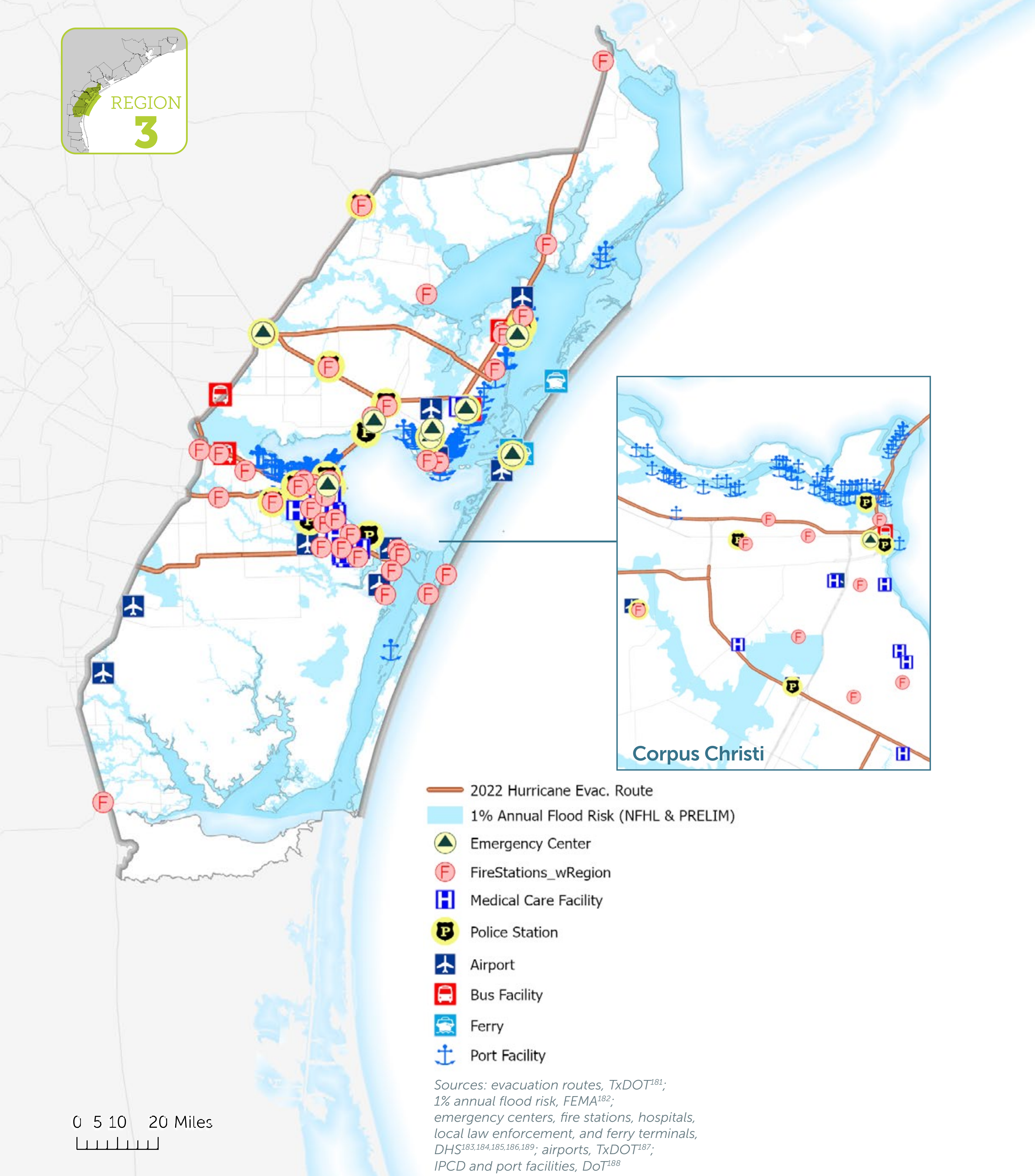
- Improving Community Resilience
- Adapting to Changing Conditions
- Addressing Under-Represented Needs



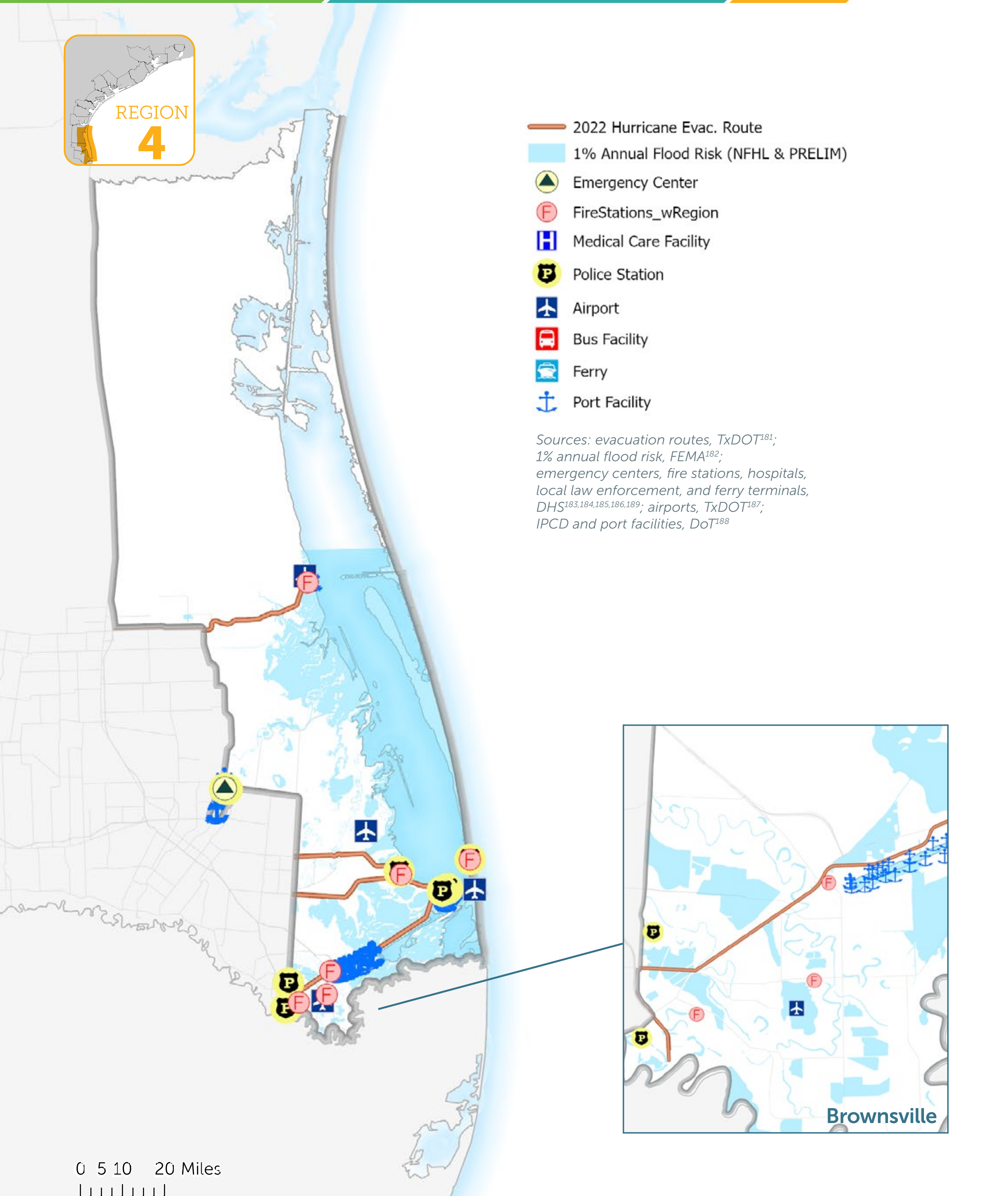
Sources: evacuation routes, TxDOT[181]; 1% annual flood risk, FEMA[182]; emergency centers, fire stations, hospitals, local law enforcement, and ferry terminals, DHS[183,184,185,186,189]; airports, TxDOT[187]; IPCD and port facilities, DoT[188]



Sources: evacuation routes, TxDOT[181]; 1% annual flood risk, FEMA[182]; emergency centers, fire stations, hospitals, local law enforcement, and ferry terminals, DHS[183,184,185,186,189]; airports, TxDOT[187]; IPCD and port facilities, DoT[188]



Sources: evacuation routes, TxDOT[181]; 1% annual flood risk, FEMA[182]; emergency centers, fire stations, hospitals, local law enforcement, and ferry terminals, DHS[183,184,185,186,189]; airports, TxDOT[187]; IPCD and port facilities, DoT[188]



Sources: evacuation routes, TxDOT[181]; 1% annual flood risk, FEMA[182]; emergency centers, fire stations, hospitals, local law enforcement, and ferry terminals, DHS[183,184,185,186,189]; airports, TxDOT[187]; IPCD and port facilities, DoT[188]

Deep Dive: TxDOT Statewide Resilience Plan

The Texas Department of Transportation is initiating a Statewide Resilience Plan (SRP) to strengthen the robustness of the State's multimodal transportation system to a range of potential disruptors. Every year, the State's transportation network is at risk to infrastructure impacts posed by extreme weather events, cyber security threats, and other human-made hazards, including dam/levee failure and border checkpoint shutdowns caused by border disruptions. Recognizing the extensive consequences these potential interruptions can have on human health and safety, supply chains, and the State's economy, TxDOT identified the need to address resilience challenges in the transportation network as a high priority in the Texas Transportation Plan (TTP 2050).[191] The need to address resilience challenges has been identified in other TxDOT plans, and there are currently efforts in place to address the resilience of Texas's transportation system.

Adding to these ongoing efforts, the SRP will evaluate physical assets critical for the operation of TxDOT's statewide multimodal transportation system. Examples of physical assets include highways, bridges, railway facilities, airports, maritime ports and waterways, bicycle and pedestrian facilities, rest areas, international border crossings, fiber network, and intelligent transportation systems. Findings and recommendations of the SRP will be used to incorporate transportation resiliency into statewide transportation planning and project development. Additionally, the SRP will provide a foundational framework for TxDOT's Districts and Divisions to consistently evaluate vulnerability and incorporate resilience considerations into TxDOT multimodal plans. The SRP is scheduled for completion in the Summer of 2024 and will be available to the public at www.txdot.gov once completed.

Hurricane Harvey flooding along Cypress Creek in Houston, TX (August 2017). (*Photo Credit: Harris County Flood Control District*[192])

5.5.9. Addressing Under-Represented Needs

Certain areas along the Texas coast have historically been less represented by studies, project implementation, and stakeholders in coastal resiliency initiatives. As a result, there are portions of the Texas coast that could be or already are at risk of damages or degradation, but where efforts are not being undertaken due to a lack of awareness, leadership, or data. This action will be an avenue to support equitable coastal resilience planning and projects along the entire coast.

Under the Addressing Under-Represented Needs action, multiple types of opportunities for projects may be considered. These opportunities broadly fall into three main categories.

Areas with no organized or active stakeholders: In some cases, vulnerabilities are understood to exist for areas of the coast, but there is not an organized, active stakeholder to take the lead on resiliency projects intended to mitigate those vulnerabilities. This action will support initiatives to organize and activate stakeholder participation in this Plan.

Areas with historically few Tier 1 projects: Similarly, this action will support projects and initiatives in locations or subregions that have historically had few or no Tier 1 projects. A historical lack of supported projects could indicate that there has been less advocacy for or attention on coastal resiliency in those areas.

Communities identified as socially vulnerable: This action will address socially vulnerable communities (for example, due to socioeconomic status, access to housing/transportation, ethnicity/language, or mobility) along the coast. The action will be used to identify opportunities to enhance coastal resources (for instance, by identifying vulnerable fisheries that support local seafood harvesting) and mitigate hazards for socially vulnerable populations. Public access to coastal areas and resources should be assets for all Texans, regardless of income. This action works to provide an equitable approach to coastal resilience in Texas.

ADDRESSING UNDER-REPRESENTED NEEDS

Today's Opportunities

- Hazard Mitigation Funding availability (IIJA, BRIC, etc.)
- Other new funding opportunities
- Consider social vulnerability

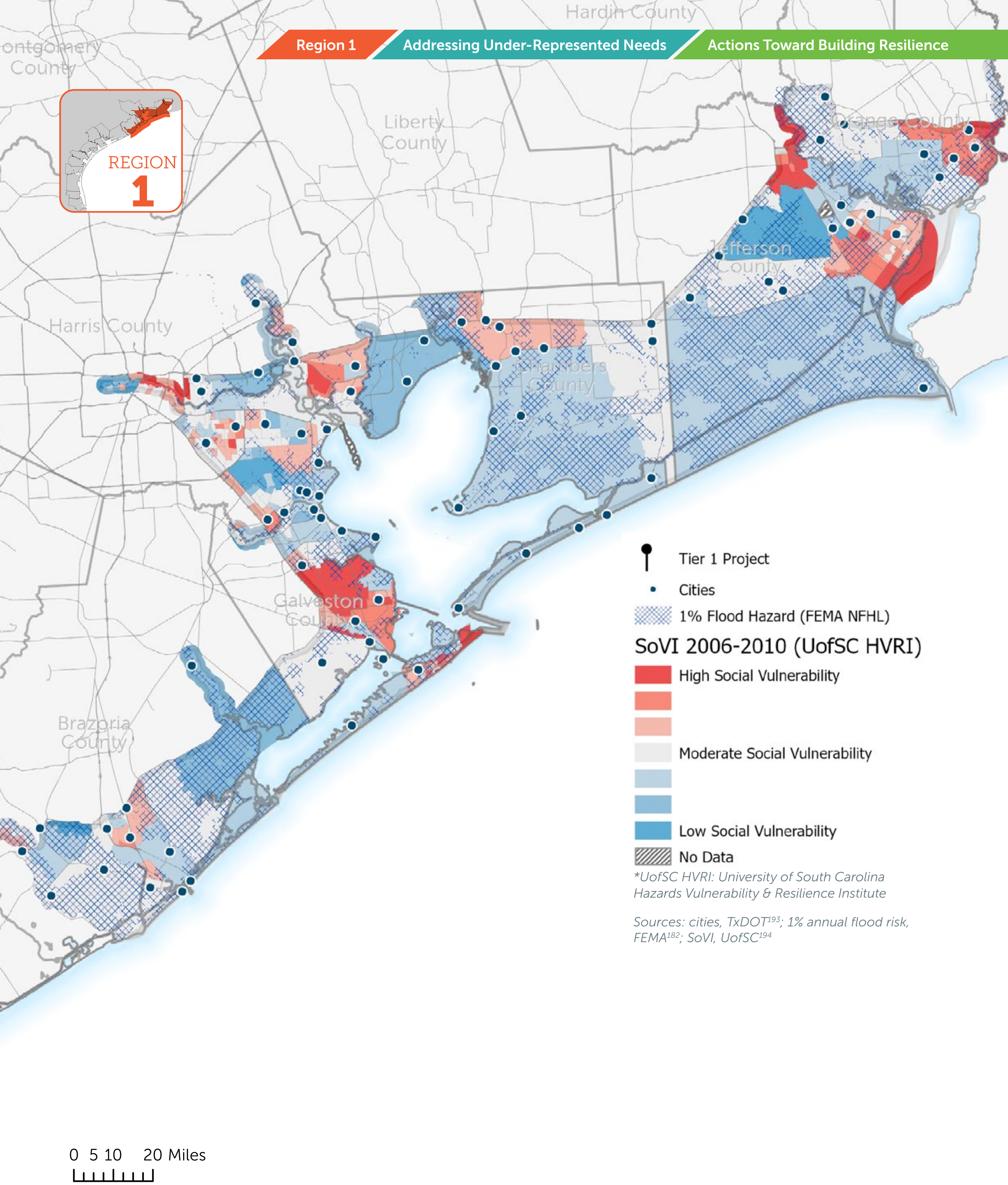
Emerging Opportunities

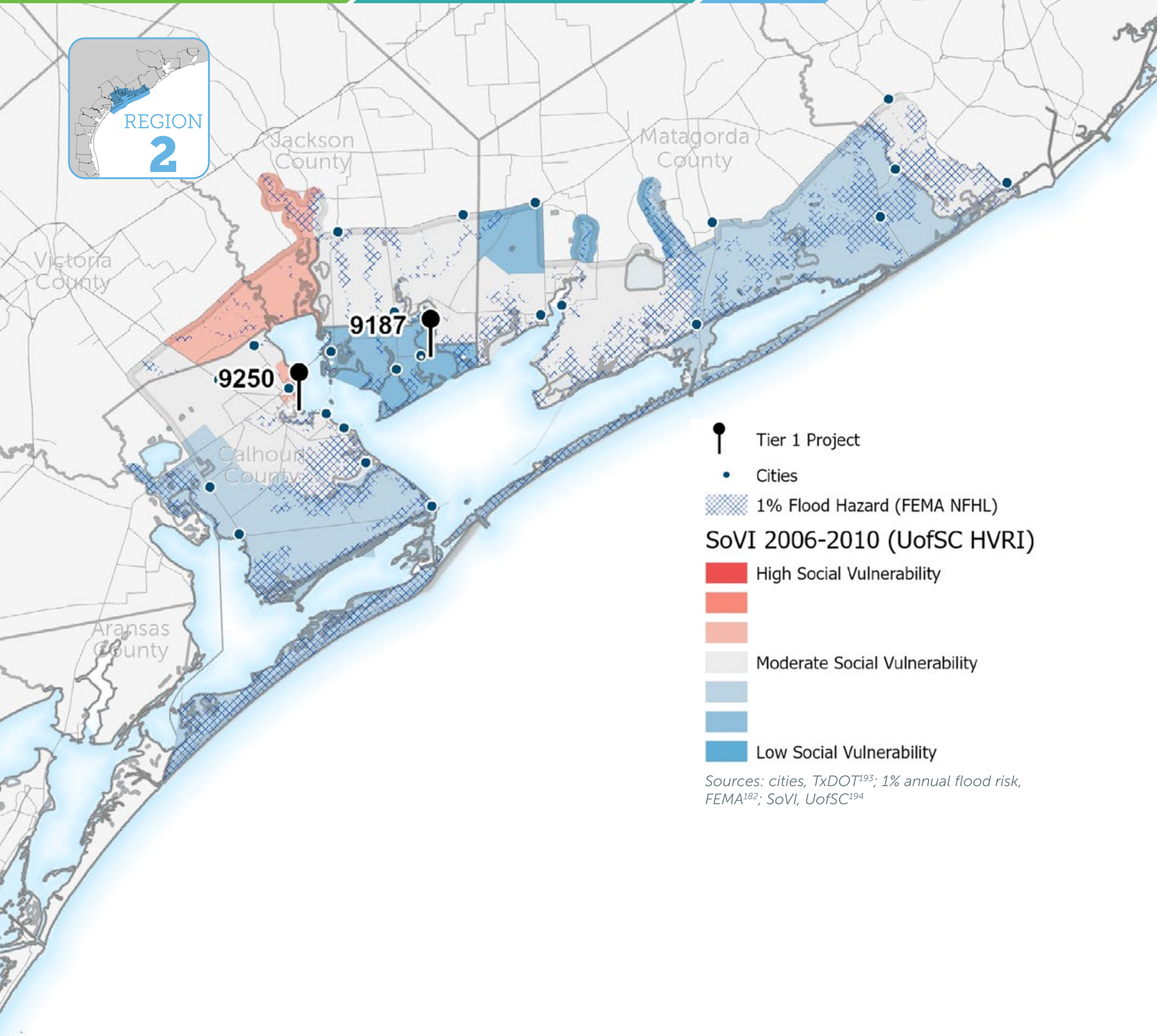
- System-wide planning
- Pre-disaster mitigation
- Building partnerships and multidimensional project teams

Related Actions

- Improving Community Resilience
- Adapting to Changing Conditions
- Growing Key Knowledge and Experience
- Maintaining Coastal Economic Growth

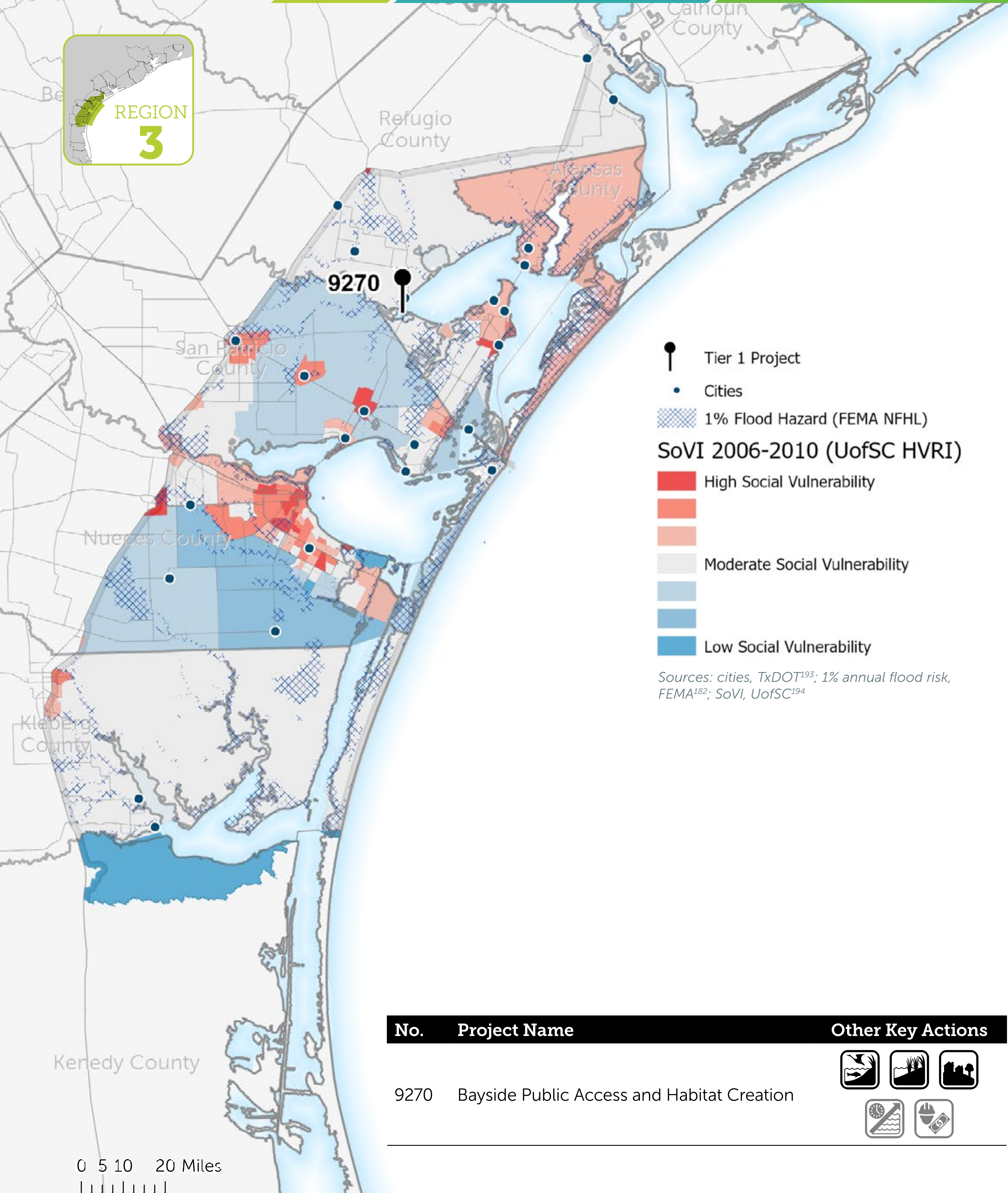
	No.	Project Name	Other Key Actions
Coastwide	2	Abandoned Vessel Removal Program	
	1237	Abandoned and Derelict Structure Removal Program	


REGION
1
Hardin County
Montgomery County
Liberty County
Orange County
Jefferson County
Harris County
Chambers County
Galveston County
Brazoria County
Tier 1 Project
Cities
1% Flood Hazard (FEMA NFHL)
SoVI 2006-2010 (UofSC HVRI)
High Social Vulnerability
Moderate Social Vulnerability
Low Social Vulnerability
No Data
*UofSC HVRI: University of South Carolina Hazards Vulnerability & Resilience Institute
Sources: cities, TxDOT193; 1% annual flood risk, FEMA182; SoVI, UofSC194
0 5 10 20 Miles



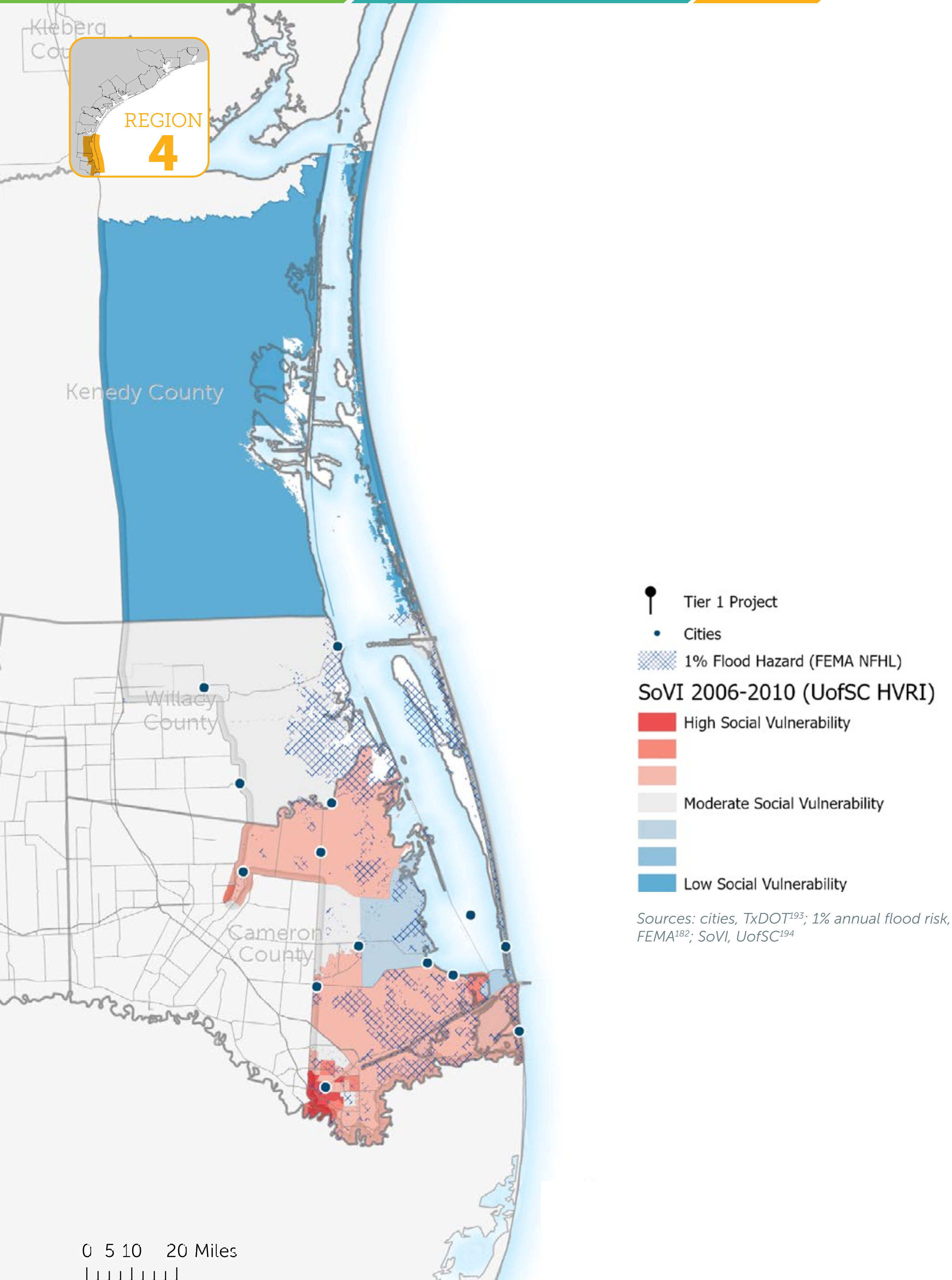
No.	Project Name	Other Key Actions
9187	Carancahua Bay Community Reefing Project	
9250	Harbor of Refuge Protection and Restoration	

0 5 10 20 Miles



Sources: cities, TxDOT[193]; 1% annual flood risk, FEMA[182]; SoVI, UofSC[194]

No.	Project Name	Other Key Actions
9270	Bayside Public Access and Habitat Creation	



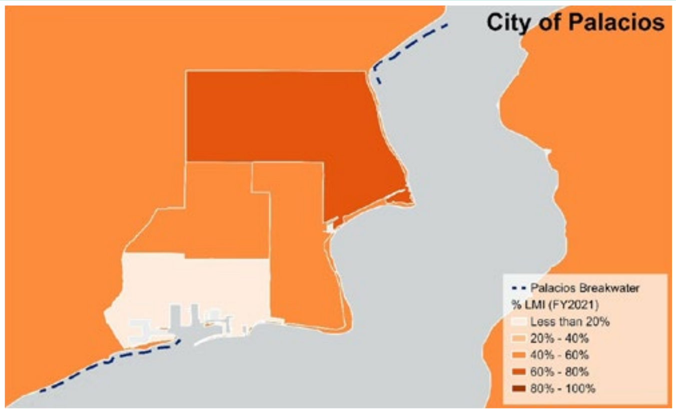
Sources: cities, TxDOT[193]; 1% annual flood risk, FEMA[182]; SoVI, UofSC[194]

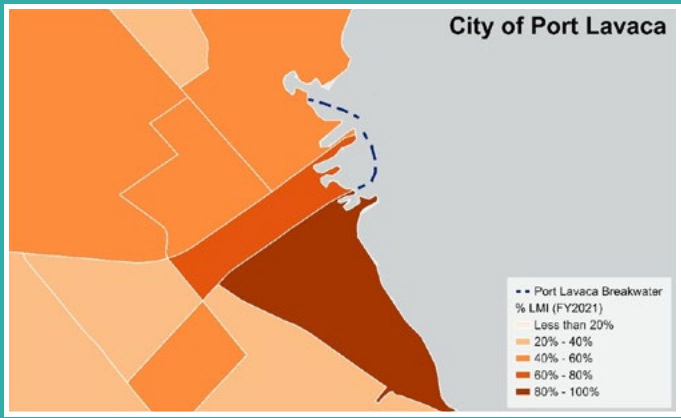
Deep Dive: Serving LMI Communities

Understanding the unique struggles and needs of economically disadvantaged communities is fundamental in directing investments that generate significant benefits for these populations. Individuals and families classified as low- to moderate-income (LMI) often face unique financial challenges. They typically earn less than the average median income in their area, which can limit their access to resources and opportunities. These communities are often located in environmentally vulnerable areas and bear a disproportionate burden of coastal hazards, complicating their daily lives. Additionally, they grapple with the stark realities of underfunding, which further limits their capacity to adapt and respond to environmental challenges.

Two Texas GLO projects from the 2019 Plan, R2-8 Port Lavaca and R2-9 Palacios, have secured 100% funding through the HUD Community Development Block Grant program's Coastal Resilience Fund, which targets funding projects in LMI populations.[195] The proposed projects in the City of Lavaca and City of Palacios are intended to stabilize and protect shorelines through activities such as: construction of breakwaters, living shorelines, and creation or restoration of marshes and oyster reef habitats. The activities in Port Lavaca are intended to benefit 3,480 households, of whom 2,160 or 62 percent are of LMI.[196] Similarly, the activities in Palacios are intended to benefit 3,485 households, of whom 1,990 or 57 percent are of LMI.[197] Respective breakwaters, along with the proportion of LMI households by census block groups, are depicted in the figures below.

Projects like these in Port Lavaca and Palacios demonstrate the potential of focused investments. These projects not only enhance coastal resilience but also improve the quality of life for a significant portion of LMI households in these communities. This holistic approach of acknowledging the unique challenges, creating targeted solutions, and distributing resources equitably paves the way for more sustainable and inclusive growth. In this way, these communities are uplifted and able to contribute to broader social and economic progress.





CDBG-MIT funded projects in the City of Palacios and City of Port Lavaca.

(Photo Credit: Port of Corpus Christi)

5.5.10. Maintaining Coastal Economic Growth

The Texas coast—home to all or much of its waterborne commerce, energy and chemical, military, commercial and recreational fishing, tourism, and nature tourism industries—can rightly be considered the economic engine for the state. The impact that the Texas coast has on the state's economy is a foundational reason for the GLO being able to invest state funding into improving coastal resilience. It is also the reason why this Plan represents a statewide investment, not simply an investment for coastal communities alone.

The Maintaining Coastal Economic Growth action will serve as a vehicle to identify resilience efforts that have a direct benefit to the state's economy. These projects should incorporate multiple resilience components, but ultimately have a foundation focused on economic growth and opportunity. This action could be used, for example, to incorporate the Texas ports and navigation system (including the GIWW), coastal tourism and ecotourism, and commercial fishing into identified resiliency projects.

One key opportunity noted for this action is the beneficial use of dredged material when it is available from new work and channel maintenance dredging projects. Another opportunity is to collaborate with the ports and navigation industry to develop and implement resilient coastal projects.

MAINTAINING COASTAL ECONOMIC GROWTH

Today's Opportunities

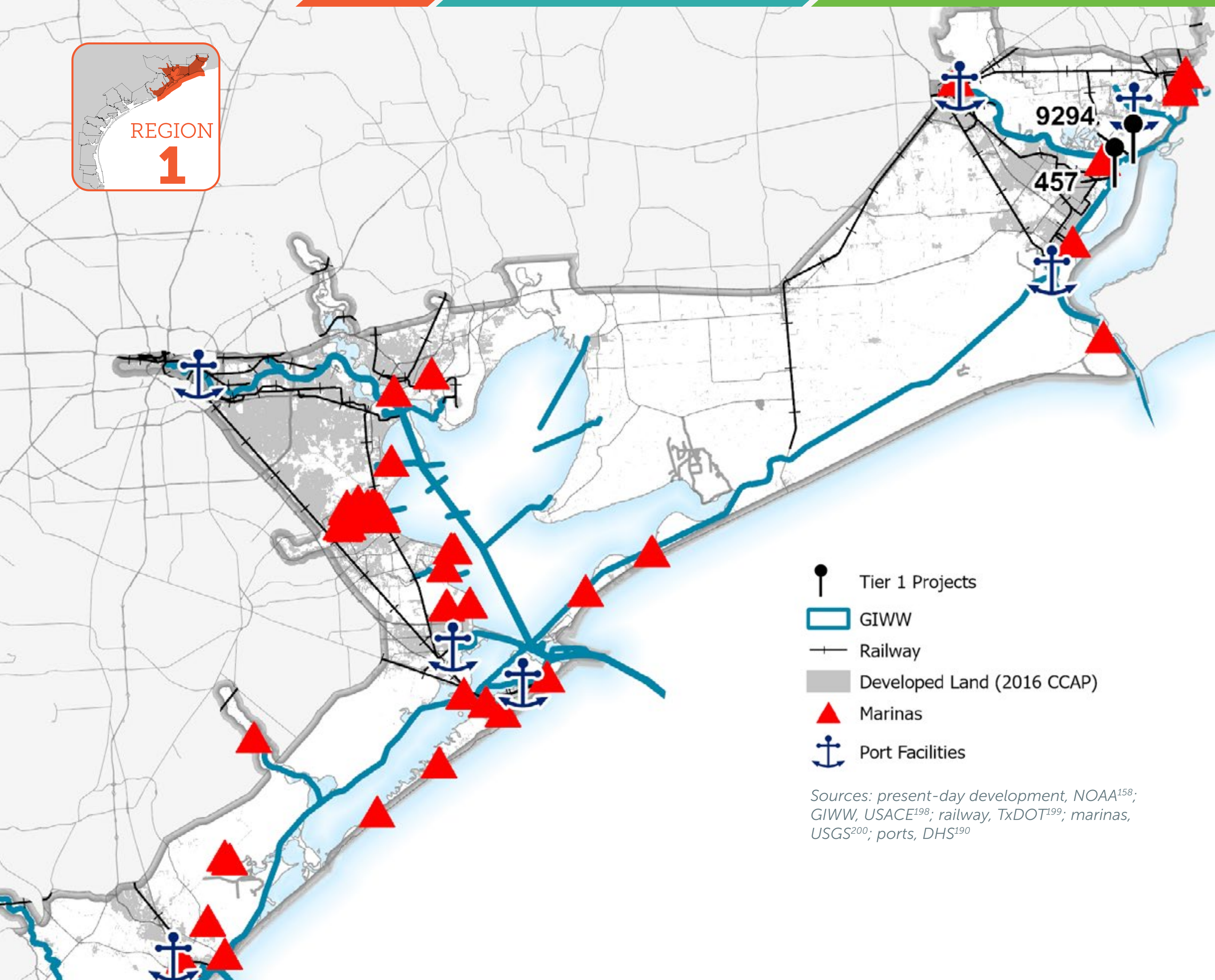
- Other new funding opportunities
- Industry in-kind collaboration
- Opportunities for BUDM
- Building partnerships and multidimensional project teams

Emerging Opportunities

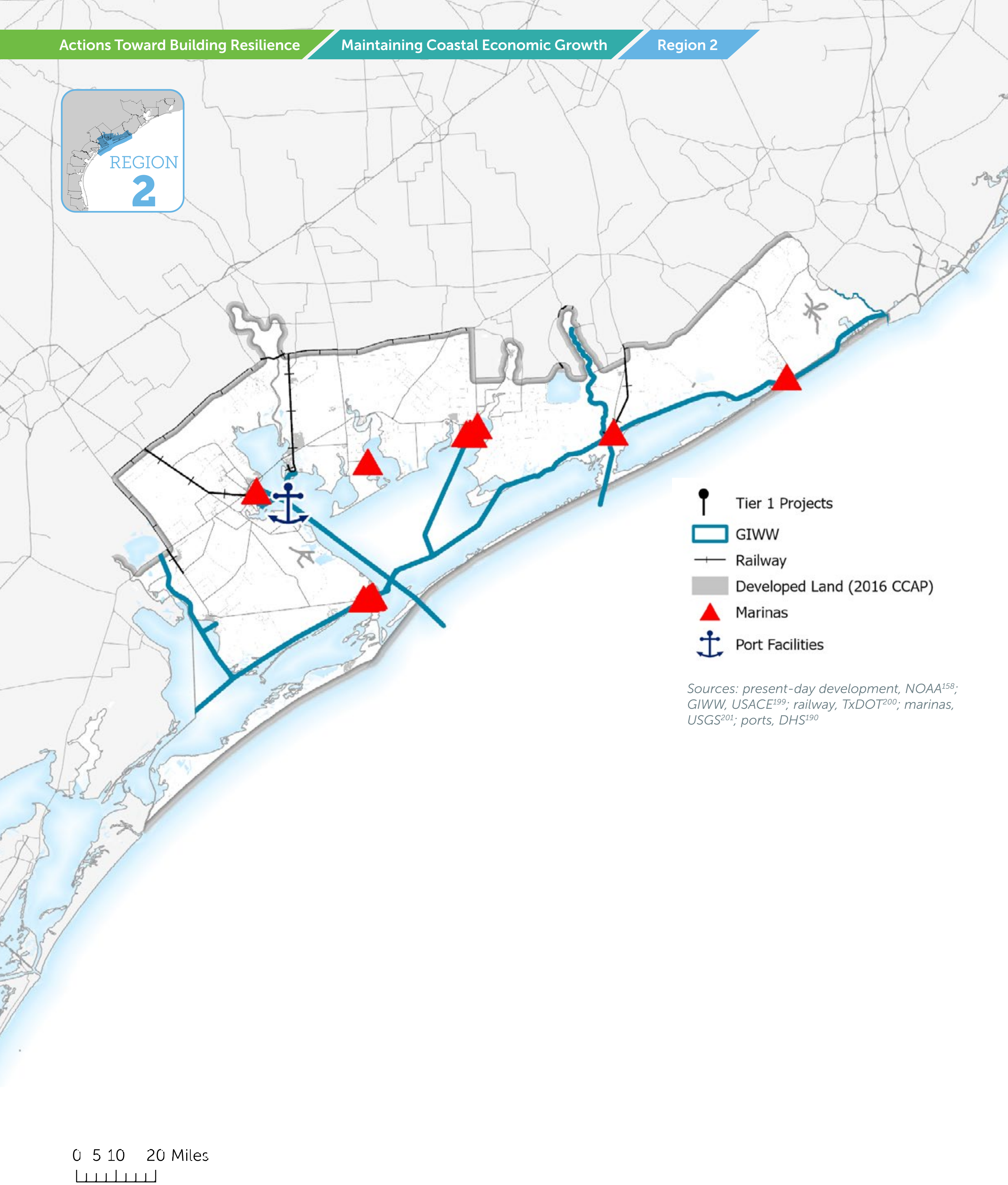
- Alternative mitigation credits
- Environmental impact bonds
- Carbon markets
- Natural capital and ecosystem services

Related Actions

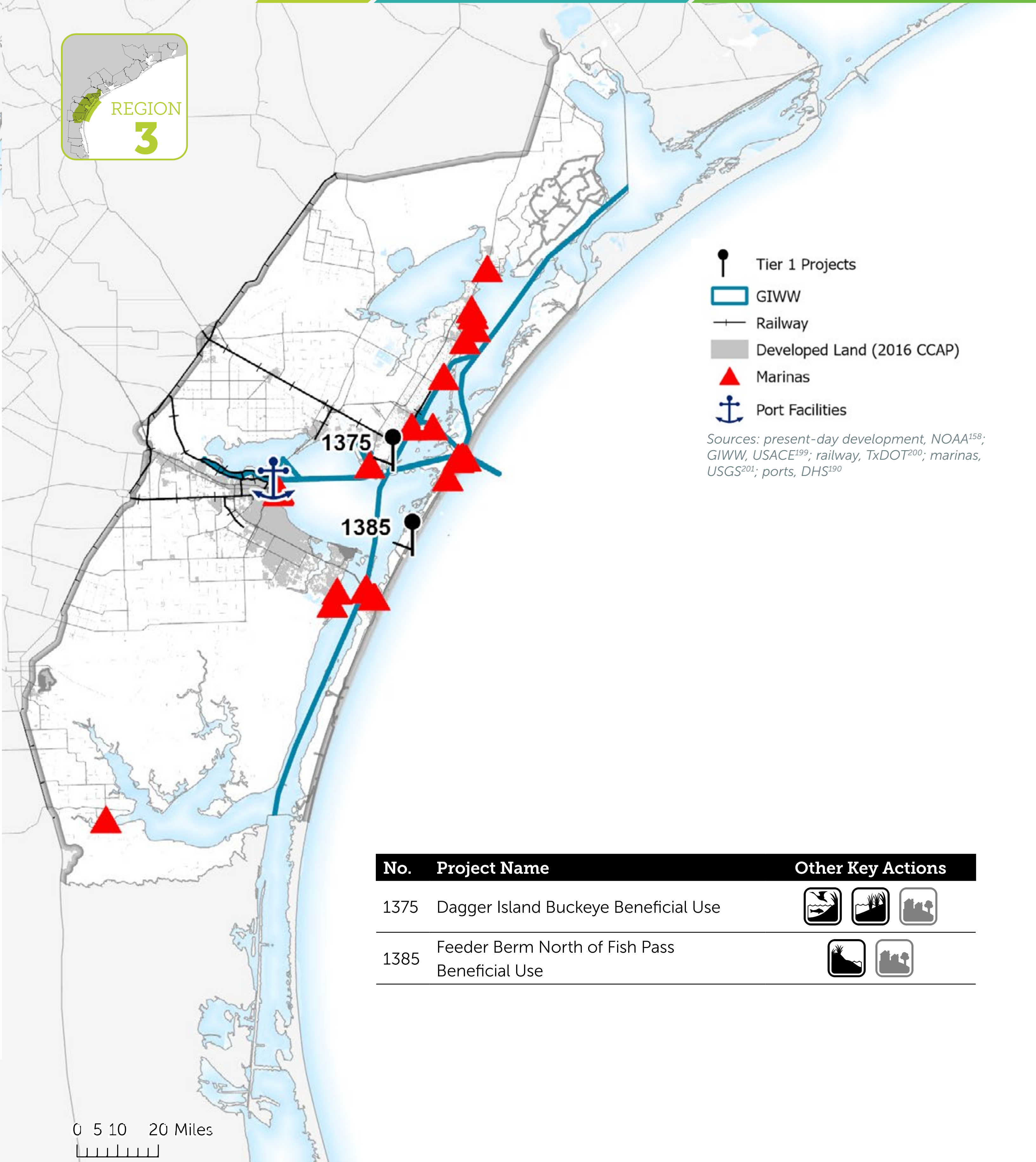
- Improving Community Resilience
- Adapting to Changing Conditions
- Growing Key Knowledge and Experience



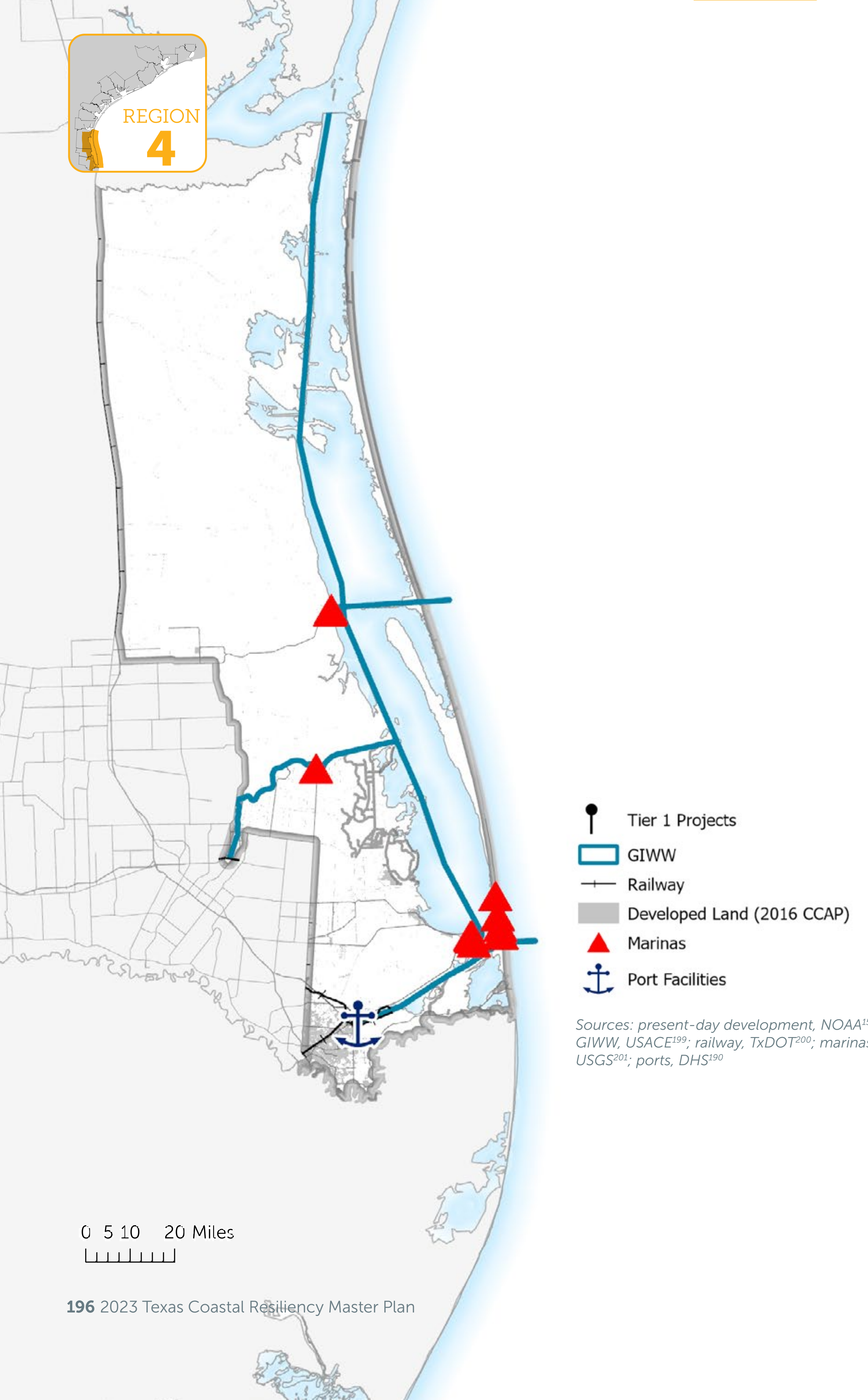
No.	Project Name	Other Key Actions
457	North Pleasure Island Shoreline Protection and Restoration	
9294	Sydnes Island Restoration	



Sources: present-day development, NOAA[158]; GIWW, USACE[199]; railway, TxDOT[200]; marinas, USGS[201]; ports, DHS[190]



No.	Project Name	Other Key Actions
1375	Dagger Island Buckeye Beneficial Use	
1385	Feeder Berm North of Fish Pass Beneficial Use	



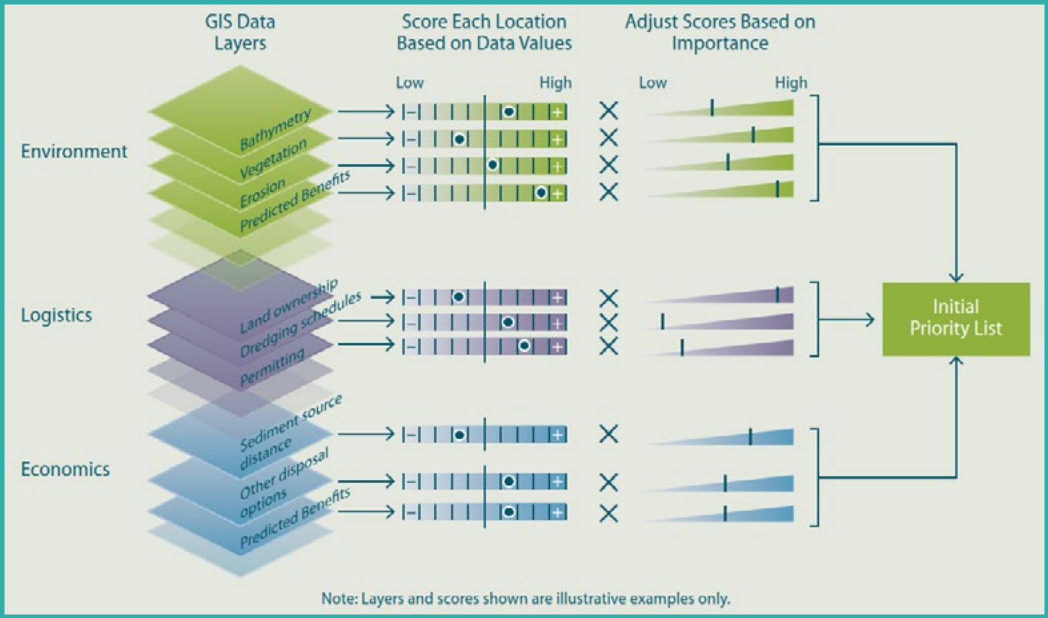
Sources: present-day development, NOAA[158]; GIWW, USACE[199]; railway, TxDOT[200]; marinas, USGS[201]; ports, DHS[190]

Deep Dive: Repurposing Dredged Material for the Environment and the Economy

The ports and navigation system in Texas is critical to the economic growth of Texas and the nation, generating $308 billion in trade annually.[3] Texas ports provide 1.8 million jobs, particularly to those living along the coast.[3] As the population of Texas continues to grow, the ports will become even more important as demand for consumer goods increases. To meet increasing demand, maintenance of the ship channels associated with the port system will be a vital component, as maintaining adequate channel depth is crucial for safe and efficient movement of goods. Larger vessels and/or more frequent vessel movement in the channels will produce more shoreline erosion, increasing the amount of channel shoaling and the need for more frequent dredge events.

Currently, the USACE Galveston District dredges approximately 30 to 40 million cubic yards of material each year.[34] Dredged material is typically placed in pre-defined dredged material placement areas (DMPAs), but often times attaining or expanding these DMPAs can be difficult and cost prohibitive. Because of this, an alternative method of dredged material disposal, known as beneficial use of dredged material, has become an invaluable alternative in recent years. However, there are many challenges associated with placing BUDM at project sites, which include identifying clean sources of sediment; coordinating dredging, permitting, and construction schedules; and finding ample funding, among others.

In addition to supporting the growing port system, the placement of BUDM provides many ecological and societal benefits. This material can be used to restore degrading wetland habitats, nourish eroded shorelines, and create and enhance rookery islands along the coast. The overall health of these habitats is directly linked to fisheries productivity within coastal bays and estuaries for both the recreational and commercial fishing industries, as well as increased bird populations. Ultimately, these enhanced public access and ecotourism opportunities lead to increased tourism revenues. Current efforts to streamline the BUDM process include the Beneficial Use Master Plan, led by Ducks Unlimited. This effort aims to improve access to BUDM opportunities through coordination with USACE, stakeholders, and other entities to identify and prioritize project sites that are near-ready to receive dredged material as it becomes available. The Beneficial Use Master Plan has led to the selection of eight sites in Regions 1 and 2 and is currently underway with site identification and design in Regions 3 and 4.



Decision support tool for the Ducks Unlimited Beneficial Use Master Plan.[201]

5.5.11. Other Evaluated Projects

The other projects that the TAC evaluated, but that were not selected as Tier 1 projects for this Plan are shown below in ascending numerical order by action.

Managing Coastal Habitats

- 1240 Chinquapin Oyster Reef Restoration
- 1269 Bird Rookery Island Creation in Espiritu Santo Bay
- 1278 Coastal Bend Oyster Restoration and Enhancement
- 1279 Coastal Grassland and Wetland Conservation
- 1289 East Matagorda Bay Emergent and Intertidal Reef Enhancement Project
- 1290 Enhancement of Moist Soil Units at Justin Hurst WMA
- 1305 Hughson Lakes Conservation and Restoration
- 1313 Lower Guadalupe River and Delta Colonial Waterbird Rookery Enhancements
- 1316 Eidelbach Flats New Island Creation
- 1327 Bayview Land Acquisition
- 1357 Texas Point Land Acquisition
- 1360 Texas Shorebird and Seabird Stewardship Program
- 1370 Aransas NWR Matagorda Island West Marsh Beneficial Use
- 1371 Little Bird Island Beneficial Use
- 1372 Aransas NWR Long Lake Marsh and Channel
- 1378 Ransom Point Beneficial Use
- 1386 DMPA 214 Bird Island Beneficial Use
- 9126 Coon Island Restoration
- 9164 Texas Seagrass Restoration
- 9202 Anahuac NWR Pumping Stations
- 9210 Hazel Bazemore Park Restoration
- 9220 Guadalupe Delta Land Protection
- 9221 Powderhorn Lake Conservation Program
- 9222 West Matagorda Peninsula Acquisition Program
- 9223 Colorado River Delta Land Assemblage
- 9225 Creating a Conservation Corridor in the Mission River Delta
- 9239 Espiritu Santo Bay Oyster Reef Restoration
- 9240 Port Bay Wetlands Protection
- 9241 Espiritu Santo Bay Shoreline Conservation
- 9255 Going to Scale: Expanding Oyster Restoration in Matagorda Bay
- 9258 West Marsh Hurricane Repair & Bayside Resilience
- 9263 Restore Tatton Prairie Overland Sheetflow and Erosion and Shoreline Protection
- 9267 GIWW Traditional Spoil Placement Island Restoration
- 9286 Packery Channel Seagrass
- 9309 East Matagorda Shoals New Island Creation

Managing Bay Shorelines

- 9246 Brown Ranch Shoreline Stabilization and Marsh Protection
- 9269 Gulf Shoreline Erosion and Pass Cavallo Exchange Maintenance
- 1325 Mustang Island State Park - Dune Habitat Conservation and Restoration
- 9001 Portland Living Shoreline
- 9198 Copano Bay Shoreline Protection and Restoration
- 1361 Children's Beach Shoreline Restoration - Phase 2

Managing Watersheds

- 9107 The Marshland Restoration Project at Anahuac NWR
- 9207 Implement and Expand the Use of Nature-Based Stormwater Infrastructure in the Baffin Bay Watershed
- 9208 The Aguanita Project: Improving Water Quality in Petronila Creek and Baffin Bay
- 9213 Matagorda Bay Habitat Enhancement: Firm Water for Focused Environmental Flows
- 9234 Developing New Water Supply for Estuarine Marsh Management
- 9238 St. Charles Bay Watershed and Drainage Restoration
- 9259 Air Force and Wynn Channel Dredging
- 9261 Freshwater/Sediment Inflow Management/Water Impoundment Restoration at Burgentine Lake
- 9262 Foester and Powderhorn Lakes Inflow Management, Enhancement, and Wetland Restoration
- 9266 Aransas NWR Ditch and Road Hydrologic Restorations, Wetland Development, and Shoreline Protection

Improving Community Resilience

- 1272 Camp Mohawk County Park Expansion Along Chocolate Bayou
- 1331 Oyster Shell Recycling Program for Reef Restoration
- 1346 San Luis Pass Park Shoreline and Facility Repair and Improvements
- 1369 Railroad Spur Drainage Detention Area
- 5192 Port Isabel Breakwater
- 9184 South Padre Island Resilient Public Access
- 9186 Nueces Bay Shoreline Repairs
- 9190 Galveston Bay Park Plan
- 9193 West Orange County Flood Control Project
- 9195 Nueces County Regional Waste Water Plant
- 9219 Hybrid Living Shoreline Stabilization Along Corpus Christi Bay
- 9231 Beach Access Enhancements in Cameron County
- 9272 Austwell Pier Erosion Mitigation
- 9273 Coastal Strategic Plan for Mission River
- 9280 Packery Channel Repairs
- 9281 Marina Breakwater Reconstruction
- 9288 Nueces County North Beach Wetlands Restoration and Enhancement
- 9293 Taylor Landing Water Main Project

Adapting to Changing Conditions

- 9217 Adaptive Management Capacity and Support for Oyster Reef Restoration
- 9243 1,000 Mile Living Shoreline Project - Phase 2

Growing Key Knowledge and Experience

- 1339 Quantifying Water Availability and Quality from Submarine Discharge Points into Gulf Estuaries
- 1363 The Importance of Pass Cavallo to the Health of Matagorda, Espiritu Santo, and Lavaca Bays
- 9188 Oyster Reef Living Shorelines
- 9200 Colony Island Network Development and Implementation Tool
- 9211 Data Repository for Resiliency Planning
- 9256 Portable Levee Tester
- 9289 Lavaca and Navidad Rivers Sediment Management Study
- 9295 Sabine-Neches Sediment Management Study
- 9299 Mangrove Establishment Demonstration Project

Enhancing Emergency Preparation and Response

- 9214 Anahuac NWR Refuge Oyster Bayou Boat Ramp
- 9290 West Jefferson County Regional Water Supply Improvements

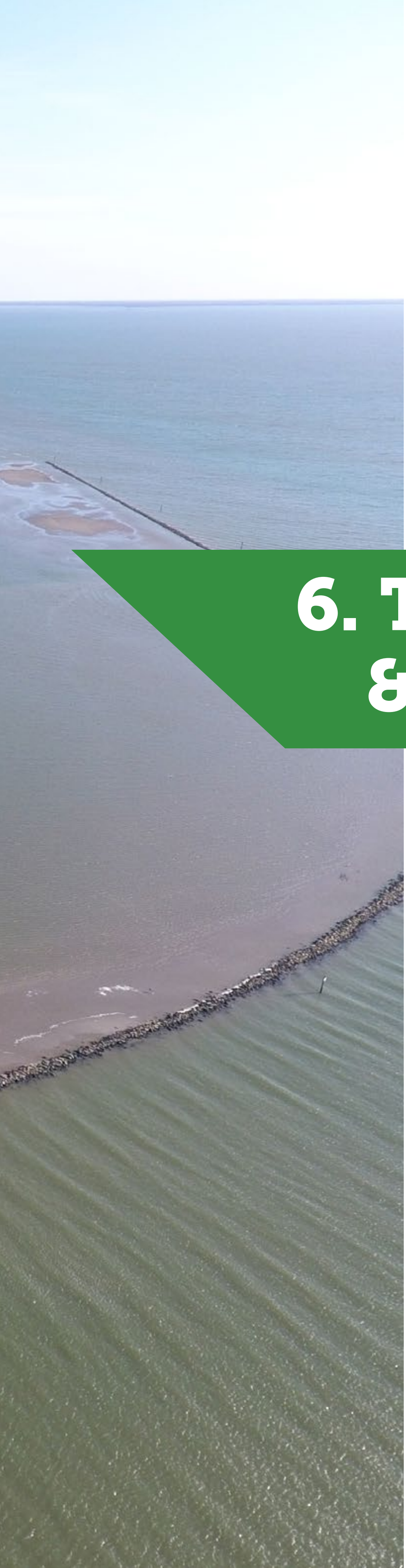
Addressing Under-Represented Needs

- 1270 Brazos River County Park Addition
- 1364 Varner Creek Park
- 9212 Port Lavaca Lighthouse Beach Park Restoration and Resiliency
- 9242 Walter Umphrey Park Bulkhead Repair and Resiliency Upgrade

Maintaining Coastal Economic Growth

- 1286 Construction and Enhancement of Artificial Reefs in the Northern Gulf of Mexico
- 1380 PA9-S Beneficial Use
- 1382 Pelican Island (M3) Beneficial Use
- 1383 Key Allegro Island Beneficial Use
- 9083 Double Bayou Habitat Preservation
- 9205 Implementation of a Coastal Harmful Algal Bloom Monitoring Network in Texas
- 9274 City of Seabrook Public Pier
- 9275 City of Seabrook Crothers Gardens Park, Waterfront Loop, and Wetlands Trail

(Photo Credit: Freese and Nichols, Inc.)



6. Texas's Path Forward & Implementation

Resiliency is the guiding principle for how the GLO plans for the future of the Texas coast. Since the 2019 Plan was published, many priority projects have made progress, many of which combine multiple lines of defense solutions for truly interconnected resiliency. The GLO accomplished successful implementation of Tier 1 projects at various stages, including several that were promising (i.e., conceptual) but were not progressing, through engagement with local sponsors, stakeholders, and project owners. The GLO also developed eight resiliency design guides and funding guides to help project planners consider specific coastal parameters that impact the life of their projects. Because of the collaborative works of the GLO with the Technical Advisory Committee, partner agencies, residents, and others, Texas's coast is stronger and more capable of responding to its vulnerabilities.

Moving forward, the GLO will continue to be proactive by looking at the coastal system as a whole to identify causal chains; propose solutions to guide policy, new projects, and land use planning; and adaptively manage projects to enhance coastal resiliency. The GLO will continue to update this Plan using an adaptable planning process that considers changing conditions, needs, and preferences of coastal community members and their coastal environments. To inform the update process, the GLO will rely on best-available scientific research, local expertise, and monitoring data and findings from completed projects. Learning from lessons of past projects will safeguard the public investment in implementing successful and effective projects for coastal resiliency.

6.1. The Path Forward

The GLO first began to enact its vision to develop a coastal resiliency plan able to fit the needs of the whole state in 2016 as part of a 2-year planning cycle. This Plan marks the third issuance of the Texas Coastal Resiliency Master Plan, and the first since moving to a 4-year process.

Moving forward, this Plan will next be updated in 2027 to continue to meet the needs of coastal communities and to adaptively adjust the funding priorities and restoration strategies using project outcomes and monitoring data from previous projects. A 4-year update cycle for this Plan allows ample time for analyzing new monitoring data that becomes available from constructed resiliency projects, soliciting and including comprehensive stakeholder outreach into the planning process, and reflecting on and considering new ideas and projects with the TAC. This 4-year update schedule also aligns with Texas's state legislative sessions, held during odd numbered years.

The planning timeline to the left shows the overall Plan timeline for the whole of the Texas Coastal Resiliency Master Plan, beginning from its inception in 2016, continuing through the publication of the 2019 Plan, and proceeded by the subsequent steps to begin working toward the 2027 Plan, following the issuance of this Plan.

One of the next hurdles toward implementing this Plan will be funding the prioritized Tier 1 projects. Funding this Plan is discussed in the following pages, including the history of funding available for coastal resiliency projects, and the outlook for receiving similar funding into the future.

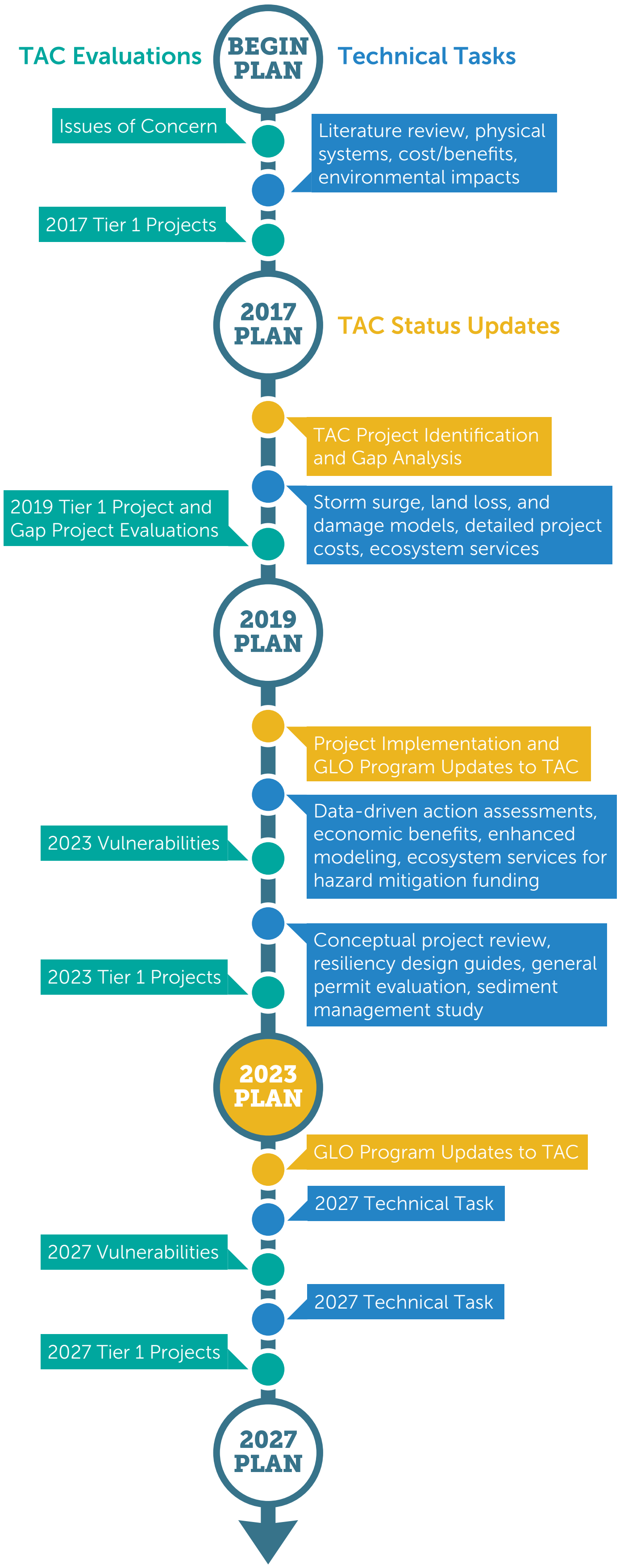


Figure 6.1: *Texas Coastal Resiliency Master Plan Timeline, 2016 - 2027*

6.2. Funding this Plan

The GLO's Coastal Protection Division is involved in many funding efforts dedicated to meeting coastal resiliency needs. These efforts have produced many implementation successes in recent years, contributing to the GLO's overall goal of restoring, protecting, and enhancing the Texas coastal area. The total funding needed for Tier 1 projects in this Plan is shown by project type in Figure 6.2.

Opportunities

The GLO has leveraged the work of this Plan to more effectively prioritize coastal projects using federal and local funding opportunities.

- **GLO Coastal Programs** – There are several federal and state grant funding programs that the GLO administers supporting coastal projects in Texas. These include the CEPRA Program; GOMESA, which pays out royalties from oil and gas exploration in the Gulf of Mexico; and the CMP, funded by NOAA, among others. See Section 6.2.1, below, for more detail.
- **Hotel Occupancy Tax** – The Hotel Occupancy Tax House Bill 6 was passed during the 2019 Texas Legislative Session and included dedicating 2% of HOT revenues in coastal counties to the GLO's CEPRA program to boost the state's capabilities to address coastal erosion and ensure money spent on the Texas coast stays on the Texas coast.
- **Integration with CDBG-MIT** – The GLO is administering nearly $4.3 billion in CDBG-MIT grants through its Community Development and Revitalization Division. Of these funds, the Coastal Resiliency Program received nearly $20.5 million for two Tier 1 projects that boosts shoreline protection in coastal communities.
- **Deepwater Horizon** - Funds collected from civil and criminal penalties from the Deepwater Horizon oil spill are administered through three funding streams: National Fish and Wildlife Foundation-Gulf Environmental Benefit Fund (NFWF-GEBF), NRDA, and the RESTORE Act. The 2019 Plan was referenced as a representation of regional priorities for the allocation of funding under these sources.

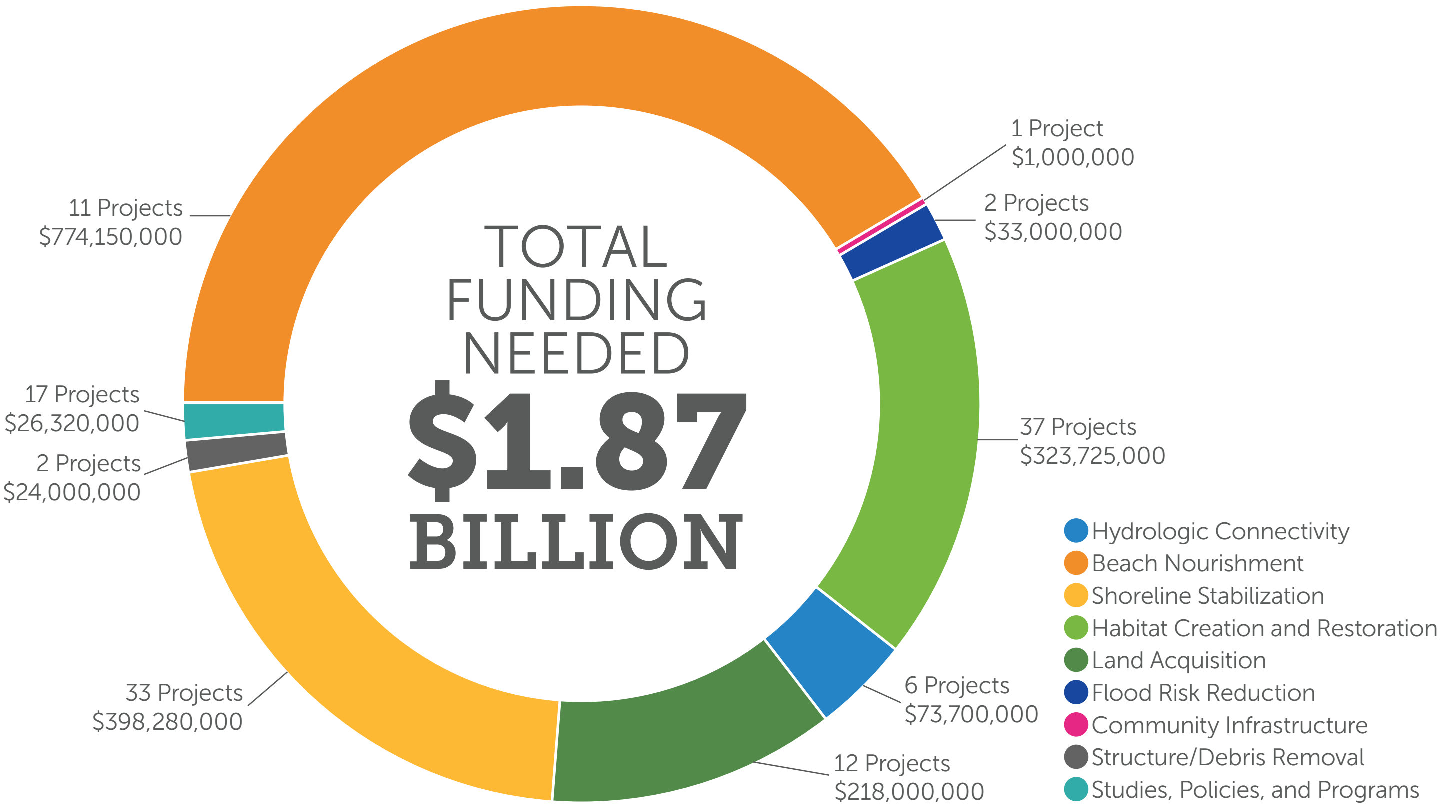


Figure 6.2: *Tier 1 Project Funding Needs*

6.2.1. GLO Coastal Funding Programs

(Photo Credit: HDR)

The GLO implements this Plan through its Coastal Protection Division, as described in Section 1. This Plan assists specifically with the funding priorities for the CEPRA, CMP, and GOMESA programs, and provides coastal-focused priorities for the CDBG funding administered through the GLO's CDR Division. Former funding sources that the GLO has been involved in administering also include the Coastal Impact Assistance Program (CIAP) that expired in 2010.

Past versions of this Plan have also been referenced by the NRDA Trustees, and decision makers for other funding sources external to the GLO such as the RESTORE Council and the NFWF-GEBF.

Funding Since 2019 Plan

In general, funding has been increasing for coastal resiliency projects since 2005, as shown in Figure 6.3. Some of these increases have been due to disaster-specific funding sources, such as NFWF-GEBF and RESTORE funds made available after the Deepwater Horizon oil spill in 2010. In 2022, the GLO and other funding partners administered $124 million in state and federal funds to benefit coastal resiliency in Texas, an $18.3 million increase from 2021. Since the inception of the Texas Coastal Resiliency Master Plan, Tier 1 projects have received a cumulative $597 million in total funding from the GLO and other funding partners, of which $457 million has been leveraged from local and other funding sources (Figure 6.4).

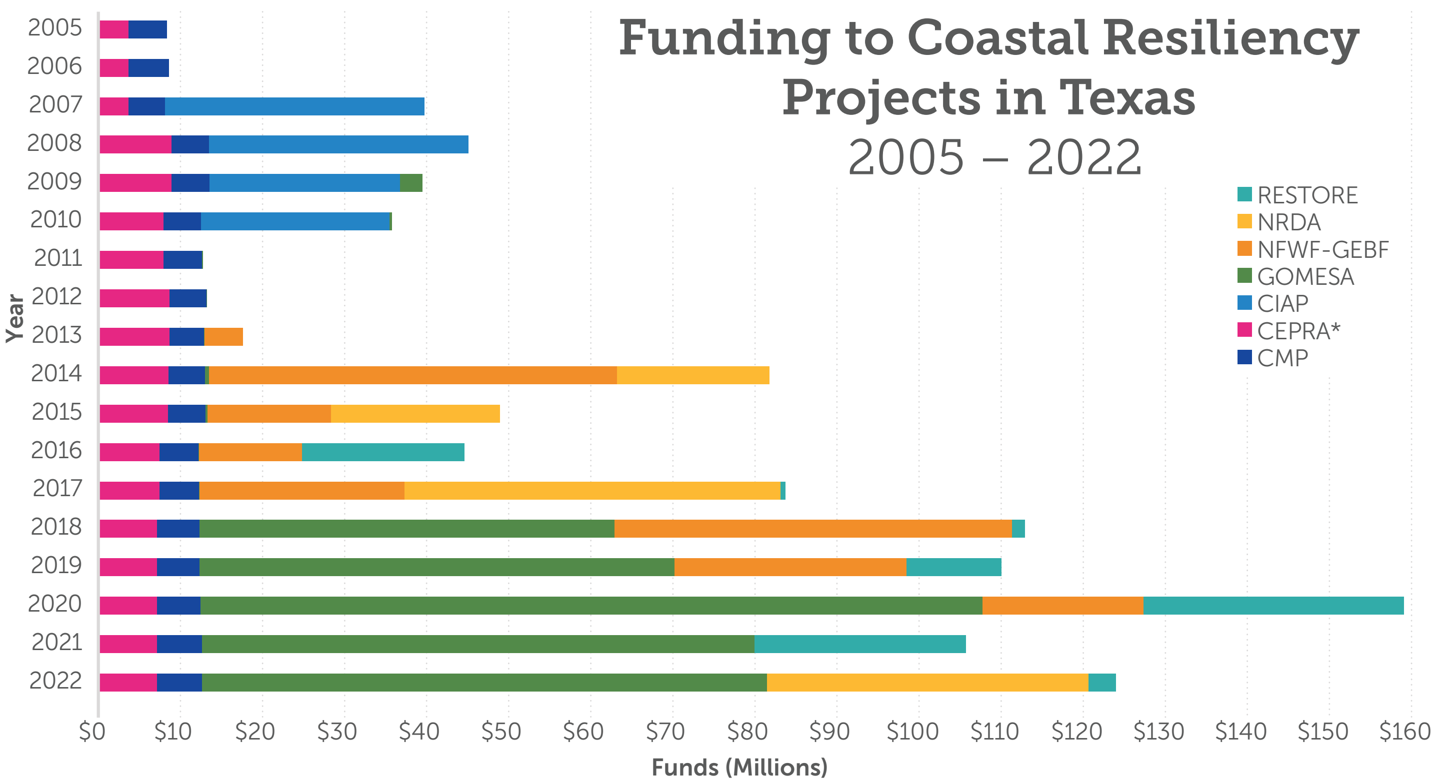


Figure 6.3: *Funding to Coastal Resiliency Projects in Texas, 2005 - 2022*
**CEPRA is funded on a two-year cycle. Those funds are shown distributed equally across both years in the biennium.*

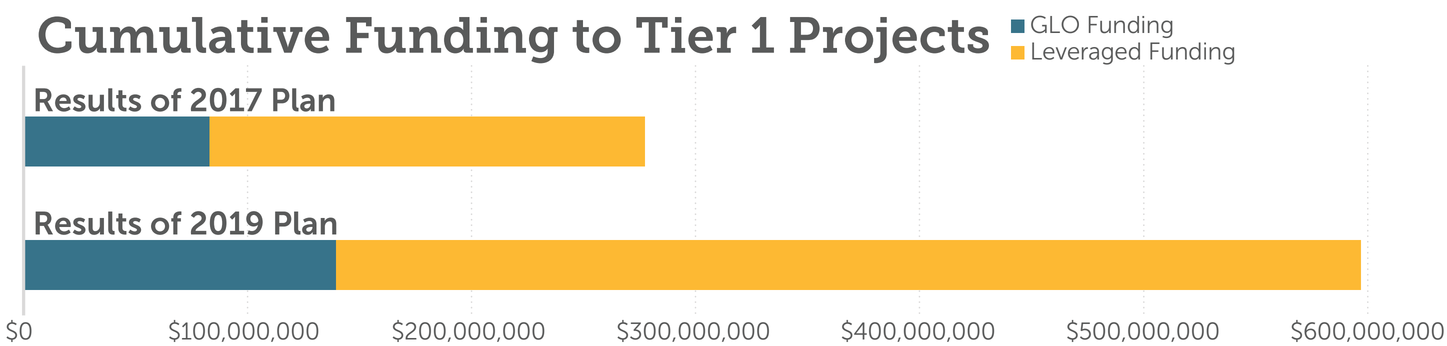


Figure 6.4: *Cumulative Funding to Tier 1 Projects*

6.2.2. Other Funding Opportunities

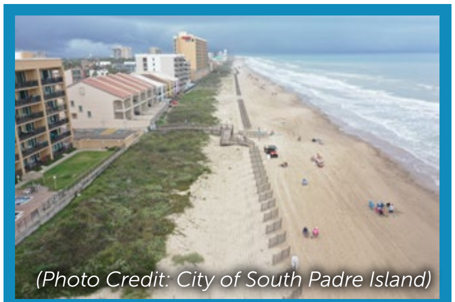
The GLO is working to implement the Tier 1 projects included in this Plan by leveraging other funding sources that are not administered by the GLO. To facilitate this, the GLO recently released a Funding Programs Resiliency Design Guide that lists state and federal grant opportunities that may be considered by lead stakeholders and project partners to fund coastal resiliency projects. The grant opportunities listed in the guide are sorted by six general categories: conservation, disaster mitigation, restoration, management, research, and non-point source pollution reduction. Much of the success of implementing Tier 1 projects has been achieved by leveraging additional funding, including local match funds from partnering communities.

6.2.3. Stakeholder Capacity Assistance

The 2019 Tier 1 project list included several concepts that were promising but were not progressing toward an actualized project for a variety of reasons including, but not limited to, lack of stakeholder support and engagement, lack of funding, or limited avenues to pursue funding opportunities. These projects were listed as "Conceptual" in the 2019 Plan.

A strong focus of the GLO's 2023 planning process was to move existing Tier 1 projects from planning into implementation phases. From the publication of the 2019 Plan until now, the GLO has been working to engage local sponsors, stakeholders, or projects owners to support conceptual projects through the next stages of development. As part of this work, the GLO directly assisted stakeholders, when practicable, to supplement the technical knowledge and/or capacity of stakeholder project teams. In some cases, the GLO's work helped identify a lead stakeholder for a project that had previously been merely a conceptual idea that had gained traction within the TAC but with no clear spokesperson.

This technical assistance effort resulted in successfully moving 11 projects from conceptual to a near actualized stage. This effort will inform future tools and supports that will promote continued successful implementation of 2023 Tier 1 projects.



(Photo Credit: City of South Padre Island)

Highlight Project: South Padre Island

Projects identified for South Padre Island, widely recognized as a symbol of the south Texas coastline, target different areas of concern from degraded habitat, beach and dune erosion, coastal flood and storm surge damage, and impact on coastal resources. When combined together, these projects represent a broader systems approach for enhancing resiliency. Tier 1 projects for South Padre Island include beach and dune management and restoration, wetlands restoration and living shorelines, property acquisition for expanded conservation of barrier island habitat, SLR monitoring, and providing non-motorized recreational access. Each project enhances and reinforces each other for better performance and enhanced resiliency for the island.

6.3. Monitoring & Adaptive Management

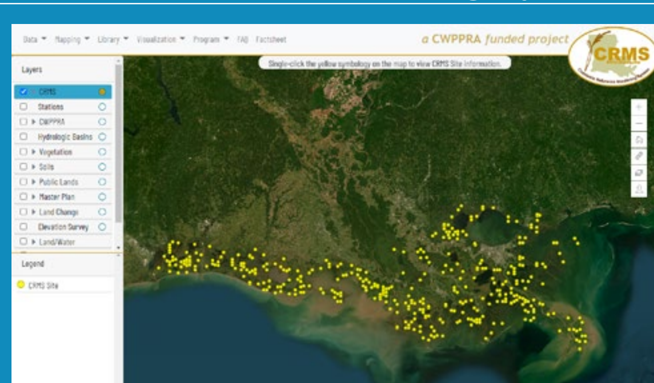
Building from the 2019 Plan, the GLO has continued to refine its planning process using adaptive management. Adaptive management is an iterative learning process and interdisciplinary approach that encourages flexible decision making in the face of uncertainties.

At the core of adaptive management is to modify existing strategies and implement new management strategies as additional information is gathered. Incorporating these techniques into the overall development of this Plan is important, as information regarding the state's coastal resources is continually growing and improving, and is also important at the project level. This information—frequently resulting from past management actions, policy changes, and project implementation—leads to the improvement of this planning process over time.

Adaptive management can be achieved using the following steps, modeled after those found in the Water Institute of the Gulf's Adaptive Management Framework for Coastal Louisiana:[202]

- integrate adaptive management into the development of the Texas Coastal Resiliency Master Plan itself and any associated technical analyses,
- support the role of science in decision making,
- encourage learning throughout the process,
- include transparency in decision making,
- integrate adaptive management practices into existing programs and project plans, and
- develop a governance structure that facilitates adaptive management.

Highlight Project: Louisiana Coastwide Reference Monitoring System[203]



As part of the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) initiative to minimize continued land loss along Louisiana's coast, the Coastwide Reference Monitoring System (CRMS) was developed to monitor the effectiveness of the restoration projects funded by CWPPRA. Since the inception of the initiative in 1990, over 200 coastal restoration and protection projects have been funded, focusing on freshwater and sediment diversion, marsh creation, shoreline protection, terracing, hydrologic restoration, barrier island restoration, and vegetative planting. To understand the level of success of these projects after completion, approximately 390 sites are continuously monitored for a range of ecological parameters including water level, salinity, vegetation, and soil characteristics. These sites can be found both within and external to CWPPRA project areas and are spread throughout nine coastal basins and four CWPPRA regions, covering the entire swath of the Louisiana coast and its varied habitats. This allows the CRMS to function as a reference network to understand how these projects support the coast, not only locally, but regionally and coastwide as well.

The collected data is summarized into maps, tables, and charts and incorporated into the annual CRMS Report Card. These publicly available reports synthesize the data into interpretable tools and indices that assess the current condition of the Louisiana coast at various times and spatial scales, including individual CRMS sites, restoration projects, hydrologic basins, and the coast as a whole. More information on this effort and the data collected can be found on the CRMS website.

The Adaptive Management Process

At a planning level, the process of adaptive management begins with outlining detailed planning goals, identifying management objectives, describing potential vulnerabilities (such as those described in Section 3), and developing procedures for data collection. The end of the process includes time for evaluating the outcomes at each step and proposing improvements to make the process better with each subsequent iteration. At this point, the process begins again. This iterative approach allows planners to learn as they go, providing opportunities to improve the process at each step and reduce uncertainty in future successes.

At a project level, the main elements of the adaptive management approach are similar to those described above. However, a specific Monitoring and Adaptive Management Plan should be developed for each project. In many cases, the GLO can provide templates or guidelines to ensure consistency of an approach across coastal resiliency projects.

The Monitoring Process

Including a monitoring component within the project design is important to effectively apply adaptive management techniques at the project level. Monitoring helps project partners assess the success of the project and the long-term health of the ecosystem against project goals. Data collected during monitoring events can help answer questions regarding the effectiveness of the project or the need to take additional action at the project site.

Alternatively, monitoring can also be conducted at a regional scale to assess system-wide trends. Developing a monitoring program entails establishing a program goal and detailing objectives to meet that goal. Program goal(s) are based on what questions the data will address, the scale of the assessment area, the timeframe in which monitoring will occur, and the anticipated available resources. When successful, a collaborative monitoring program will provide a wealth of information that will inform future planning and decision making, as well as spur on other activities such as new studies, projects, and programs along the coast.

Successfully implementing adaptive management techniques will ensure that efforts being done to enhance Texas's coastal resiliency and the individual projects identified within this Plan (a) contribute to greater coastal resiliency and (b) are consistently improving over time.

(Photo Credit: Jake Madewell/Bill Balboa)

6.4. New Innovations in Resilience

While the GLO has already implemented projects along the Texas coast protecting communities and economic resources, continued progress toward effective and innovative projects is essential to safeguarding coastal resources against habitat loss, gulf shoreline change, bay shoreline change, storm surge, inland flooding, tidal flooding, degraded water quality, and degraded water quantity.

These existing coastal vulnerabilities are projected to become more frequent, more severe, and more economically damaging in the future. Meeting the challenges of the next 4 years (and beyond) will require out-of-the-box thinking, broad collaborations, and bold leadership. Some of the ideas listed below are emerging tools and concepts that have not been widely used to date but may be increasingly beneficial to incorporate into the suite of project types for protecting Texas's coast into the future. The GLO is investigating if and how the concepts listed below could be used to advance the cause of coastal resiliency looking toward the 2027 Plan.

Degraded or Lost Habitat

Regional Advance Mitigation

Mitigation typically involves the restoration, creation, enhancement, or preservation of a wetland or other habitat to compensate for the loss of those resources as a result of development. This type of mitigation is required by the Federal Clean Water Act and Federal Endangered Species Act and typically is done on a project-by-project scale. Regional advance mitigation identifies mitigation opportunities to support planning needs on a larger scale and results in mitigation sites with higher ecological function. Additional benefits include more efficient project approvals including reduced permitting processing times.

Gulf Shoreline Change

Regional General Permit for Beach Nourishment

The GLO has funded 13 beach nourishment projects along the Texas coast from 2004 to 2018. Each of these projects required individual permits from USACE. For some projects, such as the Jamaica Beach Nourishment and Dune Restoration, the beach nourishment component of the project was delayed because of permitting issues. The GLO is pursuing the opportunity to apply for a Regional General Permit for Beach Nourishment with USACE to decrease the time required to permit projects at critically eroding, publicly accessible, Gulf-facing beaches for more efficient coastal erosion response.

(Photo Credit: Exploration Green)

Highlight Project: Exploration Green

Exploration Green is a five-phase plan funded by the CMP and Galveston Bay Foundation (GBF) to create a system of engineered water detention ponds in the community of Clear Lake City, a residential district of Houston, that can detain up to 500 million gallons of stormwater, protecting thousands of homes during storm events. Additional benefits to the community include construction of hike and bike trails for public use and enhanced wildlife viewing opportunities from native habitat restoration.

The Regional General Permit would contain Best Management Practices for minimizing the impact of beach nourishment projects based on environmental considerations, monitoring data from previous projects incorporated with scientific data, local knowledge, and anecdotal experience. The GLO has initiated parts of this work by compiling Best Management Practices for benthic organisms, birds, and sea turtles in the 2023 Technical Report.

Bay Shoreline Change

Blue Carbon Sequestration via Living Shorelines

Atmospheric carbon that is stored in coastal and marine ecosystems, such as seagrasses, wetlands, mangroves, and soil substrates, is known as blue carbon.[43] When these ecosystems are destroyed, the carbon that is stored in those systems is released back into the atmosphere, contributing to higher global carbon emissions. Living shorelines can be used to sequester and store carbon by creating new wetland systems and protecting existing wetlands and shorelines from erosion. As nations and industries work to reduce their carbon footprints, there is a growing carbon market that introduces buying and selling of carbon offsets, incentivizing investments in wetland protection and restoration projects.[43] Similar to the well-established process for wetland mitigation banking to offset wetland impacts generated by engineering projects, carbon credits can be bought and sold by private entities looking to reduce emissions, meet regulatory requirements, and/or participate in environmental stewardship. As this market continues to expand, the GLO is working with potential partners to investigate new opportunities to bring in funding from private investors to bear for living shoreline projects.

As nations and industries work to reduce their carbon footprints, there is a growing carbon market that introduces buying and selling of carbon offsets, incentivizing investments in wetland protection and restoration projects.

Townsend Bayou (Photo Credit: Rusty Feagin)

(Photo Credit: Texas General Land Office)

(Photo Credit: Patty Alexander)

Storm Surge

Coastal Independence

The GLO wants to ensure that Texans continue to thrive and prosper by avoiding risk when it is possible and building resiliency when it is not. In coastal Texas, this means giving enough space for natural systems such as barrier islands, beaches, dunes, and wetlands to provide the physical barrier and protection to coastal communities from storm surge. Most of the Tier 1 projects in the 2023 Plan involve some component of expanding the size of natural features including beach nourishment, dune restoration, barrier island creation, or wetland restoration. However, these projects are limited by geography, cost, jurisdictional boundaries, and adjacent development. The state's response for the resiliency of these systems must be tailored to the specific needs of individual environments. For example, in some cases, the most cost effective and beneficial method of building resiliency on a barrier island may involve expanding buffer areas inland rather than working against sea level rise and storm surge to expand toward the sea.

The 2019 Plan described a multiple lines of defense approach as "green" (nature-based) solutions and "gray" (built) projects working together in a complementary manner. This Plan adds another layer to the multiple lines of defense: the idea of "responsible development," or the purposeful and equitable movement of people, structures, and infrastructure away from vulnerable coastal areas to expand buffer areas for protection from episodic or chronic threats. Proactively moving Texans out of harm's way before disasters occur will maximize resiliency benefits, reduce disruptions to the economy, and minimize damage and restoration costs for communities and ecosystems alike.

Tools for coastal independence could include:

- hazard mitigation buyouts
- open space acquisitions
- land swaps
- reversionary interests
- land use and zoning
- transfer of development rights programs

Inland Flooding

Combined River Basin Flood Study

The Combined River Basin Flood Studies will analyze regional and local flood mitigation solutions to promote short and long term recovery. Initiated in 2020, this project will increase resiliency of communities most at risk for flooding by enabling them to undertake the most effective projects that reflect local priorities and needs. This project considers combined flood risks for 53 counties which received a Presidential disaster declaration from either Hurricane Harvey or the floods of 2015 and 2016 in the Lower Rio Grande Valley. The combined effort will produce regional flood plans to support current and future Texas State Flood Plans (by TWDB) and inform disaster recovery and mitigation. This project demonstrates a coordinated approach to flood risk management to improve efficiency, information sharing, and expansion of efforts for more flood resilient communities.

Tidal Flooding

Tidal Flooding

Most of Galveston Island has a flat topography, which limits its capacity to drain large volumes of water and can lead to backflow and flooding during high tides, heavy rainfalls, and storm events. The City of Galveston is currently implementing a citywide plan to switch from gravity drainage to pumped drainage as a response to increased backflow events in drainage pipes, clogging of outfalls by sediment and marine growth, intensifying rainfall and surge events, and trends of increasingly high tides.[204] The City is working toward obtaining grant funding for a $48 million pump station for its South Shores area and for approximately $112 million in combined CDBG-MIT funding for two pump stations at 37th and 51st Streets. Additionally, the City was awarded a grant from FEMA and the Texas Division of Emergency Management (TDEM) for a $32 million pump station from 14th Street along Seawall Boulevard to Galveston Channel, which is designed and pending construction.[204] The pump stations will be able to dewater roads and drainage areas during high tides and coastal storms to pump large volumes of water from onshore areas into Galveston Bay to control flooding, providing the City a level of protection similar to the Texas City ring levee.

Highlight Project: Nueces River Authority Regional WWTP

The Nueces River Authority (NRA) has identified many problems with discharge from several wastewater treatment facilities, which are old, have failing equipment, and are struggling to meet permitted effluent parameters for elevated nutrient levels and *E. coli* bacteria in the Baffin Bay and Oso Bay watersheds. To improve water quality, the NRA is working to transition local WWTPs toward a regional solution, which is currently proposed as a state-of-the-art replacement plant in an optimized location that is protected from storm surge, inland flooding, and tidal flooding. GLO is working with the NRA providing technical assistance to local plants, and portions of this work are being completed using CMP-GOMESA funds. This project is an example of an innovative, resilient solution being implemented in the responsible development and tidal flooding spaces.

(Photo Credit: © Claire Everett/TNC)

Highlight Project: Texas Water Trade

The quantity, quality, and timing of freshwater inflow from rivers to the coast is critically important to maintaining the natural salinity, nutrient, and sediment loading regimes which support biodiversity and ecosystem function in our state's bays and estuaries. While some strategies are more cost-effective and feasible to implement than others, the potential for voluntary strategies to secure freshwater inflow protection has yet to be fully explored and evaluated. Filling the niche to build such a portfolio, the Texas Water Trade and their partners lead the state in developing, funding, and testing innovative market-based strategies for freshwater inflow protection and restoration. With relatively small volumes of water, their focused flows management approach in the Galveston, Matagorda, and San Antonio Bay systems targets water deliveries to key habitat at critical times, providing important benefits to ecosystem health and facilitating habitat recovery following severe drought. Their collaborative successes demonstrate that voluntary and market-based strategies are an important conservation tool for freshwater inflows in Texas.

Degraded Water Quality

Sanitary Sewer Overflow Study

Texas's coastal waters are impacted by sanitary sewer overflows that can be responsible for contamination of surface and ground water with bacteria and pathogens, which affects the environment, recreational activities, public health, and the seafood industry. Many of the coastal water bodies including bayous, rivers, and bays are designated as impaired by the TCEQ with bacteria and other pollutants. SSOs have the potential to become more prevalent in the future if action is not taken to address issues causing them. Sea level rise will present a growing risk for inundation and increasing weather intensification patterns could put additional strain on wastewater collection systems, exacerbating the existing issues with infiltration and inflow related SSO events. The GLO is preparing a forward-looking study detailing the causes, trends, and patterns in SSOs along the Texas coast that will help inform the development of a targeted approach for solutions within the top polluting bay systems where they would be most effective. The study report in its initial rendering can be found in the 2023 Technical Report.

Degraded Water Quantity

Freshwater Environmental Flow Strategies

As the state's population grows, increasing demands for water may limit the volume and alter the quality or timing of freshwater reaching the coast. Recognizing the need to define and establish environmental flow protection for Texas rivers, streams, bays and estuaries, the 80th Texas Legislature passed Senate Bill 3 to create a stakeholder-driven process for developing environmental flow standards and set-asides. A major component of the process directs local stakeholder groups to recommend strategies to achieve the flow standards. However, while several stakeholder groups have investigated a variety of strategies, there is no clear delegation of responsibility or funding to implement such strategies. Since 2014, the TWDB has funded over 50 projects to collect environmental flow data and information needs identified in stakeholder work plans for adaptive management. Of these, several feasibility studies evaluate voluntary strategies and associated benefits, costs, and legal or other important considerations specifically for East Matagorda Bay, San Antonio Bay, and the Nueces Delta. This is a significant opportunity because even with regulations in place through the environmental flow standards, Texas will still need to foster a portfolio of options for ensuring and expanding environmental flow protection as water demands increase.

6.5. Future Implementation

The Tier 1 projects and new innovations and ideas described throughout this Plan are the result of 4 years of data-driven and stakeholder-informed strategic planning for the future of Texas's coastal resiliency. The recommendations presented in this Plan reflect a careful consideration of the complex characteristics of the Texas coastal zone, including coastal pressures and vulnerabilities, updated flood and storm surge modeling, socioeconomics, and the needs of coastal communities.

The vision embraced by the GLO for the future of the Texas coast is ambitious, but Texans have a history of overcoming difficult odds to achieve what at times seems impossible. Advancing our coastline to be more resilient in the face of future, unknown storms, changing sea levels, and continued land change is a challenge that is being accepted by coastal stakeholders across the state of Texas. Continued progress is possible by working together to learn from both past successes and failures, understanding vulnerabilities, and investing in our coast today for the benefit of all Texans tomorrow.

(Photo Credit: Lee von Gynz-Guethle)

(Photo Credit: Galveston Bay Foundation)

Understanding Project Cut Sheets

The following is meant to serve as a guide to understanding the information presented on each individual project cut sheet.

A. The top of each cut sheet is color-coded by region and categorized by county.

B. This inset map displays the general project vicinity in relation to its coastal region.

C. Basic information such as project location, status, and key project stakeholders can be found in the right column of each sheet. One or more lead stakeholders are identified for each project and are listed in bold italic font.

D. Construction-type project costs include planning, design, construction, and maintenance costs. These costs are typically developed by the Lead Stakeholder and are verified by the GLO using detailed cost templates included in the Technical Report. For non-construction projects, project costs are typically estimated by the Lead Stakeholder based on the level of effort expected, and verified by the GLO. Project totals shown can either represent total project cost or unfunded project costs, dependent on project status at the time of Plan publication.

E. These dials indicate how well the project addresses the eight coastal vulnerabilities, separated into three overarching categories. The extent of color halo around the circle indicates that the project addresses the coastal vulnerability depicted, according to the TAC evaluations.

F. This column contains a detailed map depicting the location of the individual project, a brief project description, and the need the project aims to address.

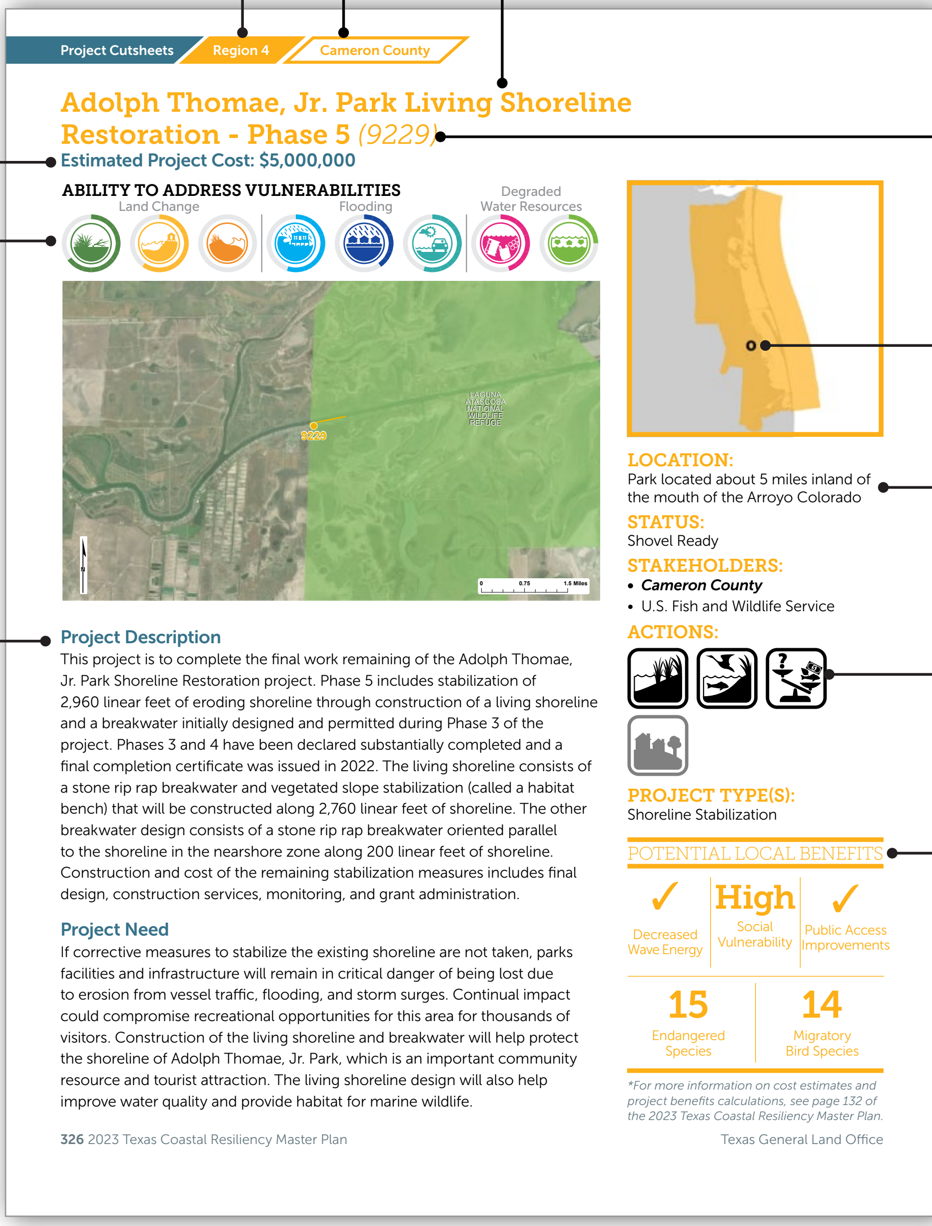
G. This section contains project classification information, including the actions and project types associated with the project. The key action is shown in black, and any additional actions are shown in gray.

H. This section includes information about the potential local benefits that the project could provide, including economic, environmental, and social benefits. More information on how benefits are measured can be found in Section 5.4 and the TCRMP Technical Report.

A Region 1 | Region 2 | Region 3 | Region 4

County where project is located

Project Name *(Project ID Number)*


Project Cutsheets | Region 4 | Cameron County

Adolph Thomae, Jr. Park Living Shoreline Restoration - Phase 5 *(9229)*

Estimated Project Cost: $5,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

LOCATION:
Park located about 5 miles inland of the mouth of the Arroyo Colorado

STATUS:
Shovel Ready

STAKEHOLDERS:
- *Cameron County*
- U.S. Fish and Wildlife Service

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization

POTENTIAL LOCAL BENEFITS

✓	High	✓
Decreased Wave Energy	Social Vulnerability	Public Access Improvements

15	14
Endangered Species	Migratory Bird Species

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Project Description

This project is to complete the final work remaining of the Adolph Thomae, Jr. Park Shoreline Restoration project. Phase 5 includes stabilization of 2,960 linear feet of eroding shoreline through construction of a living shoreline and a breakwater initially designed and permitted during Phase 3 of the project. Phases 3 and 4 have been declared substantially completed and a final completion certificate was issued in 2022. The living shoreline consists of a stone rip rap breakwater and vegetated slope stabilization (called a habitat bench) that will be constructed along 2,760 linear feet of shoreline. The other breakwater design consists of a stone rip rap breakwater oriented parallel to the shoreline in the nearshore zone along 200 linear feet of shoreline. Construction and cost of the remaining stabilization measures includes final design, construction services, monitoring, and grant administration.

Project Need

If corrective measures to stabilize the existing shoreline are not taken, parks facilities and infrastructure will remain in critical danger of being lost due to erosion from vessel traffic, flooding, and storm surges. Continual impact could compromise recreational opportunities for this area for thousands of visitors. Construction of the living shoreline and breakwater will help protect the shoreline of Adolph Thomae, Jr. Park, which is an important community resource and tourist attraction. The living shoreline design will also help improve water quality and provide habitat for marine wildlife.

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B **C** **D** **E** **F** **G** **H**

- Managing Coastal Habitats
- Managing Gulf Shorelines
- Managing Bay Shorelines
- Improving Community Resilience
- Adapting to Changing Conditions
- Managing Watersheds
- Growing Key Knowledge and Experience
- Enhancing Emergency Preparation and Response
- Addressing Under-Represented Needs
- Maintaining Coastal Economic Growth

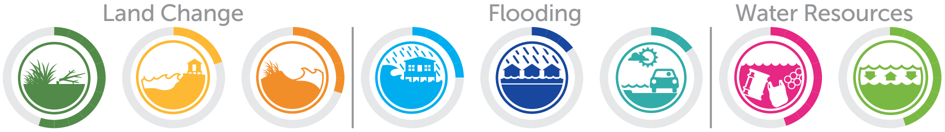
Vulnerability Icon | **TAC Rating of Project Benefit**

Land Change			Flooding			Degraded Water Resources	
Degraded or Lost Habitat	Gulf Shoreline Change	Bay Shoreline Change	Storm Surge	Inland Flooding	Tidal Flooding	Degraded Water Quality	Degraded Water Quantity

Abandoned and Derelict Structure Removal Program *(1237)*

Estimated Program Cost: $5,000,000 per year

ABILITY TO ADDRESS VULNERABILITIES



Project Description

The Texas General Land Office identifies, prioritizes, removes, and properly disposes of abandoned or unauthorized structures in coastal waters and on state-owned land. The authority for this program is found in Texas Natural Resources Code Sections 40.108(b) and 51.3021. Due to the highly corrosive effects of saltwater and the brute force of tropical storms, abandoned wells, pipelines, and platforms present risks of leaking and causing damage to the state's natural resources and economic viability. These orphaned wells, pipelines, and platforms can exude toxic pollutants, such as chlorides, hydrocarbons, arsenic, barium, lead, and mercury. These contaminants endanger the public's health and safety, as well as the plants, fish, shellfish, and mammals that all rely on healthy offshore waters, coastal bays, wetlands, and estuaries. In addition, these abandoned structures, derelict piers, docks, pilings, and other marine debris also pose navigational hazards for recreational and commercial vessels. The removal of abandoned, derelict, and/or unauthorized structures along the Texas coast would improve water quality and habitats for local wildlife, increase public safety, and decrease navigational hazards for recreational and commercial vessels.

Project Need

As of December 2022, there are at least 650 structures and objects listed in the GLO's offshore structure inventory that need to be removed due to their status as abandoned, derelict, or unauthorized. According to the inventory data, the number of objects needing to be removed is greatest in Region 1 with over 400 objects in the region. Region 4 has the least with slightly over 30. Historically, there has not been a dedicated funding source to remove these various types of abandoned structures. There have been some recent funding successes toward these goals; however, more funding is necessary to remove the remaining potentially hazardous structures. Federally declared disasters allow FEMA funding to address some removal efforts but not all incidents allow for FEMA involvement, as was true in the case of Hurricanes Nicholas and Hanna, since they did not become federally-declared disasters. The costs of removal of these types of abandoned or derelict structures range from $2,000-$3,000 for pilings; $20,000-$30,000 for piers/docks; $500,000-$700,000 for wells; and at least $1 million to $2 million for platforms.

LOCATION:

Coastwide

STATUS:

Ongoing

STAKEHOLDERS:

- ***Texas General Land Office***
- National Oceanic and Atmospheric Administration

ACTIONS:

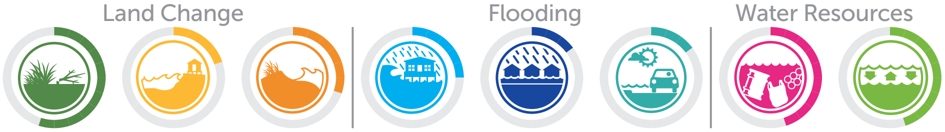
PROJECT TYPE(S):

Structure/Debris Removal; Studies, Policies, and Programs

Abandoned Vessel Removal Program *(2)*

Estimated Program Cost: $1,000,000 per year

ABILITY TO ADDRESS VULNERABILITIES



Project Description

Under Texas Natural Resources Code Sections 40.108(b) and 51.3021, the Land Commissioner has the authority to remove and dispose of derelict vessels and structures abandoned in coastal waters and on state-owned lands if the Commissioner finds them to be:

1. Involved in an actual or threatened unauthorized discharge of oil;
2. A threat to public health, safety, or welfare;
3. A threat to the environment; or
4. A navigation hazard.

Following this legislation, the Texas General Land Office created the Abandoned Vessel Removal Program to identify, prioritize, remove, and properly dispose of derelict and abandoned vessels along the entire Texas coastline.

Project Need

As of December 2022, there are over 75 vessels that meet the criteria for removal by the GLO ranging in size from 10-foot recreational vessels up to 200-plus foot barges. Historically there has not been a dedicated funding source to remove abandoned vessels. There have been some recent funding successes toward these goals, however, more funding is necessary to remove the remaining vessels. Federally declared disasters allow FEMA funding to address some vessel removal efforts but not all incidents allow for FEMA involvement. For example, Hurricanes Nicholas and Hanna were not federally declared disasters, therefore abandoned and derelict vessels resulting from those storms have been left to the state to cover costs of removal. As of December 2022, Region 1 has 59 vessels to be removed, Region 2 has two vessels, Region 3 has six vessels, and Region 4 has nine vessels.

LOCATION:
Coastwide

STATUS:
Ongoing

STAKEHOLDERS:
- ***Texas General Land Office***

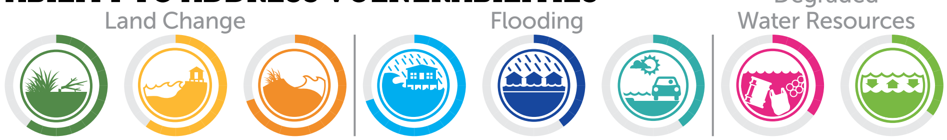
ACTIONS:

PROJECT TYPE(S):
Structure/Debris Removal; Studies, Policies, and Programs

Beach Monitoring and Maintenance Program *(2311)*

Estimated Program Cost: $1,000,000 per year

ABILITY TO ADDRESS VULNERABILITIES



Project Description

The Texas General Land Office (GLO)'s Beach Monitoring and Maintenance Program (BMMP) was established to provide ongoing monitoring and analysis for the GLO to prioritize the need for maintenance renourishment of designated bay- and Gulf-facing beaches enhanced through engineering along the Texas coast. Under the BMMP, annual monitoring surveys are conducted for all engineered beach sites. When tropical storm events occur, post-storm surveys are conducted at the sites determined by the GLO as likely to have sustained impacts. The resulting analysis of post-storm versus annual survey data forms the basis for the GLO's damage assessment of beach volume loss. If a given storm event warrants a federal disaster declaration, the BMMP survey and analysis become the basis for the GLO's pursuit of Federal Emergency Management Agency (FEMA) Public Assistance (PA) Program claims.

A beach may be considered eligible for disaster assistance funding when: the beach was constructed by the placement of imported sand (of proper grain size) to a designed elevation, width, and slope; a maintenance program involving periodic renourishment with imported sand has been established and adhered to by the applicant; and the maintenance program preserves the original beach design. Through the BMMP, the GLO, with funding through its Coastal Erosion Planning & Response Act (CEPRA) Program, tracks and collects this information to accurately identify the areas impacted and the amount of sand lost during natural disasters. A key component of the BMMP, therefore, is the ability to regularly monitor and record engineered beach sand loss. This program also provides for post-storm surveying and analysis to provide baseline data for quantifying storm impacts at BMMP sites, which also serves as the basis for the empirical data needed to support FEMA PA claims. As part of the scope of the BMMP, new and historical annual and post-storm survey data is made available online under the Coastal Habitat Restoration Geographic Information System (CHRGIS), hosted and maintained with GLO support by the Conrad Blucher Institute at Texas A&M University-Corpus Christi. The most recent upgrades to the system facilitate on-the-fly volumetric change analysis of each beach site and the downloading of raw survey data.

Project Need

The BMMP is the basis for the GLO's ongoing maintenance program to address the renourishment of designated engineered beach sites in order to maintain FEMA PA program funding eligibility. A beach monitoring and maintenance program is a prerequisite for Texas to receive funding under the FEMA PA program, which grants reimbursement eligibility to applicants for up to 90 percent of costs relating to the replacement of sand on engineered public beaches impacted by tropical storms significant enough to warrant a federal disaster declaration.

LOCATION:

Gulf and bay engineered beaches in Texas

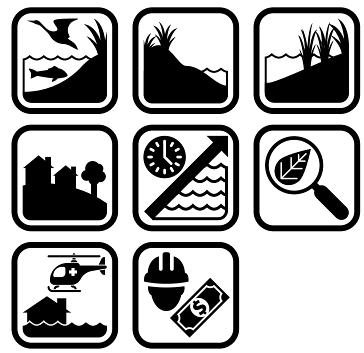
STATUS:

Ongoing

STAKEHOLDERS:

- ***Texas General Land Office***
- Texas A&M University-Corpus Christi Conrad Blucher Institute

ACTIONS:



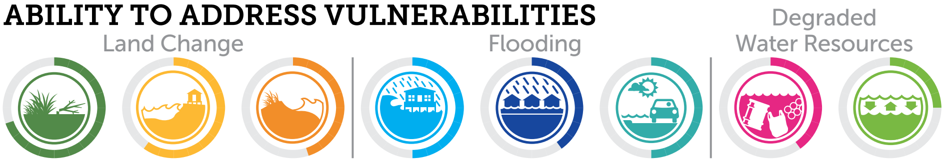
PROJECT TYPE(S):

Studies, Policies, and Programs;
Beach Nourishment;
Dune Restoration

Beneficial Use Master Plan Continuation *(1392)*

Estimated Program Cost: $1,500,000

ABILITY TO ADDRESS VULNERABILITIES



Project Description

This project will be a continuation of the work that the Beneficial Use Master Plan partners, led by Ducks Unlimited, has undertaken to identify future sources of dredged material and sites for its beneficial use. The partners have identified several locations of potential interest that are not yet recommended to progress into design, as well as locations for which intermediate levels of designs have been completed. This project will allow the partners to continue the groundwork to move beneficial use of dredged material (BUDM) projects toward future actions. A planning and prioritization effort that improves and streamlines the BUDM project process is the best way to capitalize on the significant potential for coastal restoration inherent in new or maintenance dredging. This planning process will coordinate efforts, identify efficiencies, build consensus, identify and prioritize sites, and produce plans and guidelines that will result in cost savings and streamline BUDM projects. Beneficial use has the potential to restore thousands of acres of currently degrading coastal habitat annually, thus nearly offsetting documented wetland losses, while also providing coastal resiliency and abating relative sea level rise. Many benefits flow from BUDM projects, including economic value in ecosystem services and commercial value in maritime, fishing, and wildlife revenue.

Project Need

When material is typically dredged, it is disposed of in Dredged Material Placement Areas (DMPAs). However, acquiring or expanding these DMPAs is costly, difficult, and may require use of eminent domain. As DMPAs fill up and disposal fees rise, it's become evident that an alternative option is needed. Disposing of dredged material presents a wasted opportunity, because this sediment can be repurposed to renourish shorelines and wetland habitats. In fact, Texas is losing coastal wetlands at a rate of more than 5,700 acres annually, and a major cause of this loss is insufficient sediment supply. A major barrier to implementing BUDM projects is a lack of coordination between dredging schedules, permitting, and other logistics, demonstrating a need for a coordinated planning effort.

LOCATION:
Coastwide

STATUS:
Conceptual

STAKEHOLDERS:
- ***Ducks Unlimited***
- Texas General Land Office
- National Oceanic and Atmospheric Administration
- Port of Corpus Christi Authority
- Texas Department of Transportation
- U.S. Fish and Wildlife Service
- Coastal Bend Bays & Estuaries Program
- Texas Parks and Wildlife Department
- Galveston Bay Estuary Program
- U.S. Army Corps of Engineers
- Natural Resource Damage Assessment Trustees
- Texas Commission on Environmental Quality

ACTIONS:

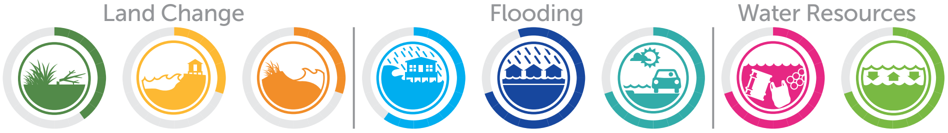
PROJECT TYPE(S):
Studies, Policies, and Programs

Clean Coast Texas Program *(9183)*

Estimated Program Cost: $500,000 per year

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

Clean Coast Texas is a collaborative effort of multiple program partners, managed by the Texas General Land Office. These partners work with numerous stakeholders, state, and local agencies in ongoing efforts to protect and enhance water resources in the Texas Coastal Zone. The Texas Coastal Zone is an important ecological and recreational area where water quality is challenged by pollution, wastewater discharge, and runoff from rapid development. Clean Coast Texas serves Texas coastal communities by providing local governments, developers, and the general public with information and tools to better manage stormwater quality and quantity. The tools and guidance provided can help Texas coastal communities implement measures to reduce the impact of nonpoint source pollution on the economy and the environment, and protect the natural resources that support a thriving Gulf Coast economy.

The program goals are to enhance management of pre-development runoff through green stormwater practices, develop water quality controls, reduce new impervious areas, develop retrofit plans, avoid conversion of areas susceptible to erosion, preserve areas for water quality benefits, limit disturbance of natural drainage features, and inspect on-site disposal systems to ensure proper function and maintenance. Stormwater runoff, floodplain management, and related water quality issues are also critical areas of study for most urban and urbanizing areas and agriculture and grazing lands.

Project Need

Clean Coast Texas, an initiative of the Texas Coastal Management Program, works to ensure vibrant and sustainable fisheries, shellfish, and ecotourism industries through sound science, collaboration, and partnership activities that focus on planning and effective management of nonpoint source pollution in Texas coastal waters. This program addresses resiliency issues focused on stormwater runoff, floodplain management and water quality for activities related to recreation, nature tourism, urban infrastructure and planning, floodplain management, wetlands, marinas, forestry, and agriculture.

LOCATION:

Urban and urbanizing communities in the Texas coastal zone

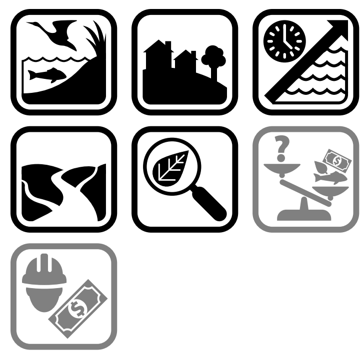
STATUS:

Ongoing

STAKEHOLDERS:

- ***Texas General Land Office***
- Texas Commission on Environmental Quality
- Incorporated Municipalities
- Regional and Watershed Planning Organizations
- Counties
- Councils of Government

ACTIONS:



PROJECT TYPE(S):

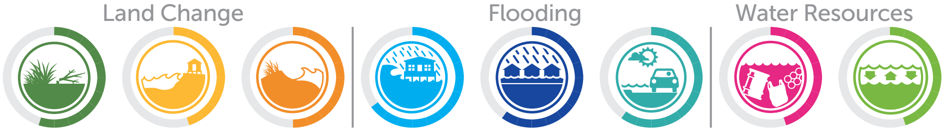
Studies, Policies, and Programs; Community Infrastructure

Data Collection to Support Continual Updates to the National Wetlands Inventory Dataset *(10013)*

Estimated Program Cost: $1,800,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change Flooding Degraded Water Resources



Project Description

Funding would implement a program to collect data along the Texas coast to allow more frequent updates to the National Wetlands Inventory (NWI). In the first phase of this project, Ducks Unlimited is updating the NWI using the most current available imagery, data, and mapping techniques. The updated maps will cover an area of 3.8 million acres in the Texas Coastal Zone and hydrologically connected inland areas in the upper eastern Texas coast from Galveston to the Louisiana border. Data will be delivered to the Texas General Land Office and U.S. Fish and Wildlife Service (USFWS) national mapper as a Geographic Information System dataset with supporting methods documentation and reports. The products of this project will serve to aid in baseline evaluation of habitats and development of management strategies for the Texas upper eastern coast. The data will be used for a variety of purposes, including wetland conservation and restoration, infrastructure planning, habitat modeling, and decision support analysis. Collecting data more frequently—for instance, on a 5-year timeframe—would allow researchers, scientists, and engineers to better assess and respond to wetland change on the Texas coast.

Project Need

The NWI is a key dataset that is used coastwide to support academic research, modeling, engineering, and design of projects in the coastal zone. It is a federally recognized dataset that is trusted to estimate accurate wetland habitat change for the purposes of environmental and construction permitting. Updates are intended to be collected every 10 years to document wetland loss or gain across the United States. However, the most recent data for much of the area in the Texas coastal region are from the 1990s and 2000s. USFWS estimates that over half of the wetlands in the United States have been lost since 1780.

LOCATION:
Coastwide

STATUS:
Ongoing

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- Ducks Unlimited
- Texas General Land Office

ACTIONS:

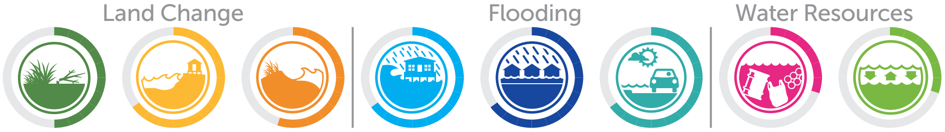
PROJECT TYPE(S):
Habitat Creation and Restoration; Studies, Policies, and Programs

Development of Optimal Coastwide Bathymetric and Topographic Models *(9180)*

Estimated Program Cost: $1,000,000*

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

Under this project, a topographic/bathymetric model of the coastal zone would be developed using the best available data. A process also would be created to maintain and update the model as new data becomes available. While good quality coastal bathymetry data exist for navigation channels and along shorelines, data are often outdated in deltas and open bay areas. Detailed and accurate topographic and bathymetric data are required for mapping coastal habitats, geoenvironments, and built environments in the coastal zone. These data are critical for creating high-resolution grids of hydrodynamic models for simulating coastal inundation, storm surge, and sea level rise impacts; water planning and floodplain management; freshwater inflow and coastal resiliency studies; predicting tides and currents for oil spill response; and for measuring coastal change. Therefore, to understand the vulnerability of the coastal zone and improve the resiliency of coastal communities, reliable topographic and bathymetric data are essential. The models from this project would be widely available to the public. This ongoing effort also would help define where the most pressing data gaps exist.

Project Need

Currently, there are no single, consistent and full-coverage bathymetric or topographic surveys of the Texas Coastal Zone. Recently, the Texas A&M University-Corpus Christi's Harte Research Institute compiled and merged the best available Light Detection and Ranging (LiDAR) data into a topographic model that required consideration of several of the most recent datasets. The Texas Water Development Board and Texas Natural Resources Information System have also partnered to investigate new technologies and to acquire bathymetric data for targeted priority areas along the coast, guided by the Texas Integrated Flooding Framework, which has identified 20 high priority areas along the Texas coast where new data is needed to increase the accuracy of coastal flood modeling. A continuous bathymetric model of Texas bays requires inclusion of multiple survey data acquired since the 1960s. Because of the cost, time required, constantly changing technology, and the need for repeat surveys in dynamic areas, it is not practical to conduct new full-coverage surveys of the entire coastal zone whenever one is needed. This project would address this situation by creating a collaborative process to develop coastwide topographic/bathymetric models using the best available data and filling priority data gaps as needed.

LOCATION:

Coastwide

STATUS:

Ongoing

STAKEHOLDERS:

- ***Texas Water Development Board***
- ***Texas A&M University-Corpus Christi Harte Research Institute***
- Texas General Land Office
- National Oceanic and Atmospheric Administration
- National Science Foundation
- Texas Disaster Information System
- Texas Natural Resources Information System

ACTIONS:

PROJECT TYPE(S):

Studies, Policies, and Programs

**The cost of bathymetry data acquisition depends on the water body and method of collection. For example, sonar techniques are estimated to cost $6,000-$9,000 per square mile ($9-$14 per acre) whereas remote sensing techniques are estimated to cost $1,800-$4,500 per square mile ($3-$7 per acre).*

Longshore Transport Modeling *(9097)*

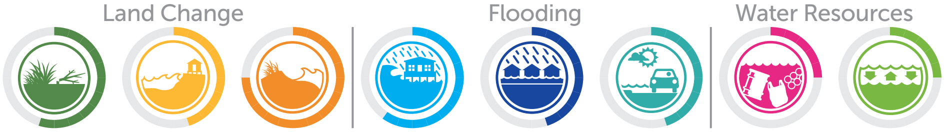
Estimated Program Cost: $2,400,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change

Flooding

Degraded Water Resources



Project Description

This project proposes modeling longshore transport processes in the Gulf of Mexico and Texas bays to better understand where, when, and how beach nourishment projects should take place. Beach nourishment construction projects are subject to wave forces and currents that displace sand offshore or relocate sand to other portions of the shoreline. Therefore, when sand is placed on a beach, it is expected that some of the sand will remain in the placement location, yet some of the sand will drift to nearby beaches, deposit/sink areas, nearshore sandbars, or be carried offshore. This study has recently been completed for Regions 1 and 4, leaving Regions 2 and 3 still in need.

Project Need

Being able to quantify volumes of sand that are expected to be displaced from various parts of the Texas shoreline, based on local wave climates and currents, would give scientists and engineers a better understanding of the large-scale processes that impact beach nourishment on the Texas coast. In addition, the models would consider riverine influx of sediment into the bays, which is a significant source of sediment transport. This project would assist the broader Texas coastal community in determining the most cost effective and viable solutions to improve and sustain Texas beaches over the long-term.

LOCATION:
Gulf shorelines coastwide

STATUS:
Study

STAKEHOLDERS:
- ***Texas General Land Office***
- Texas Water Development Board

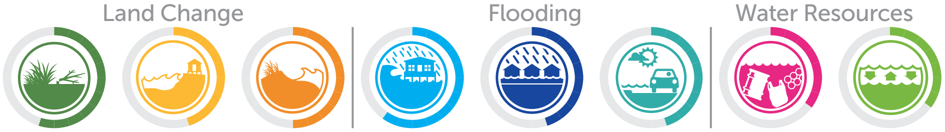
ACTIONS:

PROJECT TYPE(S):
Studies, Policies, and Programs; Beach Nourishment

Long-Term Hydrologic Monitoring Program *(9118)*

Estimated Program Cost: $500,000 per year

ABILITY TO ADDRESS VULNERABILITIES



Project Description

Funding for a long-term coastal hydrologic monitoring program would provide for comprehensive monitoring stations at key areas along the coast to collect data of hydrologic parameters, such as water source and quantity, water quality, nutrient and sediment loading, and meteorological data crucial for environmental assessment and modelling. The program would identify monitoring gaps, leverage and enhance existing infrastructure and monitoring stations where relevant (e.g., the Estuary Monitoring Program administered by the Texas Water Development Board [TWDB], Texas Coastal Ocean Observing Network) and expand hydrologic monitoring activities for comprehensive coastal coverage.

Three concurrent efforts are needed to establish and maintain a coastal hydrologic monitoring program in Texas:

1. Inventory existing hydrologic monitoring activities, conduct an analysis to determine existing station enhancement needs, and identify gaps in coastal monitoring activities.
2. Enhance existing monitoring activities to maximize efficiency and relevance to the coastal management community. For example, needs include new equipment to enhance existing stations with near-real time data transmission, capacity to measure a comprehensive suite of water quality parameters, and co-locating sensors for measuring water quantity and quality with meteorological parameters.
3. Expand monitoring activities to fill identified data gaps to ensure comprehensive coverage of hydrologic conditions along the Texas coast.

Project Need

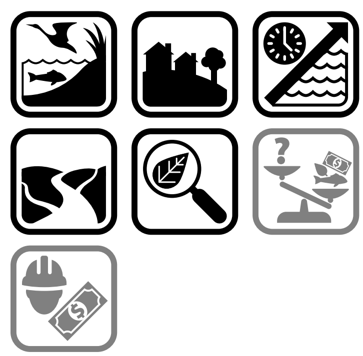
Coastal hydrology determines the environmental conditions in bays, estuaries, and nearshore regions, forming the basis for many management decisions. Multiple local, state, federal, and academic entities need continuous, long-term coastal hydrologic data, including temporal trends and characterization of spatial variability, to support management, planning, and research programs and projects. For example, the TWDB models the freshwater influx, bay circulation, and salinity transport using model simulations; however, there is limited empirical data to substantiate the simulations. In addition, models that simulate water quality for resource management of coastal fisheries/oyster mariculture and recreation need long-term data to determine trends and predictions.

LOCATION:
Coastwide

STATUS:
Monitoring

STAKEHOLDERS:
- ***Texas Water Development Board***
- U.S. Geological Survey
- National Oceanic and Atmospheric Administration
- U.S. Army Corps of Engineers
- Texas General Land Office
- Texas Water Trade
- Lower Colorado River Authority
- Guadalupe-Blanco River Authority
- Mission-Aransas National Estuarine Research Reserve
- Texas A&M University-Corpus Christi Conrad Blucher Institute
- Texas Parks and Wildlife Department
- National Park Service

ACTIONS:

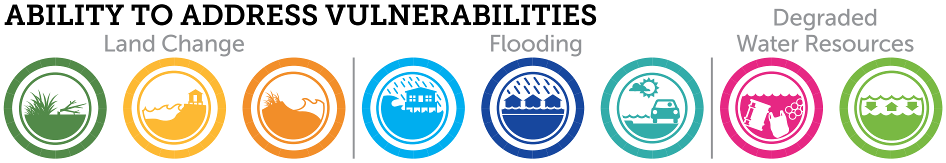


PROJECT TYPE(S):
Studies, Policies, and Programs; Hydrologic Connectivity

Texas Coastal Resiliency Master Plan *(1)*

Estimated Program Cost: $1,000,000 per year

ABILITY TO ADDRESS VULNERABILITIES



Project Description

The Texas shoreline is ecologically diverse and biologically productive. Its habitats maintain native plant and animal populations, provide nurseries, nesting and foraging areas for fish and wildlife, and reduce the impacts of coastal hazards. The Texas coastal region plays a major role in the country's energy security, with Texas leading the nation in energy production, mainly from crude oil and natural gas. Other critical state and national economic generators along the Texas coast include waterborne commerce, military transportation, chemical manufacturing, commercial fishing, recreation and tourism. The Texas General Land Office (GLO) develops the Texas Coastal Resiliency Master Plan to support the GLO's mission to preserve and enhance the state's coastal natural resources while promoting economic growth. The Texas Coastal Resiliency Master Plan is founded on the principle to create resilient coastal communities - communities with the coastal resources and infrastructure in place to withstand and rebound from natural and human-induced disturbances. Achieving coastal resiliency will reduce the state's vulnerability to coastal hazards and protect the state's coastal assets and environments.

Project Need

The Texas coast is vulnerable to an array of coastal hazards, such as coastal erosion, sea level rise, coastal storm surge, habitat loss and degradation, water quality degradation, and other issues that are putting the environmental and economic health of the coast at risk.

LOCATION:
Coastwide

STATUS:
Ongoing

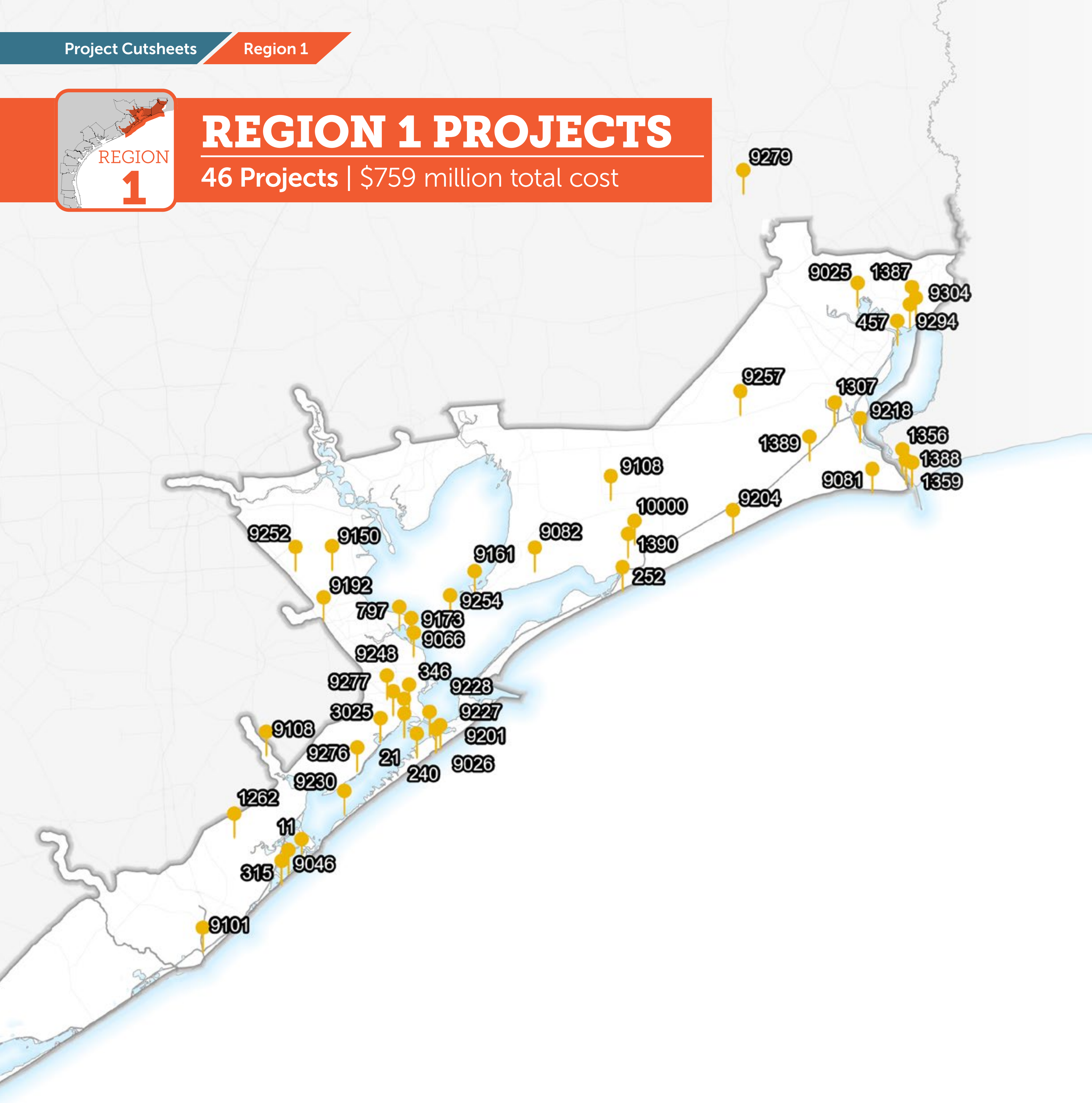
STAKEHOLDERS:
- ***Texas General Land Office***

ACTIONS:

PROJECT TYPE(S):
Studies, Policies, and Programs

REGION 1 PROJECTS

46 Projects | $759 million total cost



No.	Project Name	Cost
10000	Anahuac NWR Conservation and Restoration	$25,000,000
1390	Anahuac NWR East Unit Beneficial Use	$16,000,000
1262	Bastrop Bayou Marsh Acquisition	$10,000,000
9230	Bay Harbor Island Stabilization	$2,300,000
9025	Bessie Heights Wetland Restoration	$7,700,000
252	Bolivar Peninsula Beach and Dune Restoration	$97,500,000
9101	Brazos River and San Bernard River Restoration Strategy and Management Plan	$2,000,000
9276	Chocolate Bay Preserve Shoreline Protection and Marsh Restoration	$8,500,000
240	Coastal Heritage Preserve	$24,000,000
797	Dickinson Bay Rookery Island Restoration – Phase 3	$6,400,000
9066	Dollar Bay Wetland Protection, Restoration, and Acquisition	$9,700,000
9108	East and West Galveston Bay Watershed, Wetland, and Habitat Conservation	$15,600,000
9161	East Bay Living Shorelines and Wetland Restoration	$26,900,000
9046	Follet's Island Conservation Initiative	$7,600,000
315	Follet's Island Nourishment and Erosion Control	$127,700,000
21	Galveston Bay Rookery Island Restoration	$37,500,000
9201	Galveston Island Nourishment and Stabilization	$31,000,000
9026	Galveston Island West of Seawall to 13 Mile Road Beach Nourishment - Phase 1	$12,600,000
9254	Going to Scale: Expanding Oyster Restoration in Galveston Bay	$14,000,000
3025	Greens Lake Shoreline Protection and Wetland Restoration - Phase 2	$5,400,000
9304	Hickory Cove Marsh Restoration	$21,000,000
9248	Highland Bayou Shoreline and Marsh Restoration Project	$1,700,000
9252	Houston Parks and Recreation Department's Riparian Restoration Initiative	$4,000,000

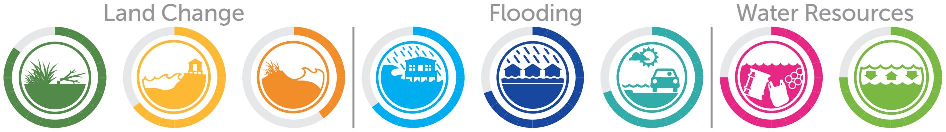
No.	Project Name	Cost
1307	J.D. Murphree WMA Shoreline Protection	$13,000,000
9228	Jones Bay Oystercatcher Habitat Restoration	$3,200,000
9218	Keith Lake Fish Pass and Baffle Repairs and Upgrades	$3,800,000
9192	Lower Clear Creek and Dickinson Bayou Watershed Flood Risk Reduction Program	$3,000,000
1387	Lower Neches WMA Lake Street Drive Beneficial Use	$6,000,000
11	Management of the Christmas Bay System	$5,000,000
9204	McFaddin NWR Gulf Shoreline Stabilization	$38,500,000
1389	McFaddin NWR Willow Lake Marsh Beneficial Use	$8,600,000
9150	Middle Armand Bayou Protection Project	$3,000,000
9082	Moody NWR Conservation and Restoration	$10,000,000
9279	Neches River Forested Floodplain	$30,000,000
457	North Pleasure Island Shoreline Protection and Restoration	$4,400,000
320	Old River Cove Restoration	$9,200,000
346	O'Quinn I-45 Estuary Shoreline Protection and Marsh Restoration	$11,000,000
9277	Pierce Marsh Wetland Restoration and Shoreline Protection	$6,500,000
9257	Southeast Texas Flood Coordination Study - Regional Flood Sensor System	$900,000
9294	Sydnes Island Restoration	$10,000,000
1356	Texas Bayou Water Control Structure	$6,000,000
9173	Texas City Levee Erosion Control and Marsh Restoration	$7,000,000
9081	Texas Point NWR Beach Nourishment Project	$43,400,000
1388	Texas Point NWR Beneficial Use	$11,400,000
1359	Texas Point NWR Shoreline Protection Sabine Neches Waterway and Oyster Habitat Creation	$5,000,000
9227	West Bay Living Shorelines at Sweetwater Preserve and Maggie's Cove	$6,100,000

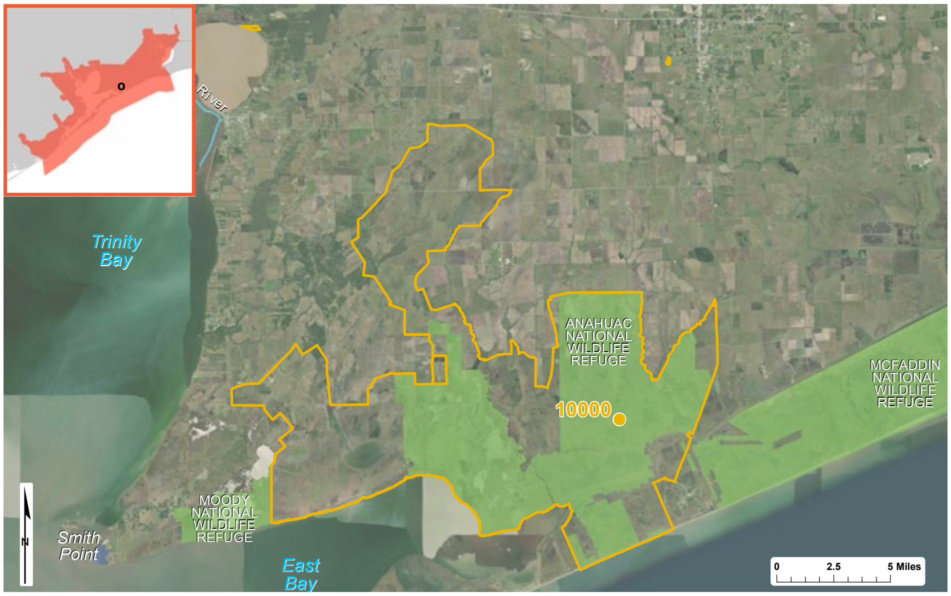
Anahuac NWR Conservation and Restoration *(10000)*

Estimated Project Cost: $25,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
National Wildlife Refuges within the Texas Chenier Plain ecosystem in Chambers and Jefferson counties

STATUS:
Shovel Ready

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- Chambers County

ACTIONS:

PROJECT TYPE(S):
Land Acquisition; Habitat Creation and Restoration

Project Description

The Texas Chenier Plain Refuge Complex supports a collection of National Wildlife Refuges (NWRs), including Anahuac, McFaddin, Texas Point, and Moody. This project would involve the acquisition of 65,000 acres of additional riverine, subtidal, freshwater, and marine habitats to include in the Texas Chenier Plain Refuge Complex and subsequent restoration and/or management of the land to a more natural and resilient state. This land spans across Chambers, Jefferson, and Galveston counties and acquisition efforts have added several thousand acres to Anahuac NWR. Additional purchases have secured significant properties in Jefferson and Galveston Counties. Interior freshwater wetlands, moist soil units, rice fields, intermediate marsh and more than a mile of beach has been acquired. Proactively working to conserve these lands would improve the capability of natural resource agencies to protect the habitats and the various species that thrive in a healthy habitat now and in the future.

Project Need

The diverse coastal wetland habitats within the Texas Chenier Plain Refuge Complex are experiencing rates of decline along the Texas coast due to changing hydrologic conditions. These complexes are some of the largest along the coast but are also some of the most vulnerable with significant subsidence likely along the Chenier Plain.

POTENTIAL LOCAL BENEFITS

12 Endangered Species | **8** Critical Facilities | **36** Migratory Bird Species

2073 Trips on Evacuation Route (Daily)

1 Critical Habitat | **✓** Avoided Future Flood Risk

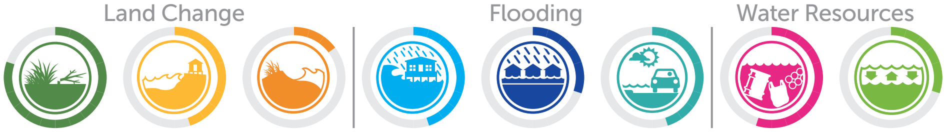
1 Wetland Type

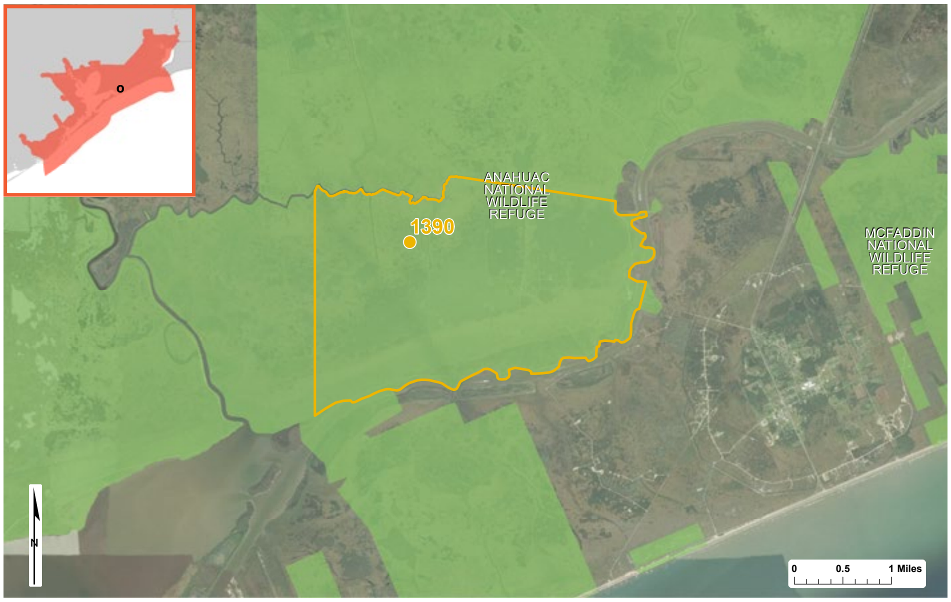
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Anahuac NWR East Unit Beneficial Use *(1390)*

Estimated Project Cost: $16,000,000

ABILITY TO ADDRESS VULNERABILITIES





Project Description

This project consists of restoring and enhancing the deteriorated marsh and open water areas within the heavily degraded Roberts Mueller habitat management unit on Anahuac National Wildlife Refuge (NWR). The tract is located on the north side of the Gulf Intracoastal Waterway (GIWW), just inland of its confluence with East Galveston Bay. Four beneficial use of dredged material (BUDM) cells are proposed, totaling 552 acres and requiring over 620,000 cubic yards of BUDM. This project is a high priority candidate in the Ducks Unlimited Beneficial Use Master Plan currently in progress. Preliminary engineering and 60% design have been completed on the four proposed restoration cells; this project would allow final engineering and design, permitting, and construction to be completed.

Project Need

Texas is losing coastal wetlands at a rate of more than 5,700 acres annually, and major causes of this loss include insufficient sediment supply, sea-level rise, subsidence, and coastal erosion. This project will regenerate previously healthy marsh on the Roberts Mueller tract of the East Unit of Anahuac NWR. From 1953 to 2018 the amount of open water has increased from less than 1% to over 68% due to the loss of emergent marsh vegetation. BUDM, using material from the GIWW, can be used to restore marsh elevations on the project site to restore emergent marsh. A major barrier to implementing BUDM projects is a lack of coordination between dredging schedules, permitting, and other logistics, demonstrating a need for a coordinated planning effort.

LOCATION:
Anahuac National Wildlife Refuge

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- Texas General Land Office
- Ducks Unlimited
- National Oceanic and Atmospheric Administration
- Natural Resource Damage Assessment Trustees
- U.S. Army Corps of Engineers
- Texas Department of Transportation
- Texas Water Trade

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

2 Wetland Types	**24** Migratory Bird Species
12 Endangered Species	✓ Protected Habitat in the Area

10,150 Existing Wetland Carbon Sequestration (tons C)

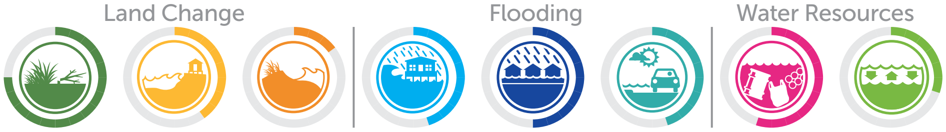
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

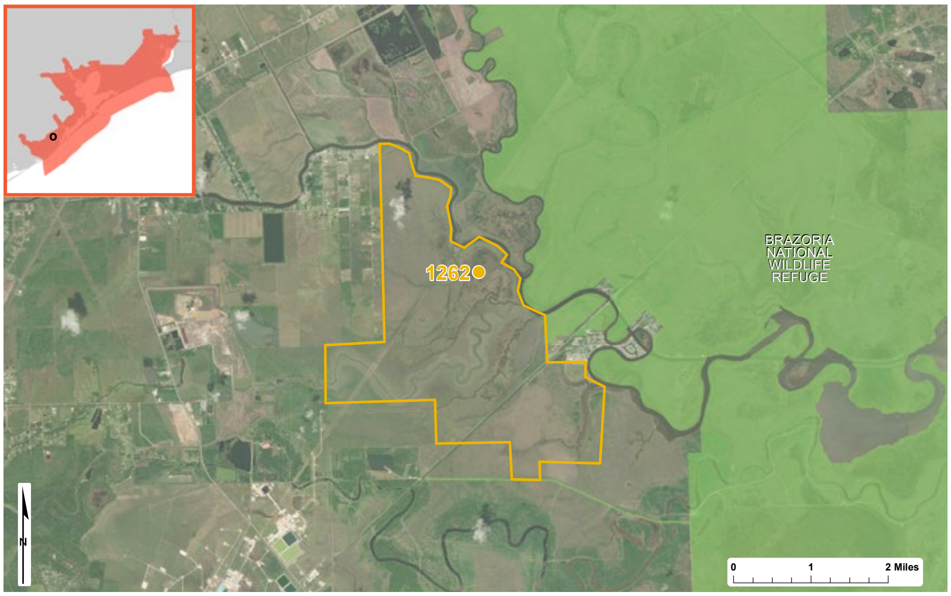
Bastrop Bayou Marsh Acquisition *(1262)*

Estimated Project Cost: $10,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



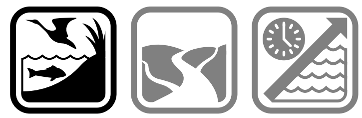


LOCATION:
Marshlands surrounding Bastrop Bayou, near West Galveston Bay

STATUS:
Conceptual

STAKEHOLDERS:
- ***Texas Conservation Partners***
- Friends of Brazoria National Wildlife Refuge
- Texas Parks & Wildlife Department
- Galveston Bay Foundation

ACTIONS:



PROJECT TYPE(S):
Land Acquisitions

Project Description

This project aims to acquire approximately 3,600 acres to therefore increase high quality coastal marsh and prairie habitat in the Brazoria National Wildlife Refuge (NWR) along Bastrop Bayou. The Brazoria NWR, established in the 1960s, is a rich component of the ebb and flow of the abundant wildlife on the Texas Gulf Coast. More than 400 species of wildlife including 320 bird species make these coastal wetlands and prairies their home. The Refuge is part of the Great Texas Birding Trail and lies in the Central Flyway. The Refuge and the proposed additions are important nursery areas for fish and shellfish, in addition to an important site for environmental education and wildlife viewing and recreation.

Project Need

This project would increase the quantity and quality of habitat surrounding the Brazoria NWR which has significant importance for biodiversity and societal needs. The project will benefit the long-term preservation of biodiversity and productivity of adjacent lands, coastal estuaries, and tidal creeks in the Brazoria NWR.

POTENTIAL LOCAL BENEFITS

2 Wetland Types

10 Endangered Species

2,800 Existing Wetland Carbon Sequestration (tons C)

21 Migratory Bird Species

✓ Protected Habitat in the Area

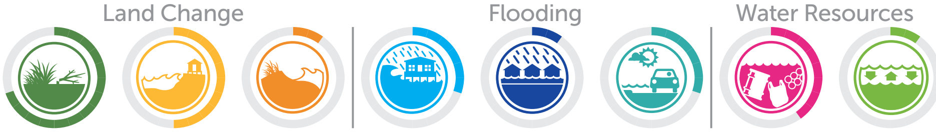
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Bay Harbor Island Stabilization *(9230)*

Estimated Project Cost: $2,300,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Bay Harbor Rookery Island

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Galveston Bay Foundation***
- U.S. Fish and Wildlife Service
- Bay Harbor Homeowners' Association
- Bay Harbor Improvement Association

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description

In 2010, the Galveston Bay Foundation (GBF), the U.S. Fish and Wildlife Service (USFWS), and other partners worked with the Bay Harbor Homeowners' Association to use dredged material to restore and create nesting habitat for colonial waterbirds at Bay Harbor Island. In 2013, approximately 225 feet of multi-row reef dome breakwaters were installed, and sediment began to accrete. The reef domes also created substrate for oyster attachment and growth. To address some failures of previous work and continued erosion along the north side of the island, GBF and USFWS developed an adaptive management strategy to stabilize the shoreline. New surveys of the original project area were conducted in 2018 to assess the current site conditions and update the original island design. The new conceptual design shows a proposed wave barrier and additional placement of dredged material to restore/expand the island footprint, restore nesting elevations, and stabilize the northern shoreline. This phase of the project would include obtaining necessary permits, final design, and construction.

Project Need

The Bay Harbor Rookery Island has been successful to-date, but the island is showing signs of erosion. Abnormally extended periods of high tides in 2016, Hurricane Harvey in 2017, and effects from several tropical systems in 2020 further exacerbated erosion at the project site. This project would not only act to stabilize the shoreline of the Bay Harbor Rookery Island but would also restore estuarine wetland habitat and create suitable nesting habitat for colonial waterbirds, including listed species and species of special concern.

POTENTIAL LOCAL BENEFITS

40	1	11
Homes	Wetland Type	Endangered Species

1	8
Rookery Island	Migratory Bird Species
✓	✓
Oyster Habitat Protected/Created	Decreased Wave Energy

$7.97M
Building Replacement Value

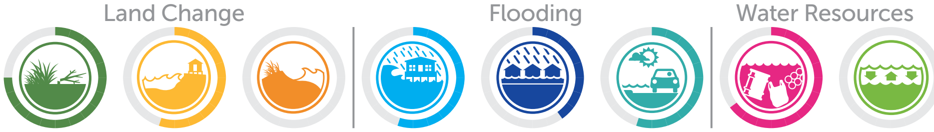
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

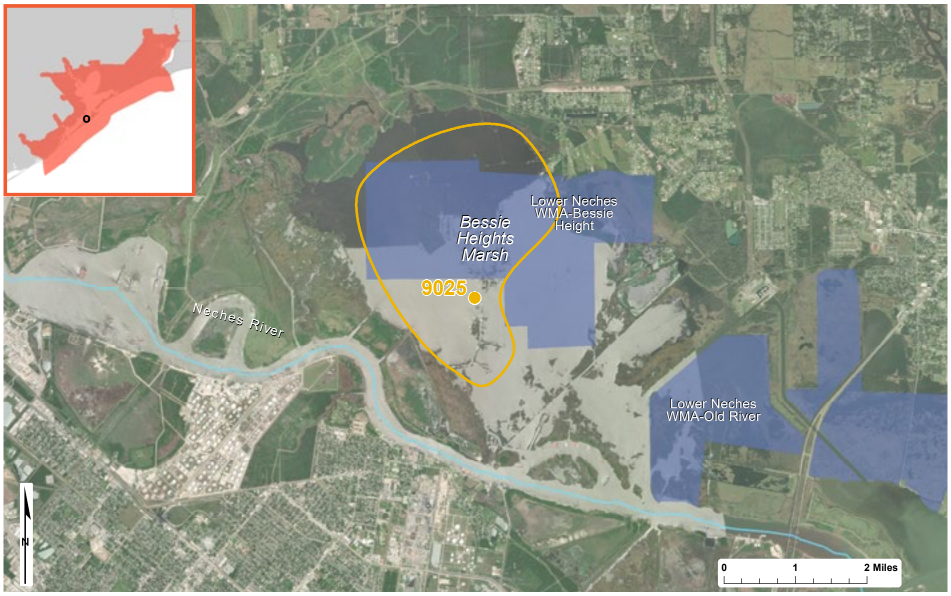
Bessie Heights Wetland Restoration *(9025)*

Estimated Project Cost: $7,700,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Lower Neches Wildlife Management Area north of Sabine Lake and SH 73

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Texas General Land Office***
- Texas Parks & Wildlife Department
- Texas Commission on Environmental Quality
- U.S. Fish and Wildlife Service
- Ducks Unlimited
- National Oceanic and Atmospheric Administration
- Natural Resource Damage Assessment Trustees

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description
The project would restore up to 1,000 acres of a historical estuarine wetland complex at Bessie Heights. The wetland restoration methodology would be to beneficially use dredged material from multiple dredging events over several years to build marsh terraces with containment cell levees. The project is currently funded for engineering and design and is permitted. Funds are still needed for construction.

Project Need
Wetlands in the Lower Neches Wildlife Management Area (WMA) are negatively impacted by subsidence and degradation due to natural and human causes. Improving the degraded wetlands would increase viability for protected species and provide potential foraging habitat for migrating and wading birds. As the project location is in an existing WMA, restoring these wetlands would create a greater expanse of open space and habitat for migrating birds, protected species, and rare estuarine species. This project also could continue to beneficially use dredged material over the long-term to create and restore the habitat periodically to mitigate relative sea level rise.

POTENTIAL LOCAL BENEFITS

5 Endangered Species	**1** Wetland Type
42,500 Existing Wetland Carbon Sequestration (tons C)	
✓ Protected Habitat in the Area	**17** Migratory Bird Species

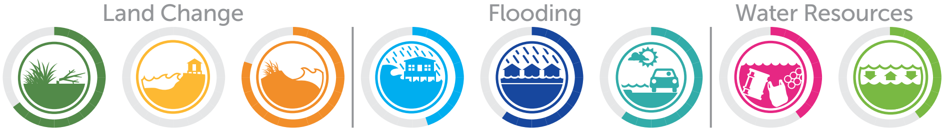
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Bolivar Peninsula Beach and Dune Restoration *(252)*

Estimated Project Cost: $97,500,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Gulf shoreline on Bolivar Peninsula from High Island on the east to Caplen on the west

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Texas General Land Office***
- Galveston County
- Texas Department of Transportation
- U.S. Army Corps of Engineers

ACTIONS:

PROJECT TYPE(S):
Beach Nourishment;
Dune Restoration

Project Description

This project would reconstruct severely eroded beaches and dunes along a 10-mile stretch of beach on the Bolivar Peninsula Gulf shoreline between the communities of High Island and Caplen. Due to sediment borrow source restrictions and funding availability, the project could be implemented with a phased approach, beginning with critical areas. Each phase would restore 2-mile stretches of shoreline at a time at an estimated cost of between $10 to $20 million per phase. Based on the findings of the North Jetty Sand Source Investigation Project, completed in 2015 by the Texas General Land Office (GLO) and Galveston County, these nourishment efforts would primarily rely on borrowing sand from a nearby, offshore source adjacent to the Houston Ship Channel north jetty. In 2016, the GLO and Galveston County worked on the first restoration segment of this project and utilized a nearby upland borrow source to construct 1.25 miles of beach nourishment and dune restoration at Caplen Beach immediately west of Rollover Pass. The regulatory phase for the County's U.S. Army Corps of Engineers (USACE) permit has been underway since November 2018. A USACE permit was submitted in 2020 for an additional 6.25 mile placement authorization and addition of the North Jetty borrow source. Section 7 consultation was initiated in August 2021 and is ongoing.

Project Need

This project would continue the significant resources invested in the project thus far and mitigate the severe, ongoing erosion. The project would indirectly address erosion via sediment transport over the entire 25-mile stretch of Gulf shoreline along the peninsula extending from High Island to Bolivar Roads.

POTENTIAL LOCAL BENEFITS

12 Endangered Species

25 Migratory Bird Species

$27.87M Building Replacement Value

22 Trips on Evacuation Route (Daily)

40 Homes

$9.71M Structure Damage (1% Storm)

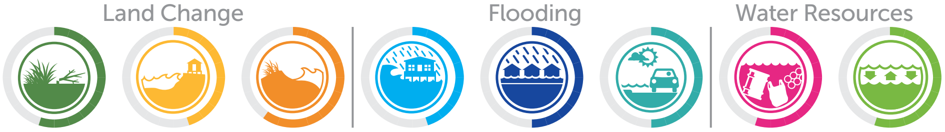
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Brazos River and San Bernard River Restoration Strategy and Management Plan *(9101)*

Estimated Project Cost: $2,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

This project proposes a management plan and restoration strategy for the Brazos and San Bernard Rivers that would include beneficial use of dredged material. The restoration strategy would have four components: (1) A study to evaluate the influence of flow, including floods, and adopted TCEQ freshwater inflow standards on salinity, suspended solids, nutrients, nekton, offshore sediment plume size and direction, and geomorphology of the Brazos River Delta; (2) The U.S. Army Corps of Engineers would assess the impact of removing locks on the Brazos River and develop a restoration plan to address the shoaling issues under a separate funding source; (3) A study to assess rainfall-runoff modeling for watersheds draining into the San Bernard Estuary and East Matagorda Bay; (4) Assessments of cumulative impacts from channel morphology and runoff patterns on the salinity gradient along the Lower Brazos River, the benefits of a potential saltwater barrier, and the restoration of the salinity gradient along the lower reach. Components of the first phase are in progress.

Project Need

The project results will inform ongoing and future regional flood plans, dredging, and sediment management strategies, including mitigation of Gulf shoreline erosion. Specific issues include sediment starvation of Sargent Beach, increased sediment deposition in the Cedar Lakes system, closure of the San Bernard River mouth, opening and closing of Cedar Lake Cut, increased deltaic processes in East Matagorda Bay at Mitchell's Cut, and saltwater intrusion.

LOCATION:

Brazos River and San Bernard River watersheds

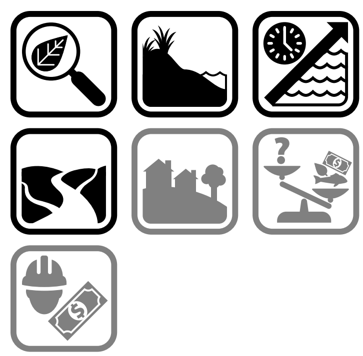
STATUS:

Study

STAKEHOLDERS:

- ***Brazoria County***
- The University of Texas-Arlington
- Texas A&M University-Galveston
- Texas Water Development Board
- Brazos River Authority
- U.S. Fish and Wildlife Service
- U.S. Army Corps of Engineers
- Texas Department of Transportation
- Texas Parks & Wildlife Department
- Fort Bend County
- Matagorda County
- City of Freeport
- Friends of the San Bernard River

ACTIONS:



PROJECT TYPE(S):

Studies, Policies, and Programs; Hydrologic Connectivity

POTENTIAL LOCAL BENEFITS

✓ Support Funding Eligibility

✓ Education & Outreach

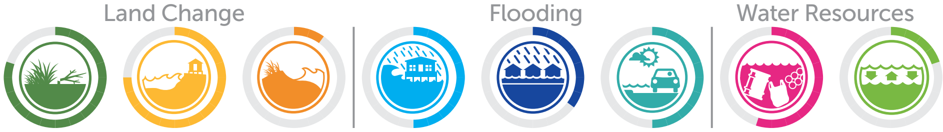
✓ Addressing Data Gaps

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Chocolate Bay Preserve Shoreline Protection and Marsh Restoration *(9276)*

Estimated Project Cost: $8,500,000

ABILITY TO ADDRESS VULNERABILITIES



LOCATION:
3 miles of eroding shoreline adjacent to the Gulf Intracoastal Waterway, West Galveston Bay, and Chocolate Bay

STATUS:
Conceptual

STAKEHOLDERS:
- ***Galveston Bay Foundation***
- Galveston Bay Estuary Program
- National Fish and Wildlife Foundation
- U.S. Fish and Wildlife Service
- Ducks Unlimited
- Brazoria National Wildlife Refuge

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description
The Chocolate Bay Preserve Shoreline Protection and Marsh Restoration Project aims to protect sensitive wetland and coastal prairie habitats. The project is located along approximately 3 miles of eroding shoreline adjacent to the Gulf Intracoastal Waterway (GIWW), West Galveston Bay, and Chocolate Bay. The project will protect a tract of land Galveston Bay Foundation (GBF) acquired in 2021, known as the Chocolate Bay Preserve. The Preserve consists of 5,215 acres of land—including 500 acres of land recently acquired using private funding and 14 miles of frontage along Halls Bayou, Halls Lake, Chocolate Bay, Alligator Point, the north shoreline of West Galveston Bay, and the GIWW—for a total prior investment of $11.9 million. This project is intended to reduce wave energy affecting the property shoreline and restore fringing marsh habitat along the shoreline through the installation of hard structure breakwaters and transplanting of marsh vegetation behind the structures. The proposed project is currently in the conceptual stage. However, due to the similarity of this project to other projects in the area, it is expected that engineering, design, and permitting should be straightforward and timely.

Project Need
Saltwater intrusion into coastal wetlands adjacent to the GIWW, driven by increased wave energy, has contributed to degradation of habitat quality on the Texas Coast. Priority habitats within the Preserve include estuarine and brackish wetlands, freshwater wetlands, coastal prairies, and shell hash beach.

POTENTIAL LOCAL BENEFITS

2	✓	1
Wetland Types	Decreased Wave Energy	Critical Facility

11	31
Endangered Species	Migratory Bird Species

38,900
Existing Wetland Carbon Sequestration (tons C)

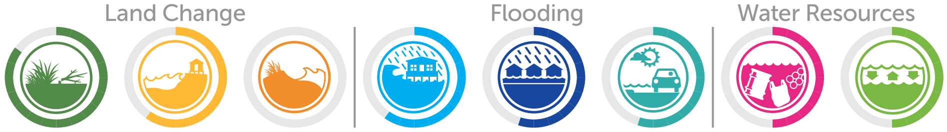
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Coastal Heritage Preserve *(240)*

Estimated Project Cost: $24,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change · Flooding · Degraded Water Resources



Project Description

The Coastal Heritage Preserve (CHP) project aims to acquire, protect, manage, and enhance up to 1,400 acres of coastal habitat on West Galveston Island. This project would add 500 acres of new acquisitions to the existing 898 acres of coastal habitat, valued at $17.7 million in land conservation. Willing sellers are identified, but full funding for this project is the limiting factor. The additional 500 acres would make the CHP more contiguous from bay to beach, enhancing the resource value over a larger landscape and protecting vast expanses of wetlands from development. Currently, Artist Boat is working on a 2-year option to conserve 148 acres on Anchor Bay. The Natural Rersource Damage Assessment Trustees have awarded $1.12 million towards a $6.5 million acquisition that will protect 2.5 miles of undeveloped shorelines and natural saltwater marshes and prevent development on the peninsula that would otherwise fragment the 507 bayside acres of the CHP. To complete the vision of 1,400 acres conserved within the CHP, an additional estimated $23,925,000 is required. The project can be scaled by phasing acquisitions, including 148 acres on Anchor Bay ($6,500,000); 198 acres of interior wetlands and coastal prairies ($7,000,000); and 65 acres of dune/swale beach ecosystem ($8,125,000).

Project Need

Acquiring these lands would provide essential buffer zones on Galveston Island to lessen the losses to surrounding communities associated with flooding and storm events. This would continue the acquisition and restoration efforts that have occurred in West Galveston Bay over the last 20 years.

LOCATION:

Conservation properties on West Galveston Island, east of Jamaica Beach

STATUS:

Acquisition Pending

STAKEHOLDERS:

- ***Artist Boat***
- Texas General Land Office
- National Fish and Wildlife Foundation
- Natural Resource Damage Assessment Trustees
- U.S. Fish and Wildlife Service
- Texas Parks & Wildlife Department
- Galveston Bay Estuary Program
- Galveston Bay Foundation
- U.S. Army Corps of Engineers
- The Brown Foundation
- The Moody Foundation
- The Kempner Foundation
- The Cynthia and George Mitchell Foundation
- The Oppenheimer Foundation

ACTIONS:

PROJECT TYPE(S):

Land Acquisition

POTENTIAL LOCAL BENEFITS

33 Migratory Bird Species

12 Endangered Species

2 Wetland Types

440 Homes

✓ Avoided Future Flood Risk

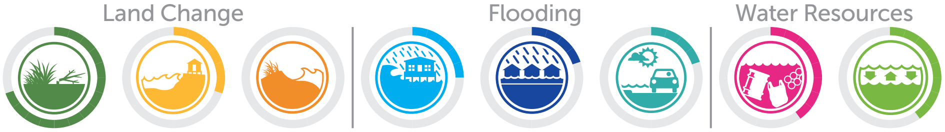
$81.78M Structure Damage (1% Storm)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Dickinson Bay Rookery Island Restoration – Phase 3 *(797)*

Estimated Project Cost: $6,400,000

ABILITY TO ADDRESS VULNERABILITIES



LOCATION:
Series of three rookery islands in Dickinson Bay

STATUS:
Ongoing

STAKEHOLDERS:
- ***Galveston Bay Foundation***
- Natural Resource Damage Assessment Trustees
- U.S. Fish and Wildlife Service
- National Oceanic and Atmospheric Administration
- Restore America's Estuaries
- Galveston Bay Estuary Program

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description

This project would restore the third 4- to 5-acre ground nesting colonial water bird rookery island in Dickinson Bay, which would be Phase 3 of the Dickinson Bay Rookery Island Restoration project (DBI3). This project also involves continued monitoring and adaptive management for two previously constructed islands DBI1 (Phase 1, 2004) and DBI2 (Phase 2, 2022). Those island habitats were restored using clean fill material, stone riprap shoreline stabilization, and newly planted vegetation. Phase 3 will be constructed in a similar manner; however, as this phase is targeting bare ground nesting bird species, vegetation will not be planted, and vegetation growth on the island would be actively managed to ensure nesting success of the targeted species. Initial design and permitting has been completed for DBI3, and Galveston Bay Foundation is set to apply for a lease. Additional funding is required to finalize design, update site surveys, and construct DBI3. Funding is also needed to implement adaptive management strategies to the Phase 1 project, including adding protective riprap in areas of recent erosion and potentially adding fill material within to provide additional nesting area and resiliency to the island.

Project Need

Three historical rookery islands in Dickinson Bay converted to subtidal habitat due to erosion and subsidence, negatively impacting populations of coastal shorebirds that rely on these islands for nesting and nursing habitat. The project would provide multiple habitat functions, including nesting space for colonial waterbirds and new oyster habitat, which would contribute to additional fish habitat in the project area.

POTENTIAL LOCAL BENEFITS

13 Migratory Bird Species	**3** Rookery Islands
11 Endangered Species	**✓** Oyster Habitat Protected/Created

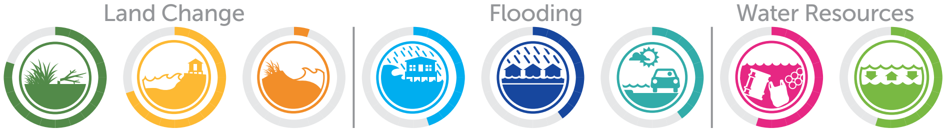
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

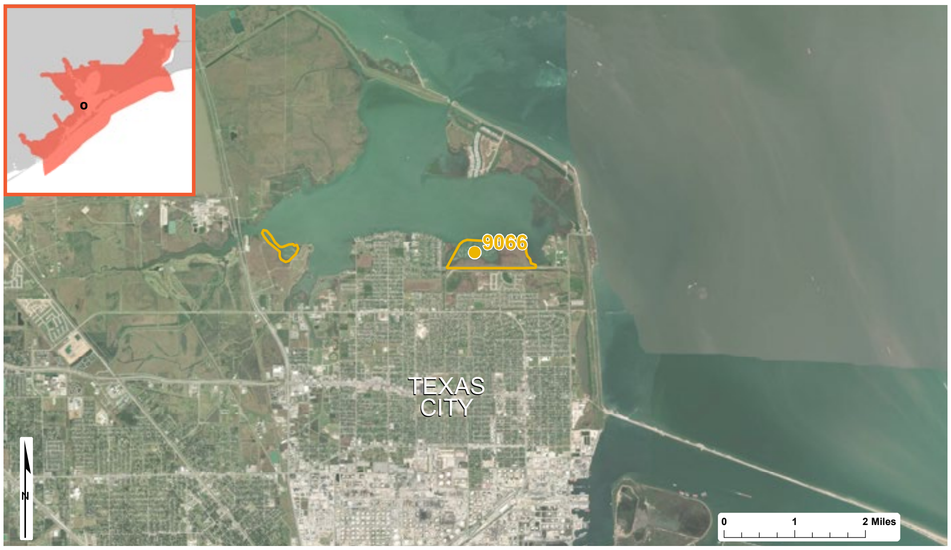
Dollar Bay Wetland Protection, Restoration, and Acquisition *(9066)*

Estimated Project Cost: $9,700,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





Project Description

The first phase of this project included constructing marsh terraces at two sites in the Dollar Bay and Moses Lake system, with breakwaters also constructed to protect the newly restored marsh. That project included acquisition of approximately 102 acres of coastal prairie habitat directly adjacent to the wetland restoration site at 50% of the appraisal value. The parcel was owned by a willing seller and was in immediate threat of development, with permitted development plans in place, but is now under conservation easement. Additional funding is necessary for the current project to construct additional shoreline protective breakwaters in front of the recently acquired 102-acre property. This project will build upon past projects at the site, including a living shoreline along The Nature Conservancy's Texas City Prairie Preserve in the same Dollar Bay and Moses Lake system.

Project Need

This area provides highly productive habitat, which is important to the life cycle of a number of marine and avian species. Subsidence, shoreline erosion, and saltwater intrusion have negatively impacted these ecologically important areas. The previously completed restoration project restored 72 acres of intertidal estuarine wetlands and provides shoreline protection for the area. The expansion project would protect approximately 102 acres of coastal prairie that is under conservation easement. This would expand the wetland corridor and better protect the overall ecological health of the area by preventing fragmentation of the wetlands.

LOCATION:

Locations along the shorelines of Dollar Bay and Moses Lake in Texas City

STATUS:

Engineering & Design

STAKEHOLDERS:

- ***Galveston Bay Foundation***
- National Fish and Wildlife Foundation
- National Oceanic and Atmospheric Administration
- U.S. Fish and Wildlife Service
- Texas General Land Office
- Ducks Unlimited
- City of Texas City
- The Nature Conservancy
- Natural Resources Conservation Service
- Coastal Conservation Association
- Shell Oil

ACTIONS:

PROJECT TYPE(S):

Habitat Creation and Restoration;
Shoreline Stabilization;
Land Acquisition

POTENTIAL LOCAL BENEFITS

2 Wetland Types

✓ Avoided Future Flood Risk

165 Existing Wetland Carbon Sequestration (tons C)

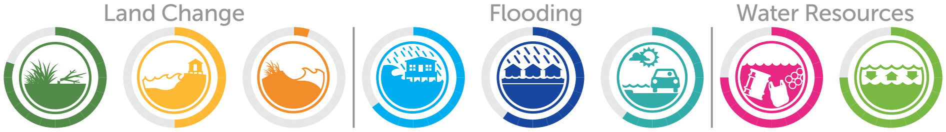
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

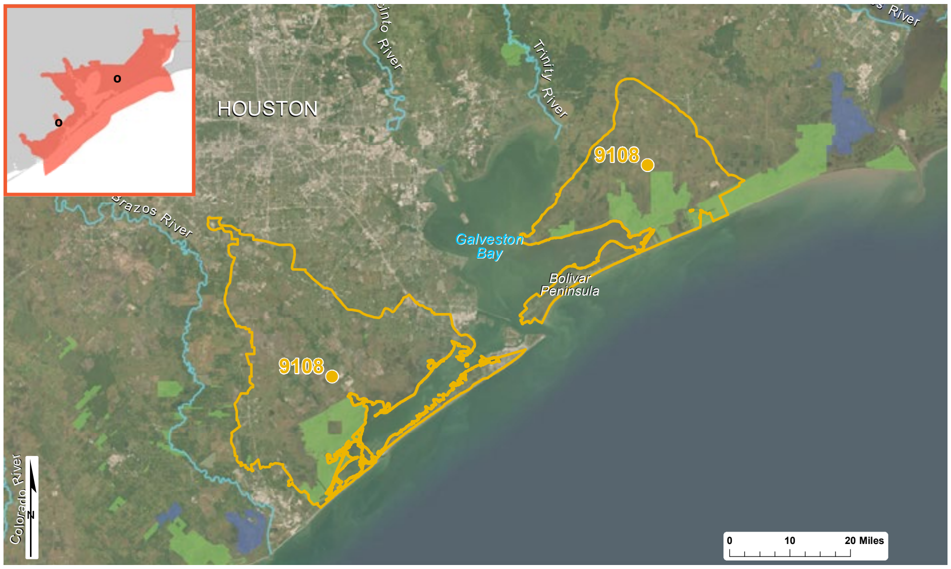
East and West Galveston Bay Watershed, Wetland, and Habitat Conservation *(9108)*

Estimated Project Cost: $15,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





Project Description

The *Galveston Bay Plan, 2nd Edition* identifies perpetual land conservation as one of the best strategies to protect the biodiversity and overall health of the Galveston Bay estuarine system. The Conservation Assistance Program (CAP), a cooperative led jointly by the Galveston Bay Estuary Program and Galveston Bay Foundation, provides regional support for land conservation within the Galveston Bay watershed. Through the CAP, approximately 7,030 acres of coastal habitat have been permanently conserved, and over $24.6 million has been leveraged for habitat conservation. The project partners propose to conserve more than 10,000 acres of wetlands, native grasslands, and other coastal habitats by acquiring fee title to priority parcels or establishing conservation easements on privately owned lands. This project would target parcels that possess unique conservation value and is scalable. Funding would ideally be implemented over a 5- to 7-year timeframe at a cost of $3 million per year, with funding for due diligence already secured through August 2024.

Project Need

Population growth in the Houston-Galveston region continues to put pressure on remaining open space. This threatens the productivity of existing wildlife and fisheries habitats, agricultural areas, and the quality of water in Galveston Bay. Conversion of natural areas, agricultural lands, and other open spaces to suburban residential and commercial land uses presents a real risk to the sustainability and productivity of the Galveston Bay estuarine system.

LOCATION:

East and West Galveston Bay watersheds

STATUS:

Acquisition Pending

STAKEHOLDERS:

- ***Galveston Bay Estuary Program***
- ***Galveston Bay Foundation***
- U.S. Fish and Wildlife Service
- Texas Parks & Wildlife Department
- Armand Bayou Nature Center
- U.S. Department of Agriculture
- National Fish and Wildlife Foundation
- Texas Conservation Partners
- Houston Audubon
- Scenic Galveston
- The Nature Conservancy
- National Oceanic and Atmospheric Administration

ACTIONS:

PROJECT TYPE(S):

Habitat Creation and Restoration; Land Acquisition

POTENTIAL LOCAL BENEFITS

2	✓	✓
Wetland Types	Protected Habitat in the Area	Avoided Future Flood Risk

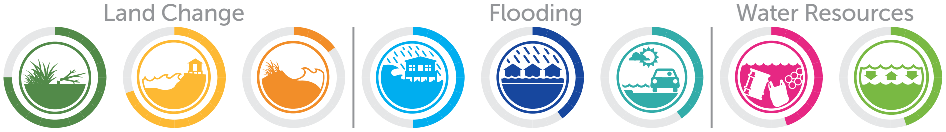
2.8M
Existing Wetland Carbon Sequestration (tons C)

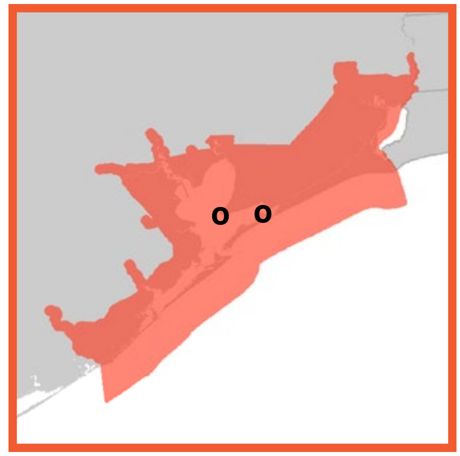
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

East Bay Living Shorelines and Wetland Restoration *(9161)*

Estimated Project Cost: $26,900,000

ABILITY TO ADDRESS VULNERABILITIES





LOCATION:

Smith Point and Rollover Pass in East Galveston Bay

STATUS:

Engineering & Design

STAKEHOLDERS:

- ***U.S. Fish and Wildlife Service***
- Texas General Land Office
- National Oceanic and Atmospheric Administration
- Ducks Unlimited
- Texas Parks & Wildlife Department

ACTIONS:

PROJECT TYPE(S):

Habitat Creation and Restoration; Shoreline Stabilization

Project Description

This project would restore and maintain the shoreline and estuarine wetlands near Smith Point, Rollover Pass, Anahuac National Wildlife Refuge (NWR), Moody NWR, and Candy Abshier Wildlife Management Area (WMA). The U.S. Fish and Wildlife Service (USFWS) has worked to secure the shoreline at Anahuac through a living shoreline which would include breakwaters. This effort is intended to link these parts of the shoreline together and protect Smith Point. USFWS also is looking to create additional oyster reefs in the area to maintain viable seed stock and improve water quality using a breakwater with interior structure to accommodate the oysters. The preferred protection method(s) may evolve in concept over time as early segments of the project contribute to the state of science. There are multiple design efforts underway in the project area, so this work is underway from various sources.

Project Need

The shorelines near Smith Point and Rollover Pass, as well as the other lands noted above, are experiencing losses of shoreline, estuarine wetland, and oyster reef habitat. Wetlands are important habitat for the area, as they provide water filtration and serve as a habitat for fish and other wildlife. This project would provide restoration efforts for the estuarine wetland habitats near Smith Point and adjacent shorelines. This project is supported by several private landowners owning lands between the shoreline protection projects at Anahuac NWR and Candy Abshier WMA. This project would connect these individual proposals and extend protection for all wetlands.

POTENTIAL LOCAL BENEFITS

✓	✓	✓
Decreased Wave Energy	Protected Habitat in the Area	Oyster Habitat Protected/ Created

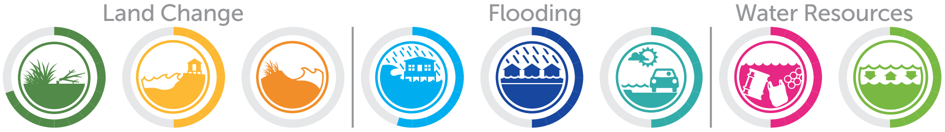
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

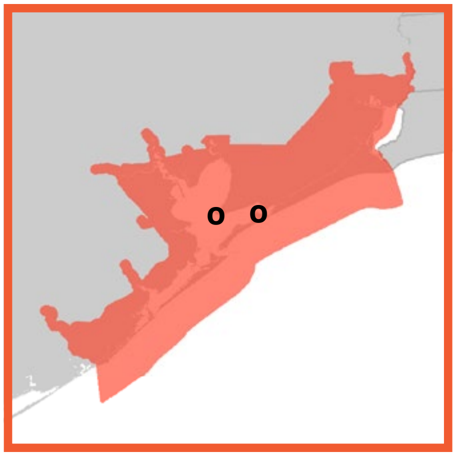
Follet's Island Conservation Initiative *(9046)*

Estimated Project Cost: $7,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



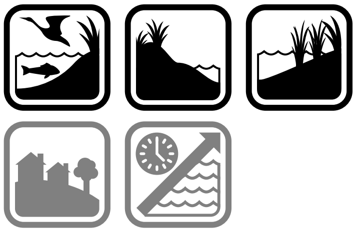


LOCATION:
Strategic properties on Follet's Island

STATUS:
Acquisition Pending

STAKEHOLDERS:
- ***Texas Parks & Wildlife Department***
- U.S. Fish and Wildlife Service
- Texas General Land Office
- Galveston Bay Estuary Program
- Natural Resource Damage Assessment Trustees

ACTIONS:



PROJECT TYPE(S):
Land Acquisition

Project Description

The Follet's Island Conservation Initiative is a partnership effort to acquire and protect 1,300 acres on the island and transfer title to the Texas Parks & Wildlife Department. Critically important wildlife habitats on the island include tall grass prairies, estuarine and freshwater wetlands, seagrass meadows, oyster reefs, mud flats, sand dunes and Gulf beaches. Follet's Island provides an ideal environment for Kemp's ridley sea turtles, piping plovers, waterfowl, wading birds, and shorebirds. Landowner negotiations are underway. Some tracts have been acquired and multiple other opportunities remain.

Project Need

Follet's Island helps protect the entire Galveston Bay estuary system, including Drum and Christmas bays, from storm degradation. The acquisition of this property would allow the natural movement and restoration of habitats after storm events.

POTENTIAL LOCAL BENEFITS

Avoided Future Flood Risk	Seagrass Protected	Oyster Habitat Protected/ Created
✓	✓	✓

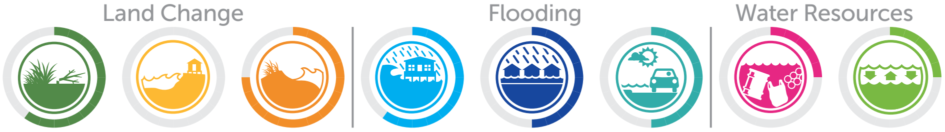
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Follet's Island Nourishment and Erosion Control *(315)*

Estimated Project Cost: $127,700,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Gulf shoreline of Follet's Island

STATUS:
Shovel Ready

STAKEHOLDERS:
- ***Texas General Land Office***
- U.S. Army Corps of Engineers
- Brazoria County
- Village of Surfside Beach

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Beach Nourishment

Project Description

To protect the Gulf shoreline, this project would utilize stone groins at Surfside Beach and beach nourishment materials placed at the southern end of Follet's Island. However, the nourishment effort does not have a significant offshore sand source that is locally viable. This creates a challenge of either pursuing small-scale projects using upland sand sources or larger projects that benefit from a single mobilization but that require more distant sand sources. It is recommended that projects be pursued on the scale of beach nourishment placed along 2 miles of shoreline at a cost of $10 million to $20 million per phase (excluding structures), with a strong emphasis on beneficial use of dredged materials to reduce the cost. This project would offset the rate of erosion and the stone groins would serve as a sand-capture mechanism to slow the rate of sand loss from the beach.

Project Need

This project would provide protection for the Gulf shoreline on Follet's Island. The Gulf of Mexico shoreline on Follet's Island near Surfside is eroding at a rate of 11.5 ft/yr according to data collected between 2000 and 2012 by the University of Texas's Bureau of Economic Geology. The placement of the beach nourishment material would offset the rate of erosion and the stone groins would serve as a sand-catching mechanism to slow the rate of sand loss from the beach face. The Village of Surfside Beach has some concerns about possible damage to roads and infrastructure due to the large quantity of heavily weighted trucks and construction equipment needed for this project, and contingency funding is included in the project cost to make repairs, if needed.

POTENTIAL LOCAL BENEFITS

1 Wetland Type	**35** Migratory Bird Species
11 Endangered Species	**120** Homes

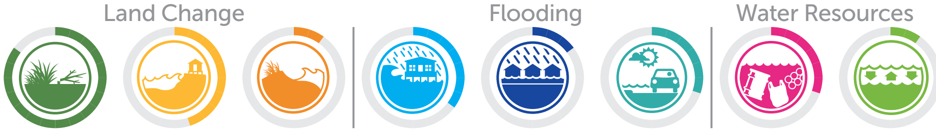
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Galveston Bay Rookery Island Restoration *(21)*

Estimated Project Cost: $37,500,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Multiple locations in Galveston Bay

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Audubon Texas***
- Texas Parks & Wildlife Department
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- Houston Audubon
- Texas General Land Office
- Natural Resource Damage Assessment Trustees

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description

The project would restore elevation and provide shoreline protection for several identified rookery islands in Galveston Bay and adjacent water bodies. Certain islands in Galveston Bay are severely eroding and eliminating critical bird habitats that are part of the coastwide rookery island network in Texas, including, but not limited to, Jigsaw Island, Deer Islands, the Vingt-Et-Un Islands, Chocolate Point Island, West Bay Bird Island, Smith Point Island, Struvelucy Island, and Rollover Bay Island. To date, 65% engineering and design have been completed for the Rollover rookery island, and a permit application submittal is pending. This project would fund all aspects of project planning, engineering and design, permitting, construction, and monitoring at multiple sites to provide shoreline stabilization and create additional acres of potential nesting habitat.

Project Need

This project addresses habitat loss for many avian species and would provide nesting areas to improve reproductive success. The ongoing loss of habitat due to sea level rise, increasing tidal amplitude, and shoreline erosion has led to a dramatic decline in the reproductive success of the American oystercatcher in particular. A fortified rookery island system in Galveston Bay would provide essential nesting and migratory habitat for bird populations. In addition, an island system could potentially serve as a wave break to help diminish Bay-generated storm surge damage to communities, preserving the local economy and minimizing disruption after coastal storms.

POTENTIAL LOCAL BENEFITS

39 Migratory Bird Species	**1** Critical Habitat	**7** Rookery Islands

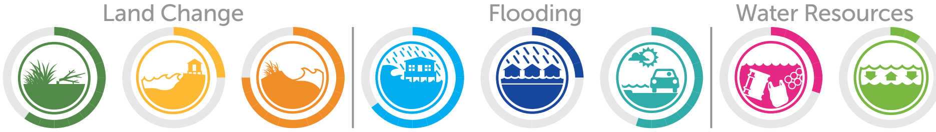
✓ Oyster Habitat Protected/Created	**12** Endangered Species

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Galveston Island Nourishment and Stabilization *(9201)*

Estimated Project Cost: $31,000,000

ABILITY TO ADDRESS VULNERABILITIES

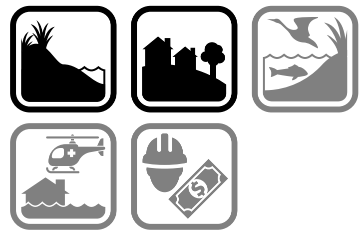


LOCATION:
Galveston Island's west end, beyond the terminus of the seawall

STATUS:
Conceptual

STAKEHOLDERS:
- ***City of Galveston***
- Texas General Land Office
- U.S. Army Corps of Engineers

ACTIONS:



PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration; Beach Nourishment

Project Description
This project seeks to apply information provided by the recent publication of the *Region 1 Longshore Transport Model and Sediment Budget* by the Texas General Land Office (GLO). It is intended to move Galveston Island into its next chapter of regional sediment management, which includes a holistic approach to the Island's erosion and instability, including the long-unaddressed area of Galveston's west end beyond the terminus of the seawall. This is a concept supported by the GLO's and U.S. Army Corps of Engineers' ongoing projects, which include engineering and design of beach nourishment from the seawall to 13 Mile Road, a Continuing Authorities Program Section 204 effort related to the beneficial use of dredged material to address erosion issues in a targeted manner, and a Planning Assistance to States proposal to update the region's sediment management strategy. This phased effort will include a study to maximize the return from the ongoing nourishment program, considering projects in the region that exist or are on the horizon. Later phases of this project will focus on the implementation of the island-wide nourishment strategy, helping identify and address the complexities inherent in balancing the needs of a shoreline that varies significantly along its 32-mile length.

Project Need
Expanding the scope of regional sediment management to address the severe erosion on the west end of Galveston Island will increase the protective buffer between developed areas and the water, enhance coastal habitat, and increase recreational opportunities in the area. Preventing sediment loss can also improve water quality.

POTENTIAL LOCAL BENEFITS

11 Endangered Species

25 Migratory Bird Species

1 Wetland Types

96 Critical Facilities

✓ Decreased Wave Energy

550 Homes

180 Existing Jobs

$702M Building Replacement Value

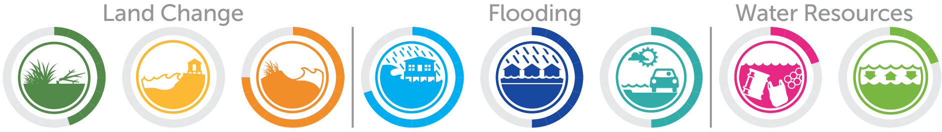
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Galveston Island West of Seawall to 13 Mile Road Beach Nourishment - Phase 1 *(9026)*

Estimated Project Cost: $12,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

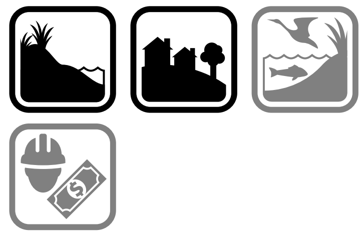


LOCATION:
West Galveston Seawall to 13 Mile Road

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Park Board of Trustees of the City of Galveston***
- Texas General Land Office
- U.S. Army Corps of Engineers

ACTIONS:



PROJECT TYPE(S):
Beach Nourishment

Project Description
This project would provide approximately 6 miles of shoreline stabilization along the Gulf beach of Galveston's West End. A feeder beach also would be created to passively nourish the shoreline from the Galveston Seawall to 13 Mile Road through natural transport. Recent nourishment efforts on Galveston Island were achieved through improved coordination of dredged materials between federal and state agencies. Continued coordination between federal and state agencies would keep costs feasible for this stretch of shoreline. This project is to be addressed under the Coastal Erosion Planning & Response Act (CEPRA) Cycle 11 (Project No. 1692) for the engineering and design (E&D) and alternatives analysis phases only. It will be consolidated with a CEPRA Cycle 12 extension, resulting in larger E&D project for beach nourishment from west of Dellanera Park Beach to 13 Mile Road at the eastern boundary of Galveston Island State Park.

Project Need
Many of the Galveston Island beaches are experiencing heavy rates of erosion with shoreline losses ranging from 1.6 to 11.5 ft/yr since the year 2000. The beach nourishment and protection of West Galveston Island, an area highly used by the public that generates important tourism benefits for the local economy, would preserve the recreational value for human use, as well as the natural habitat for wildlife.

POTENTIAL LOCAL BENEFITS

11	23	✓
Endangered Species	Migratory Bird Species	Decreased Wave Energy

360	3
Homes	Critical Facilities

$151.8M
Structure Damage (1% Storm)

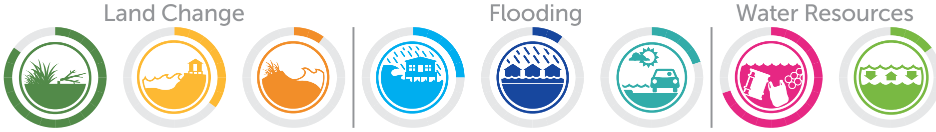
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Going to Scale: Expanding Oyster Restoration in Galveston Bay *(9254)*

Estimated Project Cost: $14,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Lower-mid Galveston Bay

STATUS:
Conceptual

STAKEHOLDERS:
- ***The Nature Conservancy***
- Texas Parks & Wildlife Department
- Texas Water Development Board
- Galveston Bay Foundation
- Galveston Bay Estuary Program

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Studies, Policies, and Programs

Project Description

This project uses a landscape approach to restore at least 100 acres of degraded subtidal and intertidal oyster reefs across the lower-mid Galveston Bay system, and to create a network of resilient oyster reefs that are spatially separate but ecologically connected through larval transport. A network of subtidal, high vertical relief reefs that serve as self-policing oyster sanctuaries combined with lower-elevation intertidal reefs that serve as de facto sanctuaries will be created within the bay system. This project will also construct subtidal sink reefs designed to increase substrate availability while supporting sustainable oyster harvest. These reefs will be positioned within the ecosystem so that the predominant currents transport larvae from the restored sanctuaries to sink reefs and unrestored reefs within the bay system. This network approach will allow for increased oyster population sustainability and oyster habitat resiliency in lower-mid Galveston Bay while maximizing benefits to oyster habitat through larval supply and transport.

Project Need

Galveston Bay oyster reefs have been subjected to multiple stressors, including heavy commercial harvest pressure, hydrologic alterations due to reduced freshwater inflow and expansion of the Houston Ship Channel, oyster disease, pollution, and predators. The Bay's oyster population and reef habitat also incurred massive habitat loss from Hurricane Ike. Estimates from the Texas Parks & Wildlife Department indicate that between 50 to 60 percent of the consolidated reefs in Galveston Bay were damaged or destroyed by Hurricane Ike-induced sedimentation.

POTENTIAL LOCAL BENEFITS

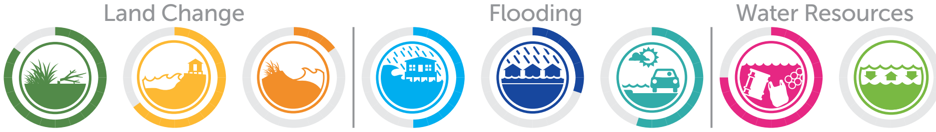
1 Wetland Type	**1** Critical Habitat
12 Endangered Species	**✓** Oyster Habitat Protected/Created

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Greens Lake Shoreline Protection and Wetland Restoration - Phase 2 *(3025)*

Estimated Project Cost: $5,400,000

ABILITY TO ADDRESS VULNERABILITIES

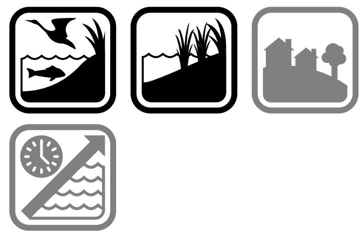


LOCATION:
North of West Bay between Carancahua Lake and Jones Bay

STATUS:
Permitted

STAKEHOLDERS:
- ***Texas General Land Office***
- Ducks Unlimited
- U.S. Fish and Wildlife Service
- Galveston Bay Foundation
- National Fish and WIldlife Foundation

ACTIONS:



PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description
This project would protect and restore fragile coastal wetland habitat, seagrass, tidal channels and oyster beds in West Galveston Bay. This would be accomplished by constructing shoreline protection breakwaters to prevent further wetland loss and beneficially using dredged materials to restore wetland function, and the cost for this project represents the cost for breakwater construction only. The breakwaters north and south of the entrance to Greens Lake are permitted and the beneficial use portion of the project has been surveyed and conceptually designed.

Project Need
The Greens Lake complex is a large, native wetland and open water tract located adjacent to West Galveston Bay in Galveston County. Approximately 5,100 acres in size, this complex consists of several ecologically important coastal habitats, including fresh, intermediate and brackish coastal wetlands, transitional high marsh and coastal prairie, dendritic tidal channels, and open water marsh ponds that contain submerged aquatic vegetation and oyster beds. However, wetland loss and degradation due to shoreline erosion and saltwater intrusion is reducing the ecological integrity and sustainability of the Greens Lake wetland complex. Restoring the emergent wetlands would help with issues related to storm surge, relative sea level rise, and coastal erosion.

POTENTIAL LOCAL BENEFITS

12 Endangered Species

1 Wetland Type	✓ Seagrass Protected	✓ Decreased Wave Energy

32 Migratory Bird Species	✓ Oyster Habitat Protected/Created

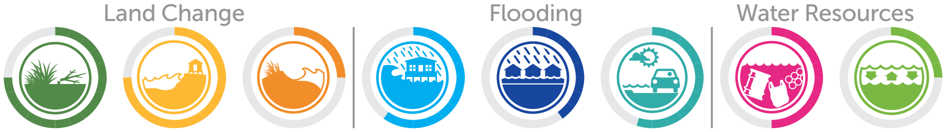
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

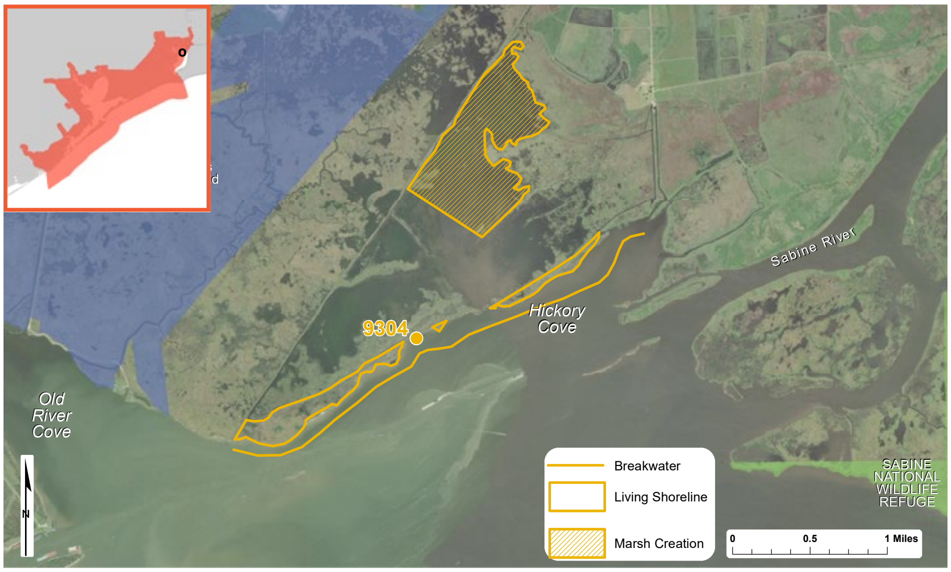
Hickory Cove Marsh Restoration *(9304)*

Estimated Project Cost: $21,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Hickory Cove, north shore of Sabine Lake

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Orange County Navigation and Port District***
- U.S. Army Corps of Engineers
- Ducks Unlimited

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description

This project would construct 14,000 linear feet of rock breakwater that will provide a site for the beneficial placement of dredge material that will create about 167 acres of coastal marsh utilizing about 750,000 cubic yards of maintenance dredged material from the Sabine-Neches Waterway. This project was selected as 1 of 10 pilot projects as part of the U.S. Army Corps of Engineers Section 1122 Water Resources Development Act authorization. To date, the preliminary engineering has been completed and the final designs are underway. The necessary regulatory clearances, permits, and surface use/ access agreements are underway. Construction is slated for Fall 2023 or Spring 2024, contingent upon finding the required 35% non-federal sponsor cost share, represented as the cost of this project, and required easements for the overall project. The breakwater will provide for the protection of a 1,200-acre degrading wetland that will also be improved through the placement of over 1.5 million yards of beneficially used maintenance dredged material. Thus, ultimately, 1,367 acres will be created and/or enhanced through this project.

Project Need

Modeling data generated for the Texas Coastal Resiliency Master Plan suggests that the entire area of salt marsh complexes within the vicinity of the Lower Neches Wildlife Management Area will convert to open water and tidal flats by the year 2100 if no action is taken. This loss of marsh habitat will allow for a marked increase of storm surge in this area from future hurricanes, further exacerbating the erosion potential into the upland communities and other freshwater wetland habitats.

POTENTIAL LOCAL BENEFITS

2 Migratory Bird Species

✓ Protected Habitat in the Area

1 Wetland Type

5 Endangered Species

✓ Decreased Wave Energy

7,090 Existing Wetland Carbon Sequestration (tons C)

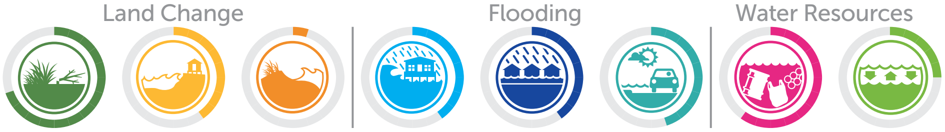
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

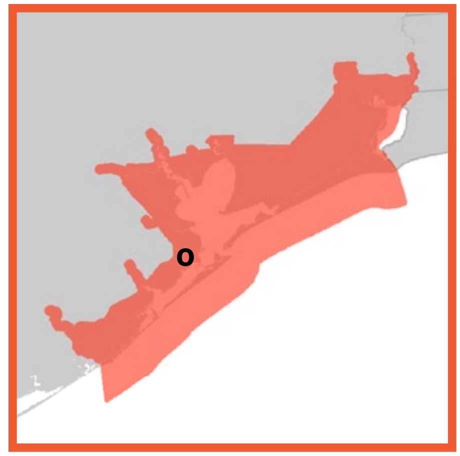
Highland Bayou Shoreline and Marsh Restoration Project *(9248)*

Estimated Project Cost: $1,700,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Highland Bayou Marsh

STATUS:
Conceptual

STAKEHOLDERS:

- ***City of La Marque***
- Galveston County
- Texas A&M AgriLife Extension Service

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

2	12	23
Wetland Types	Endangered Species	Migratory Bird Species

535
Existing Wetland Carbon Sequestration (tons C)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Project Description

Highland Bayou Park has experienced significant erosion along the banks of the lake. The City of La Marque is conceptually planning to restore the shoreline along the lake and other marsh areas at the Park. The purpose of this project is to restore these marshes by dredging areas nearby and placing the material around Highland Bayou Park to develop and enhance the vegetation near the park. This project would reduce erosion, provide bank stabilization, and help restore estuarine wetland habitat in the Highland Bayou watershed. The project would help protect habitat and wildlife resources in the Highland Bayou watershed and improve water quality. Dredging could help improve flow and tidal dynamics at strategic locations in the larger watershed. The lake inside the Park is an important recreational fishing amenity, providing estuarine wetland habitat within the Park. The marshes in this area reduce flooding by slowing and absorbing rainwater and protect water quality by filtering runoff.

Project Need

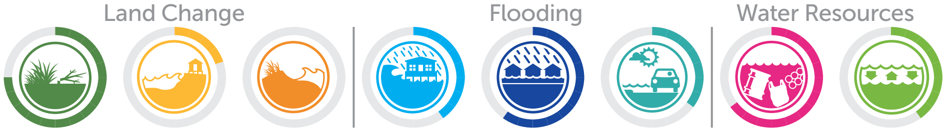
Past storms and hurricanes have caused erosion near the City-owned and maintained Highland Bayou Park. Continued erosion has contributed to degradation of the coastal marshes, resulting in loss of habitat for fish and other native species. Highland Bayou is listed as impaired by the State for high levels of bacteria and low levels of dissolved oxygen. The project supports several management measures in the Environmental Protection Agency-approved Highland Bayou Coastal Basin Watershed Protection Plan.

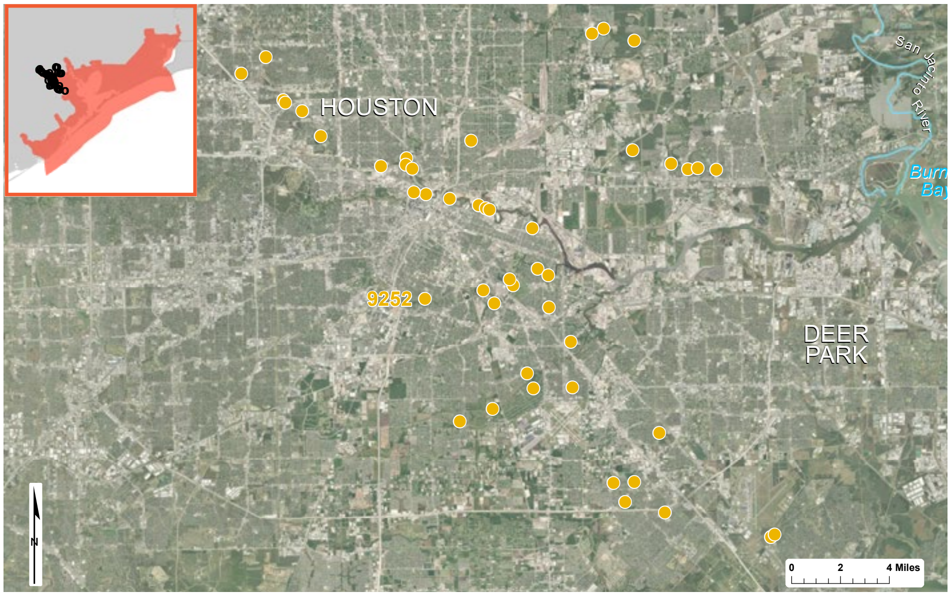
Houston Parks and Recreation Department's Riparian Restoration Initiative *(9252)*

Estimated Project Cost: $4,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
70 parks and/or waterways in southeast Houston

STATUS:
Ongoing

STAKEHOLDERS:
- ***City of Houston Parks and Recreation Department***
- Galveston Bay Estuary Program
- Student Conservation Association

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Studies, Policies, and Programs

Project Description

The City of Houston Parks and Recreation Department's Riparian Restoration Initiative will result in the restoration of riparian forest in selected parks adjacent to waterways based on a siting study already completed by the City. The restoration initiative aims to install new riparian forests or improve existing riparian forests across the city, reaching over 70 parks and 1,000 acres of parks and greenspaces by the year 2030. A total of 9 projects have been completed and 15 projects are ongoing. The entire initiative has not been funded; only certain individual projects have been funded in full. Coastal funding sources for this project would allow the City to complete restoration efforts in the 58 parks located in or immediately impacting coastal areas, of which 46 are currently unfunded, as seen in the project map. The project will help mitigate flooding, improve water quality, add recreation opportunities, reduce erosion, and create wildlife habitat throughout the City of Houston. The projects also will help to reduce urban heat from surrounding development.

Project Need

Riparian zones are narrow strips of land adjacent to streams and rivers that act as buffers between upland areas and open water. Many of Houston's riparian buffers have been removed or degraded due to development or stream channelization. The Riparian Restoration Initiative will target parks adjacent to bayous and tributaries to revitalize forested riparian buffers by removing invasive species and installing a diverse mix of native trees and shrubs.

POTENTIAL LOCAL BENEFITS

✓	7	✓
Addressing Data Gaps	Endangered Species	Education & Outreach

Medium Social Vulnerability

19	✓
Migratory Bird Species	Public Access Improvements

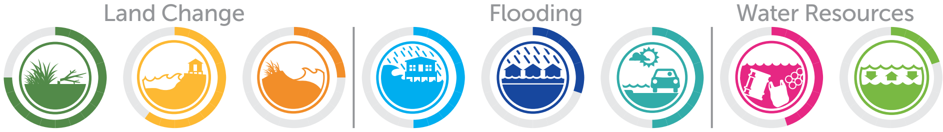
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

J.D. Murphree WMA Shoreline Protection *(1307)*

Estimated Project Cost: $13,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
J.D. Murphree Wildlife Management Area

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Ducks Unlimited***
- U.S. Fish and Wildlife Service
- Texas General Land Office
- Texas Parks & Wildlife Department

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description

The project would fund approximately 3.7 miles of rock breakwater to complete Gulf Intracoastal Waterway (GIWW) shoreline protection for the entirety of the J.D. Murphree Wildlife Management Area (WMA), focusing on the north shore, where protection is most needed. Presently, this area of shoreline remains exposed to wave energy from barges and prevailing winds. The unprotected shoreline at the WMA is immediately adjacent to freshwater wetland levee units managed as waterfowl habitat and natural coastal marsh. The breakwater structure will provide new submerged hard substrates for colonization by oyster larvae, and the interstitial spaces of the structure will provide additional habitat for nektonic species. This project can be scaled to the amount of shoreline where project planning and permitting is complete (approximately 3,500 feet). The breakwater structure will reduce rates of land loss due to erosion, including public land managed for wildlife and recreation. One mile of breakwater can provide benefits to approximately 500 to 1,000 acres of coastal habitats. One half-mile of breakwaters funded by the Texas General Land Office will be constructed in early 2023.

Project Need

Ducks Unlimited's "Decision Support Tool for Shoreline Protection along the Texas GIWW" ranks the shoreline adjacent to these habitats as high to medium priority for protection. Without protection, these shorelines will continue to erode, and the wetland compartment levees and natural coastal marsh will eventually be exposed to the impacts of wave energy and direct inflow of high salinity water. Under these conditions, vegetated marsh will gradually convert to saline, open water habitat, having less value to wildlife and fisheries.

POTENTIAL LOCAL BENEFITS

11 Endangered Species	**1** Critical Facility	**2** Wetland Types

✓ Oyster Habitat Protected/Created	✓ Decreased Wave Energy
18 Migratory Bird Species	✓ Protected Habitat in the Area

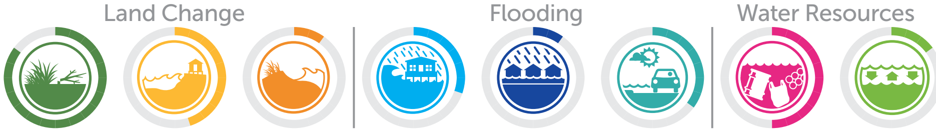
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Jones Bay Oystercatcher Habitat Restoration *(9228)*

Estimated Project Cost: $3,200,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
West of City of Galveston, just north of West Bay

STATUS:
Ongoing

STAKEHOLDERS:
- ***Galveston Bay Foundation***
- U.S. Fish and Wildlife Service
- Texas General Land Office
- Texas Parks & Wildlife Department
- Galveston Bay Estuary Program
- Gulf Coast Bird Observatory
- Natural Resource Damage Assessment Trustees
- Ducks Unlimited
- Texas A&M University

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description

This project proposes to enhance up to four remnant islands in Jones Bay. In addition, up to 1 acre of oyster reef will be restored near each nesting island to provide foraging habitat for nesting oystercatchers and their young. The Gulf Coast Bird Observatory conducted an analysis of island size in Jones Bay from 2009 to 2015 and documented a decrease in nesting island size by up to 60 percent during this time. In addition, the number of nesting oystercatcher pairs have declined from five in 2011 to only one in 2020. Their productivity also declined from 80 percent in 2011 to zero productivity in 2017, 2018, and 2019. Congruently, declines in the Eastern oyster population and increased levels of high tides have decreased foraging grounds, foraging opportunity, and food availability for oystercatchers, which depend almost exclusively on intertidal oyster reefs as a food source. Galveston Bay Foundation (GBF) has secured funds for design, permitting, construction, and monitoring at all four sites, and the total project cost reflects the cost of these activities at all four sites in Jones Bay.

Project Need

The proposed project was developed in response to an urgent need to reverse habitat loss for the American oystercatcher and increase their nesting and reproductive success. To address the threat of habitat loss and subsequent declines in the oystercatcher population, GBF aims to restore both nesting and foraging habitat in Jones Bay in hopes of supporting up to eight additional pairs of oystercatchers.

POTENTIAL LOCAL BENEFITS

4 Rookery Islands	**✓** Oyster Habitat Protected/Created
29 Migratory Bird Species	**11** Endangered Species

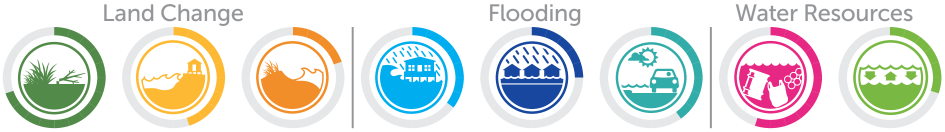
204 Nitrogen Removal by Oysters (lbs N, annually)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Keith Lake Fish Pass and Baffle Repairs and Upgrades *(9218)*

Estimated Project Cost: $3,800,000

ABILITY TO ADDRESS VULNERABILITIES



LOCATION:
Approximately 4.5 miles north of the community of Sabine Pass on the west side of SH 87

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Jefferson County***
- Salt Bayou Working Group (11 State and Federal agencies)
- Jefferson County Drainage District #6
- Ducks Unlimited
- National Fish and Wildlife Foundation

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Structure/ Debris Removal; Public Access Improvements

Project Description
Affecting over 25,000 acres of coastal habitat, construction of the Keith Lake Fish Pass baffle in 2016 was a key component of the Salt Bayou Watershed Restoration Plan. The remnant, original saltwater barrier structure was recently removed due to functionality issues. The current project provides the engineering and design (E&D) and permitting to facilitate repairs due to erosion on the back side of the southern portion of the existing rock baffle located in the Keith Lake Fish Pass and to armor both banks of the fish pass leading from the Port Arthur Canal to Keith Lake. Ongoing efforts are currently in the E&D phase to assess the repair needs to the structure, prepare a cost estimate, and coordinate the necessay regulatory and agency clearances/permitting. This phase of the project is expected to be completed by Fall 2023, and would include all preliminary plan preparation, design, environmental reviews, and permitting associated with the project. Additional funding is sought for bidding, construction, grant administration, and construction oversight activities.

Project Need
Tidal and storm currents and the unstable nature of the banks of the pass have caused marsh erosion behind the southern side of the baffle structure. The site was seriously compromised following tropical storm events in 2020, when a breach occurred along the shoreline. That breach is continuing to deepen and widen. Without repairs, the continuing enlargement of the breach will undermine the benefits of the previous construction, likely leading to poorer water quality and failure to achieve the expected ecosystem benefits.

POTENTIAL LOCAL BENEFITS

2	11	1
Wetland Types	Endangered Species	Critical Facility

6,000	18
Trips on Evacuation Route (Daily)	Migratory Bird Species

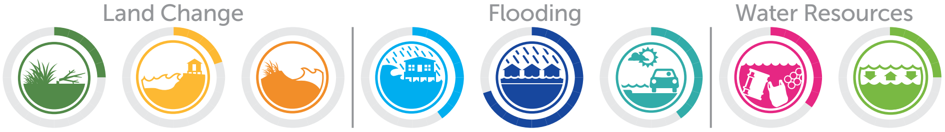
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

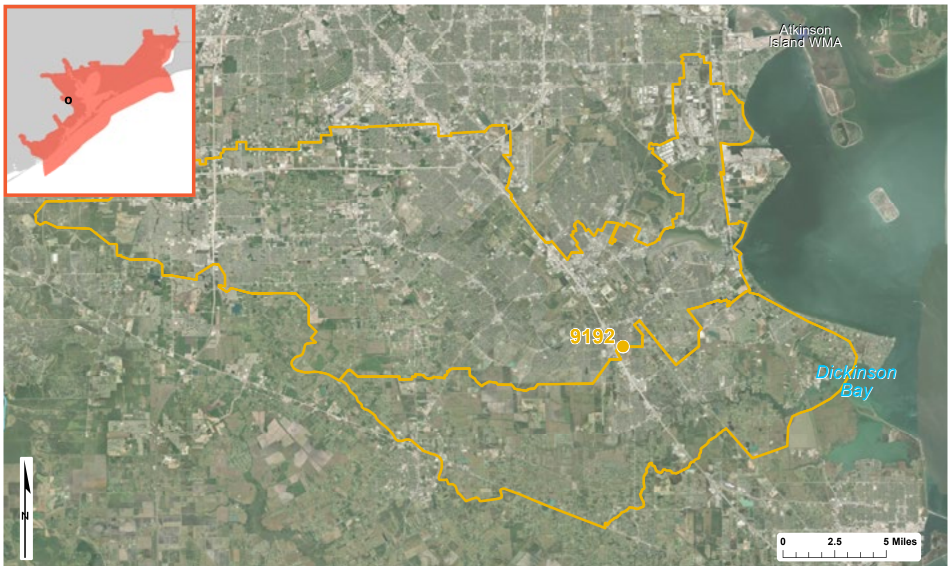
Lower Clear Creek and Dickinson Bayou Watershed Flood Risk Reduction Program *(9192)*

Estimated Project Cost: $3,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



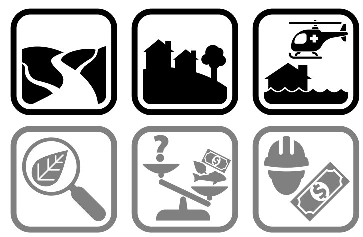


LOCATION:
Lower Clear Creek and Dickinson Bayou watersheds

STATUS:
Conceptual

STAKEHOLDERS:
- ***City of League City***
- U.S. Army Corps of Engineers
- City of Pearland
- City of Friendswood
- City of Dickinson
- Galveston County Drainage District
- Harris County Flood Control District
- Dickinson Economic Development Corporation

ACTIONS:



PROJECT TYPE(S):
Flood Risk Reduction; Studies, Policies, and Programs; Community Infrastructure

POTENTIAL LOCAL BENEFITS

✓ Avoided Future Flood Risk	810 Critical Facilities

Medium
Social Vulnerability

310.4k Homes	35k Existing Jobs

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Project Description

This project will address flood risk in the Lower Clear Creek and Dickinson Bayou watersheds and provide a final recommended flood risk management solution for surrounding communities. This would include identifying vulnerabilities present in both watersheds and developing and refining concepts to reduce regional flooding. The City of League City and partner agencies studied the unique challenges of this system and concluded that combination solutions, such as detention and conveyance improvements, and flow diversion have the greatest potential to reduce risk and maximize benefits. A subsequent federal feasibility study is required to fully understand impacts to Waters of the United States—including Clear Lake, Dickinson Bay, and Galveston Bay—to ensure downstream impacts from improvements are managed between multiple jurisdictions. Additional modeling efforts for community stormwater drainage systems is also necessary to assess performance improvements beyond the main stems of Lower Clear Creek and Dickinson Bayou and their major tributaries. This project would provide the required local match for the federal study.

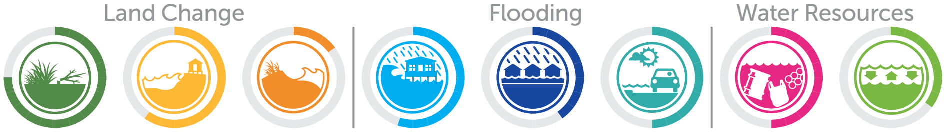
Project Need

During flood events, flooding within these two watersheds causes flow to move between the two, creating a single system and significantly increasing flood risk and complicating management. This project would link past studies with new methods to improve drainage and reduce risk for communities.

Lower Neches WMA Lake Street Drive Beneficial Use *(1387)*

Estimated Project Cost: $6,000,000

ABILITY TO ADDRESS VULNERABILITIES

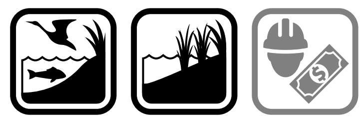


LOCATION:
The east portion of the Lower Neches WMA

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Texas Parks & Wildlife Department***
- Ducks Unlimited
- Natural Resource Damage Assessment Trustees
- National Oceanic and Atmospheric Administration
- U.S. Army Corps of Engineers

ACTIONS:



PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description
This project is a high priority candidate under the Ducks Unlimited Beneficial Use Master Plan. Ducks Unlimited has completed 60% project design and development of a U.S. Army Corps of Engineers (USACE) permit application package for the portion of the project that occurs on the Texas Parks & Wildlife Department (TPWD)-owned Lower Neches Wildlife Management Area (WMA). This project would allow final engineering and design, permitting, and construction to be completed and would consist of six restoration cells totaling 224 acres and requiring up to 400,000 cubic yards of beneficial use of dredged material (BUDM). BUDM has the potential to restore thousands of acres of currently degrading coastal habitat annually, thus nearly offsetting documented wetland losses, while also providing coastal resiliency and abating relative sea level rise and providing economic value in ecosystem services and commercial value in maritime, fishing, and wildlife revenue.

Project Need
The BUDM represents a win-win opportunity for TPWD and USACE to use dredged material beneficially to restore several marsh sites in the area. BUDM can be repurposed to renourish shorelines and wetland habitats. Texas is losing coastal wetlands at a rate of more than 5,700 acres annually, and a major cause of this loss is insufficient sediment supply. A major barrier to implementing BUDM projects is a lack of coordination between dredging schedules, permitting, and other logistics, demonstrating a need for a coordinated planning effort.

POTENTIAL LOCAL BENEFITS

190 Homes	**20** Existing Jobs	**1** Wetland Type
4 Endangered Species	**15** Migratory Bird Species	**✓** Protected Habitat in the Area

$68.35M
Building Replacement Value

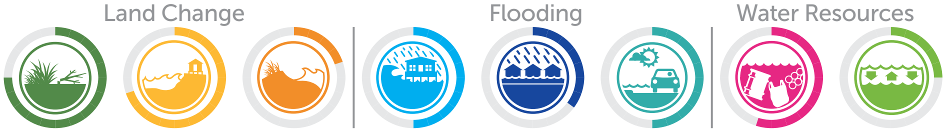
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Management of the Christmas Bay System *(11)*

Estimated Project Cost: $5,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

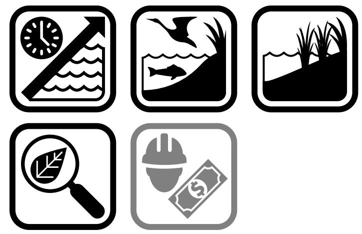


LOCATION:
Christmas Bay and surrounding areas

STATUS:
Conceptual

STAKEHOLDERS:
- ***Texas Parks & Wildlife Department***
- Texas General Land Office

ACTIONS:



PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description

The Christmas Bay and Drum Bay system is uniquely situated between the Gulf Intracoastal Waterway (GIWW) and Follett's Island. This system is a highly productive estuary that includes significant fresh and estuarine wetlands with minimal impacts from human development. The exceptions to this are the development of the GIWW, which has led to breaches and near breaches along the northwestern shorelines, as well as scattered development along Follett's Island that has impacted the dynamic interaction of sediment movement from the Gulf to bay shoreline over time. Under this project, various elements are considered to mitigate hazards to this system. The most time critical component is to mitigate the breach of Drum Bay at the GIWW near Nick's Lake, which would require hybrid solutions to limit the exposure from vessel wakes on the GIWW. Additional components include shell-based restoration at Rattlesnake and Christmas Points to stabilize these peninsulas while also promoting ecological restoration and enhancements in the area. The final component would be a long-term monitoring approach to respond to habitat loss throughout the system as a result of sediment shortages and sea level rise.

Project Need

The Christmas Bay and Drum Bay system is experiencing degradation from human impacts and is highly vulnerable to long-term challenges to sediment loss and relative sea level rise. Because the system is effectively locked in place on both sides by Follett's Island and the GIWW, it does not have the natural ability to migrate over time and requires intervention for its sustainability.

POTENTIAL LOCAL BENEFITS

11	1	✓
Endangered Species	Wetland Type	OysterHabitat Protected/ Created

✓	24
Protected Habitat in the Area	Migratory Bird Species

8,070
Existing Wetland Carbon Sequestration (tons C)

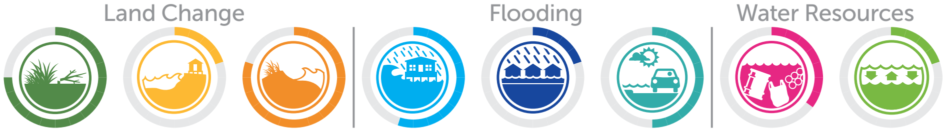
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

McFaddin NWR Gulf Shoreline Stabilization *(9204)*

Estimated Project Cost: $38,500,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

The project will conserve and protect shoreline along the Gulf of Mexico off of the McFaddin National Wildlife Refuge (NWR). Lightweight aggregate core rock breakwaters and jetties will be constructed parallel or perpendicular to the shore along the Gulf shoreline for approximately 3 miles. The breakwaters would consist of encapsulated lightweight aggregate, bedding stone, and large armor stone. Gaps between the breakwaters will facilitate movement of organisms and allow sediment laden water behind the breakwater to restore the beachfront.

Project Need

The Gulf of Mexico shoreline along the McFaddin NWR is rapidly eroding due to an increase in tidal elevations and tropical storm events. This project is designed to reduce shoreline retreat and promote shallowing and natural vegetation colonization of the overwash material landward of the structure. Stabilizing and protecting the Gulf shoreline on McFaddin NWR will protect and conserve thousands of acres coastal marsh habitat for recreationally and commercially important aquatic and avian species. Additionally, the breakwater will allow for the creation of various habitats behind the constructed structure.

LOCATION:
Gulf shoreline near Sabine Pass along the McFaddin National Wildlife Refuge

STATUS:
Conceptual

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

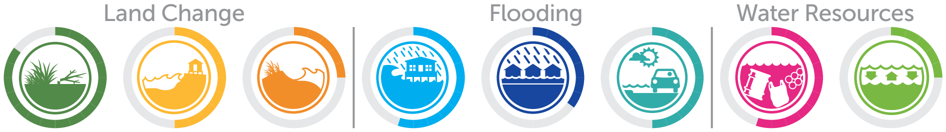
10 Endangered Species	✓ Decreased Wave Energy
✓ Protected Habitat in the Area	**2** Wetland Types

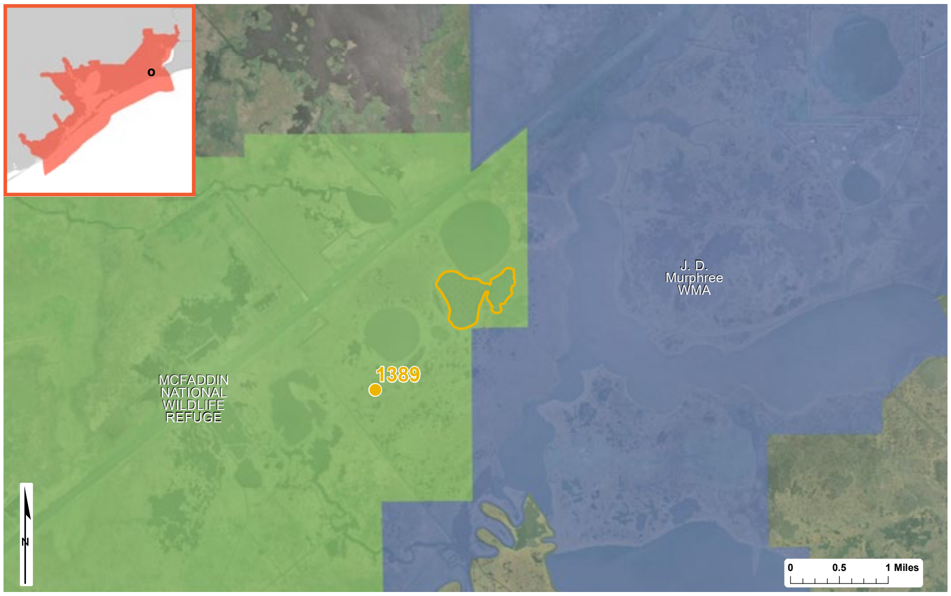
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

McFaddin NWR Willow Lake Marsh Beneficial Use *(1389)*

Estimated Project Cost: $8,600,000

ABILITY TO ADDRESS VULNERABILITIES





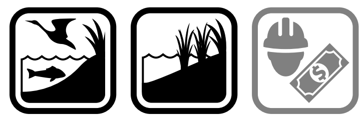
LOCATION:
McFaddin National Wildlife Refuge, Barnett Lake

STATUS:
Engineering & Design

STAKEHOLDERS:

- ***U.S. Fish and Wildlife Service***
- Ducks Unlimited
- Natural Resource Damage Assessment Trustees
- National Oceanic and Atmospheric Administration

ACTIONS:



PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description

This project is a high priority candidate for the Ducks Unlimited Beneficial Use Master Plan. This project encompasses a large project area and 7 miles of shoreline, and dredged material will be used to restore the marsh. An existing U.S. Army Corps of Engineers project will restore portions of McFaddin National Wildlife Refuge (NWR) by elevating the marsh near Keith Lake, and these restoration efforts can work in tandem to provide much-needed improvements to the NWR. Preliminary engineering and design have been completed on the Willow Lake site; this project would allow final engineering and design, permitting, and construction to be completed. The project site consists of a single, 218-acre beneficial use of dredged material (BUDM) marsh restoration area that can utilize up to 466,000 cubic yards of BUDM.

Project Need

When material is dredged, it is typically disposed of in Dredged Material Placement Areas (DMPAs). However, acquiring or expanding these DMPAs is costly, difficult, and may require use of eminent domain. As DMPAs fill up and disposal fees rise, it has become evident that an alternative option is needed. Disposing of dredged material presents a wasted opportunity, because this sediment can be repurposed to renourish shorelines and wetland habitats. In fact, Texas is losing coastal wetlands at a rate of more than 5,700 acres annually, and a major cause of this loss is insufficient sediment supply. A major barrier to implementing BUDM projects is a lack of coordination between dredging schedules, permitting, and other logistics, demonstrating a need for a coordinated planning effort.

POTENTIAL LOCAL BENEFITS

1	1	✓
Wetland Type	Migratory Bird Species	Protected Habitat in the Area

11 Endangered Species

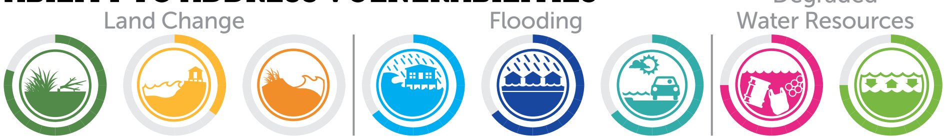
9,265 Existing Wetland Carbon Sequestration (tons C)

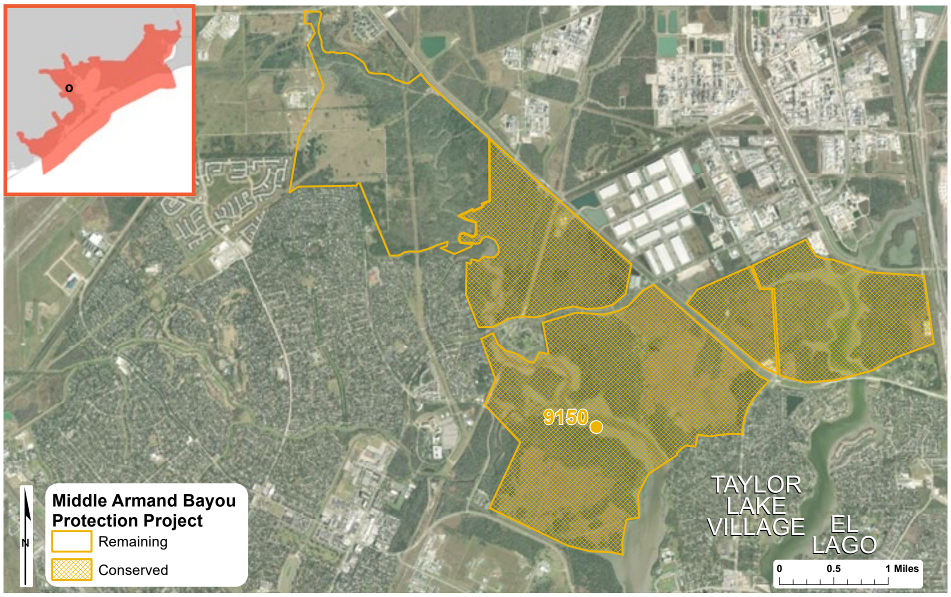
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Middle Armand Bayou Protection Project *(9150)*

Estimated Project Cost: $3,000,000

ABILITY TO ADDRESS VULNERABILITIES





LOCATION:
Strategic properties within the Armand Bayou Watershed

STATUS:
Acquisition Pending

STAKEHOLDERS:
- ***Armand Bayou Nature Center***
- Harris County Flood Control District
- Gulf Coast Bird Observatory
- Knobloch Family Foundation
- Brown Foundation
- Galveston Bay Estuary Program
- Harris County
- Texas Conservation Partners

ACTIONS:

PROJECT TYPE(S):
Land Acquisition; Habitat Creation and Restoration

Project Description

The Armand Bayou Nature Center (ABNC) manages more than 2,500 acres of urban wilderness along the southern portion of Armand Bayou. However, early conservation efforts fell short of reaching ABNC's larger goal of preserving the entirety of Armand Bayou. This project is focused on that goal of preserving 1,065 acres of habitat just north of the Nature Center. This land was in the original acquisition plan of ABNC in 1974; at the time, the landowners were not ready to sell, and ABNC did not have enough money to purchase it. After decades of oil and gas production, the field is played out and ExxonMobil is ready to sell the land. This is an historic opportunity to ensure that this critical habitat and the absolute last of the area's green space is not forever lost to development and urban sprawl. The properties in the targeted acquisition areas have repeatedly suffered damage from floodwaters and this project would prevent further development in these flood prone areas. Once the property has been acquired, this valuable coastal land and unique wildlife habitat will be designated as a nature preserve in perpetuity and placed under the management of ABNC, who will restore the land's ecosystem functions.

Project Need

Rapid growth in Houston over the past several decades has led to significant habitat loss. ABNC protects three vanishing Gulf Coast habitats: flatwood forest, coastal tall grass prairie, and the unchannelized, estuarine Armand Bayou and surrounding wetlands. The survival of these vulnerable areas is vital for the 370 species of wildlife that depend upon them and for their ecosystem services, including stormwater retention, flood abatement, and improved water quality.

POTENTIAL LOCAL BENEFITS

6	1	20
Endangered Species	Critical Facility	Migratory Bird Species

2	✓
Wetland Types	Avoided Future Flood Risk

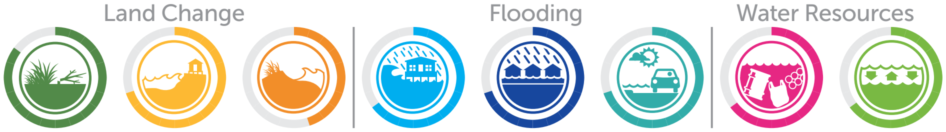
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Moody NWR Conservation and Restoration *(9082)*

Estimated Project Cost: $10,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Along the northern shoreline of East Bay and east of Lake Surprise

STATUS:
Shovel Ready

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- Chambers County

ACTIONS:

PROJECT TYPE(S):
Land Acquisition; Habitat Creation and Restoration; Shoreline Stabilization

Project Description

This project would acquire additional properties to expand the Moody National Wildlife Refuge (NWR) and conduct restoration for existing wetlands in the Refuge. A future restoration phase for the lands conserved as part of this effort would be a living shoreline stabilization project to protect the shoreline from erosion. A 270-acre tract was purchased in the target area, and the U.S. Fish and Wildlife Service is working with multiple landowners on appraisals in the project area. The project would allow the first public access to the Refuge and within better reach local disadvantaged communities at Smith Point and Oak Island. This area was heavily impacted by Hurricane Ike, and the project will prevent development in acquired areas to avoid increasing losses on the coastal plain.

Project Need

The Chambers County Greenprint for Growth and Conservation identifies critical areas for preservation, including several properties adjacent to the Moody NWR that are considered moderate to high conservation priorities. The conservation goals for Chambers County laid out in their Greenprint plan encompass preserving natural habitat, targeting restorable habitats, protecting water quality, protecting and restoring natural drainage, maintaining the rural character of the region, and creating more public access for nature-based restoration.

POTENTIAL LOCAL BENEFITS

1 Wetland Type	✓ Public Access Improvements
$49.21M	Building Replacement Value
140 Homes	✓ Avoided Future Flood Risk

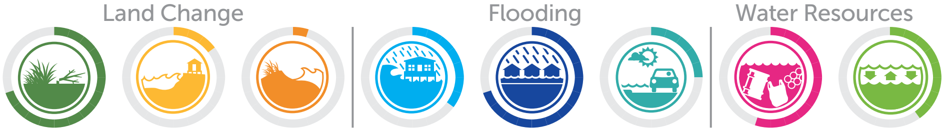
85.7k Existing Wetland Carbon Sequestration (tons C)

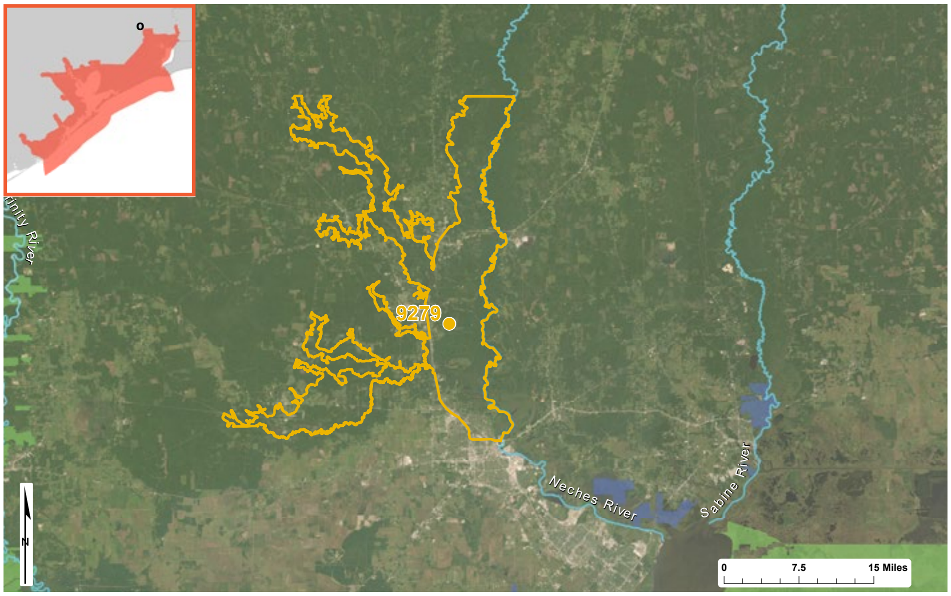
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Neches River Forested Floodplain *(9279)*

Estimated Project Cost: $30,000,000

ABILITY TO ADDRESS VULNERABILITIES





LOCATION:
Floodplain adjacent to the Neches River and its tributaries

STATUS:
Conceptual

STAKEHOLDERS:
- ***Jefferson County***
- Big Thicket Natural Heritage Trust
- Big Thicket Association
- Texas Water Development Board
- The Conservation Fund
- The Nature Conservancy
- Ducks Unlimited
- Lamar University

ACTIONS:

PROJECT TYPE(S):
Flood Risk Reduction; Land Acquisition; Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

71	15	30
Critical Facilities	Endangered Species	Migratory Bird Species

High Social Vulnerability

✓ Avoided Future Flood Risk

✓ Public Access Improvements

$3.4B Building Replacement Value

Project Description
The Texas Water Development Board (TWDB) Flood Planning Group (FPG) is tasked with managing flood mitigation planning for the Neches River Basin by developing a plan to identify specific flood risks and recommend flood management strategies and opportunities to reduce risk in the region. The plan identifies present communities and projected development threatened by future flood events within the Neches River floodplain. Guided by this plan and other best available science, the Big Thicket Natural Heritage Trust, The Conservation Fund, The Nature Conservancy, and other partners will acquire fee simple land interest and conservation easements in high-risk flood areas adjacent to the Neches River to provide nature-based downstream flood minimization and habitat protection. These lands could become part of the Big Thicket National Preserve or other state, local, or private conserved areas.

Project Need
As flood events grow more frequent and more severe, the need to improve the region's resiliency measures is more apparent than ever. The draft TWDB Neches FPG plan states: "The southern portion of the Neches River Basin, although at much higher risk of coastal and riverine flooding, is projected to experience significant growth by 2050. If no action is taken to mitigate flood risk, the exposure will increase substantially and an increase in both property damage and loss of life can be expected." Acquiring these lands will preserve floodplain function, protect people and property, and provide additional outdoor recreation opportunities, all of which are priorities for Jefferson County.

North Pleasure Island Shoreline Protection and Restoration *(457)*

Estimated Project Cost: $4,400,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

LOCATION:
Dredged material placement islands along the Sabine-Neches Waterway

STATUS:
Conceptual

STAKEHOLDERS:
- ***Jefferson County***
- City of Port Arthur
- Port of Port Arthur Navigation District

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

780 Existing Wetland Carbon Sequestration (tons C)

✓ Decreased Wave Energy

1 Wetland Type

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Project Description

This project would restore up to 40 acres of marsh and island habitat at North Pleasure Island via beneficial use of dredged material (BUDM) to provide fill and construct up to 2,000 feet of living shoreline breakwater. The restored habitat would contain wetlands and vegetated shallows. Based on available funding, the project also could be configured as a single breakwater without BUDM or planting, which would reduce the project cost by approximately $2.5 million.

Project Need

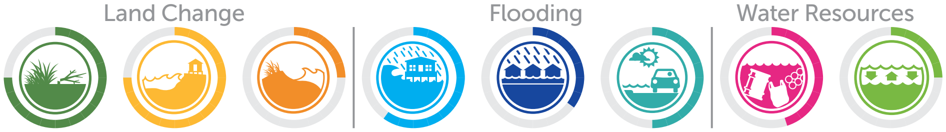
The dredged material placement islands along the Sabine-Neches Waterway are eroding due to channel use. This erosion is negatively impacting the upland habitat on the placement islands. Protecting the navigation channel would limit shoaling in the channel, reducing the frequency and cost of maintenance dredging. This project could potentially use BUDM from maintenance dredging of the Sabine-Neches Waterway or a local ship berth and/or barge facility. Restoring the dredge placement island and protecting habitats with a breakwater would greatly increase viability of fish and bird species utilizing the area for nursing habitat. This project would also provide additional soil stabilization through the restored vegetative root structures and has the potential to attenuate wave energy along the channel.

Old River Cove Restoration *(320)*

Estimated Project Cost: $9,200,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

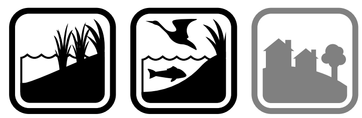


LOCATION:
Unprotected shoreline along the Lower Neches Wildlife Management Area

STATUS:
Conceptual

STAKEHOLDERS:
- ***Texas Parks & Wildlife Department***
- U.S. Army Corps of Engineers
- Texas General Land Office
- Orange County
- Texas Department of Transportation

ACTIONS:



PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description

This project would build approximately 7,000 feet of breakwaters and beneficially use dredged material to establish a living shoreline along the remaining unprotected shoreline of the Lower Neches Wildlife Management Area (WMA). The living shoreline would protect another component of a separate but related project to restore 300 acres of estuarine wetlands and shallow-water habitat within Lower Neches WMA and protect 430 acres of freshwater wetlands or uplands. The living shoreline would complement a previous shoreline stabilization project that leveraged Coastal Impact Assistance Program funding in 2012 to protect the western shoreline of Lower Neches WMA. Restoration of the wetland habitats within Lower Neches WMA will utilize beneficial use of dredged material.

Project Need

This project would protect the Lower Neches WMA from erosion caused by wind fetch across Sabine Lake and provide benefit to the existing habitat value within the WMA. These actions would prevent the loss and degradation of wetland vegetation from increased salinity and conversion of wetlands to open water and therefore would help safeguard Bridge City and nearby infrastructure from future storm surge and flooding.

POTENTIAL LOCAL BENEFITS

5	✓	1
Endangered Species	Decreased Wave Energy	Wetland Type

19	✓
Migratory Bird Species	Protected Habitat in the Area

1,275
Wetland Carbon Sequestration (tons C)

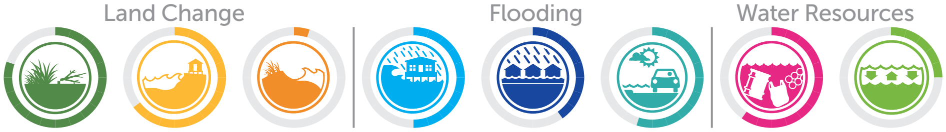
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

O'Quinn I-45 Estuary Shoreline Protection and Marsh Restoration *(346)*

Estimated Project Cost: $11,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

The O'Quinn I-45 Estuary Corridor is an intertidal marsh located near the I-45 Causeway, southeast of Bayou Vista, and is part of the greater Virginia Point Preserve complex owned and managed by Scenic Galveston. The project area includes 1.6 miles of bay shoreline protection near its junction with Jones Bay and 300-400 acres of potential estuarine wetland restoration, building upon and complementing previous restoration work by Scenic Galveston and partners in the Preserve complex. The project budget will depend on the final project shoreline design and availability of dredged material. The existing railroad embankments serve as containment for interior marsh restoration between I-45 and the railroad, which would be beneficial during construction. However, the historic Jones Bay shoreline closest to Bayou Vista along the Highland Bayou boat channel has largely disintegrated, resulting in near-total marsh loss between the railroad embankment and Jones Bay. The goal of this project is to restore habitat function to this portion of the preserve and to stabilize the entire shoreline to prevent future loss along Jones Bay, likely utilizing a combination of permanent hard structure breakwaters and sacrificial containment berms to protect the new marsh until establishment.

Project Need

The O'Quinn marsh is located near several colonial waterbird rookeries and serves as foraging grounds for many shore and waterbird species. This project will provide additional habitat with the creation of estuarine wetlands and protect existing habitat for commercially and recreationally valuable species that support recreational use and local economies.

LOCATION:

Virginia Point Peninsula Preserve Complex, O'Quinn Marsh tracts along the I-45 Causeway southeast of Bayou Vista and north-northwest of Tiki Island

STATUS:

Conceptual

STAKEHOLDERS:

- ***Scenic Galveston, Inc.***
- Texas General Land Office
- Galveston Bay Estuary Program
- U.S. Fish and Wildlife Service

ACTIONS:

PROJECT TYPE(S):

Shoreline Stabilization; Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

1 Wetland Type	**20** Migratory Bird Species	**970** Homes
✓ Decreased Wave Energy	**10** Critical Facilities	**12** Endangered Species
2,299 Trips on Evacuation Route (Daily)	**160** Existing Jobs	

$224.96M Structure Damage (1% Storm)

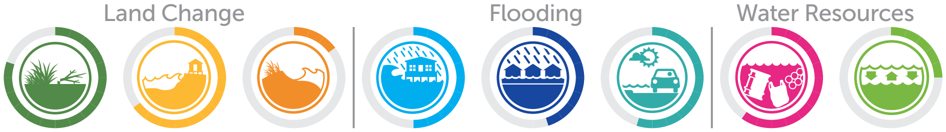
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Pierce Marsh Wetland Restoration and Shoreline Protection *(9277)*

Estimated Project Cost: $6,500,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
2,346-acre marsh in Hitchcock

STATUS:
Ongoing

STAKEHOLDERS:
- ***Galveston Bay Foundation***
- HarborWalk
- U.S. Army Corps of Engineers
- City of Bayou Vista
- Natural Resource Damage Assessment Trustees
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

12 Endangered Species

40 Existing Jobs

80 Homes

$9.45M Structure Damage (1% Storm)

8,706 Trips on Evacuation Route (Daily)

33 Migratory Bird Species

3,190 Existing Wetland Carbon Sequestration (tons C)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Project Description

The Pierce Marsh shoreline facing Jones Bay has lost between 150 and 200 feet of shoreline since the late 1960s. In this project, Galveston Bay Foundation would partner with the U.S. Army Corps of Engineers and others to use dredged material to restore 50-100 acres of intertidal marsh in Pierce Marsh over multiple dredge events, for a total 265 acres of restored habitat. The area within Pierce Marsh is conducive to large scale intertidal wetland restoration utilizing dredge material from the Gulf Intracoastal Waterway and other localized sources. Long-term planning for beneficial use of dredged material (BUDM) projects within Pierce Marsh has been completed with funding through the RESTORE Act. A nearshore breakwater is proposed to protect the shoreline from further erosion. The breakwater is conceptual at this time and could extend upwards of 8,000 feet in length to protect the wetlands.

Project Need

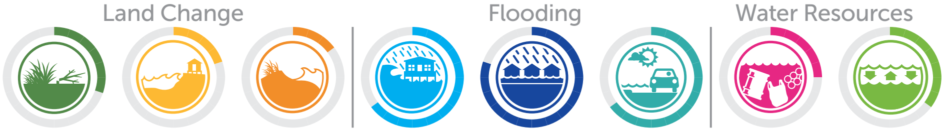
These estuarine wetlands in Pierce Marsh are experiencing high rates of degradation due to continued developments in the surrounding areas. Over the next 50 years, if this project does not occur, 35 acres are projected to erode based on historic rates. Restoration of these wetlands is needed to provide a number of ecosystem services to the area, including benefits to water quality and nesting and nursery habitat. Using BUDM to create and restore the wetland habitat will increase viability for protected species and provide potential foraging for migrating birds, building upon existing wetland restoration in the immediate vicinity and increasing the opportunity for various species to fully utilize the area.

Southeast Texas Flood Coordination Study - Regional Flood Sensor System *(9257)*

Estimated Project Cost: $900,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Southeast Texas

STATUS:
Conceptual

STAKEHOLDERS:
- ***Lamar University***
- Department of Homeland Security Science and Technology Directorate

ACTIONS:

PROJECT TYPE(S):
Studies, Policies, and Programs; Community Infrastructure

Project Description

The Southeast Texas Flood Coordination Study (SETxFCS) is an ongoing, multi-faceted project focused on activities to improve the resilience of the region to flood events. The SETxFCS's largest 2021-2023 subproject is the deployment and asset management of 75 low-cost flood level sensors in coordination with the Department of Homeland Security Science and Technology Directorate (DHS S&T) in a seven-county region, mostly in the coastal zone of Jefferson, Chambers, and Orange counties. Project tasks include asset management, technical support, mapping elevations near sensor locations, aiding with sensor installation, and developing installation strategies that limit sensor-sediment/biological interference to reduce data timeouts and site visits. Additional needs beyond the DHS S&T network are assessing regional coverage gaps and installing additional flood level sensors and rain gauges, development of long-term interagency system maintenance strategy, and development of guidance/workshops for similar deployments.

Project Need

Updated, accessible flood sensing data would help stakeholders better respond to, recover from, plan for, and manage stormwater flooding. Improved data availability from the regional flood sensor system would help stakeholders in Southeast Texas—from local stormwater managers and planners to state emergency officers—to plan for, predict, and respond to floods. A guidance document and workshops may aid other coastal communities with their own flood governance entities in developing similar networks.

POTENTIAL LOCAL BENEFITS

High Social Vulnerability

✓ Addressing Data Gaps	✓ Education & Outreach

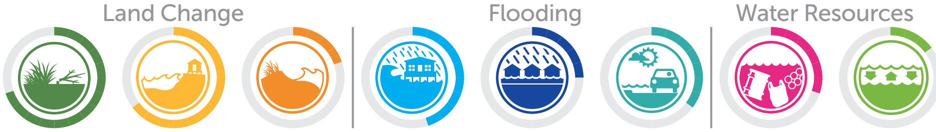
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Sydnes Island Restoration *(9294)*

Estimated Project Cost: $10,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

Sydnes Island is a dredged material placement island that separates the Gulf Intracoastal Waterway (GIWW) from the larger Sabine Lake waterbody near the Texas-Louisiana border, just south of Old River Cove. The island was originally built using material dredged from the GIWW but has eroded overtime due primarily to barge usage of the GIWW. Over a 15-year period, Sydnes Island has lost more than 8.5 acres of land. Without restoration, the island will be lost and will allow continued erosion inland at the Lower Neches Wildlife Management Area (WMA). This project proposes a wave break to protect and stabilize the island from further erosion and will create and restore island habitat through the beneficial use of dredged material. This project would not only benefit the subsistence of Sydnes Island but would also help prevent erosion and shoreline instability at the Lower Neches WMA. The restored islands would protect the Old River Cove wetlands from intrusion of higher salinity waters and would protect the wetlands from erosion caused by wind fetch across Sabine Lake. Protecting the waterway from tides and fetch enhances navigational safety and efficiency of barges that carry approximately 103 million tons of cargo across this segment of the Sabine-Neches Canal and GIWW annually.

Project Need

Sydnes Island no longer provides adequate protection for the GIWW. As a result of this loss of protection, the Old River Cove wetlands are experiencing loss and degradation from increased salinity and conversion of wetlands to open water. Losing the island would negatively impact navigation in the channel by removing the protective barrier that allows calmer waters for navigation.

LOCATION:
Island off the coast of the Lower Neches Wildlife Management Area

STATUS:
Conceptual

STAKEHOLDERS:
- ***Orange County Navigation and Port District***
- Ducks Unlimited

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

3	2	1
Endangered Species	Migratory Bird Species	Wetland Type

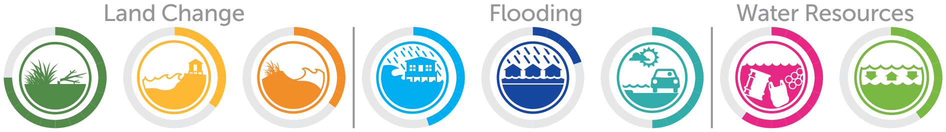
✓	✓
Decreased Wave Energy	Protected Habitat in the Area

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Texas Bayou Water Control Structure *(1356)*

Estimated Project Cost: $6,000,000

ABILITY TO ADDRESS VULNERABILITIES



Project Description

This project proposes the construction of a water control structure at Texas Bayou to regulate saltwater intrusion into the Texas Point National Wildlife Refuge (NWR). Texas Bayou begins in southeast Jefferson County and flows eastward about 4 miles before emptying into Sabine Pass and ultimately the Gulf of Mexico. The bayou meanders through channel banks lined with extensive cordgrass. The project would regulate saltwater intrusion into Texas Bayou and safeguard 750 acres of marshlands against petrochemical spills and chronic erosion caused by the wakes from ocean-going vessel traffic. The water control structure will provide a major point of protection for minimizing potential contamination from oil or chemical spill incidents that may occur in the adjacent Sabine-Neches Waterway.

Project Need

The wetlands along Texas Bayou in the Texas Point NWR are experiencing degradation due to saltwater intrusion. The Refuge's wetlands provide habitat for wintering and migrating waterfowl and functions as a nursery area for commercially and recreationally important finfish and shellfish.

LOCATION:
Bayou roughly 2 miles inland of the Gulf of Mexico at Texas Point National Wildlife Refuge

STATUS:
Conceptual

STAKEHOLDERS:
- ***Jefferson County***
- Texas General Land Office
- U.S. Fish and Wildlife Service
- Ducks Unlimited

ACTIONS:

PROJECT TYPE(S):
Hydrologic Connectivity

POTENTIAL LOCAL BENEFITS

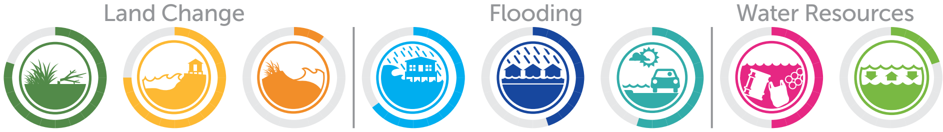
1 Wetland Type	**29** Migratory Bird Species
11 Endangered Species	✓ Protected Habitat in the Area

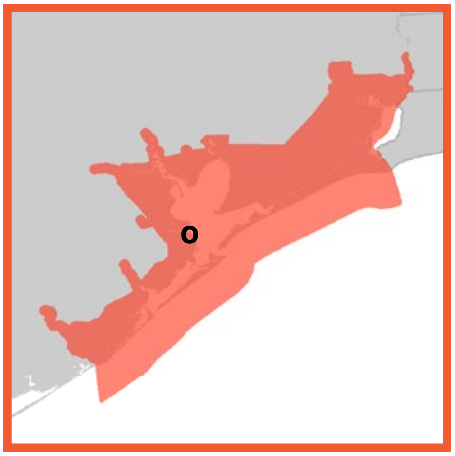
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Texas City Levee Erosion Control and Marsh Restoration *(9173)*

Estimated Project Cost: $7,000,000

ABILITY TO ADDRESS VULNERABILITIES



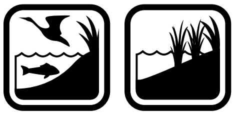


LOCATION:
The Texas City Prairie Preserve's Dickinson Bay shoreline

STATUS:
Conceptual

STAKEHOLDERS:
- ***The Nature Conservancy***
- Gulf Coast Bird Observatory
- U.S. Fish and Wildlife Service
- Galveston Bay Foundation
- Texas General Land Office
- U.S. Army Corps of Engineers

ACTIONS:



PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description

The project would construct an up to 11,000-foot living shoreline breakwater along the Texas City Prairie Preserve's Dickinson Bay shoreline to stabilize and enhance a 5,000-foot oyster shell hash/sand ridge and reduce cutbank erosion along 6,000 feet of shoreline. This shell hash ridge is valuable bird nesting habitat and protects a 71-acre intertidal wetland that is being lost to relative sea level rise and erosion from tidal wave energy. The erosion will eventually erode to a portion of the Texas City hurricane protection levee and compromise the levee without additional protection. This project will enhance and stabilize the shell ridge/sandy shoreline that provides nesting habitat for birds such as American oystercatchers and black skimmers and protect existing intertidal wetlands and coastal prairie from ongoing erosion. This project will allow these habitats to continue to serve as wildlife and fisheries habitat, provide storm surge protection, and increase water quality while serving residents, businesses, and industry of the City of Texas City and surrounding areas by ensuring the continued integrity of the hurricane flood protection levee.

Project Need

The shell hash/sand ridge, wetlands, and prairies that serve as a natural buffer and as wildlife habitat are being eroded away due to high wave energy occurring in the bay. This erosion will soon encroach upon a portion of the Texas City hurricane flood protection levee.

POTENTIAL LOCAL BENEFITS

2	12	33
Wetland Types	Endangered Species	Migratory Bird Species

✓	✓
Decreased Wave Energy	Oyster Habitat Protected/Created

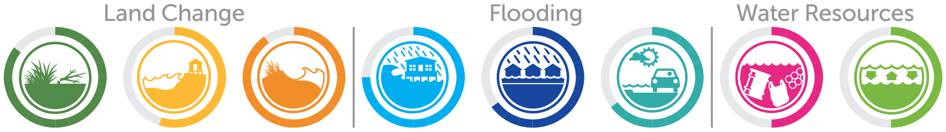
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Texas Point NWR Beach Nourishment Project *(9081)*

Estimated Project Cost: $43,400,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

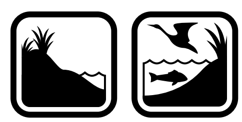


LOCATION:
Gulf shoreline of the Texas Point National Wildlife Refuge

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- Texas General Land Office

ACTIONS:



PROJECT TYPE(S):
Beach Nourishment;
Dune Restoration

Project Description

This project would conduct beach restoration at the Texas Point National Wildlife Refuge (NWR) using beneficial use of dredged material, or other innovative methods. The design phase of this project would consider how the beach ridge restoration ties into the U.S. Army Corps of Engineers' Coastal Texas Program efforts. The shoreline along the Texas Point NWR is a first line of defense for the Refuge that serves as protection against storm surge and coastal flooding events. This project would restore the beach from its currently severely eroded state. Restoring the beach in this area would ensure a healthy shoreline and protect the wetlands in the Refuge from saltwater intrusion.

Project Need

Except for the area directly adjacent to the Sabine Pass jetties, this shoreline has experienced severe erosion, based on short- and long-term shoreline change monitoring.

POTENTIAL LOCAL BENEFITS

1 Wetland Type

11 Endangered Species

High Social Vulnerability

28 Migratory Bird Species

✓ Protected Habitat in the Area

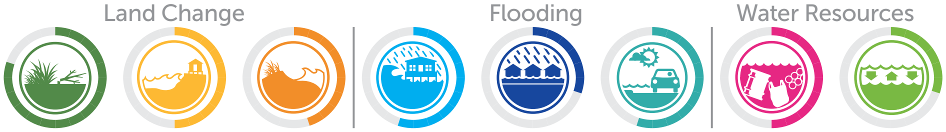
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Texas Point NWR Beneficial Use *(1388)*

Estimated Project Cost: $11,400,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Texas Point National Wildlife Refuge, facing Sabine Pass

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Ducks Unlimited***
- U.S. Fish and Wildlife Service
- National Oceanic and Atmospheric Administration
- U.S. Army Corps of Engineers

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description

This project is a high priority candidate for the Ducks Unlimited Beneficial Use Master Plan. Portions of this site have been a previous recipient of beneficial use of dredged material (BUDM) through past projects funded by the Texas General Land Office. Preliminary engineering and 60% design have been completed, and this project would allow final engineering and design, permitting, and construction to be completed. The project will consist of three marsh cells, totaling 623 acres and requiring up to 1.5 million cubic yards of BUDM. A successful BUDM project will provide coastal resiliency, abate relative sea level rise, provide economic value in ecosystem services, and provide commercial value in maritime, fishing, and wildlife-related revenue.

Project Need

Emergent marsh at Texas Point National Wildlife Refuge (NWR) is experiencing a conversion from vegetated marsh to open water due to the effects of sea level rise, erosion, and subsidence. BUDM will provide the necessary material that will provide for the restoration of marsh areas at Texas Point NWR. In fact, Texas is losing coastal wetlands at a rate of more than 5,700 acres annually, and a major cause of this loss is insufficient sediment supply. A major barrier to implementing BUDM projects is a lack of coordination between dredging schedules, permitting, and other logistics, demonstrating a need for a coordinated planning effort.

POTENTIAL LOCAL BENEFITS

1	11	29
Wetland Type	Endangered Species	Migratory Bird Species

623	✓
Acres of Wetlands Protected/Created	Protected Habitat in the Area

26,480
Existing Wetland Carbon Sequestration (tons C)

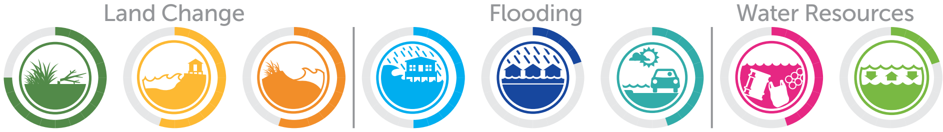
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Texas Point NWR Shoreline Protection Sabine Neches Waterway and Oyster Habitat Creation *(1359)*

Estimated Project Cost: $5,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

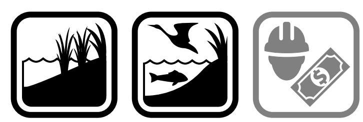


LOCATION:
Texas Point National Wildlife Refuge along the Texas-Louisiana border

STATUS:
Conceptual

STAKEHOLDERS:
- ***Jefferson County***
- Ducks Unlimited
- Texas General Land Office
- U.S. Fish and Wildlife Service

ACTIONS:



PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description

This project entails the construction of 1.5 miles of breakwater along the eroding shoreline of the Texas Point National Wildlife Refuge (NWR) along the Sabine Neches Waterway. In addition, this project calls for placement of rock materials behind the constructed breakwater and distribution of existing rock material at the existing rock weir site will create oyster habitat. This project will conduct an alternatives analysis to assess the feasibility and placement of a protective structure along the shoreline of the Sabine-Neches Waterway along a vulnerable portion where a bayou connects to the Waterway. Methods assessed will maximize performance for project longevity and ecosystem enhancement by assessing additional material emplacement and oyster break feasibility behind the offshore shoreline protection structures. Methods intend to enhance and grow the current shoreline and increase marsh habitat. The proposed project will protect 7,500 marsh habitat acres, reduce rates of land loss from erosion (including loss of public land managed for wildlife and recreation), and looks to restore important habitats through marsh mound placement and oyster break emplacement.

Project Need

This area is experiencing erosion, which reduces habitat for a host of migratory and resident avian species and terrestrial wildlife. In addition, erosion can degrade water quality, further degrading ecosystem health for aquatic species and potentially impacting fisheries.

POTENTIAL LOCAL BENEFITS

1	1	10
Wetland Type	Critical Facility	Endangered Species

29	✓
Migratory Bird Species	Protected Habitat in the Area

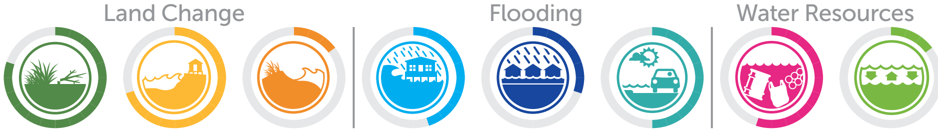
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

West Bay Living Shorelines at Sweetwater Preserve and Maggie's Cove *(9227)*

Estimated Project Cost: $6,100,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

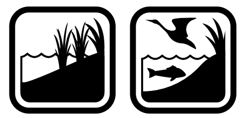


LOCATION:
Two sites in West Galveston Bay at Sweetwater Preserve and adjacent to Maggie's Cove

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Galveston Bay Foundation***
- U.S. Fish and Wildlife Service
- Texas General Land Office
- Texas Parks & Wildlife Department
- Bacon Family Trust

ACTIONS:



PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description
To expand upon more than 20 years of habitat restoration efforts in West Galveston Bay, the Galveston Bay Foundation (GBF) proposes to protect, enhance, and/or restore up to 145 acres of estuarine habitat. The proposed restoration activities are located at Sweetwater Preserve (Site 1) and adjacent to Maggie's Cove (Site 2) and will involve the construction of offshore wave barrier(s) to reduce erosion, stabilize the shoreline, and establish or enhance estuarine habitat. Pending the results of surveys and design plans, GBF and the project team will determine the best approach to establish a living shoreline or other stabilization structure at each location. A variety of natural and nature-based shoreline protection techniques will be considered to facilitate shoreline protection as well as habitat protection, enhancement, and/or creation.

Project Need
Historical subsidence has significantly impacted the shoreline of the Sweetwater Preserve, and wave energy along West Bay has resulted in severe erosion of fringing salt marsh habitat. Based on a review of aerial photography, the marsh in Maggie's Cove has retreated by up to 300 feet since 1954 as a result of subsidence and erosion. It is anticipated the project will allow for the establishment of up to 130 acres of estuarine habitat in Maggie's Cove and up to 15 acres of intertidal marsh along the Sweetwater Preserve shoreline. The project will provide protection for up to 8,000 linear feet (approximately 1.5 miles) of shoreline in West Galveston Bay.

POTENTIAL LOCAL BENEFITS

1 Wetland Type	**10** Migratory Bird Species
12 Endangered Species	**✓** Oyster Habitat Protected/Created

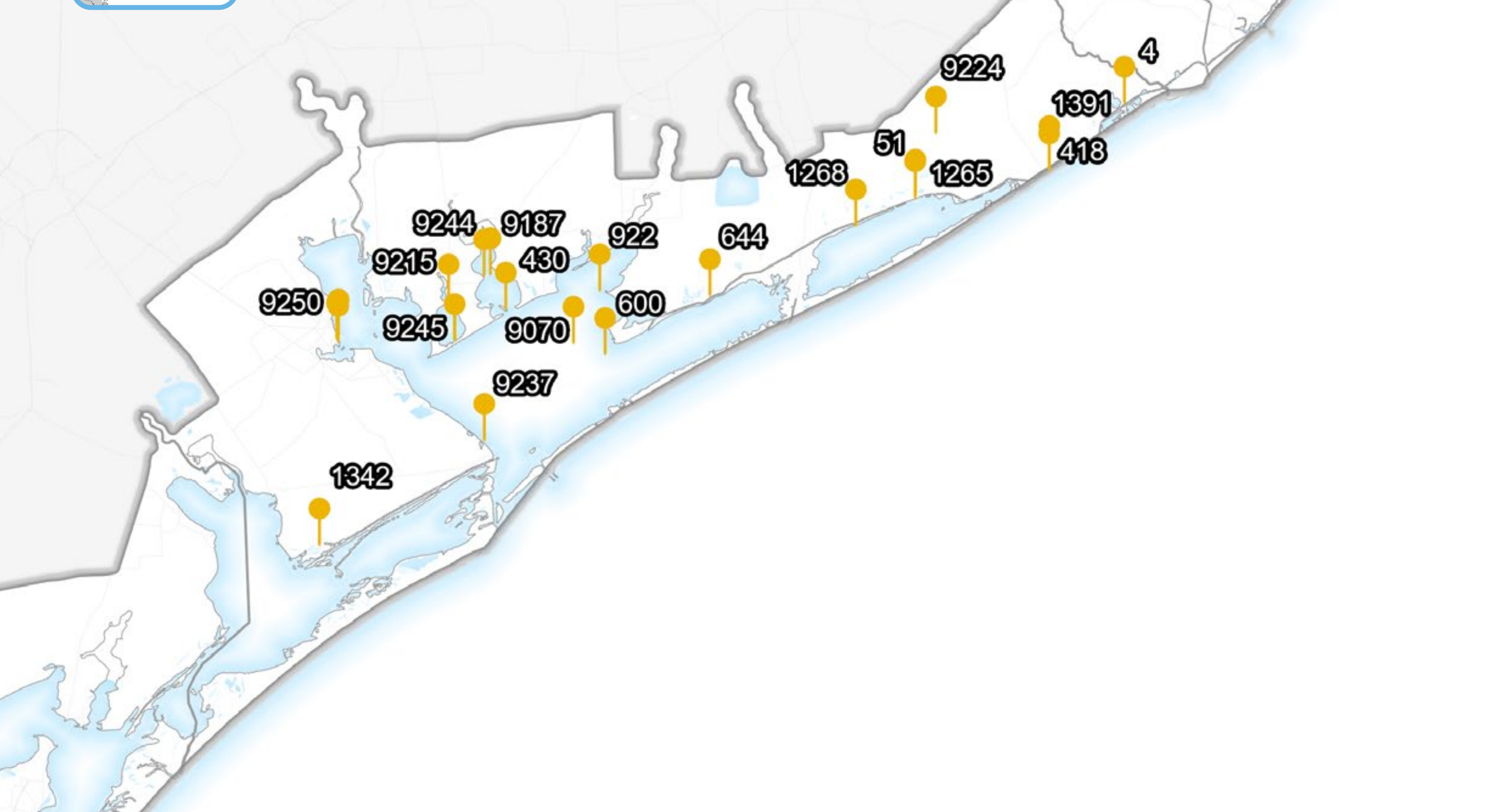
6,165
Wetland Carbon Sequestration (tons C)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

REGION 2

REGION 2 PROJECTS

19 Projects | $310 million total cost



No.	Project Name	Cost
1265	Big Boggy Marsh Protection Project	$6,000,000
1268	Bird Island Restoration and Creation of Gulf Cut Island Complex	$4,000,000
51	Boggy Cut GIWW Stabilization	$18,500,000
9237	Boggy Nature Park Shoreline Stabilization	$5,000,000
9187	Carancahua Bay Community Reefing Project	$125,000
430	Carancahua Bay Habitat Preservation and Enhancement	$9,000,000
600	Half Moon Oyster Reef Restoration - Phase 3	$2,800,000
9250	Harbor of Refuge Protection and Restoration	$6,700,000
1342	Hydrologic Restoration of Welder Flats	$4,300,000
9224	Lake Austin Coastal Prairie Conservation	$60,000,000
644	Mad Island Marsh Preserve Shoreline Protection and Coastal Ecosystem Restoration - Phase 1	$8,900,000
9070	Matagorda Bay Regional Inflow Study	$250,000
922	Oliver Point Shoreline Protection and Reef Restoration	$1,600,000
9244	Port Alto County Park Shoreline Protection and Restoration - Phase 2	$1,800,000
4	San Bernard NWR Shoreline Protection	$80,500,000
1391	San Bernard NWR Sargent Unit Beneficial Use	$11,000,000
9245	Sand Point Peninsula Living Shoreline	$5,800,000
418	Sargent Beach and Dune Restoration	$79,600,000
9215	Shoreline Protection and Restoration at Olivia Haterius County Park	$4,600,000

Big Boggy Marsh Protection Project *(1265)*

Estimated Project Cost: $6,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

LOCATION:

Big Boggy National Wildlife Refuge along the northern shoreline of East Matagorda Bay

STATUS:

Conceptual

STAKEHOLDERS:

- ***U.S. Fish and Wildlife Service***
- East Matagorda Bay Users
- Ducks Unlimited
- Texas General Land Office
- Matagorda Bay Foundation

ACTIONS:

PROJECT TYPE(S):

Shoreline Stabilization; Habitat Creation and Restoration

Project Description

This project proposes to restore features in the 1,800-acre Big Boggy National Wildlife Refuge tidal marsh that were historically present and improve conditions for fish and wildlife. The three main elements to this project include:

• **Shoreline Protection:** This 8,315-foot stretch of the GIWW was identified in the Ducks Unlimited Breakwater Prioritization Tool as a medium- to high-priority area for improvement, with a total estimated cost of $2.9 million.

• **Hydrology and Fish Passage:** The project would improve hydrologic connections and fish passage to lower Big Boggy Bayou, reopen Pelton Lake Bayou's historic connection to East Matagorda Bay, and increase culvert sizes on Chinquapin Road. The confluence of Chinquapin Bayou and Lake Austin would be restored to improve freshwater and sediment inflows.

• **Beneficial Use:** Sediment would be placed to raise substrate elevation to support approximately 200 acres of intertidal marsh through beneficial use of dredged material.

Project Need

Big Boggy Marsh represents about 25% of the tidal marsh on the north side of East Matagorda Bay. Mainland tidal marshes are extremely important because they receive freshwater flow, sediments, and nutrients from the surrounding watershed and maintain water quality, fisheries habitat, and wildlife habitat for the Bay. The elements of this project would enhance the productivity of the marsh and protect it from further degradation. The project is scalable.

POTENTIAL LOCAL BENEFITS

12	21	2
Endangered Species	Migratory Bird Species	Wetland Types

Medium	✓
Social Vulnerability	Protected Habitat in the Area

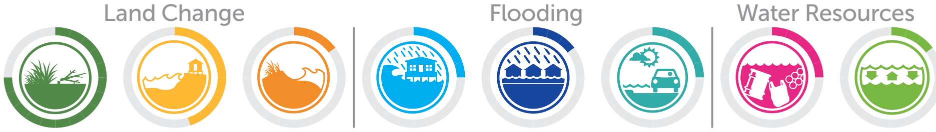
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Bird Island Restoration and Creation of Gulf Cut Island Complex *(1268)*

Estimated Project Cost: $4,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

This project will restore and add colonial waterbird habitat to East Matagorda Bay. Newly created islands will support a diversity of colonial nFesters and protect existing islands from continued and future erosion. The Gulf Cut Island complex is a series of four islands in East Matagorda Bay that are currently eroding due to wave and current-generated erosion. This project will build breakwaters, increase elevation, and expand habitat area at four existing islands to protect and restore this important habitat. Audubon Texas has received a Nationwide Permit for these activities. Funding for final engineering and design, construction, and monitoring is needed to complete the project.

Project Need

Due to erosion, subsidence, and human disturbance in Matagorda Bay, there has been a decrease in coastal breeding bird habitat in the region. The created and restored islands will support mid-coast beach nesting bird habitat and will be located far enough from existing rookeries at Dressing Point Island (7.5 miles) and Chester Island (33 miles) that a large-scale disturbance event on one island would be unlikely to impact breeding birds at all islands. These islands are important habitat for skimmers, terns, and oystercatchers. This project aims to provide coastal habitat that is critical for ecological stability in the Gulf of Mexico.

LOCATION:

East Matagorda Bay near the Gulf Cut Island complex

STATUS:

Engineering & Design

STAKEHOLDERS:

- ***Audubon Texas***
- Matagorda Bay Foundation
- U.S. Army Corps of Engineers
- Texas Parks & Wildlife Department
- Texas General Land Office
- Gulf Coast Bird Observatory
- Texas Waterbird Society
- U.S. Fish and Wildlife Service

ACTIONS:

PROJECT TYPE(S):

Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

12 Endangered Species

24 Migratory Bird Species

Medium Social Vulnerability

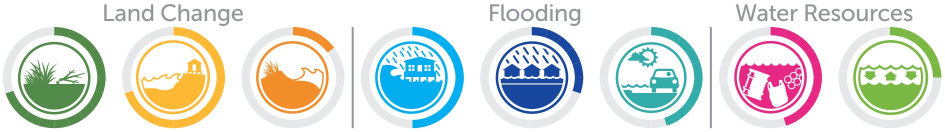
✓ Oyster Habitat Protected/ Created

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Boggy Cut GIWW Stabilization *(51)*

Estimated Project Cost: $18,500,000

ABILITY TO ADDRESS VULNERABILITIES



LOCATION:
Barrier between East Matagorda Bay and the Gulf Intracoastal Waterway

STATUS:
Conceptual

STAKEHOLDERS:
- ***TxDOT Maritime***
- U.S. Fish and Wildlife Service
- Matagorda Bay Foundation
- U.S. Army Corps of Engineers
- Texas General Land Office
- Matagorda County

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration; Land Acquisitions

Project Description

To mitigate erosion on the northern shoreline between East Matagorda Bay (EMB) and the Gulf Intracoastal Waterway (GIWW), this project proposes up to 20 miles of barrier island restoration or construction of breakwaters and wetland restoration where island restoration is not feasible. The immediate need is to construct a roughly 6-mile wave break at the sections where there is no existing separation between the two water bodies. The project can be designed to accommodate flow relationships with resources in the area and support ingress and egress pathways for fish. Additionally, it could also include an acquisition of private property adjacent to the GIWW, if willing sellers are established.

Project Need

The GIWW is experiencing erosion caused by wind, waves, and ship wakes, which exposes the GIWW to the larger fetch of EMB. This will negatively impact ship traffic, as well as the bay shoreline, which will likely continue to erode. Additionally, this lack of separation between EMB and the GIWW has resulted in trends identified for several factors: an increase in depositional rates within the GIWW, increased need for dredging those sediments, increased erosion rates on the northern shoreline of the GIWW on private and public lands, rougher conditions for barge operators, and loss of fish and wildlife habitat. Enhancing and restoring the shallow water rim of the GIWW with a living shoreline is a first step in immediately reversing the trends identified in those factors.

POTENTIAL LOCAL BENEFITS

✓ Decreased Wave Energy

1	16	12
Wetland Type	Migratory Bird Species	Endangered Species

Medium
Social Vulnerability

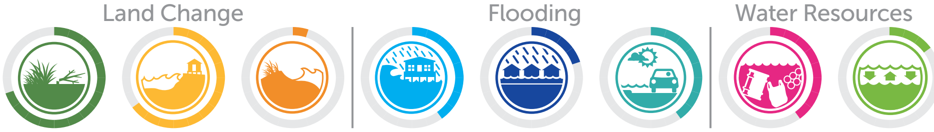
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Boggy Nature Park Shoreline Stabilization *(9237)*

Estimated Project Cost: $5,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Boggy Bayou Nature Park on Matagorda Bay

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***San Antonio Bay Partnership***
- Texas General Land Office
- Calhoun County

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration; Studies, Policies, and Programs

Project Description
The Boggy Nature Park Shoreline Stabilization project is to be completed in three phases. Phase 1 is scheduled to be completed in 2023 and includes topographic and bathymetric data collection, coastal engineering analysis, and alternatives development and analysis. Phase 2 is currently funded through the Texas General Land Office and includes preliminary design, further data collection, permitting, final design, and bid package development. Funds are being sought for Phase 3, which will include bid procurement, construction, construction oversight and potentially environmental monitoring. The Phase 1 study resulted in the development of feasible alternatives for shoreline protection, feasibility level construction cost estimates, and recommendation of a preferred alternative. Under Phase 1, a engineering analysis was performed to determine shoreline morphology, wave conditions, currents, tides, and sediment transport, and to draw conclusions on processes controlling shoreline morphology. This information will be used in the development and analysis of shoreline protection alternatives.

Project Need
Protection of approximately 3,500 feet of eroding shoreline which separates Matagorda Bay from Boggy Bayou is critical to maintaining the integrity of Boggy Bayou and the interior marsh habitat. Additionally, Boggy Nature Park is a popular area for kayakers, anglers, school groups, birders, and environmental organizations. Restoring and protecting the shoreline this community resource is important for the local community and for tourism.

POTENTIAL LOCAL BENEFITS

✓	7	1
Decreased Wave Energy	Migratory Bird Species	Wetland Type

Medium	11
Social Vulnerability	Endangered Species

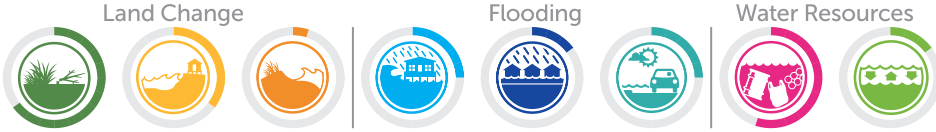
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Carancahua Bay Community Reefing Project *(9187)*

Estimated Project Cost: $125,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Carancahua Bay

STATUS:
Conceptual

STAKEHOLDERS:
- ***Matagorda Bay Foundation***
- Port Alto Association

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description

This project would fund the required studies to permit the siting and construction of a community-based oyster reef restoration project in Carancahua Bay. Once permitted, youth and adult volunteers and stakeholders would be allowed to place approved cultch, such as oyster shell and other materials, on the site during supervised community reefing weekends. Volunteers and interested stakeholders would donate cultch approved by appropriate resource agency staff and place the material using volunteer labor and privately owned boats. The project will create fisheries habitat, augment water filtration capacity of existing oyster populations, and restore some of the historic three-dimensional structure of the reefs. Equally important in this effort is the project partners' ability to facilitate, mobilize, and educate people in a process that allows them to invest in meaningful projects that protect and enhance natural resources of the state.

Project Need

Carancahua Bay has a long history as a destination for commercial oyster dredgers. Over the years, harvest pressure in this small bay increased considerably and resulted in extensive damage to historic reef. Property owners and anglers both expressed concern about the damage to reefs and the lost recreational fishing opportunities they once provided. Creating opportunities for communities to take an active role in oyster restoration will help build a sense of ownership in the creation and management of one of Texas's most important coastal resources.

POTENTIAL LOCAL BENEFITS

✓	✓	✓
Oyster Habitat Protected/ Created	Education & Outreach	Seagrass Protected

208,080

Nitrogen Removal by Oysters (lbs N, annually)

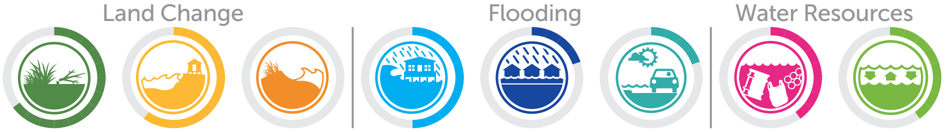
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Carancahua Bay Habitat Preservation and Enhancement *(430)*

Estimated Project Cost: $9,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

The peninsula separating Redfish Lake from West Matagorda Bay has breached and high-quality wetland and subtidal aquatic habitat is eroding quickly. The breach is also impacting managed shorelines and the Port Alto marina. The construction of approximately 3 miles of living shoreline would prevent further widening of the breach into Redfish Lake, encourage sedimentation, and help reduce erosion throughout Carancahua Bay. Phase 1 of the project is underway through 2024 with funding from a National Fish and Wildlife Foundation-Gulf Environmental Benefit Fund (NFWF-GEBF) grant. Data collection and hydrodynamic modeling of potential solutions were completed in 2022 and project partners are currently developing 30% design and permitting plans for the living shoreline. Access agreements are being negotiated with area landowners. NFWF-GEBF has committed funds for Phase 2 for final design and construction, though additional funds may be needed to complete construction and post-construction monitoring.

Project Need

The breach of the peninsula separating Redfish Lake and Matagorda Bay is eroding wetlands, seagrasses, oyster reefs and other marine habitats throughout Carancahua Bay. A living shoreline in this area would restore the health of wetlands, seagrasses, and marine habitats in Redfish Lake, Salt Lake, and throughout Carancahua Bay, supporting the local economy.

LOCATION:

Northern shoreline of West Matagorda Bay, southern shoreline of Carancahua Bay

STATUS:

Engineering & Design

STAKEHOLDERS:

- ***Matagorda Bay Foundation***
- Texas General Land Office
- Texas A&M AgriLife Research
- U.S. Fish and Wildlife Service
- National Fish and Wildlife Foundation
- Private Landowners

ACTIONS:

PROJECT TYPE(S):

Habitat Creation and Restoration; Shoreline Stabilization

POTENTIAL LOCAL BENEFITS

1	2	11
Wetland Type	Critical Facilities	Endangered Species

Medium
Social Vulnerability

21	✓
Migratory Bird Species	Oyster Habitat Protected/Created

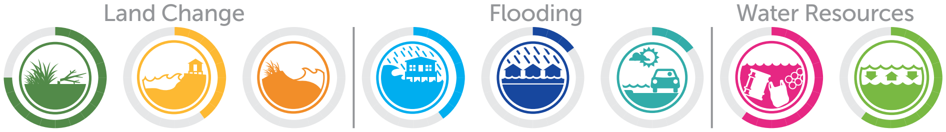
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Half Moon Oyster Reef Restoration - Phase 3 *(600)*

Estimated Project Cost: $2,800,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Oyster reef in the heart of Matagorda Bay

STATUS:
Shovel Ready

STAKEHOLDERS:
- ***The Nature Conservancy***
- Matagorda Bay Foundation

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description

Half Moon Oyster Reef is one of the largest and most successful oyster reef restoration projects of its kind, having had two successful prior phases of the restoration project, beginning in 2014. Under this current project, 30 acres of oyster reef habitat would be restored at Half Moon Oyster Reef in Matagorda Bay. The project is Phase 3 of the Half Moon Oyster Reef restoration project and is shovel ready (i.e., designed, permitted, and leased). The restoration of the reef would enhance the oyster and fisheries habitat and expand a popular recreational fishing area.

Project Need

Half Moon Oyster Reef has become a model for other oyster reef restoration projects in Texas bays. The Nature Conservancy's 2016 study of 54 previously restored acres at Half Moon Reef showed that the oyster reef restoration caused recreational fishing activity to surge. This resulted in an increase of $691,000 of the State's gross domestic product per year and over $1.2 million in annual economic activity. In addition, constructing Phase 1 of the reef contributed to a 1,014 percent increase in the overall biomass of that area within the bay, as well as a 551 percent increase in oyster size in just over 2 years.[1]

[1] Shepard, C., Dumesnil, M., and S. Carlton. n.d. *Half Moon Reef: Measuring the Recreational Fishing Benefits of a Restored Oyster Habitat.* Available at: https://www.nature.org/media/texas/hmr_final_distribution.pdf

POTENTIAL LOCAL BENEFITS

10	✓	6
Endangered Species	Oyster Habitat Protected/ Created	Migratory Bird Species

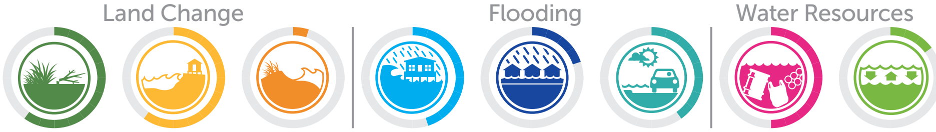
6,120
Nitrogen Removal by Oysters (lbs N, annually)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Harbor of Refuge Protection and Restoration *(9250)*

Estimated Project Cost: $6,700,000

ABILITY TO ADDRESS VULNERABILITIES



Project Description

This project will include three main elements.

1. The City of Port Lavaca Harbor of Refuge former municipal landfill area shoreline is eroding. The City needs assistance to develop a feasibility study and alternatives analysis to determine between alternatives such as a rock revetment or bulkhead nearly 1,800 feet in length to halt shoreline retreat in the harbor and reduce leakage of contaminated water into the bay.
2. To mitigate impacts from shoreline erosion along the main peninsula and minimize water conveyance issues, the City is proposing a living shoreline or rock revetment nearly 2,200 feet long, with potential marsh creation between the protection structure and natural shoreline. A feasibility study is needed for this conceptual approach.
3. The City is suggesting installation of one structure for marsh mitigation at the Harbor entrance (800 feet long) and a second to protect marsh habitat on the southern shoreline (1,900 feet long) for a total of 2,700 feet of shoreline protection. The project phase will also include at least 11 new acres of estuarine marsh as a beneficial use of dredged material site, potentially using material from dredging of the Matagorda Ship Channel or the Harbor itself.

Project Need

The erosion of the former landfill area at the Port Lavaca Harbor of Refuge is exposing trash and contaminants to Lavaca Bay, which is now a public hazard. This project should be considered an emergency need to halt active contamination from the landfill. In addition, the project would reduce sediment shoaling in the nearby Corporation Ditch, reducing upstream flood hazards in the City.

LOCATION:

Harbor of Refuge in Port Lavaca along the western shoreline of Lavaca Bay

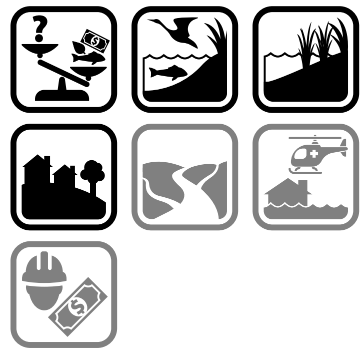
STATUS:

Conceptual

STAKEHOLDERS:

- ***City of Port Lavaca***

ACTIONS:



PROJECT TYPE(S):

Shoreline Stabilization; Flood Risk Reduction; Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

2	28	4
Wetland Types	Migratory Bird Species	Critical Facilities

$9,000 Structure Damage (1% Storm)

40	12
Existing Jobs	Endangered Species

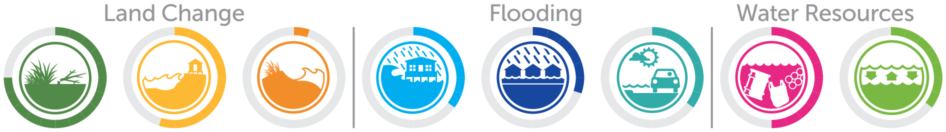
$2.36M Building Replacement Value

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Hydrologic Restoration of Welder Flats *(1342)*

Estimated Project Cost: $4,300,000

ABILITY TO ADDRESS VULNERABILITIES



Project Description

This project will plan, design, permit, and construct wetland restoration for Welder Flats. The Welder Flats landscape contains critical wetland habitat for the endangered whooping crane, but this habitat is threatened by extensive habitat conversion and loss. This project contains several subtasks that include: (1) mapping of surface upland sheet flow draining into the salt marsh; (2) modeling and design of freshwater control structures for creation of freshwater wetlands; (3) modeling of shoreline erosion abatement structures; (4) engineering and permitting of water control and erosion reduction structures; and (5) physical construction of permitted structures. Sheet flow restoration occurring via subtasks (4) and (5) of the proposed project can restore 3,000 acres of freshwater wetlands. By placing a culvert under the oil rig road to hydrologically connect the two halves of the marsh, an additional 1,200 acres of salt marshes can be restored. Placement of a living shoreline will protect 450 acres of wetland and submerged habitat.

Project Need

The landscape contains several thousand acres of coastal freshwater wetlands that have been drained through extensive manmade ditching. These ditches have reduced standing water and converted the wetlands into a drier coastal prairie and act as conduits for saltwater to enter the prairie. Freshwater inflow that flows from these ditches has been constrained by an oil rig road, which acts as a hydrologic barrier, splitting the lower salt marsh into east and west sections, creating highly variable salinities on the eastern half while starving the western half of freshwater inflow altogether.

LOCATION:

Welder Flats prairie and salt marsh at the confluence of San Antonio Bay and Espiritu Santo Bay

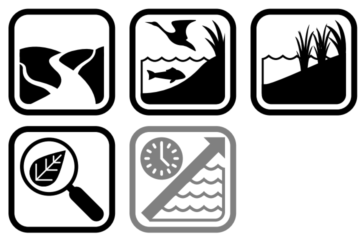
STATUS:

Study

STAKEHOLDERS:

- ***Texas A&M AgriLife Research***
- San Antonio Bay Partnership
- The Nature Conservancy
- U.S. Fish and Wildlife Service
- Cliburn Ranch
- Sea Dan Ranches Ltd.
- International Crane Foundation
- Texas Parks & Wildlife Department
- Coastal Bend Bays & Estuaries Program
- Natural Resources Conservation Service
- Texas Water Development Board

ACTIONS:



PROJECT TYPE(S):

Habitat Creation and Restoration; Studies, Policies, and Programs; Hydrologic Connectivity

POTENTIAL LOCAL BENEFITS

1	12	3
Critical Habitat	Endangered Species	Critical Facilities

Medium Social Vulnerability

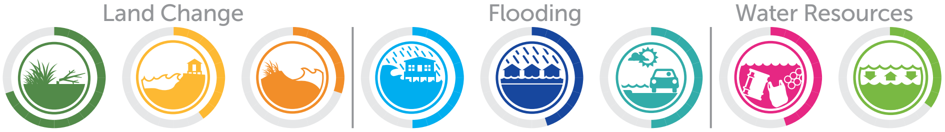
243,000
Existing Wetland Carbon Sequestration (tons C)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Lake Austin Coastal Prairie Conservation *(9224)*

Estimated Project Cost: $60,000,000

ABILITY TO ADDRESS VULNERABILITIES



LOCATION:
Coastal prairie uplands north of East Matagorda Bay

STATUS:
Acquisition Pending

STAKEHOLDERS:
- ***Coastal Prairie Conservancy***
- Land/Water Associates, LLC
- Texas Parks & Wildlife Department
- Texas Forest Service
- Natural Resources Conservation Service
- U.S. Fish and Wildlife Service

ACTIONS:

PROJECT TYPE(S):
Land Acquisition; Habitat Creation and Restoration

Project Description

Encompassing over 80,000 acres, the Lake Austin Coastal Prairie transitions gradually from grassland to salty prairie to coastal marsh. It is bounded on the east by Live Oak Bayou, which supports a freshwater wetland system, including bottomland hardwood forest, and extends to the west along the inland shore of Matagorda Bay. But the most notable and unique feature of the region is an expanse of native prairie said by experts to be the best and most extensive example of native prairie on the Texas Coast, and perhaps the entire Gulf. Much of the grassland has never been plowed and has been lightly grazed and managed with fire, so it is largely clear of brush. It is considered a candidate for re-introduction of northern Aplomado falcon and Atwater's prairie chicken. Closer to the coast, the grassland gives way to marshland that affords prime black rail habitat as well as being among the best currently unprotected areas on the coast to support future populations of the whooping crane. The prairie connects the Big Boggy National Wildlife Refuge (NWR) with the Jordan Unit of the San Bernard NWR and the Texas Parks & Wildlife Department's Matagorda Peninsula Coastal Management Area to the south.

Project Need

Key landowners are prepared to sell conservation easements. This is the best and most extensive example of native prairie on the Texas coast with countless potential ecological benefits that can be better protected through its acquisition. Notably, the property falls within a Conservation Partnership Area proposed by the U.S. Fish and Wildlife Service to be established for the Big Boggy NWR.

POTENTIAL LOCAL BENEFITS

2 Wetland Types	**8** Critical Facilities	**✓** Protected Habitat in the Area
Medium Social Vulnerability	**✓** Avoided Future Flood Risk	
12 Endangered Species	**24** Migratory Bird Species	

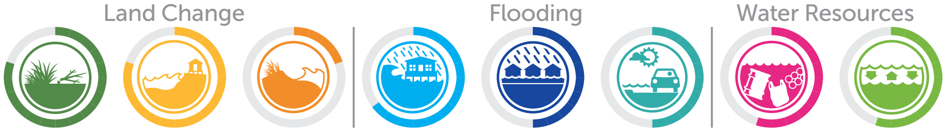
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Mad Island Marsh Preserve Shoreline Protection and Coastal Ecosystem Restoration - Phase 1 *(644)*

Estimated Project Cost: $8,900,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

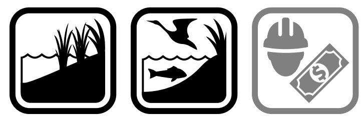


LOCATION:
Five miles west of Matagorda and south of Mad Island Lake

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***The Nature Conservancy***
- Texas General Land Office
- Texas Parks & Wildlife Department
- Texas Sea Grant

ACTIONS:



PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description
This project would protect over 6,000 acres of critically important coastal prairie and marsh ecosystem at the Mad Island Marsh Preserve. The goal of the project is to install a 2.3-mile nearshore breakwater to stem the persistent erosion and habitat loss at the Preserve along the mid-coast of Texas in Matagorda Bay. This project would help protect the shoreline of the Mad Island Marsh Preserve from erosion and habitat loss. Slowing the shoreline loss at the mouth of the Mad Island Lake Bayou is critical to maintaining a healthy salinity gradient of this estuarine system. The project is in the final design and permitting phase. Funding would be used for final engineering and construction.

Project Need
The Mad Island Marsh Preserve has been impacted by shoreline erosion at a rate of 5 to 10 ft/yr since the initial construction of the Gulf Intracoastal Waterway. The Mad Island Preserve includes approximately 7,100 acres of salt marshes, open water estuaries, freshwater and brackish lakes, wetlands, and coastal prairies along a high priority area of the Texas mid-coast. Mad Island Lake is an ecologically significant portion of the Mad Island system, providing crucial nursery habitat for marine life.

POTENTIAL LOCAL BENEFITS

Medium Social Vulnerability

12 Endangered Species

23 Migratory Bird Species

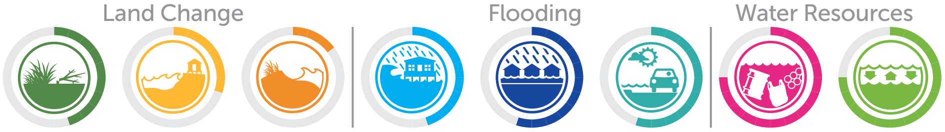
301,750 Existing Wetland Carbon Sequestration (tons C)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Matagorda Bay Regional Inflow Study *(9070)*

Estimated Project Cost: $250,000

ABILITY TO ADDRESS VULNERABILITIES



LOCATION:
Watersheds outfalling to Matagorda Bay

STATUS:
Study

STAKEHOLDERS:
- ***Matagorda Bay Foundation***
- Lower Colorado River Authority
- Texas Water Development Board
- University of Texas at Arlington
- U.S. Army Corps of Engineers
- Texas A&M AgriLife Research
- The Nature Conservancy
- Texas Water Trade

ACTIONS:

PROJECT TYPE(S):
Hydrologic Connectivity; Studies, Policies, and Programs

Project Description
Under this project, a regional hydrology study would be conducted to describe current conditions and evaluate the feasibility and collateral impacts of proposed management solutions to address freshwater inflow concerns. Adaptive management work plans resulting from Senate Bill 3 (80th Texas Legislature, 2007) Environmental Flows Process identified the need for enhanced freshwater inflows to meet environmental flow recommendations for Matagorda Bay. The outcome of the proposed study would help meet this need by improving rainfall-runoff modeling for coastal watersheds and informing future adaptive management techniques to supplement and direct freshwater flows within the coastal watersheds draining into Matagorda Bay.

Project Need
Primary concerns are the artificially prolonged and elevated salinity regimes and depletion of nutrients that occur during drought management plan implementation along the lower Colorado River watershed. Areas of concern include Peyton Creek, Lake Austin, Boggy Bayou, The Nature Conservancy's Mad Island Marsh Preserve, the Mad Island Wildlife Management Area, eastern Matagorda Bay, and Caney Creek Watershed. The Matagorda Bay System is experiencing losses of freshwater inflows from the Colorado River and Lavaca River, as well as numerous other small water bodies. This lack of freshwater inflows to Matagorda Bay and its minor bays is a systemic problem that has the potential to undermine the restoration of the rest of the area's coastal habitats, including fisheries and wetlands.

POTENTIAL LOCAL BENEFITS

✓ Education & Outreach	✓ Addressing Data Gaps

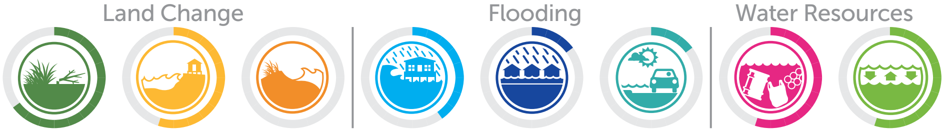
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Oliver Point Shoreline Protection and Reef Restoration *(922)*

Estimated Project Cost: $1,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

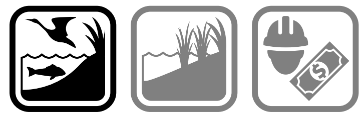


LOCATION:
Oyster reef in Matagorda Bay at or near Oliver Point

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Matagorda Bay Foundation***
- U.S. Fish and Wildlife Service
- Texas General Land Office

ACTIONS:



PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description

The Oliver Point and Oliver Reef project sites are located approximately 3 miles south-southwest of Palacios at the confluence of Tres Palacios and Matagorda bays. Prior to the passage of Hurricane Claudette in 2003, the area was characterized by the uniquely proximal locations of several important coastal habitats: oyster reef, tidal wetlands, and Coon Bay Island, which provided protection and enhancement for the point. The project would restore approximately 10 acres of the legacy point and reef in Matagorda Bay. Restoring the reef would afford wave protection to Oliver Point and Coon Island and reduce the overall erosion rate on the point and the island. Improved water quality, increased recreational fishing opportunities, enhanced marine biodiversity and other ecosystem benefits would occur with this completed project. Matagorda Bay Foundation and the Texas General Land Office are currently overseeing the development of a restoration plan for Oliver Point and Oliver Reef. The project is currently in the alternatives analysis, preliminary engineering, and permitting phases; funding was awarded by the Matagorda Bay Mitigation Trust for this project to support engineering, design, and construction.

Project Need

The Oliver Point oyster reef has lost valuable oyster habitat due to pressures such as coastal storm impacts. Due to the loss of the oyster reef structure and its protection from wave action, Oliver Point and Coon Island are experiencing rapid erosion.

POTENTIAL LOCAL BENEFITS

5	✓	11
Migratory Bird Species	Oyster Habitat Protected/ Created	Endangered Species

Medium Social Vulnerability

2,040
Nitrogen Removal by Oysters (lbs N, annually)

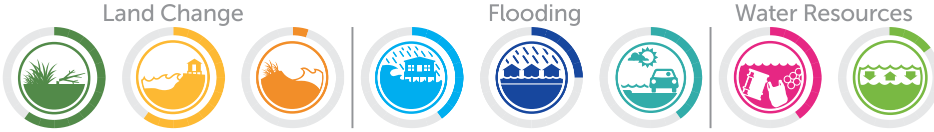
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Port Alto County Park Shoreline Protection and Restoration - Phase 2 *(9244)*

Estimated Project Cost: $1,800,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Carancahua Bay

STATUS:
Ongoing

STAKEHOLDERS:
- *Calhoun County*

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration; Hydrologic Connectivity

Project Description
This project would protect public infrastructure at Port Alto County Park on Carancahua Bay through a shoreline protection and restoration project that was not completed due to insufficient funding. The project consists of 1,750 linear feet of shoreline stabilization, as well as restoration of approximately 10 acres of coastal marsh and public park shorelines. The project may incorporate living shorelines and beneficial use of dredged material. This project would improve shoreline protection conditions, bring more sediment to the shorelines, and improve the hydrology of the marshes. It would also protect critical bay habitat, enhance community amenities, and extend public access for recreation.

Project Need
The project was constructed in 2013 with U.S. Fish and Wildlife Service Coastal Impact Assistance Program funds. However, due to high construction prices at the time, the project had to be reduced extensively in scope. Since the constructed breakwater ended shorter than the original design, the north side of the shorelines are suffering severe shoreline erosion, which is exposing the marshes to bay energies to the extent that the marshes are nearly breached to the bay. This phase of the project will update the original design and construct the necessary components to enhance the protection to the shoreline and to restore the marsh area.

POTENTIAL LOCAL BENEFITS

1 Wetland Type	11 Endangered Species	✓ Decreased Wave Energy

Medium Social Vulnerability

425 Existing Wetland Carbon Sequestration (tons C)

✓ Public Access Improvements	21 Migratory Bird Species

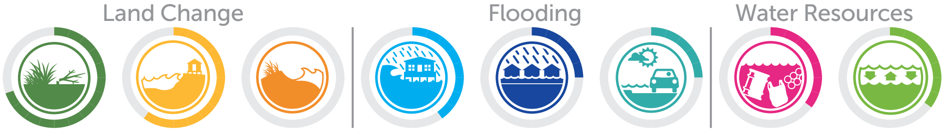
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

San Bernard NWR Shoreline Protection *(4)*

Estimated Project Cost: $80,500,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Shoreline along the Gulf Intracoastal Waterway in the San Bernard National Wildlife Refuge

STATUS:
Shovel Ready

STAKEHOLDERS:
- ***Ducks Unlimited***
- U.S. Fish and Wildlife Service
- U.S. Army Corps of Engineers
- Texas General Land Office
- Brazoria County
- Private Landowners

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description

This project would construct breakwaters as a living shoreline along 20 miles of the Gulf Intracoastal Waterway (GIWW) and restore wetlands adjacent to the GIWW. Of the 20 miles identified in this project, the U.S. Army Corps of Engineers has permitted 3 miles of breakwater along the north shoreline of the GIWW, located on U.S. Fish and Wildlife Service and privately-owned lands. Approximately 1 mile of this breakwater has been constructed. The project is shovel ready on the Sargent Unit of the refuge (1.3 miles) and is in the design and permitting phases for segments along Cedar Lake (2.8 miles). The permit and match funding for the Sargent Unit breakwaters have been secured, and that construction will be completed first. Due to potential real estate and permitting limitations, only portions of the Cedar Lakes shoreline are anticipated to be protected, and priority areas must be selected from the proposed 2.8 miles. The proposed design and construction methodology would be evaluated closely to avoid adverse impacts on water circulation patterns and oyster habitat within the lakes.

Project Need

Bay shorelines and dredged material placement areas created during the construction of the GIWW are eroding. This is creating frequent shoaling in the channel and increasing erosion of adjacent, inland wetlands. The erosion of these shorelines impacts not only the navigability of the GIWW, but also reduces and impairs habitat for important and diverse aquatic and avian species.

POTENTIAL LOCAL BENEFITS

2	13	✓
Wetland Types	Endangered Species	Decreased Wave Energy

4	27
Critical Facilities	Migratory Bird Species

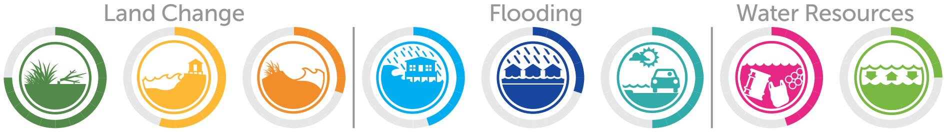
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

San Bernard NWR Sargent Unit Beneficial Use *(1391)*

Estimated Project Cost: $11,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Adjacent to the bay shoreline of Sargent Beach

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- Ducks Unlimited
- U.S. Army Corps of Engineers
- National Oceanic and Atmospheric Administration
- Natural Resource Damage Assessment Trustees
- Texas Department of Transportation

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description
This project is a high priority candidate for the Ducks Unlimited Beneficial Use Master Plan. This project will use beneficial use of dredged material (BUDM) to fill in abandon oil field canals according to marsh grade adjacent to the bay shoreline of Sargent Beach. The project area is located 2 miles away from the source of borrow material. To date, Ducks Unlimited has completed 60% project design and has developed a permit application package. This project will provide for completion of the engineering plans, permitting, and construction. The proposed project site consists of one BUDM cell totaling 201 acres and will utilize up to 112,000 cubic yards of BUDM.

Project Need
The site is located in the San Bernard National Wildlife Refuge in Matagorda County along the Gulf Intracoastal Waterway and will regenerate previously healthy marsh on the north side of the channel. The area has converted from under 3% open water in 1953 to nearly 60% open water in 2018. Placement of BUDM will restore the marsh elevation and provide for the re-establishment of the emergent marsh vegetation. BUDM has the potential to restore thousands of acres of currently degrading coastal habitat annually, thus nearly offsetting documented wetland losses, while also providing coastal resiliency and abating relative sea level rise.

POTENTIAL LOCAL BENEFITS

2	12	17
Wetland Types	Endangered Species	Migratory Bird Species

Medium	✓
Social Vulnerability	Protected Habitat in the Area

725
Existing Wetland Carbon Sequestration (tons C)

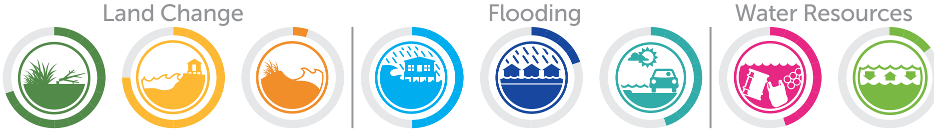
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Sand Point Peninsula Living Shoreline *(9245)*

Estimated Project Cost: $5,800,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Northern shoreline of West Matagorda Bay, southeastern shoreline of Keller Bay

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Texas A&M AgriLife Research***
- Matagorda Bay Foundation
- Matagorda Bay Mitigation Trust
- Private Landowners
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- International Crane Foundation
- Calhoun County

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Studies, Policies, and Programs; Habitat Creation and Restoration

Project Description

This project includes implementation and construction costs to support ongoing work protecting the unique estuarine resources of Keller Bay. Early considerations identified during modeling and alternatives analysis include constructing a specific type of living shoreline known as a Sand Engine, a nature-based design for high-energy coastlines that takes advantage of natural wave action, littoral processes, and sedimentary resources to promote long-term resilience of the landform. West Matagorda Bay is the ideal geomorphic environment to expand this concept to a Texas bay because it has a large fetch with relatively large waves, a shoreline composed of relatively coarse material, and the Sand Point Peninsula acts as a barrier spit that depends on overwash processes for its maintenance. This project can take advantage of the sedimentary resources that are becoming available in West Matagorda Bay, including those along the Matagorda Ship Channel and other ongoing maintenance dredging projects. The project will synergize with ongoing work by other entities at Redfish Lake and Schicke Point, two other living shoreline projects immediately upstream in the littoral drift near Carancahua Bay.

Project Need

The Sand Point Peninsula is at a tipping point; soon, it will fully breach, and Keller Bay will cease to exist as a unit distinct from West Matagorda Bay. Based on historic erosion rates of peninsula (approximately 2 to 3 ft/yr), the shoreline can be considered a critically eroding area. Keller Bay is ecologically unique in terms of water clarity and low wind fetch. Its shoreline includes up to 1,200 acres of wetlands, 250 acres of seagrass, and large oyster mounds and is known for speckled sea trout.

POTENTIAL LOCAL BENEFITS

1	12	25
Wetland Type	Endangered Species	Migratory Bird Species

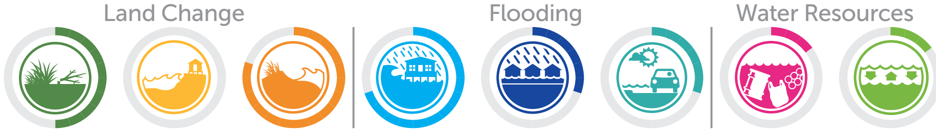
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Sargent Beach and Dune Restoration *(418)*

Estimated Project Cost: $79,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

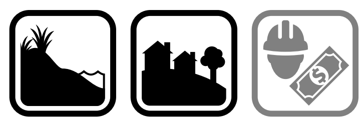


LOCATION:
Gulf shoreline south of Sargent and east of East Matagorda Bay

STATUS:
Shovel Ready

STAKEHOLDERS:
- ***Matagorda County***
- Texas General Land Office
- Port of Bay City
- U.S. Army Corps of Engineers

ACTIONS:



PROJECT TYPE(S):
Beach Nourishment;
Dune Nourishment

Project Description

The project would nourish and restore approximately 2 miles of shoreline at Sargent Beach that would include constructing five segmented offshore breakwaters at a 4-foot water depth and one angled terminal groin extending to an 8-foot water depth to retain sand on the Gulf beach shoreline on Matagorda Peninsula. Beach sediment placed between the groins would include 8,000 linear feet of nourishment north of Mitchell's Cut inlet and 3,250 linear feet south of Mitchell's Cut. The nourishment would primarily rely on sand sources that have developed nearshore, with the possibility of additional sand mined from upland dredged material placements areas and the outfall of the Colorado River. Sand would not be placed on existing beach vegetation, dunes, or dune vegetation. The project is shovel ready and will be constructed in two phases, leveraging State Gulf of Mexico Energy Security Act funds. The Phase 1 project will consist of constructing the offshore breakwaters and terminal groin; Phase 2 will include the beach nourishment. Construction will begin in 2023, and future phases of this project will nourish sections of the Sargent Beach shoreline as funding becomes available.

Project Need

The Sargent Beach shoreline is severely eroding. The recommended restoration has been identified based on an analysis of locations of critical need and modeling to indicate the project configuration with the greatest likelihood of success while accounting for sediment and funding limitations. This project would help protect the shoreline of Sargent Beach from erosion and habitat loss, and the construction of breakwaters and a terminal groin would retain sediment on the beach to slow the natural processes of offshore transport.

POTENTIAL LOCAL BENEFITS

30	4
Homes	Critical Facilities

$7.98M
Structure Damage (1% Storm)

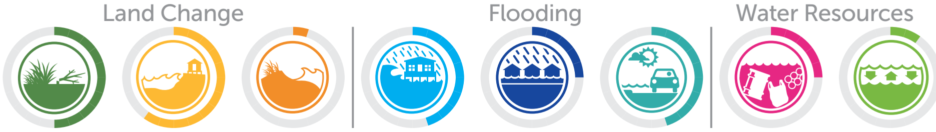
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Shoreline Protection and Restoration at Olivia Haterius County Park *(9215)*

Estimated Project Cost: $4,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
County Park located on the northern shoreline of Keller Bay

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Calhoun County***

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration; Public Access Improvements

POTENTIAL LOCAL BENEFITS

✓	11	19
Decreased Wave Energy	Endangered Species	Migratory Bird Species

Medium
Social Vulnerability

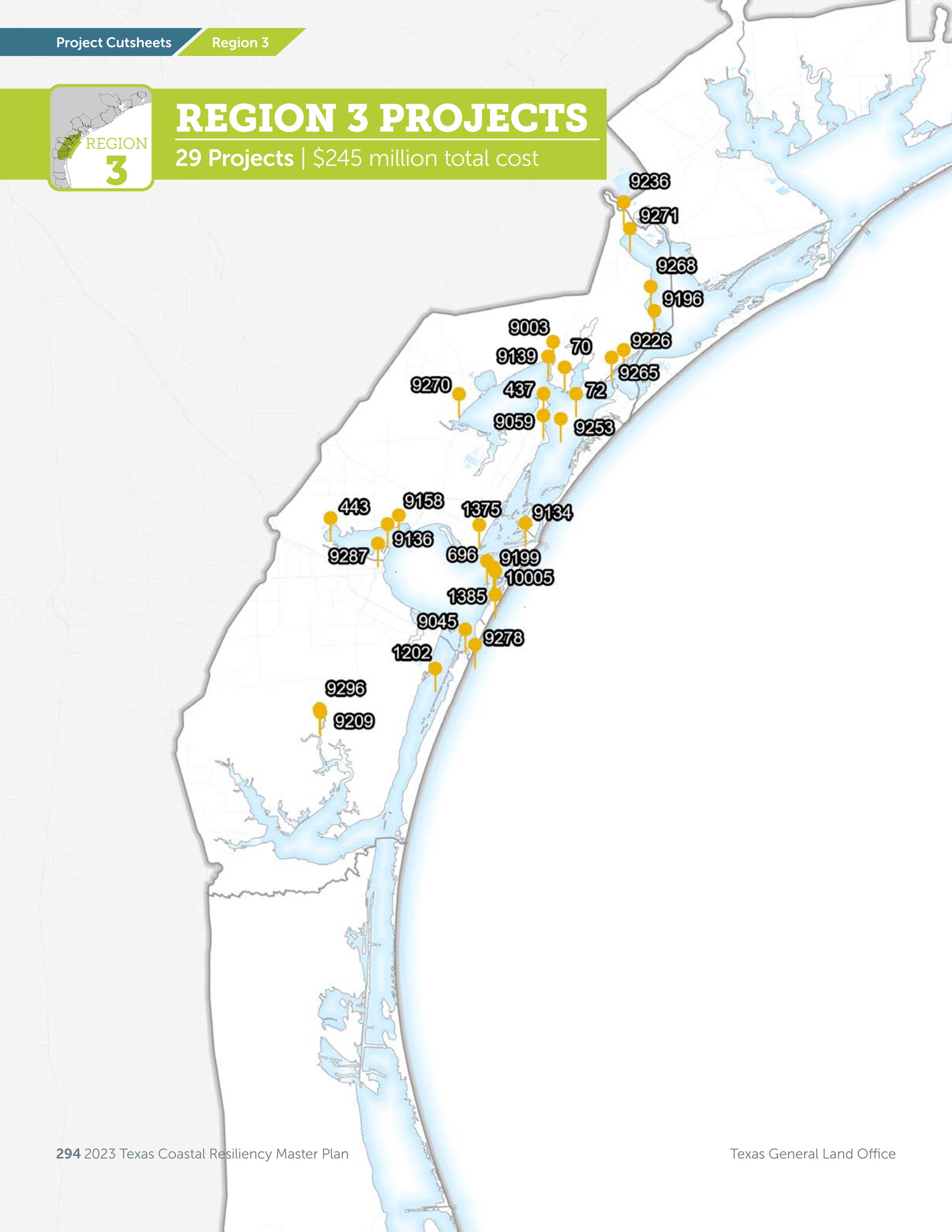
**For more information on cost estimates and project benefits calculations,* see page 132 of *the 2023 Texas Coastal Resiliency Master Plan.*

Project Description
This project would provide shoreline protection and restoration along approximately 1,350 feet of park shoreline at Olivia Haterius County Park. County Gulf of Mexico Energy Security Act funds are currently being used to produce a feasibility study and alternative analysis for the improvements. The park has a boat ramp that allows public access to Keller Bay and a 550-foot bulkhead along part of the bay shoreline. The proposed project would replace the existing bulkhead, incorporating an adjacent living shoreline, construct a breakwater to protect the boat ramp area, and improve the existing revetment along the western end of the park that protects the road along the shoreline. Another facet of the project will restore marsh areas behind the revetment.

Project Need
The project area is currently experiencing erosion along the park shoreline caused by wave energy from the open bay. The boat access channel is experiencing some shoaling. The project would protect the park road and public infrastructure, incorporate living shorelines, protect public access to Keller and Matagorda bays, attenuate wave action generated by southeasterly winds, reduce shoaling in the boat access channel, and beneficially use sediment from the channel to enhance at least 4 acres of coastal marshes.

REGION 3 PROJECTS

29 Projects | $245 million total cost



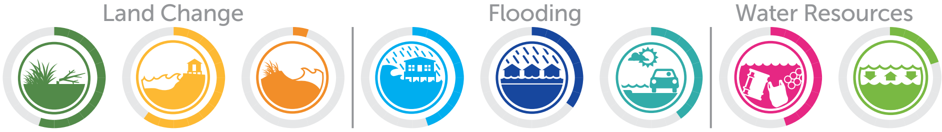
No.	Project Name	Cost
9271	Austwell Water Quality and Erosion Mitigation	$1,600,000
9270	Bayside Public Access and Habitat Creation	$6,800,000
9199	Bayside Wetland Resilience Study on Mustang Island	$1,000,000
9136	Corpus Christi Bay Wastewater, Stormwater Quality, and Pollution Management Improvements	$1,000,000
1375	Dagger Island Buckeye Beneficial Use	$5,500,000
9268	Dagger Point Stabilization	$30,000,000
9209	Farming Out Pollutants in Petronila Creek	$20,000,000
1385	Feeder Berm North of Fish Pass Beneficial Use	$3,700,000
437	Fulton Beach Road Protection	$9,600,000
9253	Going to Scale: Expanding Oyster Restoration in Aransas Bay	$14,000,000
70	Goose Island State Park Habitat Restoration and Protection	$2,600,000
9158	Indian Point Marsh Area Living Shoreline	$3,400,000
9059	Little Bay Restoration Initiative	$14,000,000
9265	Living Shorelines and Wetland Enhancements at the Aransas NWR	$6,000,000
72	Long Reef and Deadman Island Shoreline Stabilization and Habitat Protection	$5,300,000
9139	Newcomb Point Shoreline Stabilization	$4,500,000
9278	Nueces County Gulf Beach Renourishment and Protection - Phase 1	$850,000
443	Nueces County Hydrologic Restoration Study	$240,000
9226	Oyster Reef Restoration in Mesquite-Carlos-Ayres Complex	$10,000,000
9045	Packery Channel Nature Park Habitat Restoration - Phase 3	$3,000,000
9296	Petronila Creek and Oso Creek Watershed Improvements	$25,600,000
9134	Port Aransas Nature Preserve Stabilization and Restoration - Phase 2	$5,280,000
9196	Protection of the GIWW Shoreline at the Aransas NWR	$22,300,000
9236	Restoration of Freshwater Inflow to Townsend Bayou	$180,000
9287	Rincon Reef Breakwater	$31,000,000
696	Shamrock Island Restoration - Phase 2	$5,900,000
9003	Shell Point Ranch Wetlands Protection	$5,000,000
10005	Shoreline and Wetland Protection on Mustang Island – Phase 1: Cohn Preserve	$10,100,000
1202	Tern Island and Triangle Tree Island Rookery Habitat Protection	$5,900,000

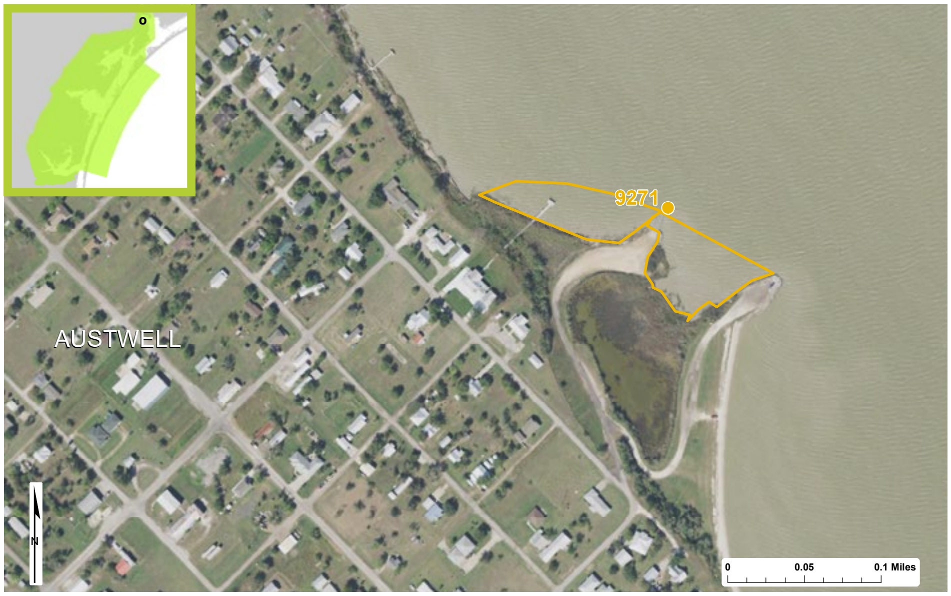
Austwell Water Quality and Erosion Mitigation *(9271)*

Estimated Project Cost: $1,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Hynes Bay in Austwell

STATUS:
Conceptual

STAKEHOLDERS:
- ***Refugio County***
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration; Community Infrastructure

Project Description

This project is a multi-faceted approach to enhance water quality, improve drainage, and mitigate erosion issues in Austwell that proposes to replace failing culvert systems and install two drop boxes where runoff is routed through a vertical concrete tube and into a horizontal pipe before being discharged into Hynes Bay. Construction of a 600-linear-foot living limestone breakwater just offshore from the current boat ramp will attenuate wave action and prevent further silting-in of the boat ramp, allowing natural colonization by a variety of aquatic organisms. In turn, the living breakwater will help stabilize the shoreline, create aquatic and wetland habitat, and create a dredged material placement area to continue to restore marshland over time. Additionally, 1,060 feet of oyster reef balls will be installed with marsh and seagrasses planted landward to restore multiple habitat types. Over time, the reef balls will not only increase biodiversity within the bay but also become popular and prosperous recreational fishing sites.

Project Need

The primary need for the project is to reduce erosion that has been occurring along this shoreline on Hynes Bay. Erosion will be mitigated by reengineering the stormwater drainage infrastructure and enhancing sediment control with the living shoreline features will help create habitat along with the oyster reef balls and seagrass bed establishment.

POTENTIAL LOCAL BENEFITS

✓ Oyster Habitat Protected/Created	**$11.2M** Building Replacement Value

✓ Decreased Wave Energy	**6** Migratory Bird Species	**1** Wetland Type

Medium High
Social Vulnerability

12 Endangered Species	**10** Homes

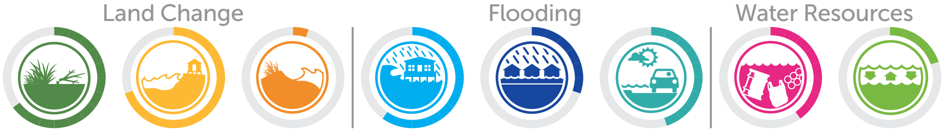
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Bayside Public Access and Habitat Creation *(9270)*

Estimated Project Cost: $6,800,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Bayside City Park on the southwestern corner of Copano Bay

STATUS:
Conceptual

STAKEHOLDERS:
- ***Refugio County***
- City of Bayside
- Coastal Bend Bays & Estuaries Program

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration; Public Access Improvements

Project Description

This project proposes shoreline stabilization, habitat creation, and increased public access opportunities in the area through construction of a 600-linear-foot limestone breakwater living shoreline feature and a 960-linear-foot bulkhead. The project also proposes retrofitting the old Copano Bay roadway pilings to construct a 3,300-linear-foot hike and bike trail and 390 linear feet of oyster reef balls. The breakwater will be constructed offshore from the existing boat ramp in this area and will help to prevent silting-in of the area. Together the breakwater and bulkhead will allow for wave attenuation and dredged material disposal areas that, along with marsh plantings, will aid in the restoration of wetlands. Further, this project would aim to acquire 5 acres of additional park land for parking to accommodate the anticipated increased use by the public of this park. The hike and bike trail will include nature viewing opportunities for birding and the oyster reef balls will create habitat in the estuarine environment for oyster reef establishment.

Project Need

This area is experiencing increased rates of erosion, which led to the closure of Copano Bay Drive over 30 years ago. With this project, Refugio County will be taking precautions for future erosion issues and increasing public access opportunities for the enjoyment of Copano Bay.

POTENTIAL LOCAL BENEFITS

✓	1	✓
Oyster Habitat Protected/ Created	Wetland Type	Seagrass Protected

Medium High
Social Vulnerability

18	✓	12
Migratory Bird Species	Public Access Improvements	Endangered Species

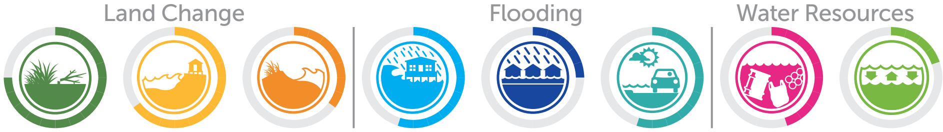
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Bayside Wetland Resilience Study on Mustang Island *(9199)*

Estimated Project Cost: $1,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Bayside of Mustang Island

STATUS:
Conceptual

STAKEHOLDERS:
- ***Coastal Bend Bays & Estuaries Program***
- Texas A&M University-Corpus Christi Conrad Blucher Institute
- Texas General Land Office
- Texas Parks & Wildlife Department
- The Nature Conservancy
- U.S. Fish and Wildlife Service
- Nueces County
- City of Port Aransas
- U.S. Army Corps of Engineers

ACTIONS:

PROJECT TYPE(S):
Studies, Policies, and Programs

Project Description
This project will preserve existing and enhance degraded wetlands on Mustang Island while making the island more resilient in the long-term by addressing chronic geomorphological concerns. A study is needed to determine the geological, geomorphic, and anthropogenic features or processes that could be preventing adequate sediment accretion and shoreline stabilization—such as soil formations, subsidence, lack of sufficient overwash to replenish soils, tidal impacts, or manmade structures impeding sediment transport. The results of such a study would inform the long-term management of the island and could include recommended solutions like sediment source, budgeting, and beneficial use of dredged material to support shoreline stabilization and wetland restoration and creation. The project would involve reviewing existing literature and relevant studies, performing an engineering assessment of present and anticipated future conditions of the island, and proposing recommended solutions.

Project Need
Mustang Island has experienced significant degradation of its coastal wetlands. This is thought to be due to underlying issues related to the geologic formation of the island, as well as coastal storm impacts and relative sea level rise. It is unlikely that a purely structural solution is sustainable long-term to address the problems across the island. Improving the long-term resilience of Mustang Island through the preservation and restoration of coastal wetlands can only be achieved by addressing the chronic geomorphological concerns.

POTENTIAL LOCAL BENEFITS

✓ Addressing Data Gaps	✓ Support Funding Eligibility

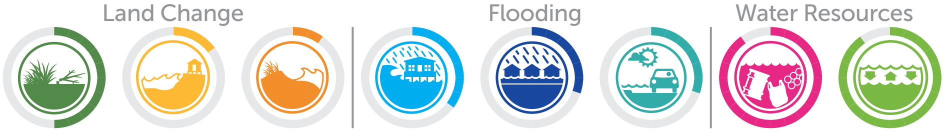
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

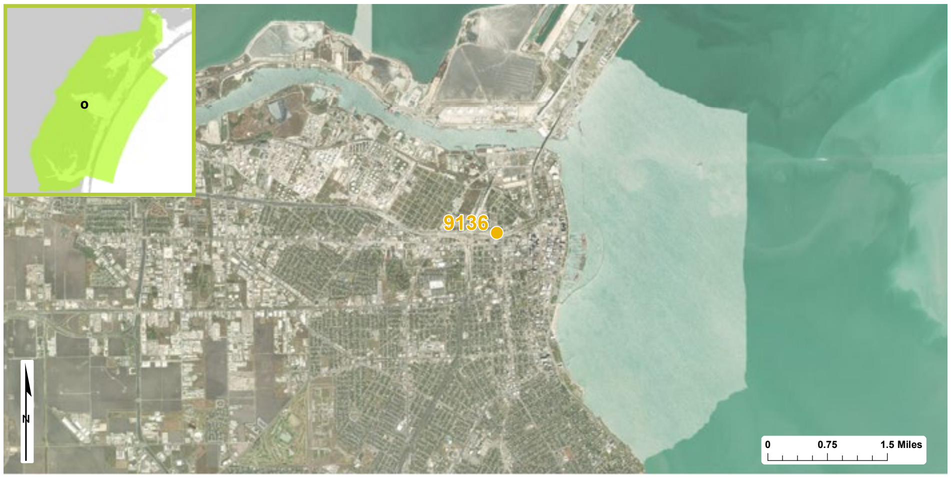
Corpus Christi Bay Wastewater, Stormwater Quality, and Pollution Management Improvements *(9136)*

Estimated Project Cost: $1,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
City of Corpus Christi Metro Area

STATUS:
Shovel Ready

STAKEHOLDERS:
- ***City of Corpus Christi***

ACTIONS:

PROJECT TYPE(S):
Structure/Debris Removal; Studies, Policies, and Programs; Community Infrastructure

Project Description

This project involves the ongoing implementation of community education programs, trash capture devices, street cleaning, and development planning in the communities around Corpus Christi Bay. These types of improvements require funding to prevent future water quality issues in the bay. In addition, there are also opportunities to increase the capacity at the wastewater treatment plant in the City of Corpus Christi as part of this project. Necessary improvements have been identified and implementation has progressed. Currently, the City sponsors regular community trash cleanups at Ropes Park and disseminates stormwater educational materials to residents at other various events. Additionally, the City has installed 90 small trash capture devices along street drainage areas, with plans to construct larger trash capture devices at 40 total outfalls from the downtown area extending along the bayfront through Cole Park. To date, eight of the 40 larger trash capture device sites are funded for design and construction from the City's bond-funded improvements budget at a cost of $2 million. The City also plans to purchase seven new street sweepers to increase the fleet to 13 sweepers at a cost of $400,000 per sweeper. This project would improve the water quality and fish and wildlife health of Corpus Christi Bay by implementing various techniques with the goal of reducing the inflow of polluted stormwater runoff, trash, and debris.

Project Need

Corpus Christi Bay suffers from polluted stormwater runoff. Trash, debris, and pollutants carried by stormwater runoff are negatively impacting the water quality of the bay, human use of the bay, and fish and wildlife populations.

POTENTIAL LOCAL BENEFITS

54,500 Trips on Evacuation Route (Daily)

✓	5	580
Education & Outreach	Critical Facilities	Homes

$325M	4,589
Building Replacement Value	Existing Jobs

Medium High
Social Vulnerability

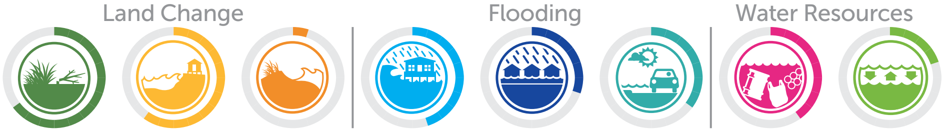
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Dagger Island Buckeye Beneficial Use *(1375)*

Estimated Project Cost: $5,500,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

As part of a Texas General Land Office (GLO) grant to Ducks Unlimited and the Port of Corpus Christi Authority (PCCA), stakeholder input was coordinated to identify potential beneficial use of dredged material (BUDM) sites. Based on stakeholder input, GLO feedback, publicly available data, and professional judgment, the project partners selected the Dagger Island Buckeye site. A 60% design has been completed with support from PCCA. PCCA has also completed a seagrass survey and an oyster survey. Due to the presence of seagrass, the project design will need to eliminate, minimize, and/or mitigate potential impacts, and the site would need shoreline protection to be successful. Though the adjacent land for this project is privately owned, the owners are interested in restoring the site. Constructing breakwaters will provide an area for BUDM placement, forming a living shoreline that will provide protection to approximately 700 acres of seagrass in Redfish Bay. This site would complement a permitted and shovel ready site just to the north. In tandem, the two sites can accommodate nearly 600,000 cubic yards of BUDM.

Project Need

The site was selected due to the erosion of the shoreline from hurricanes, storm surge, and wave energy caused by winds and large vessel traffic on the Corpus Christi Ship Channel. Dredged material from the channel must be deposited in dredged material placement areas (DMPAs), and many of the available DMPAs along the Texas coast are nearing capacity. As an alternative, PCCA, resource agencies, and stakeholders have long advocated BUDM to restore wetlands and bird islands, nourish beaches, and counteract land loss.

LOCATION:

Southwestern end of Dagger Island, north of Corpus Christi Bay

STATUS:

Engineering & Design

STAKEHOLDERS:

- ***Port of Corpus Christi Authority***
- Ducks Unlimited
- Texas Parks & Wildlife Department
- Texas General Land Office
- U.S. Army Corps of Engineers
- Texas Department of Transportation
- Private Landowners

ACTIONS:

PROJECT TYPE(S):

Shoreline Stabilization; Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

✓	1	✓
Seagrass Protected	Wetland Type	Decreased Wave Energy

14	6
Endangered Species	Migratory Bird Species

Medium High

Social Vulnerability

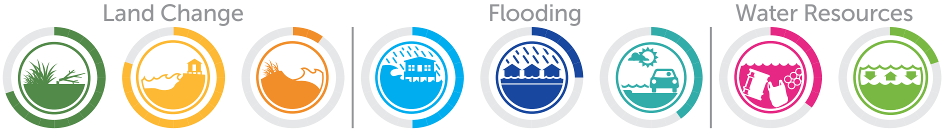
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Dagger Point Stabilization *(9268)*

Estimated Project Cost: $30,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

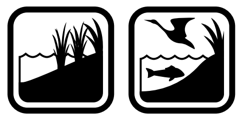


LOCATION:
Shoreline of San Antonio Bay in the Aransas National Wildlife Refuge

STATUS:
Ongoing

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- Coastal Bend Bays & Estuaries Program
- Texas General Land Office
- Matagorda Bay Mitigation Trust

ACTIONS:



PROJECT TYPE(S):
Shoreline Stabilization

Project Description

The Aransas National Wildlife Refuge has identified a large range of needs on its federal land, including shoreline restoration, hydrologic restoration, prairie and marsh restoration, agricultural land inflows, strategic water impoundment cleanouts, habitat creation, and susceptibility to relative sea level rise over 150 miles of Refuge shoreline. The Dagger Point Stabilization project is one of 11 overarching projects that were identified through a process to consolidate multiple restoration and resiliency needs within the Refuge. This project is proposed as high priority to address bay shoreline erosion concerns. Some funding has been received through a U.S. Fish and Wildlife Service project, the Texas General Land Office, and the Matagorda Bay Mitigation Trust for an in-depth assessment of the area to recommend remediation measures, with permitting and construction to follow. Depending on the stabilization approach used, dredged materials could be obtained from channel maintenance activities near the Refuge. Alternatively, material can also be utilized in-situ through managing existing sediment flow, slowing sediment loss at the bluff, and by utilizing a combination of wave breaks and living shoreline features.

Project Need

With increasingly diminishing habitats along the Texas Gulf Coast, the Refuge plays a critical role in coastal habitat preservation and management. Addressing Dagger Point's stabilization needs will enhance long-term resiliency to coastal hazards throughout the Refuge.

POTENTIAL LOCAL BENEFITS

✓	2	1
Protected Habitat in the Area	Wetland Types	Critical Habitat

13	32
Endanagerd Species	Migratory Bird Species

Medium
Social Vulnerability

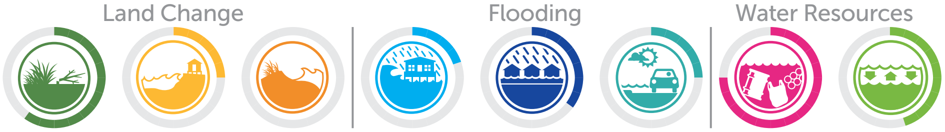
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

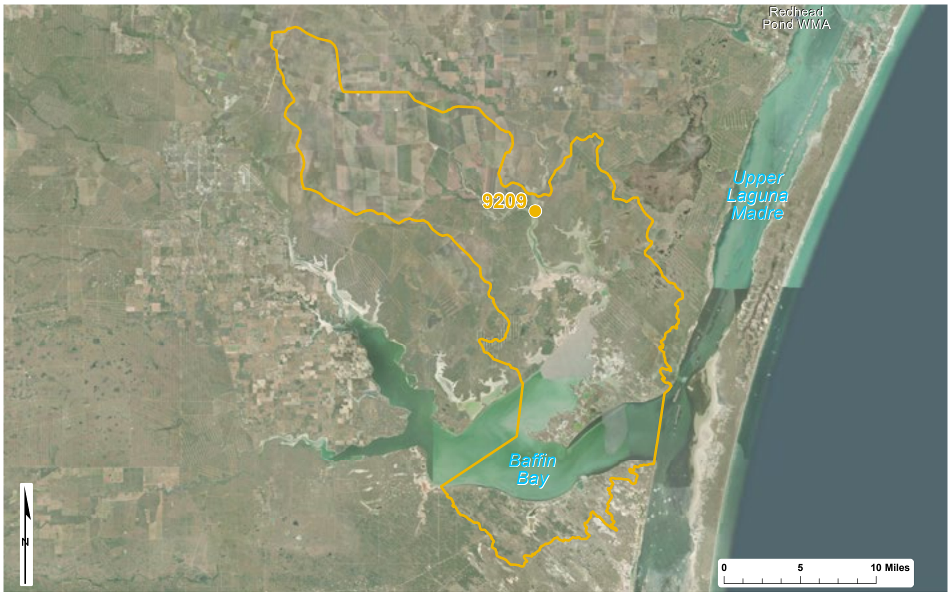
Farming Out Pollutants in Petronila Creek *(9209)*

Estimated Project Cost: $20,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



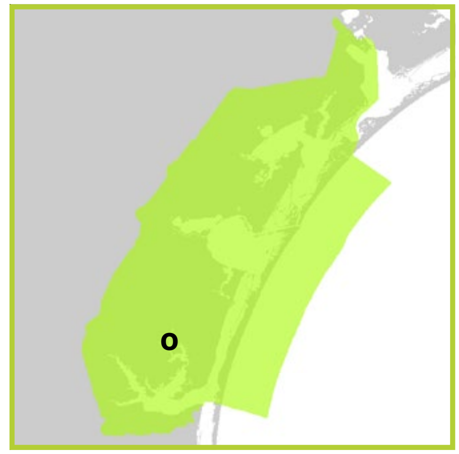


Project Description

Baffin Bay is considered one of the jewels of the Texas coast with tremendous fishing and recreation potential and a positive economic impact. The Baffin Bay Stakeholder Group was formed to better understand water quality issues in the Bay and develop collaborative solutions. The Group's proposed project involves expanding riparian buffers along Petronila Creek to filter nutrients and pollutants to improve water quality. The proposed project would allow the Group to develop a landowner incentive program for riparian restoration along Petronila Creek. Following evaluation of riparian function after 5 to 6 years, landowners would be able to enter their riparian area into a conservation easement or the Riparian Restoration Incentive Program. In 2019, with funding from the Coastal Bend Bays & Estuaries Program, the Nueces River Authority (NRA) completed an aerial evaluation of the riparian areas along Petronila Creek and its tributaries to identify riparian restoration opportunities. Results are being used by the NRA to conduct outreach to landowners.

Project Need

Water quality degradation threatens the health of Baffin Bay, impacting ecosystem benefits and economic and recreational opportunities. The Bay has experienced prolonged, dense blooms of brown tide. In 2010, a significant fish kill coincided with hypoxia and a dense algae bloom. Baffin Bay and its watershed streams exceed the Texas Commission on Environmental Quality's screening levels for chlorophyll, a proxy for algal biomass. The streams feeding Petronila Creek are considered impaired for several water quality variables.



LOCATION:
Northwest of Baffin Bay, southeast of Kingsville

STATUS:
Conceptual

STAKEHOLDERS:
- ***Coastal Bend Bays & Estuaries Program***
- Nueces River Authority
- Baffin Bay Stakeholder Group
- Kleberg County

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Studies, Policies, and Programs; Hydrologic Connectivity

POTENTIAL LOCAL BENEFITS

2	16	21
Wetland Types	Endangered Species	Migratory Bird Species

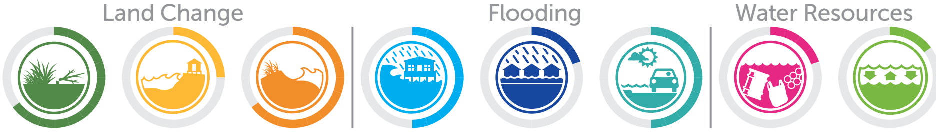
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Feeder Berm North of Fish Pass Beneficial Use *(1385)*

Estimated Project Cost: $3,700,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
On the Gulf shoreline of Mustang Island, north of Fish Pass

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Port of Corpus Christi Authority***
- Ducks Unlimited
- Texas A&M University-Corpus Christi Conrad Blucher Institute
- Nueces County
- Texas General Land Office
- Texas Parks & Wildlife Department

ACTIONS:

PROJECT TYPE(S):
Beach Nourishment

Project Description

As part of a Texas General Land Office (GLO) grant to Ducks Unlimited and the Port of Corpus Christi Authority (PCCA), stakeholder input was coordinated to identify and receive information about potential beneficial use of dredged material (BUDM) sites. Based on stakeholder input, GLO feedback, publicly available data, and professional judgment, the project team selected this project site for 60% design development and cost estimation; the 60% design has been completed using support from PCCA. A U.S. Army Corps of Engineers Individual Permit application is drafted and pending submittal. Recently, beach erosion has occurred between Fish Pass and the north end of Mustang Island State Park. This project would use dredged material from PCCA's channel deepening projects to place sediment between 10- and 15-foot depths along the Gulf of Mexico shoreline. The proposed berm would nourish eroding beaches over time as a result of natural processes driven by prevailing southeast winds and resulting nearshore currents.

Project Need

Hurricane Hanna resulted in more damage to the area's bay and Gulf beaches than Hurricane Harvey. Gulf beach erosion directly reduces available habitat for threatened and endangered sea turtles and avian species and reduces the economic and recreational values that beaches provide humans. Texas A&M University-Corpus Christi's Conrad Blucher Institute identified an area north of Fish Pass to be an ideal location for a feeder berm. University of Texas Bureau of Economic Geology data indicate that this area of the coast has a long-term erosion rate of approximately 0.5 meters per year.

POTENTIAL LOCAL BENEFITS

✓	1	1
Decreased Wave Energy	Critical Habitat	Wetland Type

Medium High

Social Vulnerability

14	29
Endangered Species	Migratory Bird Species

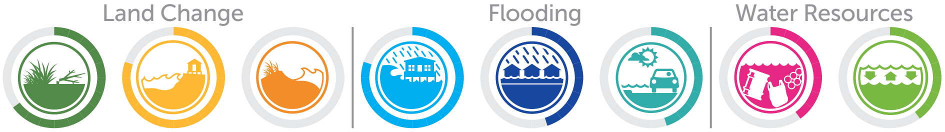
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Fulton Beach Road Protection *(437)*

Estimated Project Cost: $9,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Road along the northwest shoreline of Aransas Bay, east of I-35

STATUS:
Permitted (partially)

STAKEHOLDERS:
- ***Aransas County Navigation District***
- Aransas County
- City of Rockport
- Town of Fulton

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization; Community Infrastructure

Project Description

This project would utilize various methods to stabilize Fulton Beach Road, create a variety of habitats, and improve access to public recreation and ecotourism attractions. The project would stabilize up to 4 miles of Fulton Beach Road with living shoreline features including beneficial use of dredged material for construction of wetland islands and reef habitat, breakwaters with fill for vegetative plantings, and other components to provide shoreline stabilization, habitat, and public access for water-based recreation. This roadway is critical to the local communities as an evacuation route and is an iconic coastal attraction for the county's vital ecotourism industry. The roadway could be undermined or damaged if the erosion in this area is not controlled. This project would protect Fulton Beach Road and high-value property at risk of erosion. The project would also create large areas of wetland, oyster, fishery, and bird habitat that would enhance the local ecotourism economy by adding extensive water-based recreation features. The southern portion has received a U.S. Army Corps of Engineers (USACE) permit and the northern portion is awaiting a USACE permit.

Project Need

This roadway is critical to the local communities as an evacuation route. The roadway could be undermined or damaged if the erosion in this area is not controlled.

POTENTIAL LOCAL BENEFITS

$40.8M
Building Replacement Value

200
Homes

145
Existing Jobs

259 Trips on Evacuation Route (Daily)

✓ Public Access Improvements

✓ Seagrass Protected

Medium
Social Vulnerability

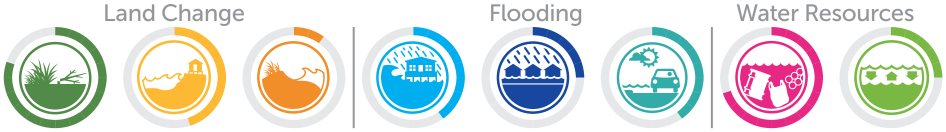
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Going to Scale: Expanding Oyster Restoration in Aransas Bay *(9253)*

Estimated Project Cost: $14,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

This project seeks to restore a minimum of 100 acres of degraded subtidal and intertidal oyster reefs across the bay system, using a landscape approach to create a network of resilient oyster reefs, spatially separate but ecologically connected through larval transport. A network of subtidal, high vertical relief reefs, that serve as self-policing oyster sanctuaries, combined with lower-elevation intertidal reefs that serve as de facto sanctuaries will be created within the bay systems. It will also construct subtidal sink reefs designed to increase substrate availability while supporting sustainable oyster harvest. These reefs will be positioned within the ecosystem so that the predominant currents transport larvae from the restored sanctuaries to sink reefs and unrestored reefs within the bay system. This network approach will allow for increased oyster population sustainability and oyster habitat resiliency, while maximizing oyster fisheries benefit through larval supply and transport.

Project Need

Oyster harvest in Aransas Bay has dramatically increased in the past decade, from 39,000 sacks in 2014 to 174,000 sacks in 2016, approximately 36% of the landings from the entire state of Texas. This increased harvest pressure has resulted in substrate degradation in Aransas Bay, and Texas Parks & Wildlife Department's degradation index shows multiple reefs in Aransas Bay that are classified as degraded in terms of reduced live oyster, spat, and substrate abundance. Furthermore, the estuary is experiencing high levels of erosion that could benefit from the protection offered by restored, intertidal oyster reefs.

LOCATION:

Aransas Bay System, including Aransas, Copano, St. Charles, and Mesquite bays

STATUS:

Conceptual

STAKEHOLDERS:

- ***The Nature Conservancy***
- Texas Parks & Wildlife Department
- Texas Water Development Board
- Mission-Aransas National Estuarine Research Reserve
- Texas A&M University-Corpus Christi Harte Research Institute

ACTIONS:

PROJECT TYPE(S):

Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

13	35	2
Endangered Species	Migratory Bird Species	Critical Habitats

✓	✓
Oyster Habitat Protected/Created	Seagrass Protected

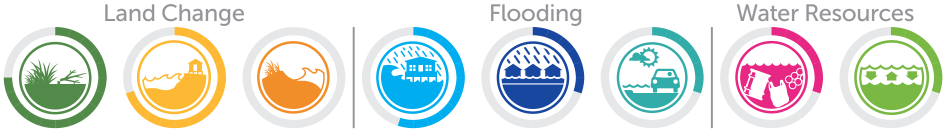
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Goose Island State Park Habitat Restoration and Protection *(70)*

Estimated Project Cost: $2,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Goose Island State Park, at the convergence of Aransas and St. Charles bays

STATUS:
Permitted

STAKEHOLDERS:
- ***Texas Parks & Wildlife Department***
- Texas A&M University-Corpus Christi

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description
This project will provide shoreline and habitat protection for the critical estuarine wetland habitat of Goose Island State Park through multiple types of restoration activities, such as beneficial use of dredged material, transplanting marsh grasses for the wetland habitat, and oyster reef restoration along the rapidly eroding shorelines of the State Park within St. Charles and Aransas bays. The project will continue recent construction of a living reef made of oyster shell and other wetland enhancements just offshore of the State Park.

Project Need
The shoreline at Goose Island State Park is eroding at a rate of approximately 1.7 ft/yr since 1951 due to wave action generated by southeast winds. As a result, this area is in need of protection and restoration.

POTENTIAL LOCAL BENEFITS

✓	1	✓
Seagrass Protected	Wetland Type	Oyster Habitat Protected/ Created

1,063
Existing Wetland Carbon Sequestration (tons C)

1	13	33
Critical Habitat	Endangered Species	Migratory Bird Species

Medium
Social Vulnerability

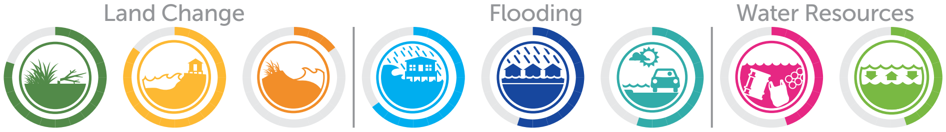
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Indian Point Marsh Area Living Shoreline *(9158)*

Estimated Project Cost: $3,400,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

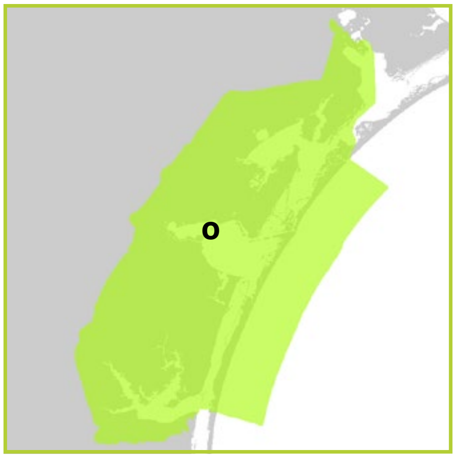


Project Description

The Indian Point Marsh Area (IPMA) is located within the city limits of the City of Portland. This project would design living shorelines using breakwaters on the southwestern side of the marsh area at IPMA. This would include new geotechnical surveys, topo-bathymetric surveys, permitting and construction drawings. According to the Coastal Bend Bays & Estuaries Program, the marshes in this area have historically provided numerous biological, physical, and chemical functions, including groundwater discharge/recharge, flood storage and desynchronization, shoreline erosion control, sediment entrapment, water quality improvement, food chain support/nutrient export, fisheries and wildlife habitat, and recreation and education opportunities.

Project Need

IPMA is one of the last natural marsh areas on the inland shorelines of east Corpus Christi Bay. IPMA also functions as a buffer zone, protecting the Nueces Bay Causeway (US 181/SH 35) from storm impacts. In the last 20 years, IPMA has lost more than 40 percent of its area due to shoreline erosion, subsidence, and storm surge.



LOCATION:

Directly adjacent to the northern landing of the Nueces Bay Causeway

STATUS:

Engineering & Design

STAKEHOLDERS:

- ***Coastal Bend Bays & Estuaries Program***
- Port of Corpus Christi Authority
- City of Portland
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):

Habitat Creation and Restoration; Shoreline Stabilization

POTENTIAL LOCAL BENEFITS

✓	✓	✓
Seagrass Protected	Public Access Improvements	Decreased Wave Energy

52,000 Trips on Evacuation Route (Daily)

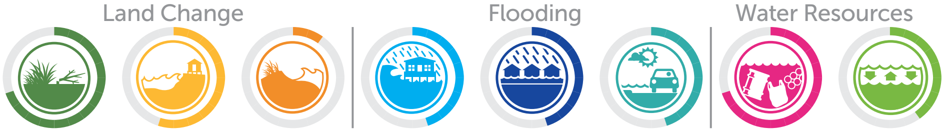
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

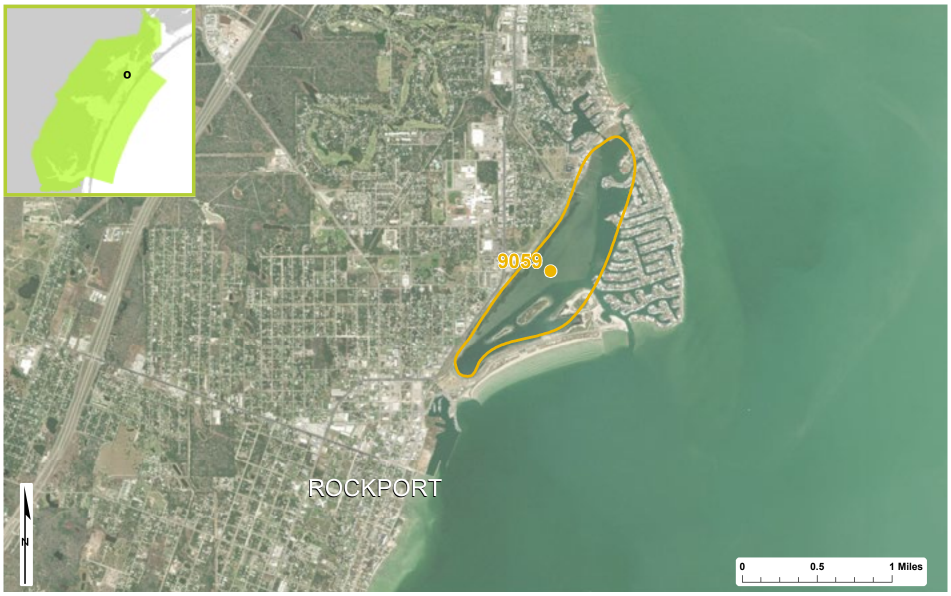
Little Bay Restoration Initiative *(9059)*

Estimated Project Cost: $14,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Adjacent to Aransas Bay, between Rockport and Fulton

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Aransas County Navigation District***
- Aransas County
- City of Rockport
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration; Hydrologic Connectivity

Project Description

This project would improve water quality in Little Bay, a shallow, enclosed bay with approximately 420 acres of surface area and to return it to its natural, vegetated state. The project would include four tasks to address these issues:

1. Evaluate, select, and implement Best Management Practices to reduce impacts due to point source and nonpoint source inflows—such as re-routing of and/or treatment of inflows, landscape modifications, and other actions to cost-effectively improve water quality.
2. Evaluate, select, and implement circulation improvements to enhance water quality, including widening and deepening existing channels and creation of new circulation inlets or other similar projects.
3. Construct a living shoreline to provide new marsh habitat and protect critical infrastructure from erosion occurring along Broadway Street, which provides bay access to fishermen, bird watchers, tourists, and ecotourists.
4. Evaluate and implement plans for beneficial use of dredged material to construct the living shoreline and to restore and stabilize eroded rookery islands.

Project Need

This effort would help alleviate nuisance algal blooms, bacterial concerns, and water quality issues that threaten the local tourism-driven economy. It would also make Little Bay better able to sustain and enrich an ecosystem that provides habitat for oyster reefs, wetlands, and seagrasses, as well as local wildlife, migratory birds, fish, crustaceans, and terrestrial and aquatic fauna.

POTENTIAL LOCAL BENEFITS

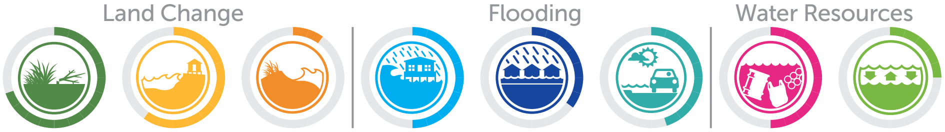
1 Wetland Type	**3** Critical Facilities
21 Migratory Bird Species	**13** Endangered Species

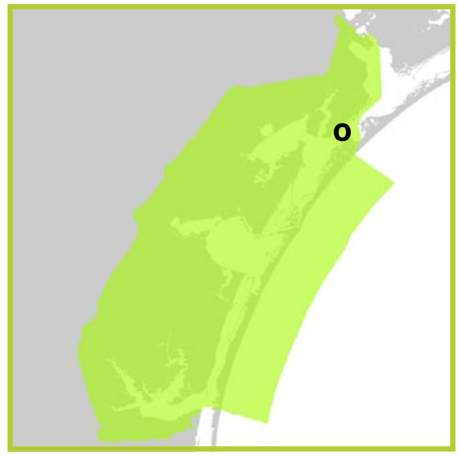
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Living Shorelines and Wetland Enhancements at the Aransas NWR *(9265)*

Estimated Project Cost: $6,000,000

ABILITY TO ADDRESS VULNERABILITIES





LOCATION:
The confluence of the Gulf Intracoastal Waterway, Aransas Bay, and St. Charles Bay

STATUS:
Conceptual

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- Coastal Bend Bays & Estuaries Program

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

✓ Protected Habitat in the Area

✓ Oyster Habitat Protected/ Created

✓ Seagrass Protected

13 Endangered Species

34 Migratory Bird Species

Medium Social Vulnerability

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Project Description

The Aransas National Wildlife Refuge has identified a large range of needs on its federal land, including shoreline restoration, hydrologic restoration, prairie and marsh restoration, agricultural land inflows, strategic water impoundment cleanouts, habitat creation, and susceptibility to relative sea level rise over 150 miles of Refuge shoreline. The Living Shoreline and Living Wetland Enhancement at the Aransas NWR project is one of 11 overarching projects that were identified through a process to consolidate multiple restoration and resiliency needs within the Refuge. This project has multiple components and phases, with the living shoreline as Phase 1. Starting at the confluence of the Gulf Intracoastal Waterway, Aransas Bay, and St. Charles Bay, this is a high-energy shoreline requiring features promoting a living shoreline to stabilize the area, reestablish wetlands/marsh and alleviate shoreline erosion. Additional phases would extend the project around the easternmost and western Refuge boundary along Aransas, San Carlos, Mesquite, and Ayers bays to the east and St. Charles Bay to the west at strategic locations exhibiting similar effects needing attention to stop or reverse the loss of habitat and Refuge land.

Project Need

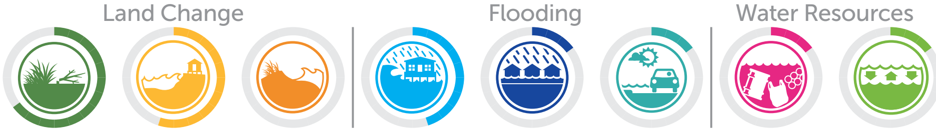
With increasingly diminishing habitats along the Texas Gulf Coast, the Refuge plays a critical role in coastal habitat preservation and management. Addressing the overall restoration needs for the watershed will enhance long-term resiliency to coastal hazards throughout the Refuge.

Long Reef and Deadman Island Shoreline Stabilization and Habitat Protection *(72)*

Estimated Project Cost: $5,300,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

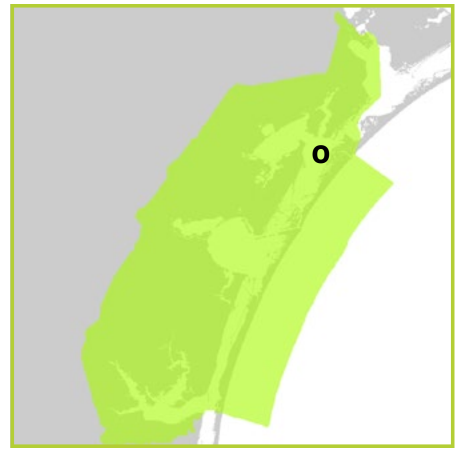


Project Description

Long Reef and Deadman Island present good options for rookery island restoration in the Aransas Bay System. In 2021, Coastal Bend Bays & Estuaries Program (CBBEP) received funding from the Texas General Land Office to develop a project to restore and protect rookery islands in Aransas Bay, focusing on Deadman Island, as well as a separate island known as Long Reef. CBBEP has contracted with a qualified engineering firm to perform an alternatives analysis, submit permit applications, conduct data collection, and complete 70% preliminary design for these rookery islands. This project would fund final design, bidding, construction, and monitoring for restoration alternative(s) permitted by CBBEP. It is anticipated that construction will involve the installation of a breakwater structure around the perimeter of the island(s) and placement of fill material inside the breakwater structure(s) in order to expand the footprint of the island.

Project Need

Within the Coastal Bend, a major migratory route for birds, suitable nesting habitat is thought to be the most limiting factor for most of the colonial waterbird species, leading to the decline of many species. Because the Aransas Bay system has a very limited number of active rookery islands, the need to create additional nesting areas for colonial waterbirds has been identified as a high priority by local coastal resource managers. This urgency was elevated even further after Hurricane Harvey resulted in major erosion of every rookery island in the Aransas Bay system, including Long Reef and Deadman Island.



LOCATION:
Aransas Bay

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Coastal Bend Bays & Estuaries Program***
- Audubon Texas
- U.S. Fish and Wildlife Service
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

POTENTIAL LOCAL BENEFITS

11	9	1
Endangered Species	Migratory Bird Species	Wetland Type

Medium
Social Vulnerability

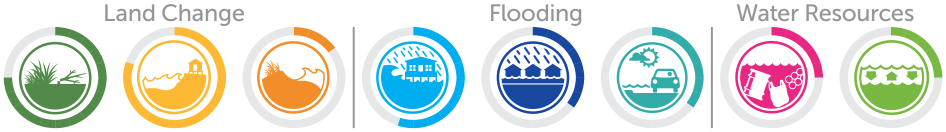
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

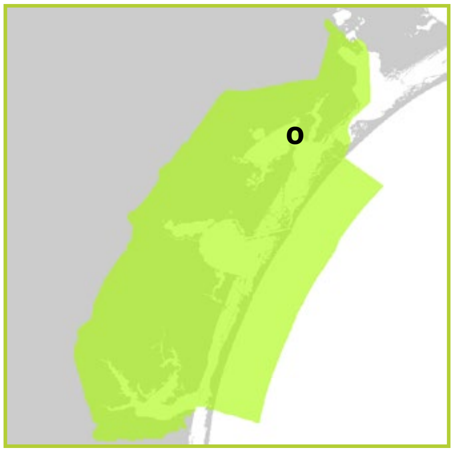
Newcomb Point Shoreline Stabilization *(9139)*

Estimated Project Cost: $4,500,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Point on Copano Bay, south of Holiday Beach

STATUS:
Engineering and Design

STAKEHOLDERS:
- ***Texas Parks & Wildlife Department***
- Coastal Bend Bays & Estuaries Program
- Aransas County
- U.S. Fish and Wildlife Service

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description

Newcomb Point is located northeast of Copano Bay and contains the areas known as Newcomb Marsh and Newcomb Bend. This project would place shoreline stabilization at Newcomb Point to help protect the valuable habitat from threats of erosion. Potential solutions could include creating a living shoreline that would protect the shoreline from erosion, such as a semi-submerged breakwater with vegetation behind it to allow the shoreline to accrete and stabilize naturally, as well as restoration activities within the degraded marsh areas. The Texas Parks & Wildlife Department has received initial funding and will be partnering with Aransas County, the Coastal Bend Bays & Estuaries Program, and the Texas General Land Office to complete the surveying, alternatives analysis, engineering, design, and permitting for structural and non-structural methods for protection and restoration of the shoreline and marsh habitat. Additional funds will be needed for the final engineering and construction phase of this project.

Project Need

The erosion of this shoreline is endangering the survival of the wetland habitat at Newcomb Point, which supports a diverse ecosystem and is directly adjacent to the shoreline. This area is currently unprotected and is valuable occupied whooping crane habitat.

POTENTIAL LOCAL BENEFITS

33	✓	13
Migratory Bird Species	Seagrass Protected	Endangered Species

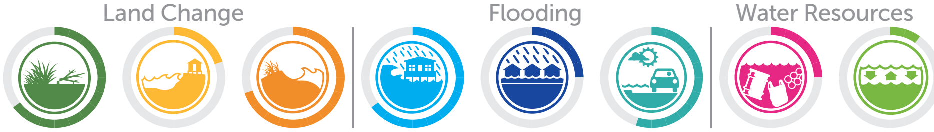
Medium
Social Vulnerability

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Nueces County Gulf Beach Renourishment and Protection - Phase 1 *(9278)*

Estimated Project Cost: $850,000

ABILITY TO ADDRESS VULNERABILITIES



LOCATION:
Mustang Island and North Padre Island, just east and southeast of Corpus Christi

STATUS:
Conceptual

STAKEHOLDERS:
- ***Nueces County***

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Beach Nourishment

Project Description
In 2020, Hurricane Hanna did extensive shoreline and dune erosion damage in Nueces County along Mustang Island and North Padre Island. Nueces County historically does not have engineered beaches; however, the severe erosion impacts resulting from Hurricane Hanna have now made reliance on natural beach recovery processes all but impossible. Data has been compiled dating back to 2002 that shows it would take these beaches 11 years to recover naturally in a perfect situation that did not factor in sea level rise or impacts from future storms. This project proposes engineering and design, permitting, and the identification of sand sources for nourishment, including studying the beneficial use of dredged material to renourish the beach and dune system. Renourishing the beach and dune system can have positive environmental, economic, and social impacts by enhancing ecosystem benefits, restoring habitat for wildlife, and expanding recreational opportunities for visitors. Additionally, restoration of the beach and dune systems on islands can help maintain the buffer between communities and coastal storm impacts.

Project Need
This area is experiencing beach and dune erosion, which reduces habitat for birds and terrestrial wildlife and impacts recreational opportunities for residents and visitors. In addition, erosion can degrade water quality, further degrading ecosystem health for aquatic species and potentially impacting fisheries.

POTENTIAL LOCAL BENEFITS

260	340	2
Homes	Existing Jobs	Critical Facilities

$279.7M Building Replacement Value

✓	2
Decreased Wave Energy	Wetland Types

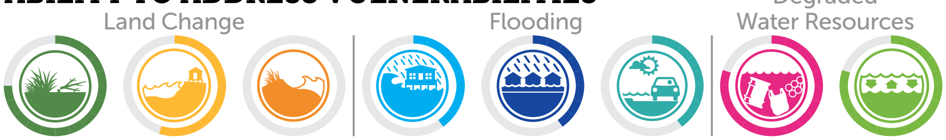
Medium High
Social Vulnerability

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Nueces County Hydrologic Restoration Study *(443)*

Estimated Project Cost: $240,000

ABILITY TO ADDRESS VULNERABILITIES



Project Description

An adaptive management hydrologic restoration study would look at the interactions of the physical systems that affect the hydrology in Nueces and San Patricio counties, as well as the stakeholder interactions in the region. Work has been conducted on Nueces Bay freshwater inflows via adaptive management plans of the Senate Bill 3 (80th Texas Legislature, 2007) Environmental Flows Process. Two current studies include: *Using Comparative Long-Term Benthic Data for Adaptive Management of Freshwater Inflow to Three Estuaries (Colorado-Lavaca, Guadalupe, and Nueces)* and *Influence of Freshwater Inflow Gradients on Estuarine Nutrient-Phytoplankton Dynamics in the Three Estuaries (Guadalupe, Nueces, and Upper Laguna Madre)*. This hydrologic restoration study would identify how to best restore coastal ecosystems within the delta system in a manner that is more resilient to freshwater inflow fluctuations. The study would build upon these efforts and would be invaluable for long-term decision making for the mutual benefits of all the county's residents and industries, such as addressing the need for continued monitoring of freshwater inflows and their effects on coastal systems to support ongoing planning and restoration work.

Project Need

The coastal systems throughout Nueces and San Patricio counties are experiencing impaired quality and lower quantities of freshwater inflows to Nueces Bay and Corpus Christi Bay. The water quality and quantity issues impact physical processes throughout the bays and exacerbate degradation of coastal habitats.

LOCATION:

Watersheds in the Nueces River Basin

STATUS:

Study

STAKEHOLDERS:

- ***Coastal Bend Bays & Estuaries Program***
- Texas Commission on Environmental Quality
- Texas Water Development Board
- Texas A&M University-Corpus Christi
- Nueces River Authority
- City of Corpus Christi
- Port of Corpus Christi Authority

ACTIONS:

PROJECT TYPE(S):

Studies, Policies, and Programs; Hydrologic Connectivity

POTENTIAL LOCAL BENEFITS

✓	✓	2
Education & Outreach	Addressing Data Gaps	Wetland Types

Medium High

Social Vulnerability

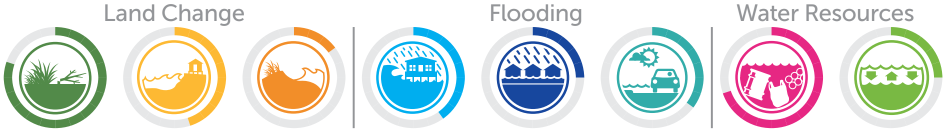
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Oyster Reef Restoration in Mesquite-Carlos-Ayres Complex *(9226)*

Estimated Project Cost: $10,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change Flooding Degraded Water Resources



LOCATION:
Carlos, Mesquite, and Ayres bays

STATUS:
Study

STAKEHOLDERS:
- ***Texas A&M University-Corpus Christi Harte Research Institute***
- Coastal Conservation Association
- FlatsWorthy
- Coastal Bend Bays & Estuaries Program

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description
Oyster reefs in the Mesquite-Carlos-Ayres Complex are historically productive reefs that have suffered substantial degradation in recent years from Hurricane Harvey in 2017 and high commercial harvest pressure. The proposed project will restore oyster reefs within the Mesquite-Carlos-Ayres Complex, part of the Mission-Aransas National Estuarine Research Reserve (MANERR). This project will result in an expanded network of restored oyster reefs that will provide a community resilience benefit to the towns of Rockport and Fulton, MANERR, and the Aransas National Wildlife Refuge (NWR) by providing natural buffers against erosion, improving water quality, enhancing recreation and tourism, and providing fish and wildlife critical habitat benefits. The methodology selected for restoration would be determined during the design phase.

Project Need
Recent monitoring of oyster reefs in the Mesquite-Carlos-Ayres Complex has shown counts that are below the 25th percentile of average oyster abundance for Texas bays. These oyster reefs are ecologically important, supporting the adjacent Aransas NWR by mitigating marsh and terrestrial habitat loss (including essential whooping crane habitat) from persistent shoreline erosion, and supporting colonial waterbird and shorebird populations (including American oystercatcher, a conservation strategy priority species) that are directly associated with the reefs. The community importance of these reefs is evidenced by the large number of conservation groups and private citizens who have raised concerns about the degradation of these reefs.

POTENTIAL LOCAL BENEFITS

2	✓	✓
Wetland Types	Oyster Habitat Protected/ Created	Seagrass Protected

13	30
Endangered Species	Migratory Bird Species

Medium
Social Vulnerability

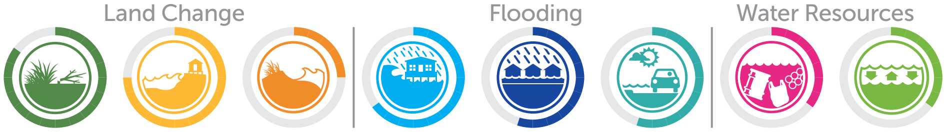
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

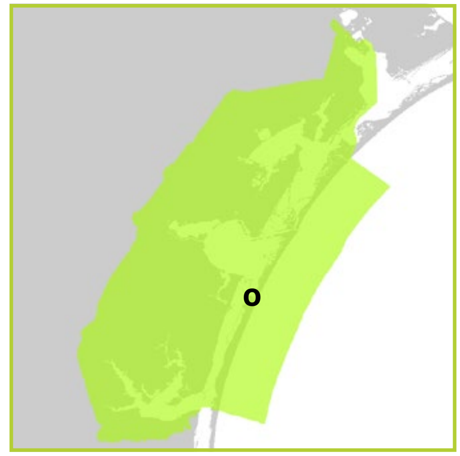
Packery Channel Nature Park Habitat Restoration - Phase 3 *(9045)*

Estimated Project Cost: $3,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Public Park located directly adjacent to Packery Channel

STATUS:
Ongoing

STAKEHOLDERS:
- ***Nueces County***
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization; Studies, Policies, and Programs; Public Access and Improvements

Project Description

The Nueces County Coastal Parks Department is in the process of implementing a living shoreline with Texas General Land Office funding along Packery Channel Park that includes a new fishing pier that was proposed as Phase 2 of this project. This project under Phase 3 will consist of expanding the woodland habitat units on the property, creating additional pockets of freshwater wetlands, expanding the boardwalk within the park, and conducting monitoring of the wildlife use of the restored areas within the park. The woodland habitats within the park are vital habitat to numerous species of migratory birds, but are under significant threat of degradation from municipal, commercial, and residential development. This project would help expand the woodlands, in addition to continuing control and removal of 4.5 acres of invasive Brazilian Pepper Trees. The project also would create a wetland mosaic habitat at Packery Channel Nature Park that would add ecological value to a region that is being rapidly depleted of healthy wetland ecosystems. There is also a need to add additional elevated boardwalk to expand bird watching and observation.

Project Need

A key element of the project would be to collect monitoring data on how birds are responding to the restored habitat. Nueces County would continue to work closely with federal and state biologists to enhance the Coastal Bend's natural resources and respond to the needs of the migratory bird populations that use the site. Monitoring data would be used to develop scientifically based guidance for other projects regarding plant survival, site structure, and bird use.

POTENTIAL LOCAL BENEFITS

1	14	30
Wetland Type	Endangered Species	Migratory Bird Species

1	✓
Critical Habitat	Public Access Improvements

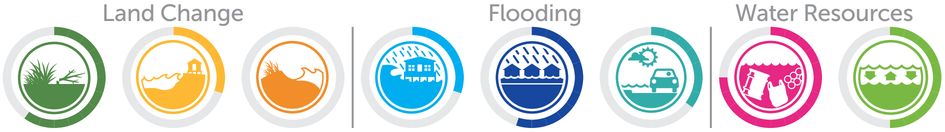
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

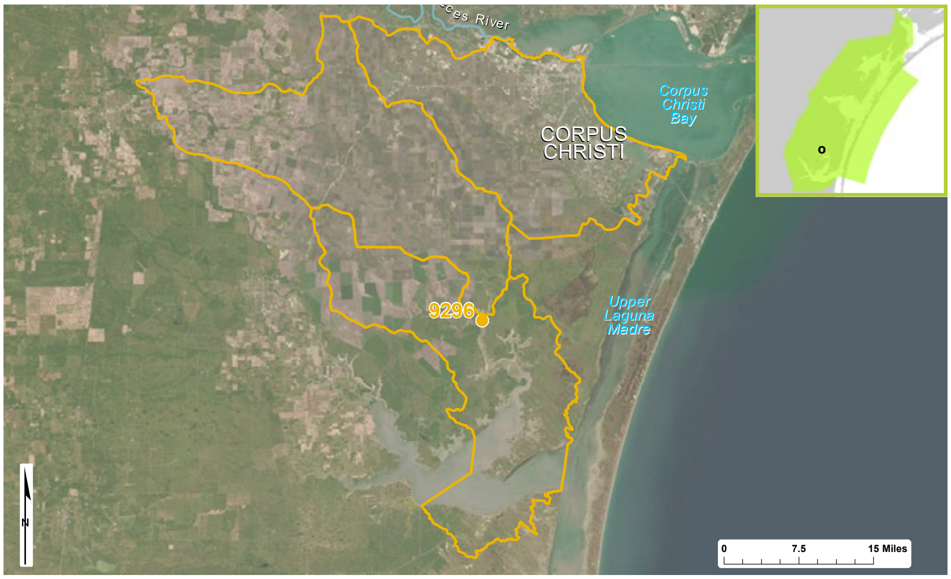
Petronila Creek and Oso Creek Watershed Improvements *(9296)*

Estimated Project Cost: $25,600,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





Project Description

This project is a compilation of hazard mitigation projects spanning the Oso Creek and Petronila Creek watersheds, anticipated to be completed over multiple phases to alleviate flooding and nonpoint source pollution. Project prioritization would be informed by the tri-county Flood Infrastructure Fund study being led by Nueces County, with funding from the Texas Water Development Board. This project would include the three Petronila Creek alternatives under the Texas Trustee Implementation Group (TIG) Restoration Plan, as well as the projects listed for Oso Creek and Petronila Creek in the Nueces County Hazard Mitigation Plan (HMP). Texas TIG restoration alternatives for Petronila Creek include: (1) constructing treatment wetlands to reduce water quality impacts from agriculture runoff into Baffin Bay; (2) implementing conservation practices within the Petronila Creek watershed to improve regional water quality; and (3) converting a channelized ditch back into a meandering natural system to reduce nutrient loading and erosion impacts. The Nueces County HMP also includes drainage control on Oso Creek and green infrastructure and nature-based solutions for both watersheds.

Project Need

Petronila Creek was identified as having the greatest opportunity for implementing nonpoint source nutrient reduction strategies due to modeling of nutrient loads associated with adjacent pasture, grassland, and cropland systems. Oso Creek has experienced localized drainage issues which have impacted infrastructure, downstream flooding, and even dam failures.

LOCATION:
Petronila and Oso Creek watersheds

STATUS:
Conceptual

STAKEHOLDERS:
- ***Nueces County***
- Coastal Bend Bays & Estuaries Program
- Natural Resource Damage Assessment Trustees
- Nueces County
- Baffin Bay Stakeholder Group
- Nueces River Authority
- Kleberg County
- Texas Water Development Board
- Private Landowners

ACTIONS:

PROJECT TYPE(S):
Studies, Policies, and Programs; Hydrologic Connectivity

POTENTIAL LOCAL BENEFITS

16 Endangered Species	**696** Critical Facilities
2 Wetland Types	**1** Critical Habitat

Medium High
Social Vulnerability

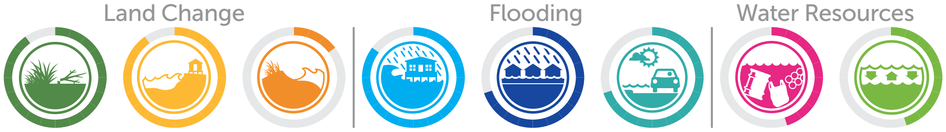
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

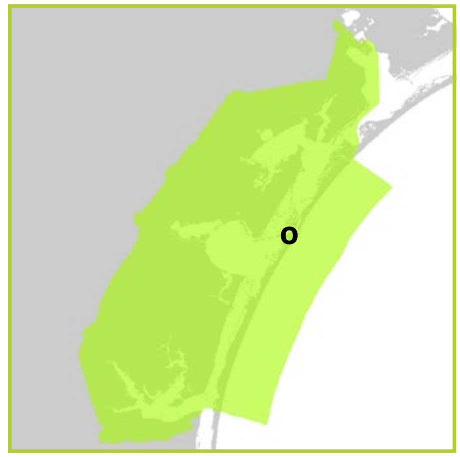
Port Aransas Nature Preserve Stabilization and Restoration - Phase 2 *(9134)*

Estimated Project Cost: $5,280,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Port Aransas Nature Preserve, south of the Corpus Christi Ship Channel

STATUS:
Ongoing

STAKEHOLDERS:
- ***City of Port Aransas***
- Texas General Land Office
- Port of Corpus Christi Authority

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description

This project includes two phases: (1) repairing breaches in the Corpus Christi Ship Channel (CCSC) bulkhead and rock revetment created by Hurricane Harvey storm surge on the north end of Mustang Island, and (2) rebuilding land lost and restoring marsh, tidal flat, and upland habitat. The bulkhead repair (Phase 1) is under construction (estimated to be complete summer 2023); once that project is complete, the Texas General Land Office will repair the rock revetment. Phase 2 includes rebuilding and restoring land and elevations suitable for habitats lost. The City of Port Aransas is beginning work on a Sediment Management and Restoration Plan, which will be complete by the end of September 2023. The plan will include stakeholder engagement, data review and collection, restoration alternatives, additional ideas for sediment sourcing, and permitting. While restoring this area, the design for the bulkhead will account for the future deepening and widening of the CCSC and relative sea level rise by building the bulkhead higher. The restoration project could include beneficial use of dredged material to restore land elevation through partnerships with the Port of Corpus Christi Authority and the U.S. Army Corps of Engineers. There is also a potential to leverage Federal Emergency Management Agency Public Assistance funding for this project.

Project Need

Following Hurricane Harvey, wave action from ships in the ship channel and high tides from storms caused further erosion through several cuts that were created in the bulkhead and rock revetment during the storm, and approximately 11 acres of habitat were lost. This project would repair damages from Hurricane Harvey and protect and rebuild wetland habitat.

POTENTIAL LOCAL BENEFITS

2	✓	1
Wetland Types	Decreased Wave Energy	Public Access Improvement

Medium High

Social Vulnerability

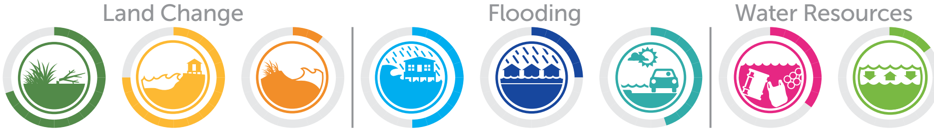
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

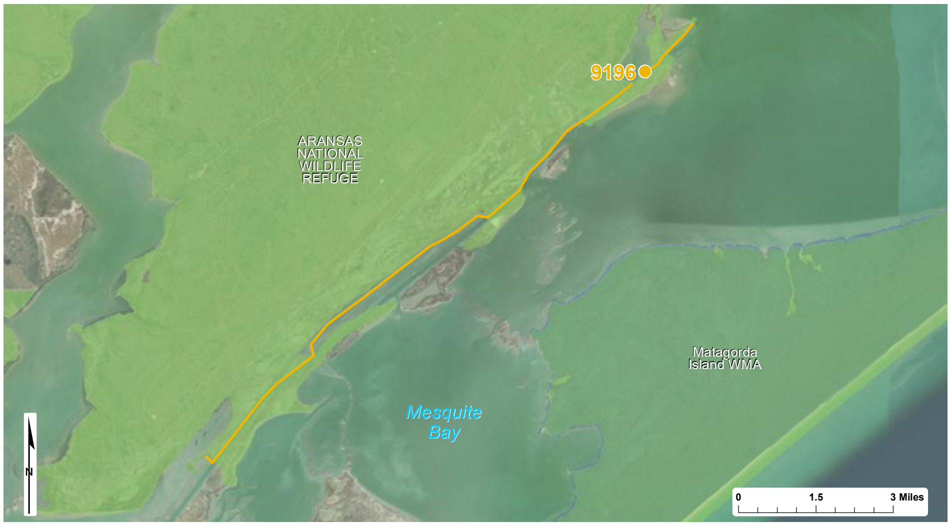
Protection of the GIWW Shoreline at the Aransas NWR *(9196)*

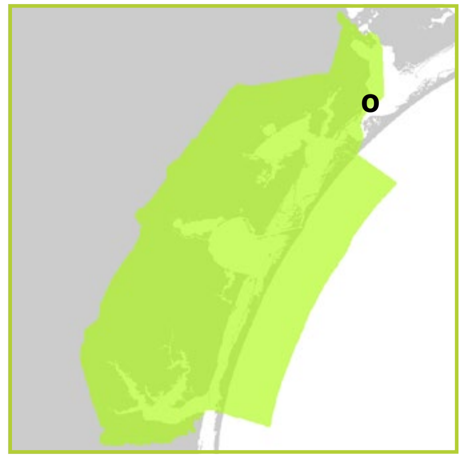
Estimated Project Cost: $22,300,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





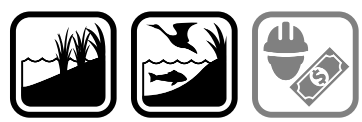


LOCATION:
The Gulf Intracoastal Waterway along the Aransas NWR

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Coastal Bend Bays & Estuaries Program***
- U.S. Fish and Wildlife Service
- Aransas National Wildlife Refuge
- Aransas County

ACTIONS:



PROJECT TYPE(S):
Shoreline Stabilization

Project Description

The Aransas National Wildlife Refuge (NWR) was bisected by the Gulf Intracoastal Waterway (GIWW) in 1941. This created approximately 12 miles of GIWW shoreline on either side of the waterway that Aransas NWR manages. Much of the existing GIWW shoreline is covered in protective revetments known as articulated concrete block mattresses to prevent shoreline erosion. The Coastal Bend Bays & Estuaries Program contracted with a qualified engineering firm to conduct an existing condition evaluation and develop potential shoreline stabilization concepts for the GIWW shoreline at Aransas NWR. Funding is needed for additional engineering and design work and the eventual implementation and construction of identified and permitted protection strategies. The project tentatively includes providing roughly 34,000 linear feet of shoreline protection (potentially rock breakwaters) to prevent continued erosion of the shoreline.

Project Need

Since their installation, portions of protective revetments along the GIWW at Aransas NWR have become dislodged or moved out of place, leading to localized erosion and shoreline and habitat loss. The GIWW is an integral part of the Texas transportation system and is one of the busiest inland waterways in the nation. The erosion issues along this section of the GIWW are primarily due to barges pushing up along the shoreline, as well as storm events and ongoing sea level rise. Stabilizing protective infrastructure would help alleviate erosion issues along the GIWW, as well as benefit wintering habitat for the federally endangered whooping crane and other aquatic and wetland species.

POTENTIAL LOCAL BENEFITS

13	30	1
Endangered Species	Migratory Bird Species	Critical Habitat

✓ Protected Habitat in the Area

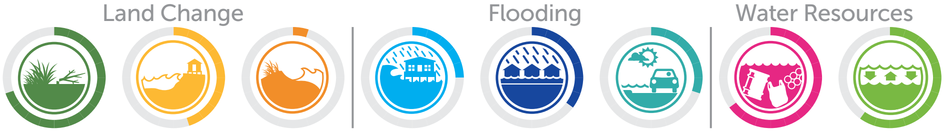
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Restoration of Freshwater Inflow to Townsend Bayou *(9236)*

Estimated Project Cost: $180,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



Project Description

The goal of this project is to quantify the amount of freshwater inflow necessary to counteract saltwater intrusion into the marsh and map its flow pathways throughout the marsh complex. This project will plan, permit, and enact an experimental pulse of freshwater into the north basin above SH 35 and track its hydrologic influence on the downstream watershed. Specific tasks include: (1) conducting a comprehensive GIS landcover analysis of the north part of the watershed to complement work previously performed by the National Wildlife Federation on the lower portion; (2) deploying sensors within Townsend Bayou and the North Basin to map salinities and water flow before and after experimental pulsing; (3) acquiring water—Texas Water Trade has acquired an option to purchase water from the Guadalupe-Blanco River Authority for this project; (4) pulsing variable quantities of freshwater into the watershed and map its flow; (5) creating a hydrologic model to represent flow through the marsh and identify barriers to flow; and (6) making recommendations on the feasibility of future freshwater pulses into Townsend Bayou. This work will allow for better understanding of flow behavior and, if successful, provide recommendations to restore freshwater inflow to the Townsend Bayou marsh. Based on the results of this study, a second phase to enact the recommendations will be needed.

Project Need

The Townsend Bayou marsh is suffering from saltwater intrusion caused by a lack of freshwater inflow, lack of sediment inflow, and sea level rise. Over 10% of its freshwater, brackish, and saltwater wetlands have been lost since 1941.

LOCATION:

Townsend Bayou, Hynes Bay, and San Antonio Bay

STATUS:

Conceptual

STAKEHOLDERS:

- ***San Antonio Bay Partnership***
- Texas Parks & Wildlife Department
- Texas A&M AgriLife Research
- Texas Water Trade
- International Crane Foundation
- Texas Water Development Board

ACTIONS:

PROJECT TYPE(S):

Studies, Policies, and Programs; Hydrologic Connectivity

POTENTIAL LOCAL BENEFITS

✓ Addressing Data Gaps	✓ Support Funding Eligibility
12 Endangered Species	3 Critical Facilities
2 Wetland Types	19 Migratory Bird Species

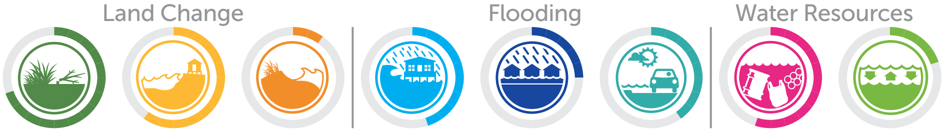
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Rincon Reef Breakwater *(9287)*

Estimated Project Cost: $31,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Along North Beach, near Corpus Christi

STATUS:
Conceptual

STAKEHOLDERS:
- ***Nueces County***
- Palacios Marine Agricultural Research, Inc.
- Ed Rachal Foundation
- Port of Corpus Christi Authority
- City of Corpus Christi

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

Project Description

This project is Phase 1 of two standalone restoration projects and will construct a new submerged breakwater with integrated oyster reef parallel to the shoreline to reduce wave energies while creating habitat. The breakwater will be constructed using established techniques to maximize wave energy reduction, creation of a viable reef, and user access. The project will be supplemented by a unique dedicated oyster hatchery that will accelerate development of a sustainable oyster community integrated into the breakwater. This mobile oyster hatchery will be one of only four in existence and the only one dedicated to reef restoration and conservation; it will be capable of producing at least 20 million larvae per week. That capacity will allow seeding of the newly-created reef at a rate of 10,000 to 15,000 oyster larvae per square meter per week to accelerate establishment, with an overall goal to eventually establish densities of 200 to 800 oysters per square meter of active reef habitat. This Phase 1 project will focus first on protection of the area around the U.S.S. Lexington to reduce wave energy in that specific location. The Phase 2 project would involve a complex of living shoreline and habitat islands to reduce erosion, allow multi-habitat restoration and development, and generate ecosystem diversity.

Project Need

North Beach, a historic shoreline at the intersection of Corpus Christi and Nueces bays, was once protected by El Rincón Oyster Reef. The beach is now under constant threat of erosion because that reef was destroyed by natural and human-made causes to the point that emergent wetlands and seagrass meadows once there cannot reestablish.

POTENTIAL LOCAL BENEFITS

170	450	✓
Homes	Existing Jobs	Decreased Wave Energy

$106M Building Replacement Value

$16M Structure Damage (1% Storm)

Medium High
Social Vulnerability

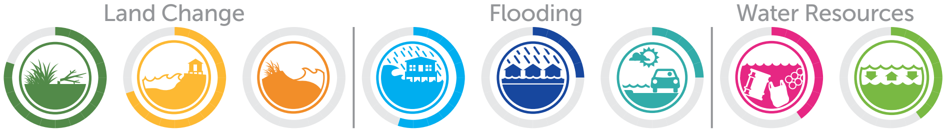
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

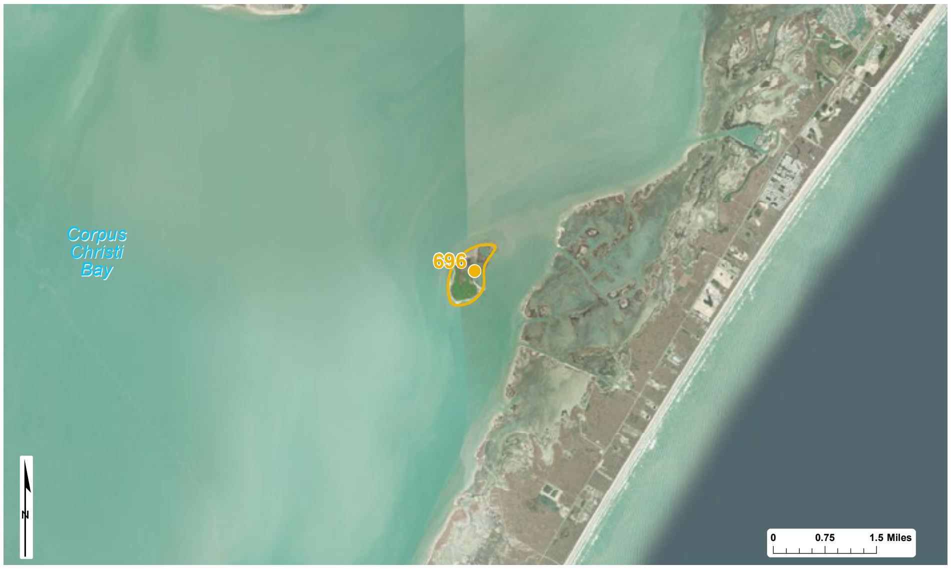
Shamrock Island Restoration - Phase 2 *(696)*

Estimated Project Cost: $5,900,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



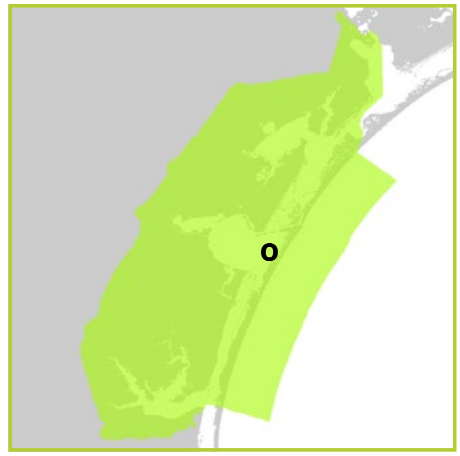


Project Description

This project was partially completed in 2016, when a shoreline breach was filled, and two breakwaters were built (constituting 3 of 4 components completed). However, the breach fill was subsequently blown out during Hurricane Harvey in 2017. Texas General Land Office and RESTORE funds were secured for redesign, permitting, and construction of the breach repair utilizing stabilizing gabions, but construction of the feeder mound to nourish the north shoreline remained unfunded. This component of the project would install a 45,000-cubic yard feeder mound in the shallows within the offshore breakwaters and northwest shoreline of the island to help fortify and stabilize the northern beach shoreline. The beach nourishment mound and north breach repair have a permit pending and are expected to be shovel ready once full funding becomes available. The project would be monitored for several years following construction to assess its physical and ecological impacts on the coastal ecosystem. Funding for this phase of the project would be used for construction of the feeder mound and post-construction monitoring.

Project Need

Shamrock Island is one of the most productive bird nesting islands in the Coastal Bend. Erosion that is caused by waves from northerlies and storm surges and exacerbated by relative sea level rise is diminishing the viability of the island as nesting habitat. Completing the breach repair and feeder mound would protect approximately 2,000 feet of prime beach nesting habitat, 12 acres of estuarine wetlands, 14 acres of seagrass, and 23 acres of upland nesting habitat from erosion.



LOCATION:
Island in Corpus Christi Bay northwest of Mustang Island

STATUS:
Shovel Ready (Permit Pending)

STAKEHOLDERS:
- ***The Nature Conservancy***
- Texas General Land Office
- Coastal Bend Bays & Estuaries Program
- Shell Oil
- Private Donors

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

POTENTIAL LOCAL BENEFITS

13	35
Endangered Species	Migratory Bird Species

✓ Seagrass Protected

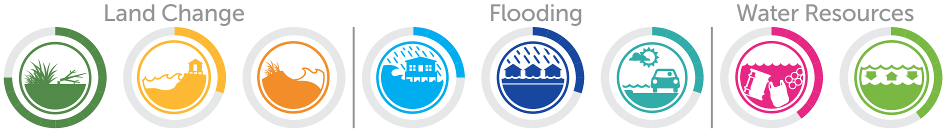
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

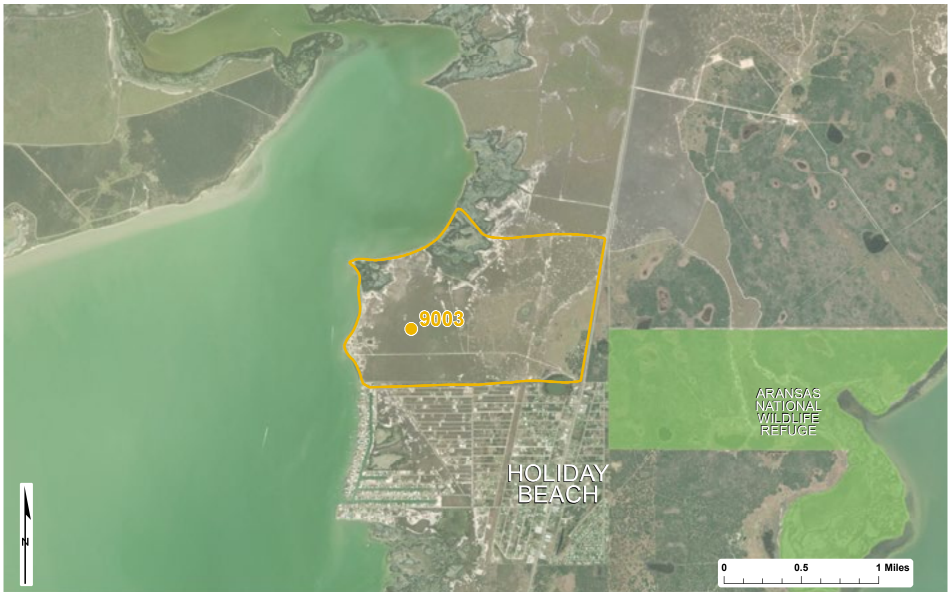
Shell Point Ranch Wetlands Protection *(9003)*

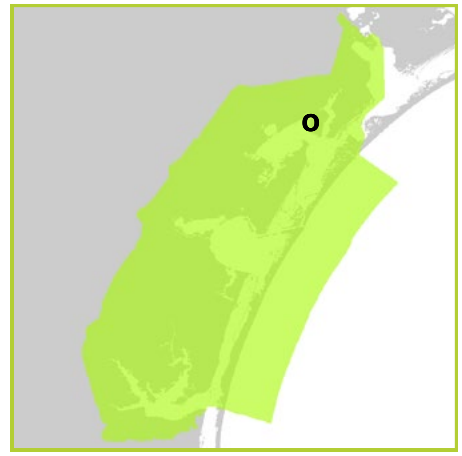
Estimated Project Cost: $5,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources







LOCATION:
Tract on the eastern shoreline of Copano Bay, near Holiday Beach

STATUS:
Acquisition Pending

STAKEHOLDERS:
- ***Texas Parks & Wildlife Department***

ACTIONS:

PROJECT TYPE(S):
Land Acquisition

Project Description

This project would acquire approximately 400 acres of coastal habitats that support coastal prairie, freshwater and estuarine wetlands, and the southernmost extents of mima mounds at Shell Point Ranch. After successful completion of this project, the next step would be to protect additional areas north and east of Shell Point through acquisitions or conservation easements to provide a contiguous wildlife corridor to benefit whooping cranes and increase coastal land preservation. The mosaic of habitats proposed for acquisition would benefit mottled ducks and whooping cranes, in addition to other neighboring wildlife.

Project Need

Nearby development threatens upland prairie and wetlands, which are necessary for wildlife diversity. The acquisition also would mitigate flooding and storm surge damage to the area. Undeveloped coastal lands can provide benefits to water quality by filtering stormwater runoff from developed areas before it reaches Texas bays. These lands can also serve as wetland migration corridors to allow wetlands to move inland as sea levels rise.

POTENTIAL LOCAL BENEFITS

2,520
Existing Wetland Carbon Sequestration (tons C)

13	33	2
Endangered Species	Migratory Bird Species	Wetland Types

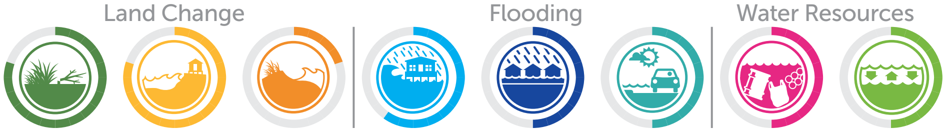
60	✓
Homes	Avoided Future Flood Risk

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Shoreline and Wetland Protection on Mustang Island – Phase 1: Cohn Preserve *(10005)*

Estimated Project Cost: $10,100,000

ABILITY TO ADDRESS VULNERABILITIES



LOCATION:
The bay side of Mustang Island between Fish Pass and Flato Cut

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***The Nature Conservancy***
- Texas General Land Office
- Texas Parks & Wildlife Department
- Coastal Bend Bays & Estuaries Program
- U.S. Fish and Wildlife Service
- Texas A&M University-Corpus Christi Conrad Blucher Institute
- Nueces County
- Private Partners

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description
The 480-acre Cohn Preserve and 3,950-acre Mustang Island State Park on Mustang Island shelter the southern reach of Croaker Hole from Corpus Christi Bay. The Preserve and the State Park are undergoing significant degradation of their shorelines and coastal wetlands through conversion of wetlands to tidal flats and conversion of tidal flats to open water due to sediment deficits, relative sea level rise, and coastal storms. The proposed Cohn Preserve project is a near-term solution to address emergency shoreline stabilization and wetland enhancement needs at the Preserve. The project would involve surveying existing conditions, advancing engineering design of living shoreline alternatives, developing breach repair designs, and beginning the permitting process to repair and stabilize the eroding shoreline along the preserve. Final engineering and design, project construction, and filling the breach on Mustang Island State Park will occur in subsequent phases.

Project Need
It is estimated that sections of the Cohn Preserve have lost roughly 30 feet of shore front since 2014, and approximately 10 to 12 feet in 2020 alone, resulting in critical conditions for the area. There are particular areas of concern where the shoreline is breached and the peninsula separating the wetlands from Corpus Christi Bay is rapidly eroding. Vegetation impacted during the 2021 freeze has shown minimal to no recovery, exacerbating the erosion. Additionally, lessons learned from this project will be applicable to future wetland conservation efforts on the backside of Mustang Island.

POTENTIAL LOCAL BENEFITS

✓	✓	2
Seagrass Protected	Oyster Habitat Protected/ Created	Wetland Types

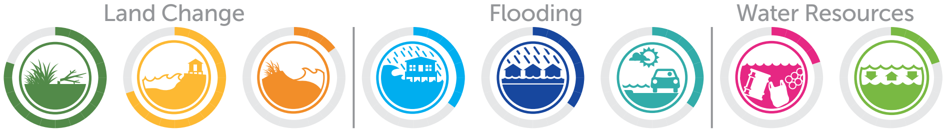
83,400
Existing Wetland Carbon Sequestration (tons C)

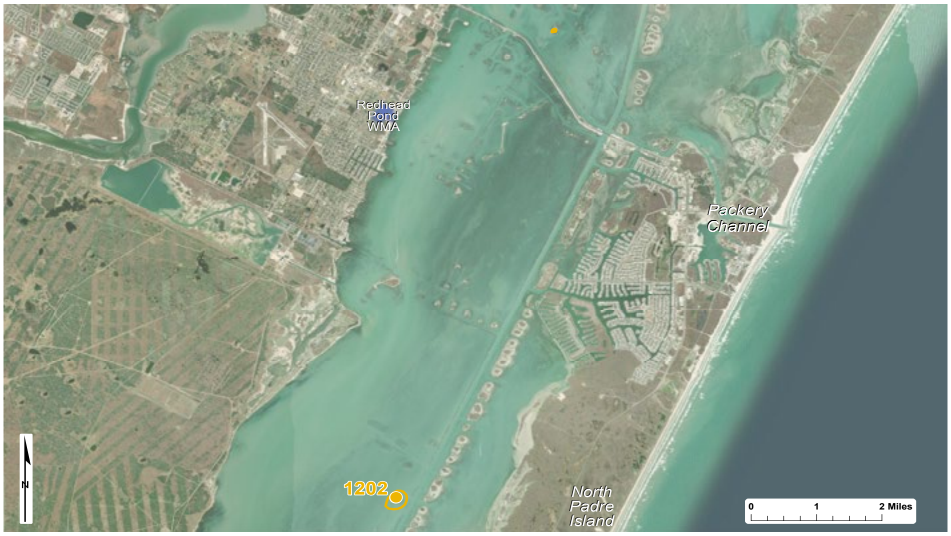
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Tern Island and Triangle Tree Island Rookery Habitat Protection *(1202)*

Estimated Project Cost: $5,900,000

ABILITY TO ADDRESS VULNERABILITIES





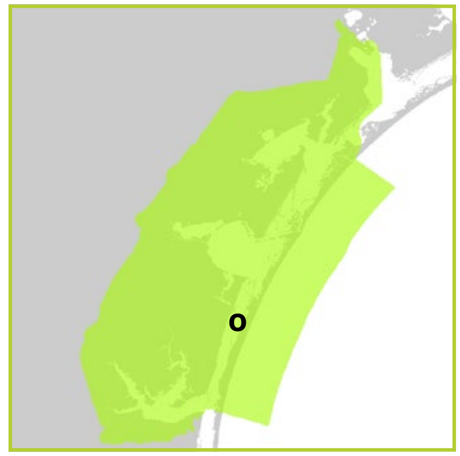
Project Description

This project would protect Tern and Triangle Tree Islands in the Upper Laguna Madre from erosion by constructing shoreline protection structures for each rookery island. The structures will be designed to protect the islands from erosion and also trap and secure sediment from future dredge placement events. The Coastal Bend Bays & Estuaries Program has received funds to complete preliminary and final engineering and design, permitting, and partial construction for both islands. Additional construction funds are needed.

- **Triangle Tree Island:** Preliminary engineering, alternatives analysis, and 30% design for 900 linear feet of shoreline protection is complete. Permitting has been initiated with the U.S. Army Corps of Engineers. The final engineering and design phase for the project will include a structure designed to protect the north side of the island from erosion and trap and secure dredged sediment.
- **Tern Island:** A feasibility study and alternatives analysis have been completed and identified the construction of 1,300 linear feet of riprap breakwater around the perimeter of the island as the best alternative. Preliminary engineering and design will begin in early 2023, followed by permitting and final engineering.

Project Need

Tern and Triangle Tree Islands provide nesting habitat for herons, egrets, gulls, terns, and skimmers; erosion from wind and waves is leading to loss of this critical habitat. The rate of erosion and the loss of nesting habitat is expected to increase as sea level continues to rise.



LOCATION:

Two islands in the Upper Laguna Madre, one about 7 miles southwest and another 0.5 mile north of the JFK Memorial Causeway

STATUS:

Engineering & Design

STAKEHOLDERS:

- ***Coastal Bend Bays & Estuaries Program***
- Audubon Texas
- U.S. Fish and Wildlife Service
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):

Habitat Creation and Restoration; Shoreline Stabilization

POTENTIAL LOCAL BENEFITS

✓	✓	10
Seagrass Protected	Decreased Wave Energy	Migratory Bird Species

383

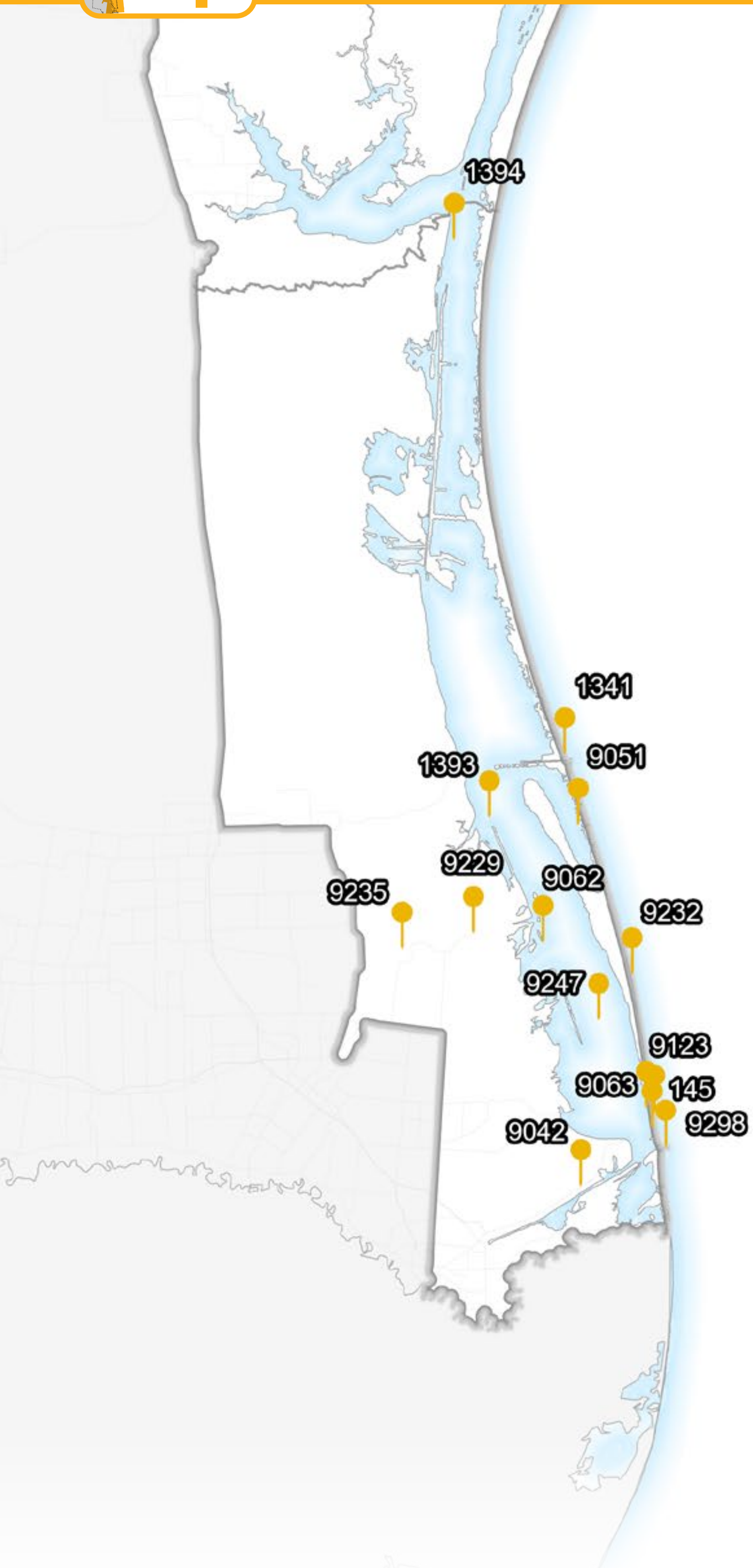
Existing Wetland Carbon Sequestration (tons C)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

REGION 4

REGION 4 PROJECTS

14 Projects | $472 million total cost



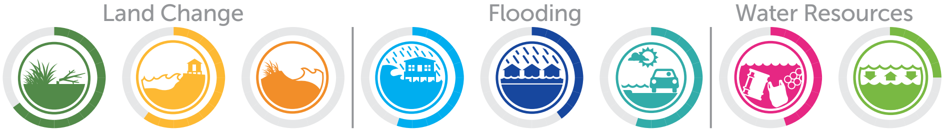
No.	Project Name	Cost
9229	Adolph Thomae, Jr. Park Living Shoreline Restoration - Phase 5	$5,000,000
9042	Bahia Grande Living Shoreline	$6,000,000
9298	Beach and Dune System Monitoring Program for Willacy and Cameron Counties	$850,000
9232	Cameron County Beach Nourishment	$285,000,000
9123	City of South Padre Island Living Shoreline	$12,500,000
9247	Developing a Comprehensive Conservation and Resiliency Management Plan for the Lower Laguna Madre	$1,200,000
1393	Protection and Restoration of Benny's Shack Islands	$4,700,000
1394	Protection and Restoration of Rabbit Island South	$3,300,000
9235	Resaca System Restoration Project - Phase 1	$1,000,000
1341	Restoration of Sea Turtle Nesting Beach at Padre Island National Seashore	$3,800,000
9063	Restore Barrier Island Bayside Wetlands on South Padre Island	$20,000,000
9062	Restore Laguna Madre Rookery Islands	$14,400,000
145	South Padre Island Beach and Dune Management and Restoration	$89,000,000
9051	South Padre Island Coastal Beach Protection	$25,000,000

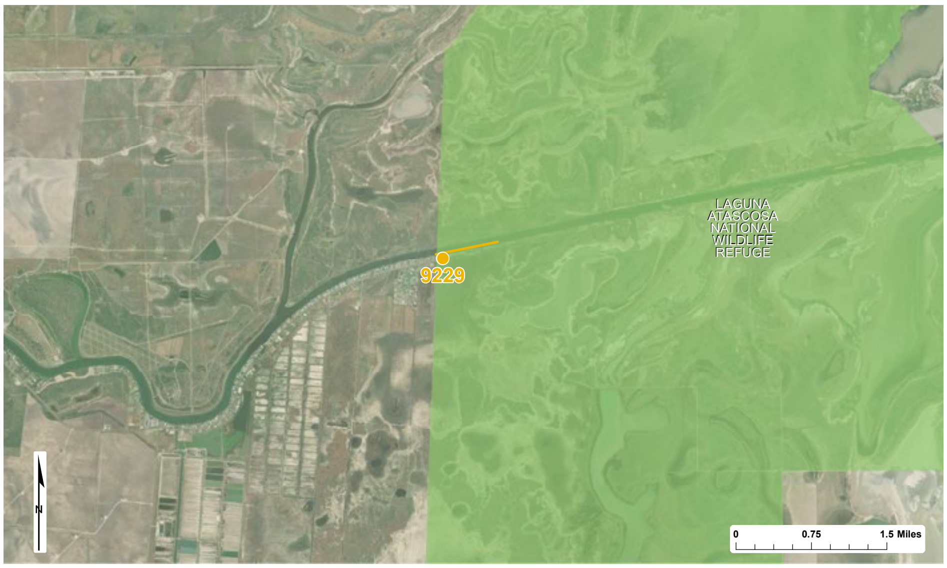
Adolph Thomae, Jr. Park Living Shoreline Restoration - Phase 5 *(9229)*

Estimated Project Cost: $5,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Park located about 5 miles inland of the mouth of the Arroyo Colorado

STATUS:
Shovel Ready

STAKEHOLDERS:
- ***Cameron County***
- U.S. Fish and Wildlife Service

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization

Project Description
This project is to complete the final work remaining of the Adolph Thomae, Jr. Park Shoreline Restoration project. Phase 5 includes stabilization of 2,960 linear feet of eroding shoreline through construction of a living shoreline and a breakwater initially designed and permitted during Phase 3 of the project. Phases 3 and 4 have been declared substantially completed and a final completion certificate was issued in 2022. The living shoreline consists of a stone rip rap breakwater and vegetated slope stabilization (called a habitat bench) that will be constructed along 2,760 linear feet of shoreline. The other breakwater design consists of a stone rip rap breakwater oriented parallel to the shoreline in the nearshore zone along 200 linear feet of shoreline. Construction and cost of the remaining stabilization measures includes final design, construction services, monitoring, and grant administration.

Project Need
If corrective measures to stabilize the existing shoreline are not taken, parks facilities and infrastructure will remain in critical danger of being lost due to erosion from vessel traffic, flooding, and storm surges. Continual impact could compromise recreational opportunities for this area for thousands of visitors. Construction of the living shoreline and breakwater will help protect the shoreline of Adolph Thomae, Jr. Park, which is an important community resource and tourist attraction. The living shoreline design will also help improve water quality and provide habitat for marine wildlife.

POTENTIAL LOCAL BENEFITS

✓	High	✓
Decreased Wave Energy	Social Vulnerability	Public Access Improvements

15	14
Endangered Species	Migratory Bird Species

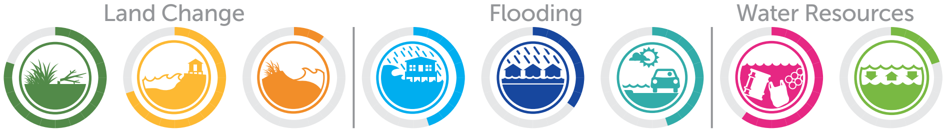
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

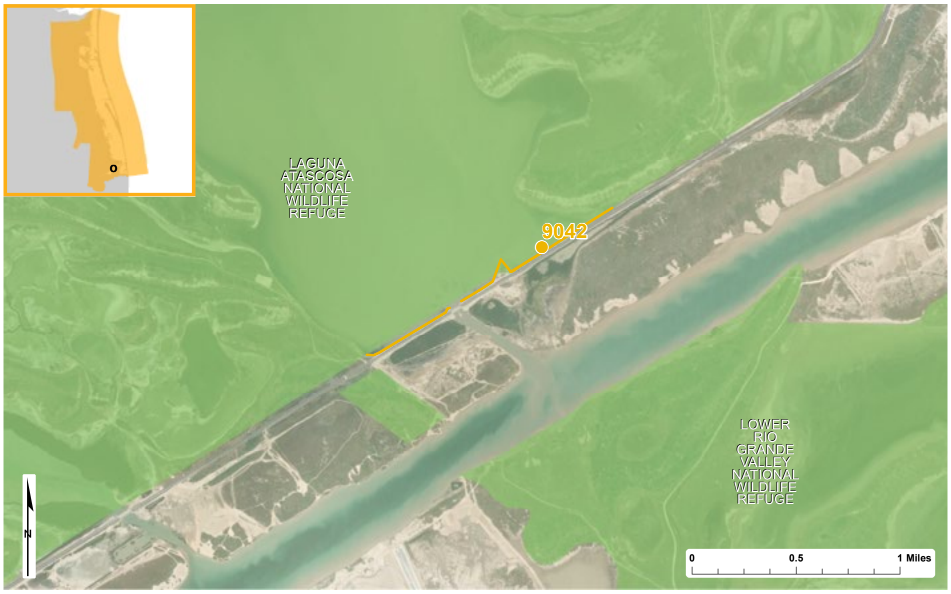
Bahia Grande Living Shoreline *(9042)*

Estimated Project Cost: $6,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





Project Description

Work to restore the hydrologic connectivity and biological productivity of the Bahia Grande has been ongoing since 2005. Currently, the shoreline proposed for restoration as a continuation of this effort is rapidly eroding due to waves and sea level rise and is encroaching on SH 48. There is not enough space for parking to support the nearshore areas that are a public amenity used for recreational fishing. Moreover, the riprap along the shoreline has exposed rebar that poses a threat to public safety when pedestrians traverse the area to access fishing locations. The priorities for the project include 1 mile of erosion control, environmental resource improvement, fixing unsafe riprap, public recreation access, safe and uninterrupted public transit, and parking expansion. Phase 1 of the project will include the replacement of the riprap with a living shoreline, designed to extend from the existing shoreline at a slope mimicking the naturally occurring Bahia Grande fringe wetlands and improving biological productivity and complexity, among other nature-inspired designs.

Project Need

The current public use demand for the shoreline area is more than the existing facilities can handle, resulting in health and safety concerns surrounding the vehicular and pedestrian traffic. The number of visitors to the Bahia Grande is having a negative impact on the area, as those seeking to access the water inundate the designated parking areas and spill onto the roadside, tidal flats, and surrounding vegetation.

LOCATION:

Shoreline along SH 48 and the Bahia Grande

STATUS:

Conceptual

STAKEHOLDERS:

- ***Cameron County***
- Port of Brownsville
- Texas Department of Transportation
- Texas General Land Office
- The University of Texas Rio Grande Valley
- U.S. Fish and Wildlife Service

ACTIONS:

PROJECT TYPE(S):

Shoreline Stabilization; Habitat Creation and Restoration; Public Access Improvements

POTENTIAL LOCAL BENEFITS

2 Wetland Types

High Social Vulnerability

1 Critical Facility

105 Existing Wetland Carbon Sequestration (tons C)

15 Endangered Species

21 Migratory Bird Species

10,000 Trips on Evacuation Route (Daily)

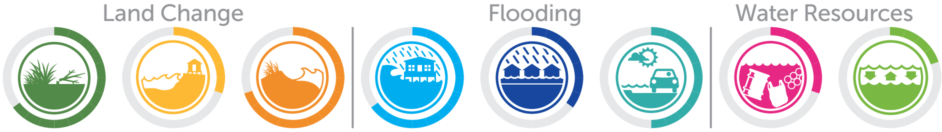
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

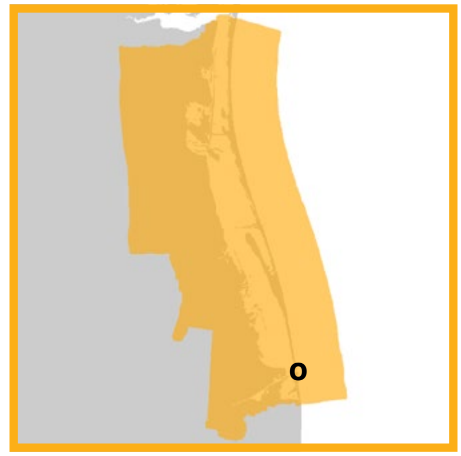
Beach and Dune System Monitoring Program for Willacy and Cameron Counties *(9298)*

Estimated Project Cost: $850,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Gulf shoreline of Willacy and Cameron counties

STATUS:
Conceptual

STAKEHOLDERS:
- ***Cameron County***
- Willacy County
- City of South Padre Island

ACTIONS:

PROJECT TYPE(S):
Studies, Policies, and Programs

POTENTIAL LOCAL BENEFITS

✓	1	✓
Addressing Data Gaps	Wetland Type	Education & Outreach

High Social Vulnerability

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Project Description

This project seeks funding to establish an optimized beach-dune monitoring and nourishment/restoration program based on routinely collected photogrammetry and multispectral remote sensing data, as well as data collected immediately after significant events (e.g., tropical storms, king tides). The information will be processed and posted on a digital platform for the public, government agencies, researchers, and others to access. The output of post-processing the data will show the areas of South Padre Island the beach dune system is most vulnerable that can then be the focus of subsequent beach nourishment efforts. This project will be complementary to the annual Texas General Land Office (GLO) Beach Monitoring and Maintenance Program (BMMP) and will provide sufficient data to easily and scientifically quantify sand losses that can be accounted for in Federal Emergency Management Agency (FEMA) disaster declarations. If a given tropical storm event warrants a federal disaster declaration, the BMMP survey and analysis become the basis for the GLO's pursuit of FEMA Public Assistance program claims.

Project Need

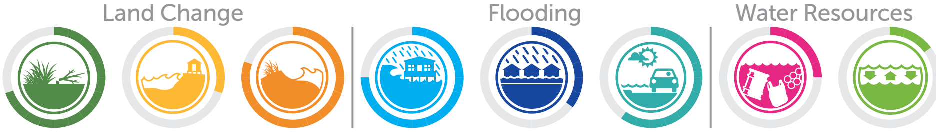
The data collected will provide much needed information on beach-dune system morphology and vegetation changes over time and the impacts that various meteorological phenomena have on the natural resiliency of the system.

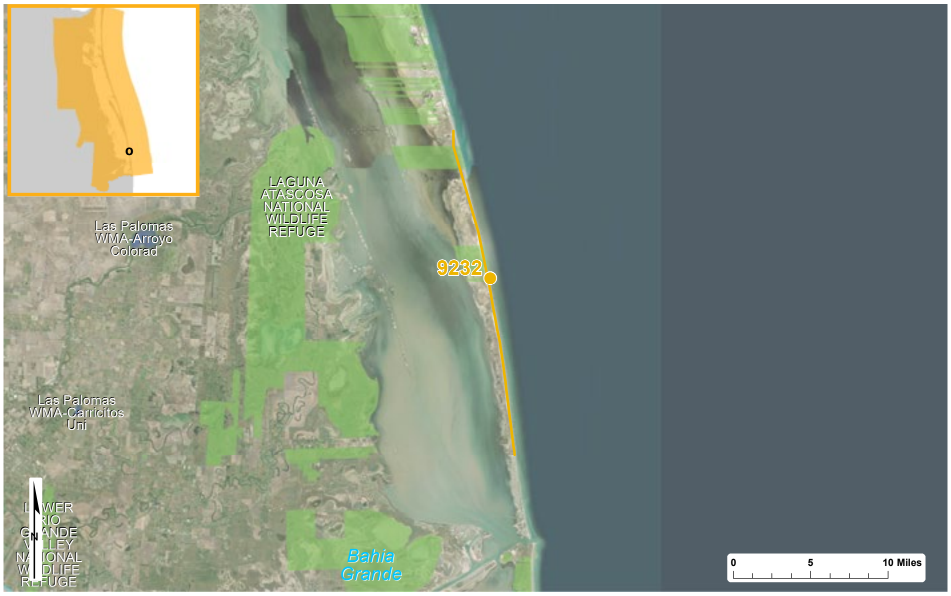
Cameron County Beach Nourishment *(9232)*

Estimated Project Cost: $285,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Northern end of South Padre Island

STATUS:
Permitted (partially)

STAKEHOLDERS:
- ***Cameron County***
- City of South Padre Island

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Beach Nourishment

Project Description

This project will conduct beach nourishment activities within a 600-foot construction width along 14 miles of shoreline within Cameron County's jurisdiction, including Isla Blanca Park, Andy Bowie Park, and the remaining 12 miles of shoreline north of the City of South Padre Island. Permits for placement along the parks mentioned have been secured, but a permit for the remaining 12 miles is still needed. The 600-foot construction width will include a 300-foot berm crest and a 300-foot slope to the toe of fill to match the existing permitted dimensions of beach nourishment templates to the south of Andy Bowie Park. Sand from a beneficial use borrow source located near the Brazos Santiago Pass or other future identified and permitted sources will be used for beach nourishment activities, and phasing of these activities is based on overall sediment availability and local funding for cost sharing. In August 2022, the U.S. Army Corps of Engineers, in partnership with Cameron County and the City of South Padre Island, completed a Regional Sediment Management Plan. This plan will be used to determine the optimal location of beneficial use of dredged material placement, depending on the time of the year when it will take place, among other factors.

Project Need

Beaches along South Padre Island have been affected by sea level rise, a degraded sand system, and erosion from tropical storms and storm surge. Beach nourishment is needed to combat erosion of the shoreline and enhance and replenish the offshore sand system.

POTENTIAL LOCAL BENEFITS

1	High	✓
Wetland Type	Social Vulnerability	Avoided Future Flood Risk

✓	1
Decreased Wave Energy	Critical Facility

12	31
Endangered Species	Migratory Bird Species

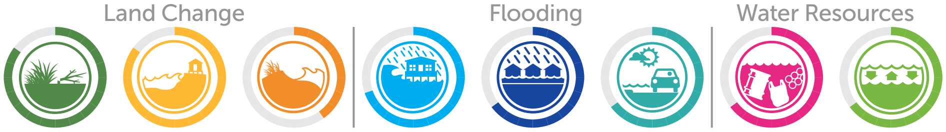
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

City of South Padre Island Living Shoreline *(9123)*

Estimated Project Cost: $12,500,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Bay side of South Padre Island, just north of the Queen Isabella Causeway

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***City of South Padre Island***
- National Fish and Wildlife Foundation

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description

This project would construct a living shoreline as a first step toward modernizing the City of South Padre Island's shoreline protection methods. Traditionally, shorelines in this area have been stabilized using hard materials and structures, such as rip rap and bulkheads. The project would improve many of these areas by using natural infrastructure placed along the bayside of the City of South Padre Island. Specifically, "laguna bibs," or pockets of living shoreline, would be installed between the Laguna Madre and the deeper Tompkins Channel. These living shoreline areas would restore the black mangroves, seagrasses, and oyster habitats that are declining in the region. Recreational fishing is one of the Laguna Madre's biggest draws, and it has also been shown that wetlands and oyster beds lead to better fishing due to the shelter that they provide for juvenile fisheries. Maintaining access routes to the Laguna Madre would be an important consideration during the project design phase.

Project Need

Black mangroves, oysters, and seagrasses have declined in the Laguna Madre due to natural and human-induced causes (e.g., changes in freshwater inflows and salinity, inadequate protection from ship wakes). This leaves the majority of the City's bay side exposed directly to wave action against existing rubble riprap and concrete bulkheads. This project would serve as environmental restoration for the area and provide environmental uplift for the bay side of the island. Individuals who live on the bay side would see an increase in the buffer zone between their properties and the bay, reducing nuisance flooding.

POTENTIAL LOCAL BENEFITS

5 Critical Facilities

1 Wetland Type

✓ Seagrass Protected

$1.79B Building Replacement Value

High Social Vulnerability

1,140 Homes

$111.45M Structure Damage (1% Storm)

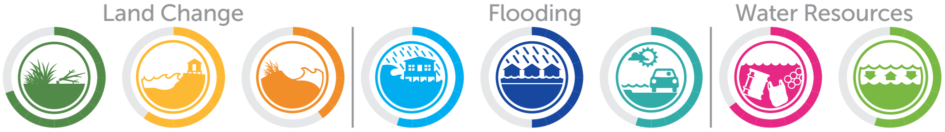
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

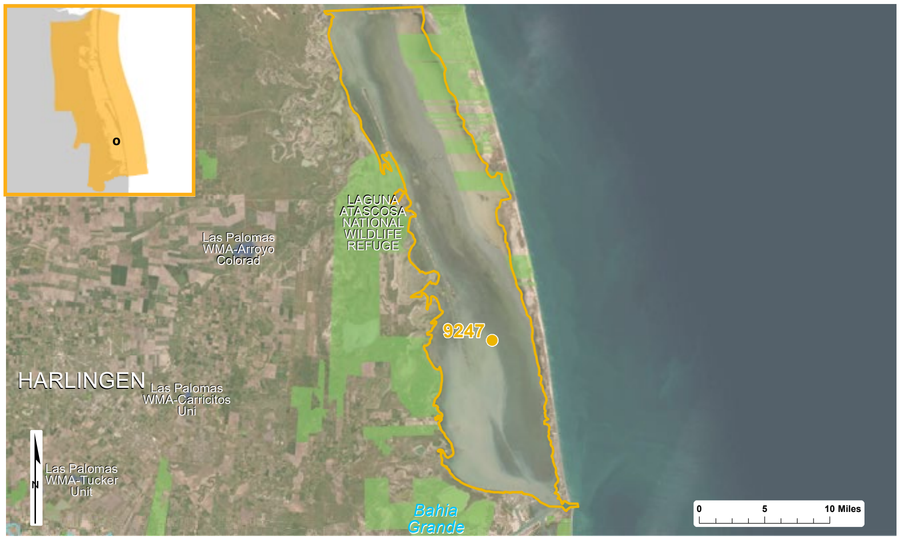
Developing a Comprehensive Conservation and Resiliency Management Plan for the Lower Laguna Madre *(9247)*

Estimated Project Cost: $1,200,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





Project Description

Coastal resiliency of human society and coastal ecosystems are inextricably tied together. The Lower Laguna Madre (LLM) is a vibrant ecosystem and hosts most of the seagrass in Texas, which results in a very productive fishery. This project will develop a Comprehensive Conservation and Resiliency Management Plan to provide long-term management of living resources of the Lower Laguna Madre, which are critical to the coastal economy. A diversity of local stakeholders and state agencies will develop and implement the plan based on local priorities. These efforts will be guided by a consensus-building approach that involves community members in the decision-making process aimed at sustaining local ecosystems and communities to withstand, adapt to, and recover from adverse situations. This effort will result in a collaborative, effective, efficient, and adaptable coastal ecosystem-based network.

Project Need

There are no state agencies with a comprehensive approach to manage the LLM and conserve and protect its attributes. Multiple state agencies monitor and/or manage portions of the ecosystem but there is no lead entity. The stakeholders will lead the effort to provide long-term management of living resources of the LLM with simultaneous attention to the resiliency of local communities. This project would build a comprehensive management and resiliency plan that would help to alleviate and mitigate impacts observed in the LLM such as coastal development, eutrophication, changes in freshwater inflow, and heavy recreational use.

LOCATION:

Lower Laguna Madre

STATUS:

Conceptual

STAKEHOLDERS:

- ***University of Texas-Rio Grande Valley***
- ***Texas Water Development Board***
- Lower Laguna Madre Estuary Partnership
- Cameron County
- Kenedy County
- Wilacy County
- Brooks County
- Hidalgo County
- Starr County

ACTIONS:

PROJECT TYPE(S):

Studies, Policies, and Programs

POTENTIAL LOCAL BENEFITS

✓ Support Funding Eligibility

✓ Education & Outreach

✓ Seagrass Protected

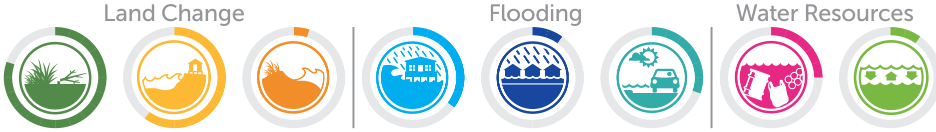
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

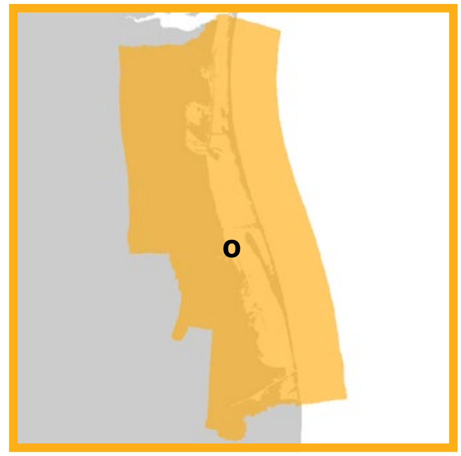
Protection and Restoration of Benny's Shack Islands *(1393)*

Estimated Project Cost: $4,700,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Northern portion of the Laguna Madre

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Coastal Bend Bays & Estuaries Program***
- U.S. Fish and Wildlife Service
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

Project Description

The Coastal Bend Bays & Estuaries Program (CBBEP) and the Texas General Land Office have partnered on a project to restore and protect rookery islands in Aransas Bay, the Upper Laguna Madre, and the Lower Laguna Madre (LLM). In the LLM, the project will focus on Benny's Shack Islands, which are eroding rapidly. CBBEP has contracted with an engineering firm to perform an alternatives analysis, permitting, data collection, and preliminary design (70%) for Benny's Shack Islands. Once engineering/design and permitting are complete, CBBEP will seek funds for the construction of the chosen design. It is anticipated that erosion will be addressed through construction of a breakwater structure that will protect the shoreline, while also serving to retain sediment from dredge placement events in the nearby Gulf Intracoastal Waterway.

Project Need

Texas colonial waterbirds typically nest in spring/summer months in dense groups on small islands in the bays. Threats such as development, habitat loss, and human disturbance are taking their toll. Long-term data show that the majority of colonial waterbird populations in Texas are declining, some by as much as 60-70%. The rookery islands known as Benny's Shack have historically supported a large number of nesting waterbirds, but erosion on the northern shoreline due to winds from severe cold fronts is causing the loss of nesting habitat. The high rate of erosion is causing considerable loss of very old mature brush that supports a diverse community of nesting wading birds, making this a project of great urgency.

POTENTIAL LOCAL BENEFITS

✓ Seagrass Protected	High Social Vulnerability	1 Wetland Type
2 Rookery Islands	10 Endangered Species	✓ Addressing Data Gaps

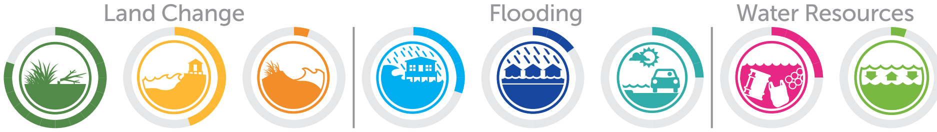
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Protection and Restoration of Rabbit Island South *(1394)*

Estimated Project Cost: $3,300,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources

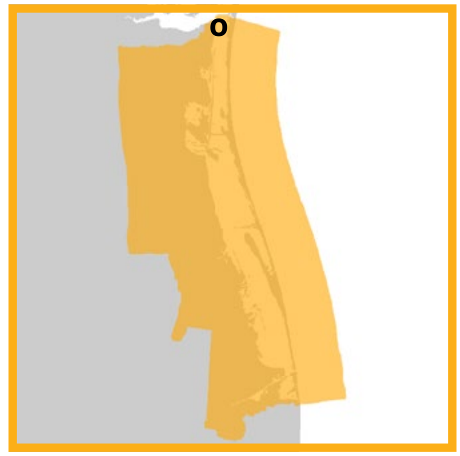


Project Description

As part of a Texas General Land Office (GLO) grant to Ducks Unlimited, stakeholder input was coordinated to identify and receive information about potential beneficial use of dredged material sites. Based on stakeholder input, GLO feedback, publicly available data, and professional judgment, the project team selected Rabbit Island South and completed a 60% design, cost estimate, and permit application package. This island, located south of the original Rabbit Island, is one of the highest priority islands in the area to conserve and restore for avian and other wildlife species. Protective shoreline stabilization structures would need to be constructed, likely from rock, and the target area needed to effectively restore the island is 5 to 8 acres. Topographic and bathymetric surveys have been completed, and a preliminary assessment of seagrass presence and soil sampling have been conducted. The Coastal Bend Bays & Estuaries Program has been working closely with Ducks Unlimited on this project and is prepared to seek funding for the construction phase once additional planning and permitting work is complete.

Project Need

Rookery islands in the Upper Laguna Madre suffered heavy damage from Hurricane Hanna. The islands are now almost completely gone. There is concern that the islands in this system could be underwater within two years if restoration and protection efforts are not undertaken. Restoration is needed to secure, restore, and stabilize the islands in this system.



LOCATION:
Bird rookery island in the Upper Laguna Madre near Baffin Bay

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Coastal Bend Bays & Estuaries Program***
- Texas General Land Office
- U.S. Army Corps of Engineers
- TxDOT
- Ducks Unlimited

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Shoreline Stabilization

POTENTIAL LOCAL BENEFITS

✓ Seagrass Protected	High Social Vulnerability	1 Wetland Type

54 Existing Wetland Carbon Sequestration (tons C)

1 Rookery Island	10 Endangered Species	4 Migratory Bird Species

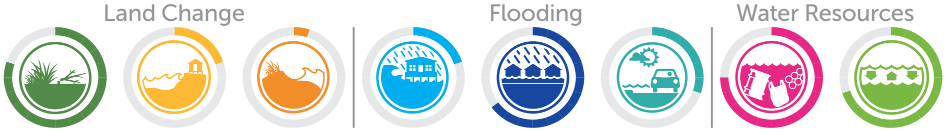
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

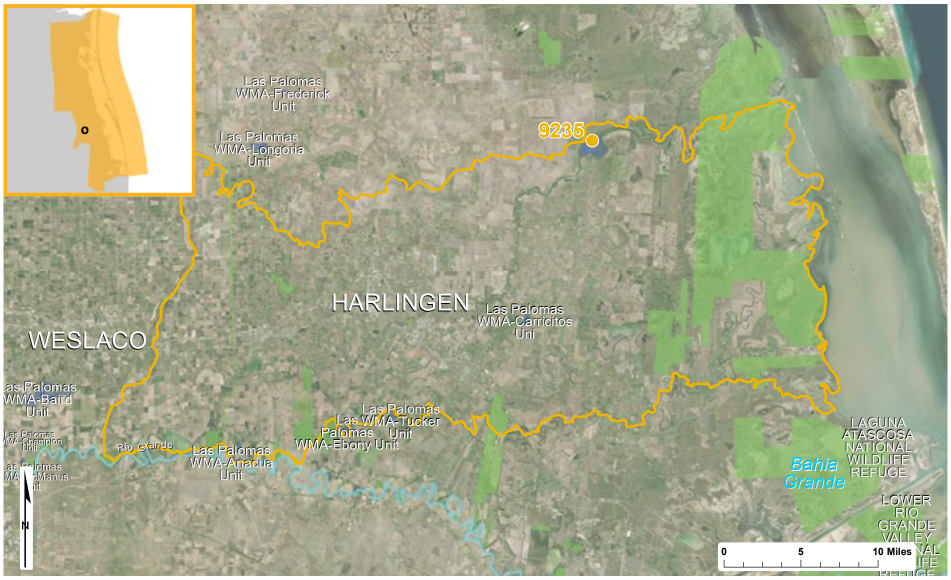
Resaca System Restoration Project - Phase 1 *(9235)*

Estimated Project Cost: $1,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





Project Description

In southeastern regions of Cameron County, there is a system of vestigial and abandoned meandering distributary canals of the Rio Grande known as resacas. Historically, these naturally leveed, low-lying geologic features hosted a unique habitat but have lost their original hydrologic function due to human impacts on the watershed. Over the years, these resacas have been disconnected by roads, railway crossings, and dikes, and only a few sections have preserved some of their natural functions. This project would restore the resacas' hydrologic and ecosystem capabilities by diverting water from the Arroyo Colorado to the Resaca de Los Fresnos, subsequently hydraulically connecting several resacas and restoring their ecosystem services and ecologic functions. The first phase of this project would be to complete a feasibility level analysis; authorization and funding are needed.

Project Need

This project is necessary to return the hydrological and ecological functions of resacas to manage flood risk for neighboring communities. The benefits resulting from this multipurpose project include increased multi-jurisdictional resilience, restored hydrologic functionality of the watershed, enhanced water quality using nature-based solutions, rehabilitated habitat, and ecosystem services restoration. At a social level, the implementation of this project will further advance the County's and U.S. Army Corps of Engineers' objectives to take meaningful actions towards economically disadvantaged communities.

LOCATION:

Distributary canals (resacas) in the Rio Grande region, specifically the Arroyo Colorado

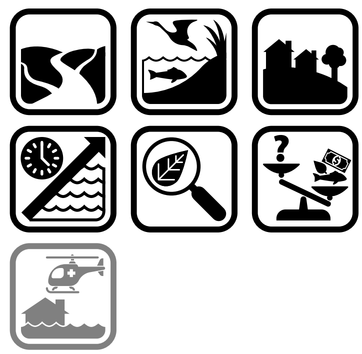
STATUS:

Conceptual

STAKEHOLDERS:

- ***Cameron County***
- U.S. Army Corps of Engineers
- Texas Water Development Board
- Lower Laguna Madre Estuary Partnership
- City of Combes
- City of Harlingen
- City of La Feria
- City of Primera
- City of Santa Rosa

ACTIONS:



PROJECT TYPE(S):

Studies, Policies, and Programs; Hydrologic Connectivity

POTENTIAL LOCAL BENEFITS

✓	High	2
Seagrass Protected	Social Vulnerability	Wetland Types

6,211
Trips on Evacuation Route (Daily)

17	415	1
Endangered Species	Critical Facilities	Critical Habitat

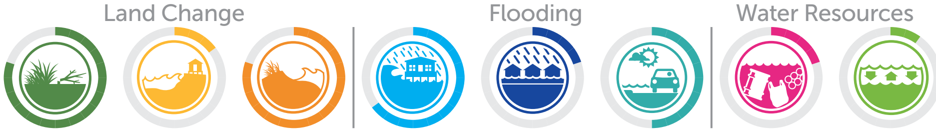
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Restoration of Sea Turtle Nesting Beach at Padre Island National Seashore *(1341)*

Estimated Project Cost: $3,800,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Padre Island National Seashore

STATUS:
Conceptual

STAKEHOLDERS:
- ***National Park Service***
- U.S. Fish and Wildlife Service
- Texas Parks & Wildlife Department
- Port of Port Mansfield

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Beach Nourishment

Project Description

This project will fund the beneficial use of dredge material from dredging activities in 2023 and 2026, with placement of dredged material upon the beach north of the Mansfield Channel along Padre Island National Seashore. Each event will have two phases, one for engineering and design and the second for implementation, and will move approximately 174,000 cubic yards of sand. The National Park Service (NPS) Denver Service Center will provide project and contract management support for the NPS in establishing an interagency agreement with the U.S. Army Corps of Engineers.

Project Need

Suitable nesting beaches are critical for maintaining healthy sea turtle populations. However, in many locations, nesting beach habitat is being lost or compromised due to sea level rise, encroachment, and erosion. Erosion specifically is a compromising factor at Padre Island National Seashore (PINS), which supports the largest nesting population of endangered Kemp's ridley sea turtles in the U.S. While PINS staff have made tremendous efforts to protect and enhance Kemp's ridley nesting habitat, the nesting beach at the south end of PINS is eroding due to a lack of natural renourishment. The shoreline average rate of change from 2017-2019 alone (-12.07 ft/yr) is 4.5 times greater than the average rate of change from 1930-2012 (+2.69 ft/yr). An eroding shoreline limits the availability of nesting habitat at PINS and could in the future reduce the population of Kemp's ridley sea turtles. Therefore, reducing the amount of erosion and restoring the beach is a priority.

POTENTIAL LOCAL BENEFITS

10	High	1
Endangered Species	Social Vulnerability	Wetland Type

15 Migratory Bird Species

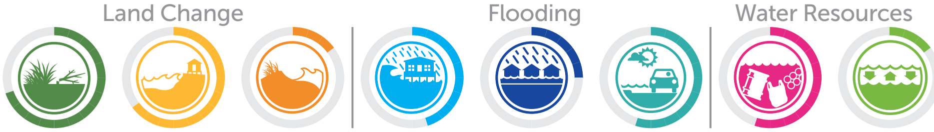
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

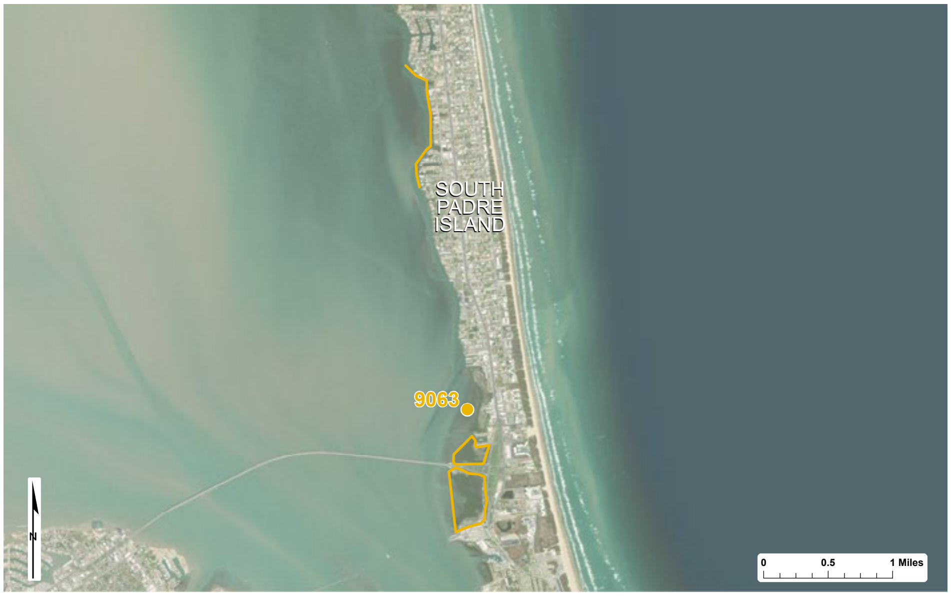
Restore Barrier Island Bayside Wetlands on South Padre Island *(9063)*

Estimated Project Cost: $20,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Bay side of South Padre Island

STATUS:
Conceptual

STAKEHOLDERS:
- ***City of South Padre Island***
- Texas General Land Office

ACTIONS:

PROJECT TYPE(S):
Shoreline Stabilization; Habitat Creation and Restoration

POTENTIAL LOCAL BENEFITS

✓	1	36
Decreased Wave Energy	Critical Habitat	Migratory Bird Species

$348M
Building Replacement Value

12	210	4
Endangered Species	Homes	Critical Facilities

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Project Description

This project would restore the wetlands on the bay side of South Padre Island by depositing dredged, non-beach quality materials in a beneficial use approach to help rebuild degraded wetlands. This would help mitigate the impacts of relative sea level rise, sediment redistribution, and erosive wave action. With depositing non-beach quality beneficial material, new intertidal wetlands could replace riprap street endings and introduce vital marsh habitat. The areas specifically targeted for restoration would be the state-owned submerged land north of the causeway landing, the shoreline of Lis Memorial Park, and some of the areas along the western side of the island around the City's western street endings of: Huisache, Oleander, Gardenia, Hibiscus, Saturn, Venus, Jupiter, Mars, Aries, Verna Jean, Georgia Ruth, Carolyn, and Cora Lee. This project will be complementary to the City's ongoing Tier 1 project for a living shoreline along Tompkins Channel.

Project Need

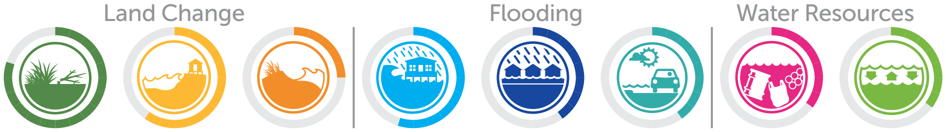
Wetlands have declined along the bay side of South Padre Island due to a variety of human-induced and other environmental factors. As a result, residents of South Padre Island are losing the wave and water level attenuation provided by mangroves and other wetland habitats, one of their most effective natural protections against coastal flooding.

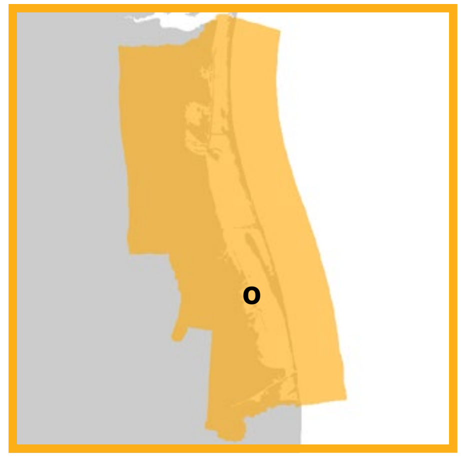
Restore Laguna Madre Rookery Islands *(9062)*

Estimated Project Cost: $14,400,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Rookery islands in the bay areas between North Padre Island, South Padre Island, and the mainland

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Texas Parks & Wildlife Department***
- Texas General Land Office
- U.S. Fish and Wildlife Service

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description

This project would restore approximately eight eroding islands located south of Mansfield Channel and north and south of the Arroyo Colorado. The project also could restore one to two additional islands in the upper Laguna Madre, which have similar erosion problems, if funding is available. Most of these rookery islands were originally created by beneficially using dredged material from the construction and maintenance of the Gulf Intracoastal Waterway and function within the broader network of Texas coastal rookery islands. Restoring the islands would likely involve a combination of any or all of the following activities: using additional sediment material to restore island elevations, adding shoreline stabilization, and reestablishing native habitat.

Project Need

Rebuilding and maintaining Texas rookery islands is critical to ensure migratory bird and shorebird populations remain stable across the state, which supports nature tourism in the surrounding areas. The GLO's Coastal Management Program funded a 2016 study of "Predicted Waterbird Habitat Loss on Eroding Texas Rookery Islands," which identifies and ranks islands with the most strategic restoration needs. The selected islands for restoration within this project range from "medium" to "extremely high" risk of erosion within the next 10 years based on that report.

POTENTIAL LOCAL BENEFITS

7	1	12
Migratory Bird Species	Wetland Type	Endangered Species

High
Social Vulnerability

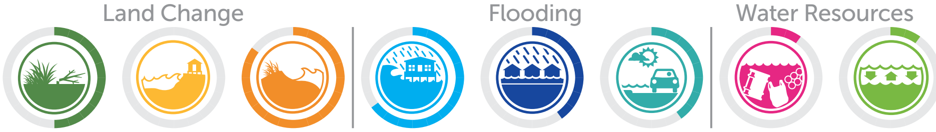
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

South Padre Island Beach and Dune Management and Restoration *(145)*

Estimated Project Cost: $89,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Gulf shoreline of the City of South Padre Island

STATUS:
Shovel Ready

STAKEHOLDERS:
- ***City of South Padre Island***
- Cameron County
- Texas General Land Office
- U.S. Army Corps of Engineers

ACTIONS:

PROJECT TYPE(S):
Beach Nourishment;
Dune Restoration

Project Description

The City of South Padre Island's beach and dune system is a widely recognized symbol of the South Texas coastline and has been partially preserved through the beneficial use of dredged material (BUDM) from the Brownsville Ship Channel since 1988 under a perpetual Memorandum of Agreement between the U.S. Army Corps of Engineers (USACE) Galveston District and the Texas General Land Office (GLO). This project would fund annual beach renourishment along the eroding shoreline. Additionally, annual beach monitoring surveying, analysis, and reporting are undertaken as part of the project. Whenever possible, the City of South Padre Island, as the permit holder, and Cameron County work alongside GLO and USACE to place BUDM on beaches when regular dredging at the channel occurs. The most recent onshore placement of material took place from May to July 2021 and included approximately 355,250 cubic yards. Three-quarters of the material (75%) was placed in Placement Area 5 within the northern City limits and one-quarter (25%) of the material was placed in Isla Blanca Park.

Project Need

Gulf shoreline erosion occurs across the island at a regional scale, impacting County and City beaches, leading to potential damage to the environment, private property, and public infrastructure while hindering economic development. The Gulf shoreline erosion rate along much of the island averages between 10 to 15 ft/yr. The beaches and dunes are the primary defense against storm surge from tropical storms and hurricanes to islanders and bayfront communities on the mainland.

POTENTIAL LOCAL BENEFITS

160 Homes

1 Wetland Type

$41.1M Structure Damage (1% Storm)

$723M Building Replacement Value

2 Critical Facilities

High Social Vulnerability

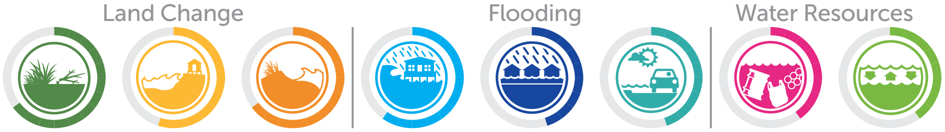
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

South Padre Island Coastal Beach Protection *(9051)*

Estimated Project Cost: $25,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources



LOCATION:
Northern portions of South Padre Island

STATUS:
Ongoing

STAKEHOLDERS:
- ***U.S. Fish and Wildlife Service***
- The Nature Conservancy

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration; Land Acquisition

Project Description

Under this project, funding would be used to acquire numerous undeveloped properties that are for sale on the northern end of South Padre Island. The U.S. Fish and Wildlife Service, as stewards of the Laguna Atascosa National Wildlife Refuge, would manage the available tracts. This project would protect the barrier island from erosion and reduce negative impacts on human life and communities from sea level rise, coastal storms, and morphologic barrier island changes (e.g., island landform migration) by precluding development on environmentally sensitive areas. Natural landscapes and floodplains filter pollutants from point and nonpoint sources, promote nutrient cycling, and help retain sediment. This project would protect the natural habitats and ecosystems from human encroachment that could cause native species to diminish.

Project Need

Barrier islands, by nature, are dynamic environments that are, on a geological scale, constantly changing in location and size. Barrier islands also are a first line of defense for storm surge protection. The area is also a world-renowned migratory route for many species of birds. Preserving undeveloped properties would safeguard important foraging and nesting habitat for various bird species.

POTENTIAL LOCAL BENEFITS

17	1	13
Migratory Bird Species	Critical Habitat	Endangered Species

High Social Vulnerability

2	✓
Wetland Types	Avoided Future Flood Risk

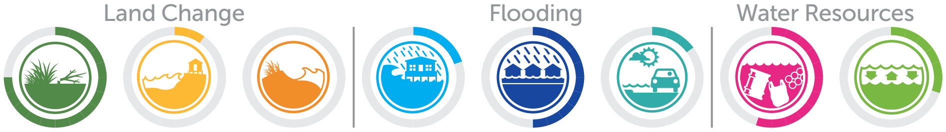
456.7k
Existing Wetland Carbon Sequestration (tons C)

**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Columbia Bottomlands Ecosystem Preservation *(1284)*

Estimated Project Cost: $4,700,000 per year

ABILITY TO ADDRESS VULNERABILITIES



LOCATION:
The Colombia Bottomlands, San Bernard National Wildlife Refuge, and agricultural lands in the Brazos River and San Bernard River Floodplains

STATUS:
Acquisition Pending

STAKEHOLDERS:
- ***Texas Conservation Partners***
- ***The Nature Conservancy***
- Natural Resources Conservation Service
- Houston Endowment
- Friends of Brazoria Wildlife Refuges
- U.S. Fish and Wildlife Service
- Coastal Prairie Conservancy

ACTIONS:

PROJECT TYPE(S):
Land Acquisition; Habitat Creation and Restoration

Project Description

The U.S. Fish and Wildlife Service (USFWS)'s Columbia Bottomlands (Austin's Woods) Conservation Plan was developed to conserve the unique and internationally significant wetland forest ecosystem of the Columbia Bottomlands found along the Texas Mid-Coast in Brazoria, Fort Bend, Wharton, and Matagorda counties. In the updated Land Protection Plan, USFWS has initiated the acquisition of an additional 40,000 acres of bottomland forest and associated coastal wetlands on the Gulf of Mexico. Under this project, agricultural lands in the Brazos River and San Bernard River floodplains would be acquired and bottomland hardwood forest habitats would be restored. Approximately 10,000 acres have been acquired to date, but additional funding is requested to complete the project. The acquired and restored land would be added to the Columbia Bottomlands conservation area, which is part of the San Bernard National Wildlife Refuge. The project protects freshwater inflow to coastal estuaries. Acquisition of habitat will provide public benefits in the form of recreational uses as well as educational and research opportunities.

Project Need

The Columbia Bottomlands are the only significant expanse of forest adjacent to the Gulf of Mexico in Texas. They are home to large populations of birds and wildlife, including more than 400 different species. Coastal streams flow through the Columbia Bottomlands watersheds and include marshes, creeks, sloughs, bayous, and the San Bernard, Brazos, and Colorado Rivers. However, the Columbia Bottomlands ecosystem continues to lose thousands of acres of forested habitat each year. Remaining bottomland tracts are threatened with urbanization, logging, drainage and clearing for agriculture, floodplain development, and industrial construction.

POTENTIAL LOCAL BENEFITS

16	✓	3
Endangered Species	Protected Habitat in the Area	Critical Habitats

Medium

Social Vulnerability

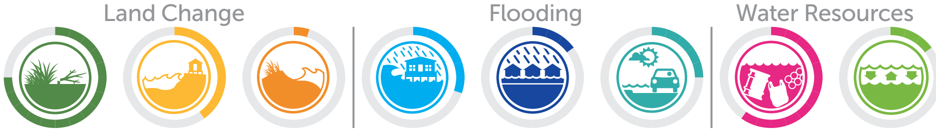
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

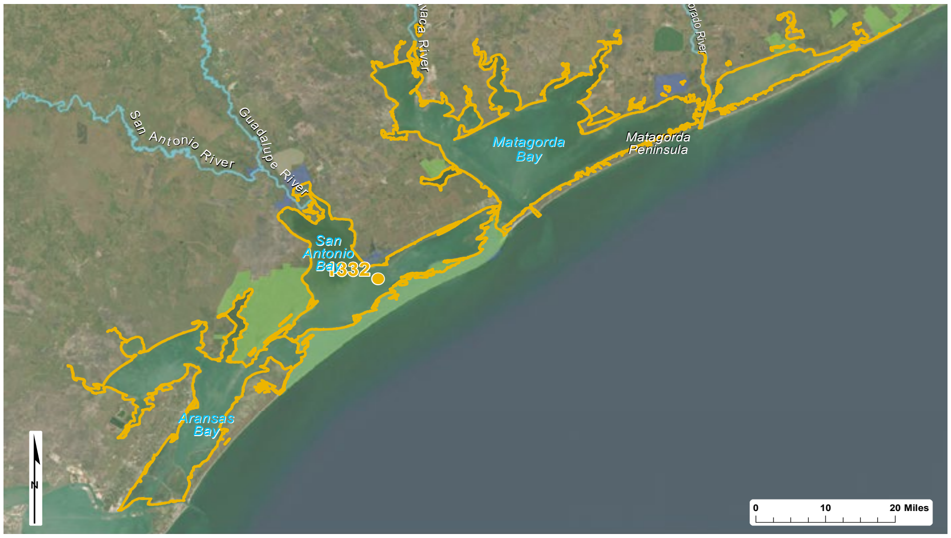
Paired Subtidal and Intertidal Oyster Reef Restoration in Texas Bays *(1332)*

Estimated Project Cost: $1,000,000

ABILITY TO ADDRESS VULNERABILITIES

Land Change | Flooding | Degraded Water Resources





LOCATION:
Copano-Aransas Estuary, Guadalupe Estuary, and Lavaca-Colorado Estuary

STATUS:
Engineering & Design

STAKEHOLDERS:
- ***Texas A&M University-Corpus Christi Harte Research Institute***
- Texas General Land Office
- Texas Parks & Wildlife Department
- Coastal Conservation Association
- National Oceanic and Atmospheric Administration

ACTIONS:

PROJECT TYPE(S):
Habitat Creation and Restoration

Project Description

This project will restore subtidal and intertidal oyster habitats in the Copano-Aransas Estuary (specifically the Mission-Aransas National Estuarine Research Reserve), Guadalupe Estuary, and the Lavaca-Colorado Estuary to fully support their role in estuarine ecosystems. In Texas estuaries, oyster reefs exist in both the deeper, subtidal region, as well as the harsher, intertidal region, which experiences greater exposure to wave energy and other environmental challenges. Although the spatial configuration of intertidal oyster reefs is less complex than that of subtidal oyster reefs, preliminary data show that faunal abundance on intertidal reefs is greater by several orders of magnitude. These data also suggest that biomass and community composition of intertidal reefs are unique. Restored habitats will be monitored after construction to gain much needed insight to guide restoration methods to maximize habitat value and ecosystem function.

Project Need

Oyster reefs were once dominant habitat features in many estuarine systems; however, they are now one of the most degraded marine habitats on Earth, with estimates suggesting that more than 85% of oyster reefs have been lost globally. Overharvesting and loss of reef habitat compromises the ability of oyster reefs to support high productivity and abundant marine life and provide valuable ecosystem services. While restoration efforts are commonly undertaken to restore subtidal reefs where commercial harvest is allowable, recent occurrences of redirected harvest on intertidal oyster reefs has increased the need for restoration of these distinctive reef types.

POTENTIAL LOCAL BENEFITS

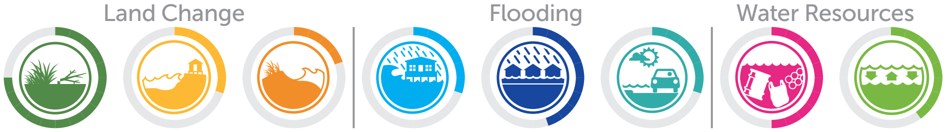
15	✓	2
Endangered Species	Oyster Habitat Protected/ Created	Critical Habitats

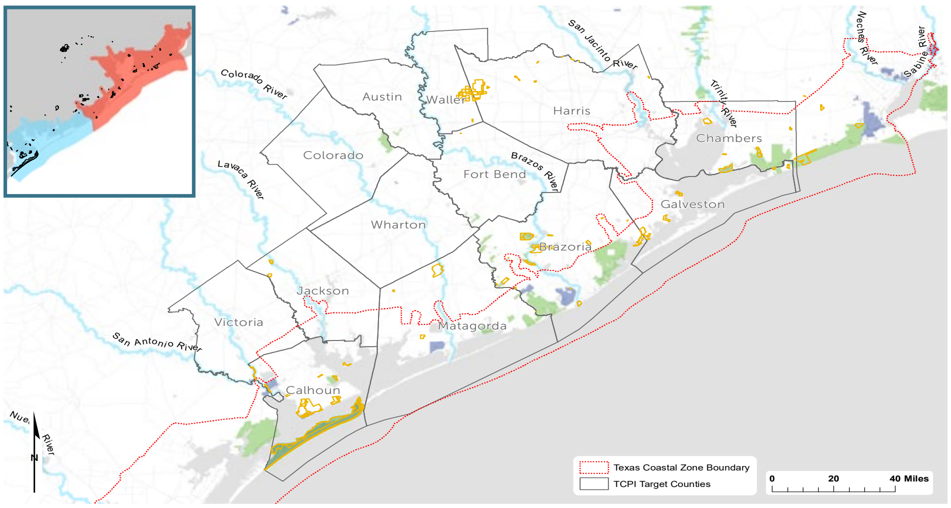
**For more information on cost estimates and project benefits calculations, see page 132 of the 2023 Texas Coastal Resiliency Master Plan.*

Texas Coastal Prairie Initiative *(9216)*

Estimated Project Cost: $3,500,000 per year

ABILITY TO ADDRESS VULNERABILITIES





Project Description

The Texas Coastal Prairie Initiative (TCPI) is a regional initiative involving 25 partners including land trusts, government agencies, universities, and other entities that are collaborating to identify and protect the coastal prairie ecosystem on the Texas mid- to upper-coast, a region under high threat of development. The program provides funding to private landowners that perform beneficial habitat management practices and/or enter conservation easements to permanently protect their land. Projects are screened based on scoring criteria that identify the highest value projects for conservation of the coastal prairie based on vegetation diversity and habitat value, habitat for priority species, scale and strategic location, and watershed value. High-scoring projects are eligible to receive cost share assistance from the Natural Resources Conservation Service (NRCS); funding is sought for the remaining project cost, including due diligence and transaction costs, and to fund additional high-scoring projects when the cost of eligible projects exceeds the annual funding available from NRCS.

Project Need

The coastal prairie ecosystem requires large, contiguous, protected areas to survive, as the foraging, mating, and brood-rearing requirements of many species require large, connected areas of land to maintain healthy populations. Timing is of the essence in entering conservation projects with private landowners, and the process for selecting and funding eligible projects under the TCPI will result in more timely conservation action.

LOCATION:

Coastal prairie habitats along the mid- to upper-Texas Coast

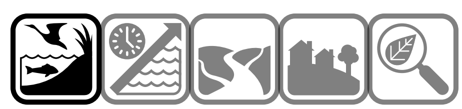
STATUS:

Ongoing

STAKEHOLDERS:

- ***Coastal Prairie Conservancy***
- Armand Bayou Nature Center
- Audubon Texas
- Colorado River Land Trust
- Ducks Unlimited
- Environmental Institute of Houston
- Galveston Bay Foundation
- Guadalupe Blanco River Trust
- Gulf Coast Joint Venture
- Harris County Precinct 2
- Houston-Galveston Area Council
- International Crane Foundation
- Matagorda Bay Foundation
- Mississippi State University
- Native Prairies Association of Texas
- The Nature Conservancy
- Quail Forever
- Texas Agricultural Land Trust
- Texas A&M Natural Resources Institute
- Texas Conservation Partners
- Texas Parks & Wildlife Department
- Texas Rice Industry Coalition for the Environment
- University of Houston Coastal Center

ACTIONS:



PROJECT TYPE(S):

Land Acquisition; Habitat Creation and Restoration; Studies, Policies, and Programs

POTENTIAL LOCAL BENEFITS

16	39
Endangered Species	Migratory Bird Species

**For more information on cost estimates and project benefits calculations, see page 134 of the 2023 Texas Coastal Resiliency Master Plan.*

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