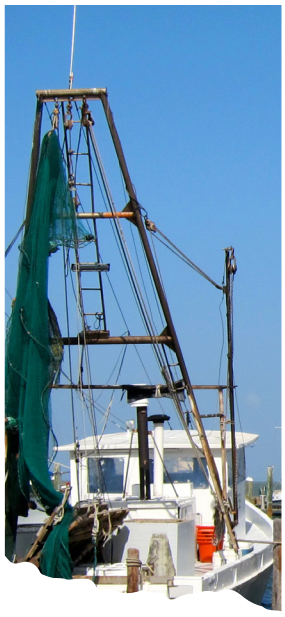
TEXAS COASTAL RESILIENCY MASTER PLAN

MARCH 2019

George P. Bush, Commissioner, Texas General Land Office



Message from the Commissioner

As I enter my second term as the Commissioner of the Texas General Land Office (GLO), my commitment to protect the people, economy and natural resources of the Texas coast is steadfast. Under my direction, the GLO is pursuing every available opportunity to increase the resiliency of our coastal region, which is vitally important to not just this state, but the entire nation. We are working with the U.S. Army Corps of Engineers to construct the projects identified in the Sabine Pass to Galveston Bay Study, and to create a comprehensive plan with the development of the Coastal Texas Study. Through implementation of the Coastal Erosion Planning and Response Act, Open Beaches Act and Dune Protection Act, we are protecting and enhancing these critical resources along the Texas coast. We work with state and federal resource agencies to address the negative impacts on the state's critical ecosystems through the Natural Resource Damage Assessment Program. We manage state-owned submerged land for the State of Texas, and we ensure state and federal actions are consistent with the goals and policies of the Texas Coastal Management Program.

George P. Bush, Commissioner, Texas General Land Office

In 2017, the GLO issued its first statewide plan to bolster coastal resiliency in Texas. The second, 2019 version of the Texas Coastal Resiliency Master Plan (Resiliency Plan) is a critical part of my strategy to address the Issues of Concern on the coast and to support a primary mission of the GLO. The 2019 Resiliency Plan builds on the 2017 version with a broader scope to address the natural and built environments in a more holistic manner. The Resiliency Plan's focus is to protect coastal infrastructure and natural resources through the implementation of recommended high priority (Tier 1) projects. The Resiliency Plan also incorporates the utilization of the most current storm surge and relative sea level rise models to illustrate the need and benefit of these projects into the future. The Tier 1 projects in the Resiliency Plan were vetted and evaluated by federal, state and local experts to identify the best projects that will provide a framework for communities and other stakeholders to guide efforts to increase resiliency measures along our coast. The Resiliency Plan also will be used to help direct GLO priorities in all aspects of coastal management.

Resilient communities are critical to ensure a promising future along the Texas coast. The information in the Resiliency Plan can help coastal communities identify the methods needed to increase resiliency and mitigate the negative impact of natural disasters and environmental degradation issues. The GLO is committed to working with coastal communities, large and small, to implement actions and strategies that will benefit the environment and the economy.

Hurricane Harvey reminded us of the destructive and deadly impacts a hurricane can inflict on a community and, frankly, our entire state. With the release of the 2019 Texas Coastal Resiliency Master Plan, Texas has a unique opportunity to fund and implement projects that will shore up our coastal region and greatly enhance its resiliency. Federal, state and local decision makers can use the Resiliency Plan as a guidebook to effectively meet the restoration and planning needs of the Texas coast.

I am committed to the continued development and implementation of the Resiliency Plan now and into the future to ensure coordinated enhancement of coastal ecosystems, infrastructure and communities. This work will benefit all Texans and will guarantee a strong coast for a strong Texas.

Resiliency Plan Summary

The Texas General Land Office (GLO) is pleased to present the 2019 Texas Coastal Resiliency Master Plan (Resiliency Plan) – the second installment of a 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.

Pleasure Pier on Galveston Island. (Photo Credit: Texas General Land Office)

The Texas coast is an integrated network of built infrastructure and natural environments that should be considered in partnership to understand and achieve coastal resiliency. The state's natural coastal environments contribute resources and invaluable ecosystem services – such as cultural and recreational benefits, seafood, flood prevention and habitat productivity – that bolster business development, improve quality of life, and attract people to Texas. The coast's built environments provide the support services, transportation and infrastructure systems that allow communities, businesses and families to grow and flourish up and down the coast.

Today, the population of the Texas coastal region has reached 6.7 million, nearly one quarter of the state's population.[1] In 2050, the population of the state's coastal region is expected to exceed 10 million.[2] By planning for this population growth now, there is an opportunity for smart and resilient development. Creating a statewide culture that values and protects the Texas coast will provide a more prosperous future for families and communities throughout the entire state.

Cruise Ship docked in Galveston. (Photo Credit: Texas General Land Office)

Value & Vulnerability

While Texas is full of diverse landscapes and city settings, there is no doubt the value of its coast is unmatched. Supported by its vast expanse of port enterprises and the energy industry's exploration and production endeavors, the Texas coast is both the main trade hub for the rest of the state and the leading energy producer for the nation.[3] In recent years, Texas ports provided $368 billion in economic value to the state – roughly 23 percent of the total state gross domestic product – and handled 23 percent of all U.S. port tonnage annually.[4,5,6] This economic activity is forecasted to continue to increase, as it is fueled by the expansion of the Panama Canal and Texas ship channels, the surge in the state's population, and increasing worldwide waterborne trade. Texas generates more than one-fifth of the energy produced in the U.S., including 30 percent of the U.S. crude oil refining capacity and 25 percent of the nation's identified natural gas resources.[3] Most of the state's refineries are situated near ports on the Gulf Coast, and two liquified natural gas import terminals are located in the coastal region. In addition, the Texas coast supports a multitude of other industries, including pipeline transportation, manufacturing, cruise ships, aerospace, commercial and recreational fishing, tourism, agriculture and forestry. In total, the Texas coastal region accounts for roughly 24 percent of the state's population, 23.5 percent of the state's businesses, 26 percent of the state's workforce, and brings in 29 percent of the state's total annual average wages.[1,7] The workers at these industries depend on the continued viability of the coast for their livelihoods. But we must remember that the rest of the state's residents and visitors also rely on the coast for the goods and services, recreation and quality of life that a strong and resilient coast provides.

Cotton farm in Texas coastal region. (Photo Credit: Texas General Land Office)

The Texas coast is clearly an economic powerhouse for the state and the nation, but it also is extremely vulnerable to the Issues of Concern. The coastal region is susceptible to the extreme impacts from natural disasters as well as the impacts

from long-term environmental, social and economic pressures that can have dire consequences. These impacts can result in widespread flooding, structural damage and shoreline erosion—such as in the wake of a major hurricane —to smaller, but more numerous episodes of high tide events and fish kills. This Resiliency Plan identifies eight priority Issues of Concern that encompass risks and threats to the vitality of coastal communities, habitats and industries:

- Altered, Degraded or Lost Habitat
- Gulf Beach Erosion and Dune Degradation
- Bay Shoreline Erosion
- Existing and Future Coastal Storm Surge Damage
- Coastal Flood Damage
- Impact on Water Quality and Quantity
- Impact on Coastal Resources
- Abandoned or Derelict Vessels, Structures and Debris

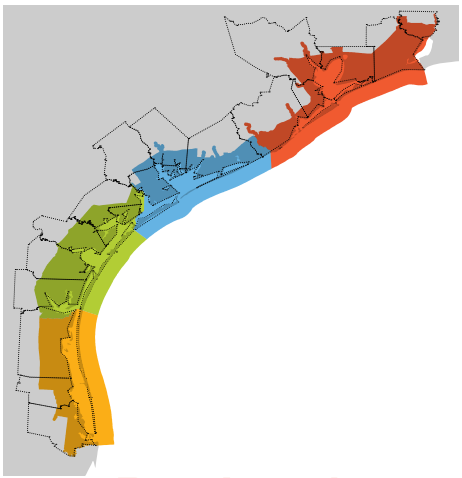
Working to better understand and defend the coast against these Issues of Concern, the GLO's Planning Team used advanced coastal modeling to predict where future coastal hazards may impact Texas. These models characterize how present-day built and natural environments are susceptible to climatic impacts, including relative sea level rise and coastal storm surge. These models not only support the need for present-day improvements, but also validate that the projects presented in this Resiliency Plan are viable solutions to the issues at hand.

2019 Actions and Tier 1 Projects

The GLO Planning Team uses four coastal regions throughout the Resiliency Plan process. The Resiliency Plan lays out 11 Actions that can be performed at the state and regional level to increase long-term resiliency. The Actions were developed to align with regional and coastwide priorities identified through information gathered during several regional meetings with the GLO's Technical Advisory Committee (TAC), a group of coastal experts who met with planners at the Texas General Land Office over the course of the two-year planning process. The following 11 Actions define the key areas on which to improve and enhance the Texas coast now and in the future:

- Beach and Dune Sustainability
- Coastal Storm Risk Management
- Delta Management
- Oyster Reef Enhancement
- Regional Infrastructure Improvements
- Responsible Development
- Rookery Island Enhancement
- Watershed Planning
- Wetland Protection and/or Shoreline Stabilization
- Data Collection and Monitoring (Coastwide)
- Storm Preparedness and Response (Coastwide)

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

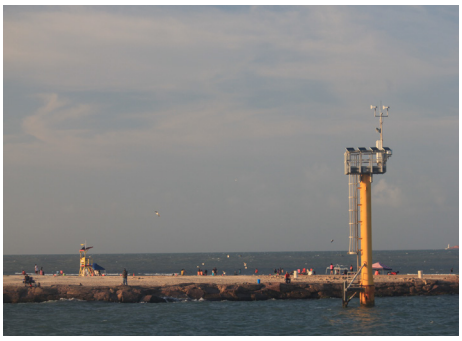
Region 4
Kenedy County
Willacy County
Cameron County

Dredge operating near Galveston Island. (Photo Credit: Texas General Land Office)

To bring about these needed Actions along the entire Texas coast, the Resiliency Plan lists 123 recommended Tier 1 projects, selected from a group of approximately 250 reviewed projects. The Tier 1 projects address the majority of high priority needs identified by data gathering and modeling completed by the GLO's Planning Team and through working meetings with the TAC. The projects range from small-scale, locally-achievable solutions to large-scale collaborative projects that involve multiple state and federal agencies, municipalities, and private and public stakeholders. In many cases, small-scale projects are one piece within a larger framework of restoration needs. For instance, restoring water flow to a previously blocked wetland enhances the overall health of the larger estuarine system. Working together, the GLO and its partners are striving to receive funding to implement these needed Tier 1 projects and to develop new, effective and long-term processes and relationships to make our collective vision of a resilient coastal Texas a reality.

The cumulative cost of the 123 Tier 1 projects is $5.4 billion. The 123 projects have been thoroughly reviewed and vetted by the TAC and the GLO. The projects mitigate, collectively and individually, the coastal Issues of Concern identified in the Resiliency Plan. They also align with the prescribed Actions to address current and future regional and coastwide needs. Furthermore, the implementation methods recommended within each of the project descriptions are Resiliency Strategies that are demonstrated to be successful by similar past achievements and current technical research.

Each recommended Action to improve resiliency considers future conditions along the coast, including socially-driven changes, such as increased development, and environmentally-driven changes, such as relative sea level rise and more frequent and extreme storms. The Tier 1 projects were selected with knowledge of future planned initiatives, such as the U.S. Army Corps of Engineers' Sabine Pass to Galveston Bay Study levee system improvements on the upper coast and the Coastal Texas Study coastwide storm surge suppression and ecosystem restoration alternatives. Enacting the Resiliency Plan's recommendations and future improvements will help the GLO ensure that the state's investment in coastal resiliency will return benefits to its industries, environments and people.

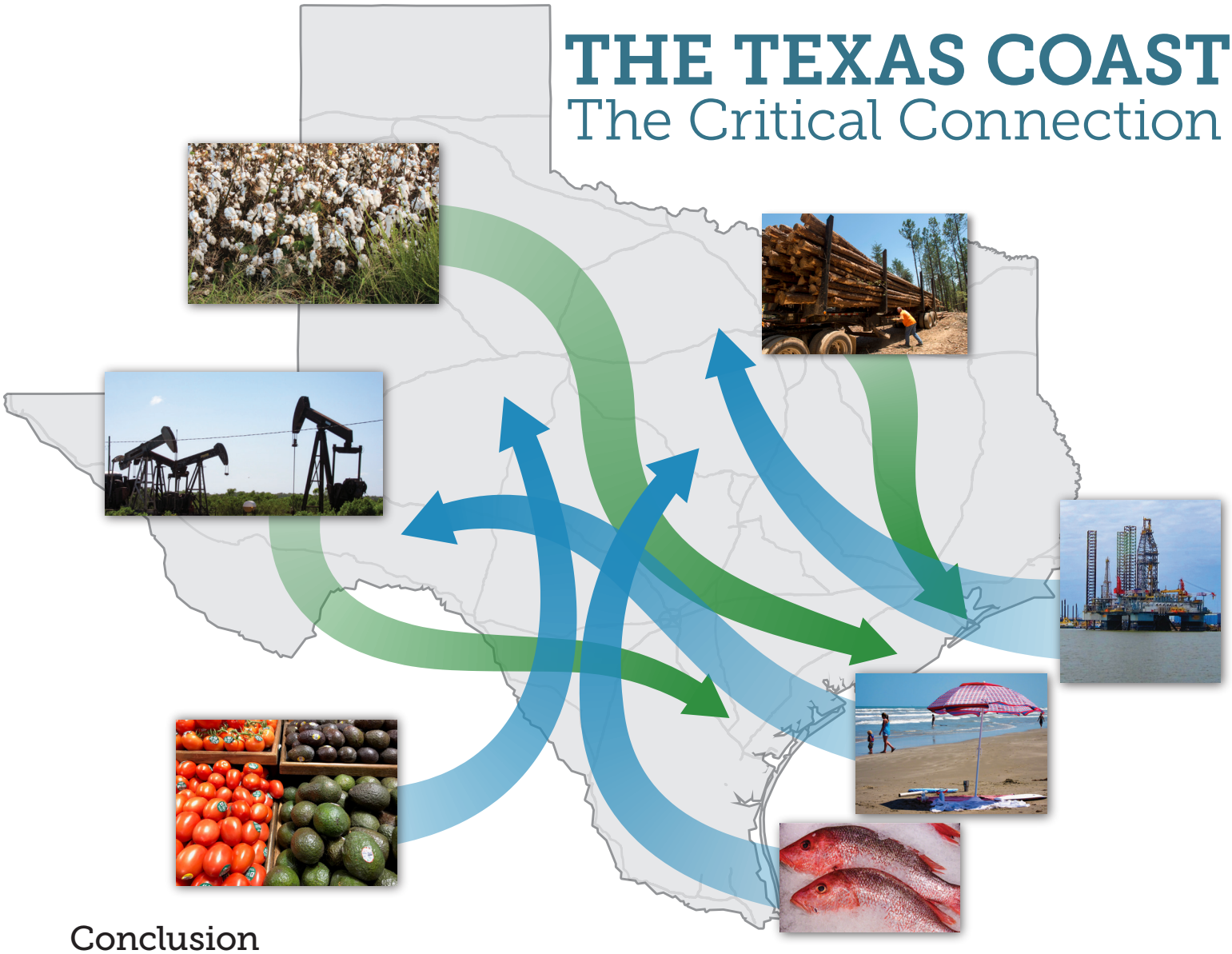


TCOON station near South Padre Island. (Photo Credit: Texas General Land Office)

Implementation and Path Forward

Coastal resiliency does not stop at project implementation. It can only be achieved as the result of continual learning and improvement among all those who actively work to enhance the coast. For this reason, the Resiliency Plan promotes post-project monitoring and adaptive management. Monitoring completed projects will help the GLO and other coastal entities validate project success and protect public investment by confirming that projects are performing as expected. Adaptively managing projects will involve identifying areas where improvements to restoration strategies or construction methods are needed. This approach also will work to correct any deficiencies for application to future projects. Together, monitoring and adaptive management will help the GLO identify the highest performing projects, design more effective future project solutions, and collect desperately needed long-term data to improve coastal science, engineering and planning for the next generation of coastal management.

THE TEXAS COAST
The Critical Connection



Conclusion

The Texas Coastal Resiliency Master Plan provides a strategic pathway to restore, enhance and protect the coast. This can't be done alone. It will require a coordinated effort to address the Issues of Concern and enact the appropriate solutions to create a resilient Texas coast. The GLO is proud to continue to bring together stakeholders from industries, agencies, academia, local governments, and interested parties across this great state to address these issues. By building strong partnerships, the vision for Texas coastal resiliency can be broadened to take on bigger projects that have longer life cycles, use economic resources more efficiently, and have higher expectations for long-term success.

A resilient coast is the responsibility of all Texans. We all benefit from investing to maintain the built and natural environments along our coast to ensure the future survival of the coast for the state. The GLO looks forward to working together with stakeholders to ensure a strong coast for a strong Texas.

Vegetated dune system. (Photo Credit: Texas General Land Office)

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 Crouch Environmental Services, for their tireless and dedicated work on the development of the 2019 Texas Coastal Resiliency Master Plan.

Creating all of the elements in this document was a true team effort.

GLO Planning Team

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Acknowledgments

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- Aransas County
- Arcadis
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- Asakura Robinson Company
- Audubon Society
- Bayou Preservation Association
- Brazoria County Parks Department
- Calhoun County
- Cameron County
- Cameron County Parks and Recreation
- City of Beaumont
- City of Bridge City
- City of Brownsville
- City of Corpus Christi
- City of Danbury
- City of Friendswood
- City of Galveston
- City of Morgan's Point
- City of Orange
- City of Palacios
- City of Pasadena
- City of Port Aransas
- City of Port Lavaca
- City of Rockport
- City of Seabrook
- City of Seabrook Office of Emergency Management
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- Matagorda County
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- Mott MacDonald
- National Oceanic and Atmospheric Administration
- National Park Service
- National Wildlife Federation
- Native Plant Center
- Nueces County
- Nueces County Coastal Parks
- Office of the Texas Governor
- Orange County
- Orange County Drainage District
- Oso Bay Wetlands Preserve & Learning Center
- Port Aransas Nature Preserve
- Port of Beaumont
- Port of Brownsville
- Port of Corpus Christi
- Port of Houston
- Port of Palacios
- Port of Texas City
- Recovery and Relief Services, Inc.
- Refugio County
- Rice University
- S&B Infrastructure, Ltd.
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- San Patricio County
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- Texas A&M University - Corpus Christi
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- Texas American Shore & Beach Preservation Association
- Texas Commission on Environmental Quality
- Texas Department of Transportation
- Texas Division of Emergency Management
- Texas General Land Office
- Texas Parks and Wildlife Department
- Texas Sea Grant at Texas A&M University
- Texas State Soil and Water Conservation Board
- Texas Surf Museum
- Texas Water Development Board
- The Meadows Center for Water and the Environment
- The Nature Conservancy
- The University of Texas - Arlington
- The University of Texas - Rio Grande Valley
- The Water Institute of the Gulf
- Turtle Island Restoration Network
- U.S. Army Corps of Engineers
- U.S. Department of Agriculture
- U.S. Department of Homeland Security - Infrastructure Protection
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- Velasco Drainage District
- Vickrey & Associates, Inc.
- Victoria Chamber of Commerce
- Willacy County
- Willacy County Navigation District

Abbreviations

ADCIRC: ADvanced CIRCulation Model
ADLH: Altered, Degraded or Lost Habitat
ADVSD: Abandoned or Derelict Vessels, Structures and Debris
ANWR: Aransas National Wildlife Refuge
BMMP: Beach Monitoring and Maintenance Program
BSE: Bay Shoreline Erosion
BUDM: Beneficial use of dredged material
CCSC: Corpus Christi Ship Channel
CDR: Community Development and Revitalization
CEPRA: Coastal Erosion Planning and Response Act
CFD: Coastal Flood Damage
CMP: Texas Coastal Management Program
CORS: Continuously Operating Reference Stations
CRS: Community Rating System
EFCSSD: Existing and Future Coastal Storm Surge Damage
FEMA: Federal Emergency Management Agency
FM: Farm-to-Market road
GBEDD: Gulf Beach Erosion and Dune Degradation
GBEP: Galveston Bay Estuary Program
GBF: Galveston Bay Foundation
GIWW: Gulf Intracoastal Waterway
GLO: Texas General Land Office
GMSLR: Global mean sea level rise
GOMESA: Gulf of Mexico Energy Security Act
HSC: Houston Ship Channel
IBHS: Insurance Institute for Business & Home Safety
ICR: Impact on Coastal Resources
IH: Interstate Highway
InSAR: Interferometric Synthetic Aperture Radar
IOC: Issue of Concern
IPMA: Indian Point Marsh Area
IWQQ: Impact on Water Quality and Quantity
LiDAR: Light Detection and Ranging
LNWMA: Lower Neches Wildlife Management Area
MPY: Maximum potential yield
NASA: National Aeronautics and Space Administration
NFIP: National Flood Insurance Program
NOAA: National Oceanic and Atmospheric Administration
NPS: Nonpoint Source
NRDA: Natural Resource Damage Assessment
NWI: National Wetlands Inventory
OSPRA: Oil Spill Prevention and Response Act of 1991
PA: Public Assistance
RBSSA: Redfish Bay State Scientific Area
Resiliency Plan: Texas Coastal Resiliency Master Plan
RSLR: Relative sea level rise
SH: State Highway
SLAMM: Sea Level Affecting Marshes Model
SWAN: Simulating Waves Nearshore Model
TAC: Technical Advisory Committee
TAMU-CC: Texas A&M University-Corpus Christi
TCEQ: Texas Commission on Environmental Quality
TCPP: Texas City Prairie Preserve
TPWD: Texas Parks & Wildlife Department
USACE: U.S. Army Corps of Engineers
USD: U.S. dollars
USFWS: U.S. Fish and Wildlife Service
WPP: Watershed Protection Plan
WWTP: Wastewater treatment plant

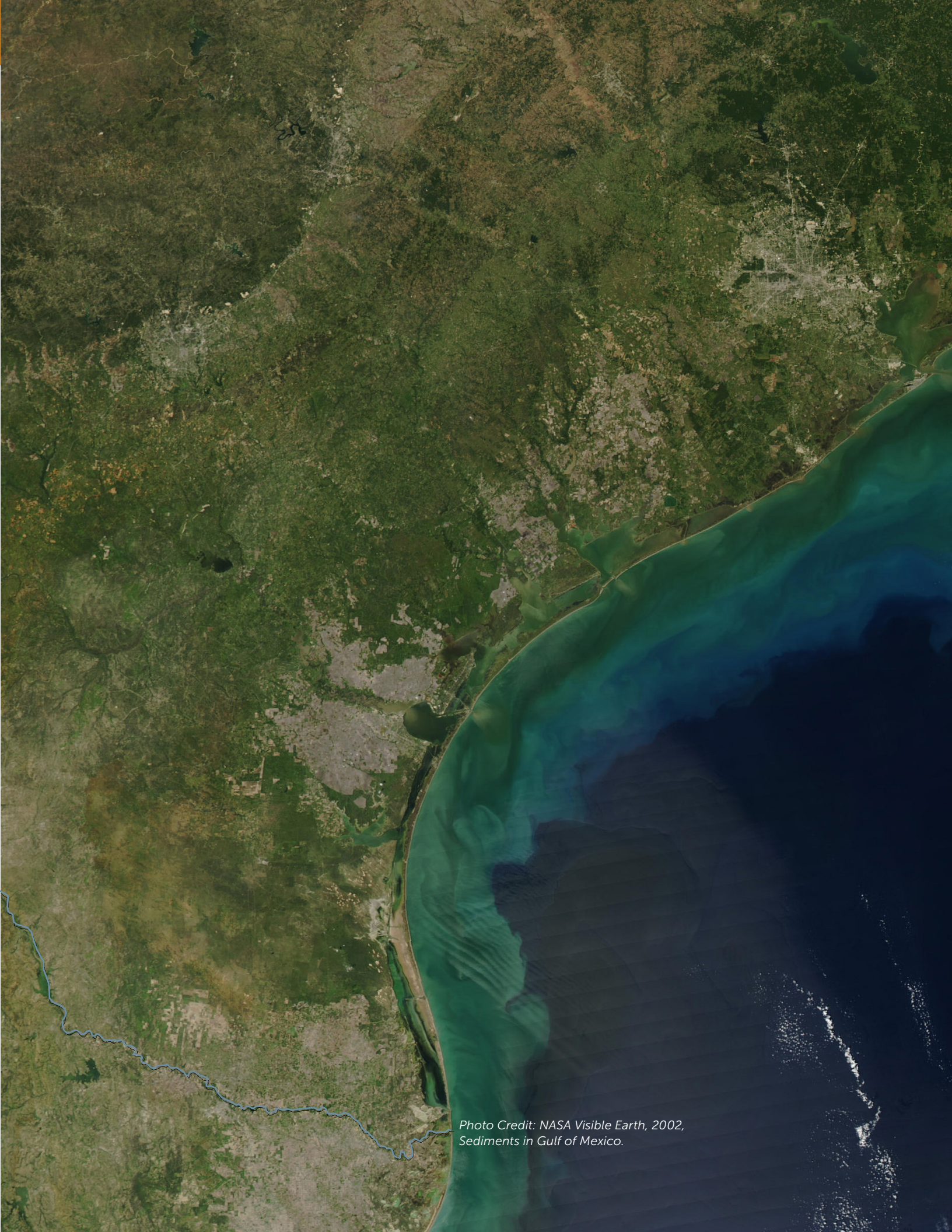
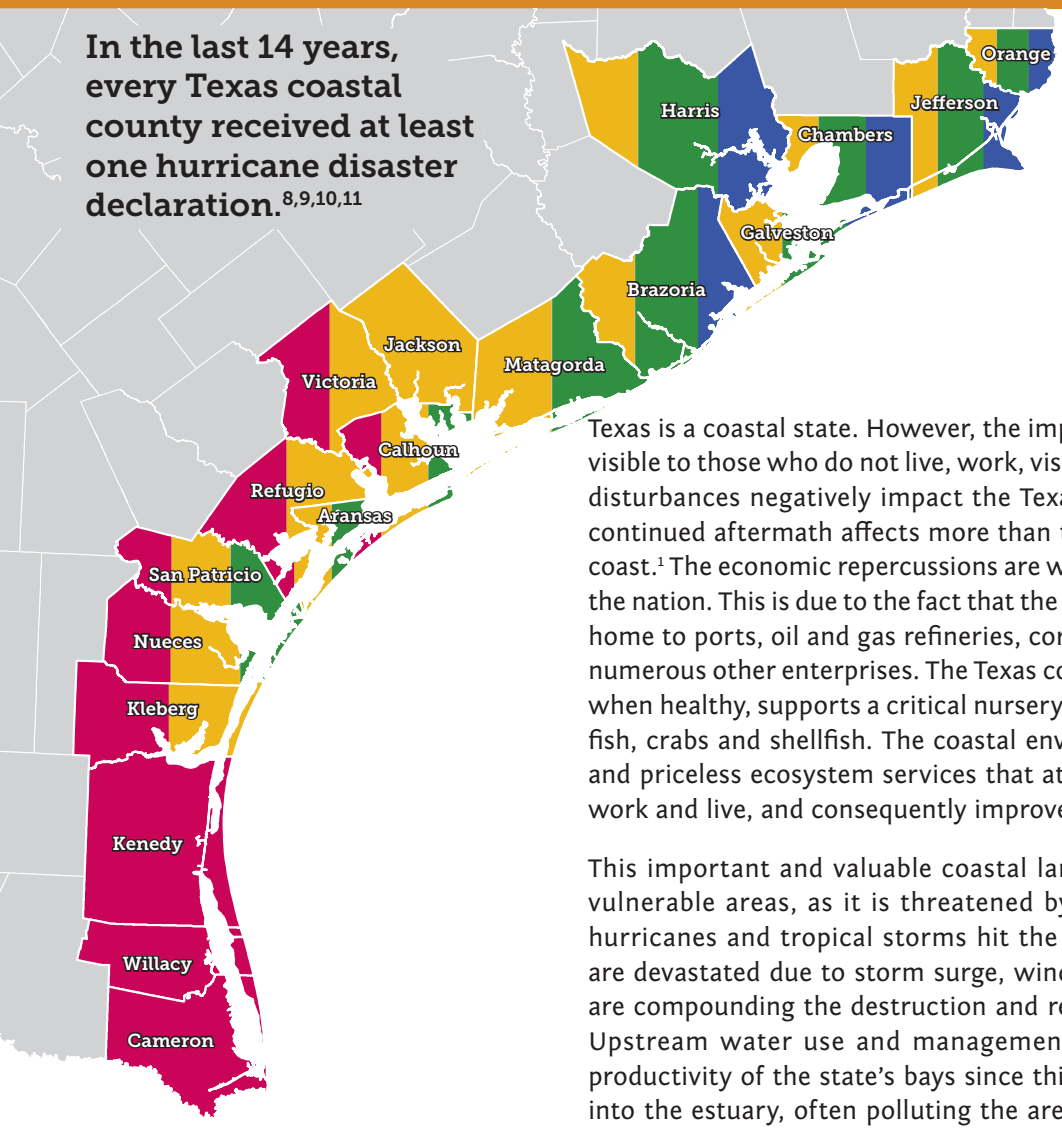


Photo Credit: NASA Visible Earth, 2002, Sediments in Gulf of Mexico.

1. Introduction

Hurricane Rita in 2005. Hurricane Dolly in 2008. Hurricane Ike in 2008. Hurricane Harvey in 2017. In the last 14 years, the entire coastal region of Texas was severely damaged, and in some places decimated by the powerful winds, heavy rain and storm surge caused by these hurricanes. Homes, businesses, vital infrastructure and critical habitats were destroyed.

In the last 14 years, every Texas coastal county received at least one hurricane disaster declaration.[8,9,10,11]



Texas is a coastal state. However, the importance of the Texas coast is not always visible to those who do not live, work, visit or recreate on the coast. When tropical disturbances negatively impact the Texas coast, the immediate fallout and the continued aftermath affects more than the 6.7 million people that live along the coast.[1] The economic repercussions are widespread throughout the state and even the nation. This is due to the fact that the Texas coast is an economic powerhouse—home to ports, oil and gas refineries, corporate headquarters, military bases and numerous other enterprises. The Texas coast also is home to an environment that, when healthy, supports a critical nursery for hundreds of species of birds, wildlife, fish, crabs and shellfish. The coastal environment contributes natural resources and priceless ecosystem services that attract people to Texas as a place to visit, work and live, and consequently improves the quality of their life.

This important and valuable coastal landscape also is one of the state's most vulnerable areas, as it is threatened by natural and man-made forces. When hurricanes and tropical storms hit the Texas coast, homes and infrastructure are devastated due to storm surge, wind damage and flooding. Rising sea levels are compounding the destruction and reshaping the coast as we know it today. Upstream water use and management practices can negatively impact the productivity of the state's bays since this water flows downstream and empties into the estuary, often polluting the area and harming sensitive ecosystems. To advance the state's ability to become more resilient and better withstand these and other coastal threats, a Texas-sized Resiliency Plan for the coast is necessary.

The vision for the Texas Coastal Resiliency Master Plan (Resiliency 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. This can be accomplished through the funding and implementation of the recommended Tier 1 projects in the Resiliency Plan.

Resiliency (n.)

Coastal resiliency is the ability of coastal resources and coastal infrastructure to withstand natural or man-made disturbances and quickly rebound from coastal hazards. There are two dimensions of resiliency: **1) Taking actions** to eliminate or reduce significant adverse impacts from natural and human-induced disturbances; and **2) Responding effectively** in instances when such adverse impacts cannot be avoided.

Support for the Port Aransas community after Hurricane Harvey. (Photo Credit: Texas General Land Office)

The coastal connection between industry and recreation in Port Aransas. (Photo Credit: Texas General Land Office)

The Purpose of the Resiliency Plan

Recognizing in 2016 that Texas did not have a state-sponsored coastal plan, Commissioner Bush directed his Coastal Resources Division of the Texas General Land Office (GLO) to develop the Texas Coastal Resiliency Master Plan, which is in alignment with the GLO's mission to restore, enhance and protect the state's coastal natural resources. The first iteration of the Resiliency Plan, released in March 2017, highlighted the value of the Texas coast, its resources, and the Issues of Concern that endangered coastal communities. These Issues of Concern included storm surge, flooding, erosion, loss of habitat, negative impacts on wildlife and fisheries, degradation of water quality and quantity, and the adverse impacts from abandoned or derelict vessels, structures and debris. The 2017 Resiliency Plan also presented Resiliency Strategies and recommended funding nature-based projects to mitigate the impacts of the Issues of Concern that threaten the vitality and productivity of the coastal area.

In the fall of 2017, the GLO began work on the 2019 version of the Resiliency Plan, which has a broader scope to address both natural and built environments as they pertain to resiliency for coastal communities. Using a "multiple lines of defense" approach, the 2019 Resiliency Plan identifies Actions that can be performed at the state and regional level to increase long-term resiliency. The 2019 Resiliency Plan presents an expanded list of nature-based projects and introduces resilient coastal infrastructure projects. All projects underwent expert review and evaluation by the Technical Advisory Committee (TAC) to advance the Texas coast toward greater resilience.

With a ready list of vetted Tier 1 projects identified through the planning process, the GLO will use the 2019 Resiliency Plan to guide long-term coastal management initiatives. This will strengthen and advance the overall mission of the GLO to safeguard the state's coastal resources and communities. Furthermore, the Resiliency Plan can be used by local governments and elected officials to highlight the Issues of Concern in their coastal communities, and to take action to make their communities more resilient to the next big storm.

Multiple Lines of Defense

A strategy to enhance coastal resiliency by layering natural and/or man-made protection measures to reduce the risk of coastal Issues of Concern. For instance, to reduce the risk of storm surge damage, a wider beach and vegetated sand dunes may be constructed, in addition to elevating homes and infrastructure.

A HISTORY OF SUCCESS

Beach and Dune Restoration Along Galveston's Historic Seawall Beach

Winner of the American Shore and Beach Preservation Association's 2018 Best Restored Beach

In 2017, with funding from the GLO, the Galveston Island Park Board of Trustees, the City of Galveston Industrial Development Corp and the Federal Emergency Management Agency, approximately 3.69 miles (19,487 linear feet) of Gulf beach was re-nourished, from 12th Street to 61st street fronting the Galveston seawall. Prior to this project, this area had not received a major re-nourishment since an emergency re-nourishment after Hurricane Ike. The city's tourism economy is directly tied to the recreational opportunities provided by having a wide beach fronting the seawall. The beach also provides storm surge protection and reinforces the structural integrity of the seawall. The restored beach also protects FM 3005, which serves as a hurricane evacuation route.

Photo Credit: Galveston Island Park Board of Trustees

Resiliency Plan Goals and Objectives

Three primary goals and associated objectives served as the guideposts for developing the GLO's 2019 Resiliency Plan.

Goal 1: The GLO will use the Resiliency Plan to direct its authority to identify, select and fund projects that address the Issues of Concern and restore, enhance and protect the Texas coast.

Objective 1: Analyze the Issues of Concern that hinder coastal resiliency along the Texas coast.
Primary Actions:

- Use existing scientific data and modeling results to identity the current and future coastal conditions.
- Consult with Technical Advisory Committee members to validate, by region, the Issues of Concern along the Texas coast.

Objective 2: Evaluate and select projects – regional and coastwide – that reduce or eliminate the identified Issues of Concern and enhance coastal resiliency.
Primary Actions:

- Undertake a comprehensive review and analysis of existing and relevant projects.
- Gather new project ideas through technical analyses and outreach to the Technical Advisory Committee and coastal stakeholders.
- Elicit input from the Technical Advisory Committee to determine the level of benefit a project will have on the Issues of Concern in each of the four coastal regions.
- Obtain data from the Technical Advisory Committee to evaluate the feasibility and priority of projects in an objective, science-based manner.
- Provide a list of recommended Tier 1 projects for funding and implementation.

Objective 3: Utilize GLO authority, various funding streams and coastal partners to fund and implement identified Tier 1 priority projects.
Primary Actions:

- Secure a legislative appropriation to fund Tier 1 projects in the Texas Coastal Resiliency Master Plan.
- Coordinate with federal, state and local entities to carry out and complete Tier 1 projects to shore up and enhance resiliency along the Texas coast.

Goal 2: Develop an adaptable Resiliency Plan that accommodates changing coastal conditions. The Resiliency Plan will provide long-term, multiple lines of defense solutions to restore, enhance and protect coastal habitats, infrastructure and communities.

Objective 1: Maintain and update the Resiliency Plan on a regular basis.
Primary Actions:

- Secure a continued funding source for the future iterations of the Texas Coastal Resiliency Master Plan.
- Design and implement an adaptable update process that considers changing conditions, needs and preferences of coastal communities and their coastal ecosystems.
- Maintain ongoing communication with the Technical Advisory Committee and stakeholders throughout the Resiliency Plan's development. Collect and incorporate applicable expert knowledge and scientific data into Resiliency Plan updates.
- Continue to refine and enhance Resiliency Strategies and Actions presented within the Resiliency Plan, incorporating new information and changing coastal conditions.

Goal 3: Communicate the environmental and economic value of the Texas coast to 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.
Primary Actions:

- Maintain strong partnerships with the Technical Advisory Committee and stakeholders to build upon the knowledge base utilized to develop the Resiliency Plan.
- Continue communications with elected officials on the importance of allocating funds to implement vetted projects, with an overall goal of enhancing the habitat and infrastructure in our coastal communities to create a more resilient Texas to mitigate future coastal disasters.
- Coordinate with other coastal entities who fund projects to advance the purpose of the Resiliency Plan.

Technical Advisory Committee

To identify the Issues of Concern facing the Texas coast and evaluate projects to address these coastal challenges, the GLO formed a Technical Advisory Committee. The development of the Resiliency Plan is guided by the input from the TAC – a group of statewide and regional coastal decision makers and technical experts drawn from state and federal agencies, universities, local governments, non-profit organizations, engineering firms, ports, and regional trusts, foundations and partnerships. TAC members specialize in coastal science, coastal engineering practices, current coastal conditions, and coastal management and policy. TAC members were invited to share their expert feedback with fellow TAC members and the GLO during a series of meetings along the Texas coast. The TAC provided critical input throughout the entire planning process with regard to scientific and specialized knowledge of coastal problems and possible solutions.

Coastal Management at the Texas General Land Office

As the steward of state-owned lands, the GLO is responsible for the management of the Texas coastline, from tidally-influenced streams and riverbeds out 10.3 miles into the Gulf of Mexico. To achieve this legislatively-mandated responsibility, the GLO operates various coastal programs, projects and partnerships that all work together to address erosion, loss of habitat, impacts on wildlife and fisheries, degradation of water quality and quantity, storm surge, nuisance flooding, public access to beaches and the enhancement of coastal resiliency. The Resiliency Plan guides the overarching vision of coastal resiliency that these coastal programs work to achieve.

In addition to developing this Resiliency Plan, the following coastal initiatives fulfill the GLO's mission to restore, enhance and protect the Texas coast:

- **Texas Coastal Management Program (CMP)** – The purpose of the CMP is to improve the 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; coastal resiliency enhancements to protect coastal natural resources; coastal planning and community engagement to enhance coastal resiliency; and efforts that support the implementation of a fully-certified Coastal Nonpoint Source (NPS) Pollution Program in accordance with the conditions of Coastal Zone Management Act §6217(g).
- **Coastal Erosion Planning and Response Act (CEPRA) Program** – On September 1, 1999, Senate Bill 1690 of the 76th Legislature became law and enacted the Coastal Erosion Planning and Response Act to create the first state-funded coastal erosion program for Texas. Since CEPRA's inception, the GLO has administered CEPRA through its Coastal Resources Division. Projects and studies funded through the CEPRA program use a variety of coastal erosion response methods to protect the Gulf Intracoastal Waterway (GIWW), the chemical and refinery facilities, the public Gulf-facing beaches and bay shorelines, wetlands, marshes, road infrastructure and commercial businesses. Administered using a biennial legislative appropriation from the General Revenue Fund, the program undertakes a coordinated, needs-based approach through partnership with local communities, state and federal agencies, and non-profit entities that leverage funding toward erosion response goals.
- **Gulf of Mexico Energy Security Act (GOMESA) Program** – Under the GOMESA program, Alabama, Louisiana, Mississippi and Texas share oil and gas lease revenues for coastal restoration and conservation projects as well as for hurricane protection. 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 the CMP and CEPRA programs, particularly related to project construction. Funding also will be prioritized to implement projects in the Texas Coastal Resiliency Master Plan.
- **Natural Resource Damage Assessment (NRDA) Program** – 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 Department of Interior act on behalf of the public as natural resource trustees. The Trustee Agencies 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 Open Beaches Act. It also ensures 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.

Photo Credit: Texas General Land Office

A HISTORY OF SUCCESS

Shell Bank - Oyster Shell Recycling and Reef Restoration

For the past 8 years, the CMP has partnered with Texas A&M University-Corpus Christi (TAMU-CC) to fund the Shell Bank Oyster Shell Recycling Program. This has reclaimed and recycled over 721,700 oyster shells from participating restaurants, seafood wholesalers and festivals to create and restore oyster reefs along the Texas Coastal Bend. Last year, TAMU-CC hosted two community shell bagging events in which 170 volunteers bagged 46,044 pounds of shells that were later used to build artificial oyster reef habitat. TAMU-CC also created and installed an interactive educational kiosk in one of the partner restaurants to educate the public on the importance of oysters to marine ecosystems and why recycling oyster shell is beneficial.

Photo Credit: Texas A&M University - Corpus Christi

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

- **Texas Coastal Nonpoint Source Pollution Program** – This program is a partnership with networked state agencies (TPWD, Railroad Commission of Texas, Texas Department of Transportation, TCEQ, Texas State Soil and Water Conservation Board and GLO) and coastal communities. It aims to implement programs and policies to enhance the management and resiliency of coastal water resources, as they relate to stormwater runoff, floodplain management, and related water quality issues.

- **Coastal Texas Study** – The Coastal Texas Protection and Restoration Feasibility Study, also known as the Coastal Texas Study, proposes a comprehensive plan to reduce damages from storm surge and restore the Texas coastal ecosystem through the combination of coastal storm risk management and ecosystem restoration alternatives. The study is led by the U.S. Army Corps of Engineers (USACE) in partnership with the GLO, and will involve engineering, economic and environmental analyses on large-scale solutions. The final report will be complete in 2021. Tying in the projects in the Texas Coastal Resiliency Master Plan with the Coastal Texas Study will create a more resilient coast for Texas.

- **Community Development and Revitalization (CDR) Program** – The CDR Program administers federal funds in communities that are impacted by federally-declared disasters. This includes managing short-term housing in partnership with the Federal Emergency Management Agency (FEMA), as well as administering grants for housing development, infrastructure repair, mitigation, economic development, and long-term planning with the U.S. Department of Housing and Urban Development.

- **Oil Spill Prevention and Response Program** – The unfortunate lessons learned during the 1989 T/V Exxon Valdez Alaskan oil spill and two significant spills in Texas waters in 1990 (T/V Mega Borg and T/B Apex) 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 "police power of the state to protect its coastal waters and adjacent shorelines." GLO Oil Spill Teams work daily 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 derelict vessels and structures and eliminate these potential pollution causes. All actions protect our precious natural resources and ensure that oil stays out of Texas coastal waters.

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

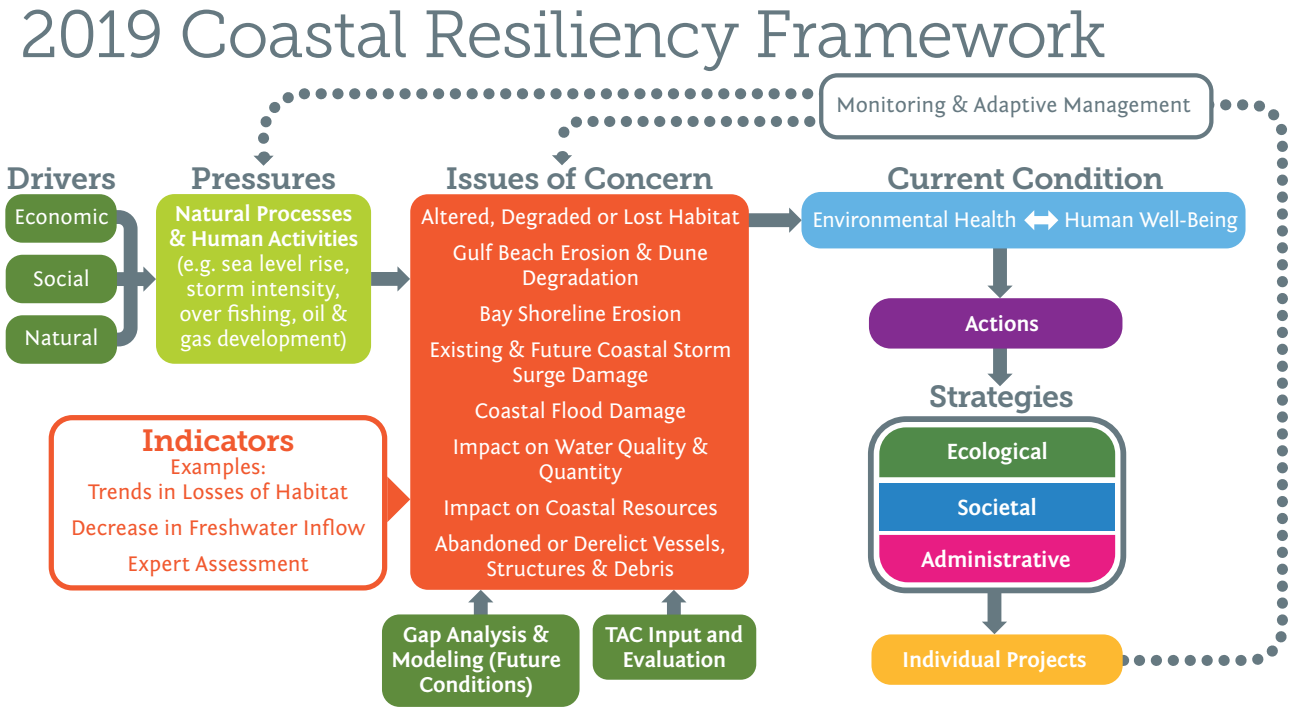
Primary Enhancements in the 2019 Resiliency Plan

The 2017 Resiliency Plan laid the groundwork to better understand the state's coastal conditions, the Issues of Concern, and the goals and recommendations to achieve a resilient coast through the selection and implementation of recommended Tier 1 projects. The 2019 Resiliency Plan builds from its predecessor using four major focus points:

1. **Comprehensive Planning Includes Coastal Infrastructure.** The GLO wants to ensure that Texas evolves not just as a state with a coast, but as a coastal state. Leveraging a GLO-funded critical infrastructure study, the GLO aims to empower Texas communities to develop responsibly by avoiding risk related to the Issues of Concern when it is possible and building resiliently when it is not. Infrastructure projects that consider future events before they happen can make Texans safer during coastal storms. This also can facilitate timely recovery.
2. **A Multiple Lines of Defense Approach.** The 2019 Resiliency Plan incorporates a broader vision of "green" (nature-based) and "gray" (built) projects working together in a complementary manner. This approach utilizes the natural physical features of the landscape, like the barrier islands and dune ridges, along with built infrastructure, like roads and seawalls, to collectively reduce risk and to mitigate against the coastal Issues of Concern.
3. **Future Conditions Matter Now.** To develop the 2019 Resiliency Plan, the GLO incorporated coastal modeling for future habitat change, flooding and storm impacts. This modeling assisted with identification of areas where project implementation would reduce future risk and costly damage.
4. **Adaptive Management Informs Decisions.** The 2019 Resiliency Plan recognizes, at a programmatic-level, changes to enhance policy, public awareness and participation among coastal stakeholders. The 2019 Resiliency Plan has a strong focus on monitoring projects after implementation to measure successes and to promote better decision-making. The GLO leverages work performed through its own studies, as well as those of others, to ensure the cost-effective use of data and technology.

Coastal Resiliency Framework

The 2019 Resiliency Plan uses a modified version of the Coastal Resiliency Framework referenced in the 2017 Resiliency Plan, shown below. It depicts how ***Drivers***, such as economic, social and natural stimuli create ***Pressures***, or resultant natural and human activities. These pressures then generate ***Issues of Concern*** (made noticeable by the ***Indicators*** produced) that impact the ***Current Conditions*** of the coast. The framework also shows how ***Modeling*** to describe future conditions and ***TAC Input and Evaluation*** contribute to the planning process. Then, based on the coast's current conditions, the Plan identifies ***Actions*** (state-level initiatives), ***Strategies*** (overarching methodologies proposed to improve the coast), and recommended ***Individual Projects*** that lead to a better, more resilient coastal condition. ***Monitoring & Adaptive Management*** are key additional elements to understand how to improve this process with each new project that is put forward.



The GLO used the 2017 Resiliency Plan to:

1. Emphasize the state's coastal needs to the Texas State Legislature in the 2017 legislative session and request budgetary assistance to implement projects; and
2. Provide emergency appropriations requests to NOAA after Hurricane Harvey hit Texas.

Developments Since the 2017 Resiliency Plan

The 2017 hurricane season was one of the most severe seasons on record for the Gulf Coast. When Hurricane Harvey made landfall near Rockport, it flooded homes and businesses, destroyed habitats, and left a trail of debris in its path. The GLO played a significant role in managing disaster recovery by redirecting funds set aside for coastal erosion response projects to help communities get back on their feet.

Hurricane Harvey emphasized the need for smart and resilient coastal planning to protect the state's environment, infrastructure and industries from future storms. Harvey exposed weaknesses in coastal planning, but it also showed the strength of emergency response planning and the can-do, collaborative culture that makes Texas coastal communities and businesses so successful.

Following the release of the 2017 Resiliency Plan, short-term recovery needs for Hurricane Harvey continue to be addressed. The 2019 Resiliency Plan looks to the long-term future of coastal resiliency. To adapt to the changing needs of the coast, the goal of the GLO is to revisit and revise the Resiliency Plan regularly to bring new issues to the forefront and set updated goals and targets. However, to continue to seize opportunities to shore up the future of the Texas coast, state funding is necessary for work on future versions of the Resiliency Plan.

2017 Resiliency Plan Projects Completed

Since the 2017 Resiliency Plan was published, seven of its 63 Tier 1 projects were completed. All of the remaining projects are carried forward into this Resiliency Plan.

A (Region 1)	**Sweetwater Preserve Expansion** Acquired 275 acres on Galveston Island to preserve coastal grasslands, brackish estuarine wetlands, and extensive salt barrens and sand flats.
B (Region 1)	**Pierce Marsh Living Shoreline** Protected over 1 mile of bay shoreline, benefiting 2,000 acres of wetlands at Pierce Marsh.
C (Region 1)	**Moses Lake Wetlands Restoration - Phase 3** Protected 8,000 feet of bay shorelines.
D (Region 1)	**Sabine Ranch Habitat Protection** Protected 12,100 acres of freshwater coastal wetlands.
E (Region 2)	**Schicke Point Living Shoreline and Marsh Protection** Installed nearly 1.3 miles of rip-rap breakwaters to protect receding intertidal marsh.
F (Region 3)	**Mustang Island State Park Acquisition** Created a contiguous 5,100-acre conservation area for wetlands, dunes, and beach habitats on Mustang Island.
G (Region 4)	**Laguna Heights Wetlands Acquisition** Protected 1,400 acres of wetlands and coastal prairie adjacent to the Bahia Grande.

A

Photo Credit: Philip Smith, Galveston Bay Foundation

B

Photo Credit: Philip Smith, Galveston Bay Foundation

C

Photo Credit: Chris Levitz, AECOM

D

Photo Credit: The Conservation Fund. 2019. Available at: https://www.conservationfund.org/projects/sabine-ranch-texas

E

Photo Credit: Dave Buzan, Freese and Nichols, Inc.

F

Photo Credit: Kendal Keyes, Mustang Island State Park

G

Photo Credit: Laguna Atascosa National Wildlife Refuge

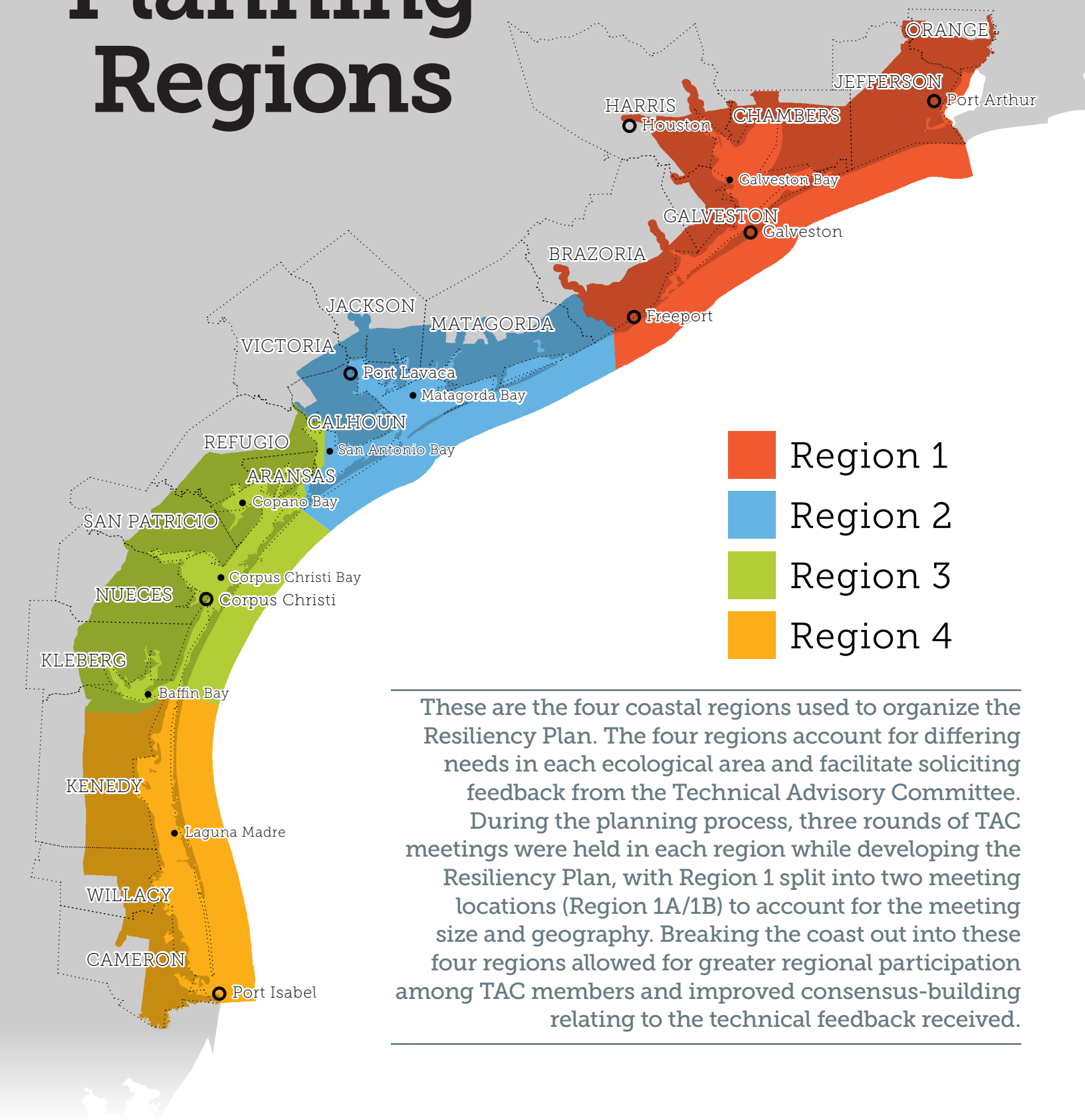
Photo Credit: AECOM

2. Coastal Connections: The Value and Vulnerability of the Texas Coast

To fully understand the significance of the Texas coast, it is necessary to examine the environmental and economic characteristics of the coast – which are intricately interconnected – and the benefits the coast provides to the entire state and nation. This means that every Texan – from a child from the Texas Hill Country visiting the beach, to a nurse in the Panhandle, a teacher in El Paso, a car salesman in Longview, or a farmer exporting crops at the ports – has a connection to the coast. We all benefit from the coast in some way, and we can all be impacted by its vulnerabilities.

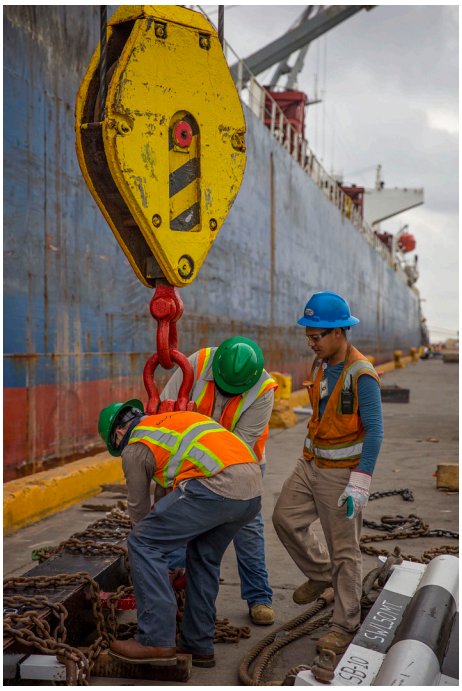
This section of the Resiliency Plan will present a coastwide characterization of the environments and the economy, with a more detailed regional look at the natural and man-made environments of the Texas coastline. It aims to give each reader an entry-point to understanding their connection to the coast.

Planning Regions



These are the four coastal regions used to organize the Resiliency Plan. The four regions account for differing needs in each ecological area and facilitate soliciting feedback from the Technical Advisory Committee. During the planning process, three rounds of TAC meetings were held in each region while developing the Resiliency Plan, with Region 1 split into two meeting locations (Region 1A/1B) to account for the meeting size and geography. Breaking the coast out into these four regions allowed for greater regional participation among TAC members and improved consensus-building relating to the technical feedback received.

The Valuable Texas Coast



Our coast provides employment for over 2.5 million people in Texas, serving as an economic engine for the state.[7] (Photo Credit: Port of Brownsville)

"As the nation's top exporting state, Texas plays a key role in ensuring American products reach markets across the globe, and international trade and the movement of goods are crucial to the Texas economy. Texas' seaports play a critical role in maintaining our state's economic strength, and keeping those ports competitive will be an important part of Texas' growth in the coming decades."

Glenn Hegar - Texas Comptroller of Public Accounts[4]

Ocean Economy

The Texas ocean economy consists of enterprises that rely on coastal features, resources and amenities. These include **waterborne commerce**, **energy and chemical industries**, **commercial and recreational fishing**, and **tourism and nature tourism**. The data below represent Texas coastal counties in 2017.

Region	Annual Wages	No. of Jobs (Businesses)	Average Wage per Employee
1	**$155.9** billion	**2,301,000** (133,900)	**$62,700**
2	**$2.7** billion	**54,450** (4,100)	**$50,800**
3	**$7.4** billion	**163,000** (10,450)	**$45,600**
4	**$3.2** billion	**111,900** (6,600)	**$28,900**

Source: Bureau of Labor Statistics, 2017[7]

Waterborne Commerce - Ports & Waterways

Texas ports and waterways serve as the strategic center of an operating network that handles cargo and commodities that fuel the state's economy.

4 of the top 10
Four Texas ports were among the top 10 fastest growing U.S. ports by export revenue in 2017 - Port Houston, Port of Corpus Christi, Port of Beaumont and Port Freeport.[4]

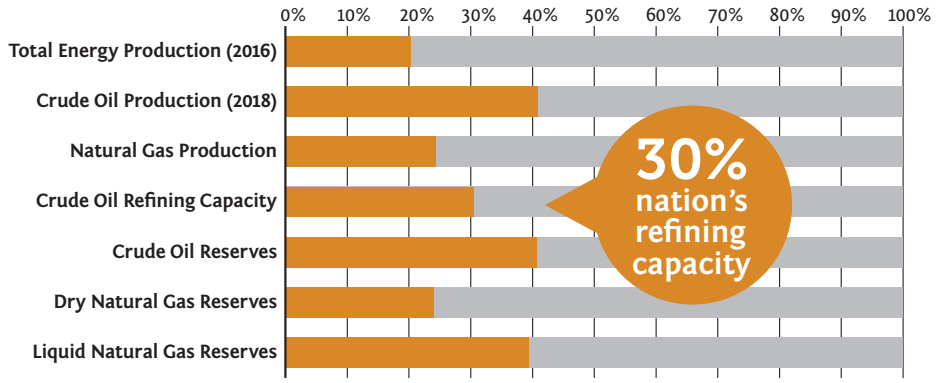
$368 billion
Economic value provided to the state by Texas ports in 2015.[4]

$68.7 billion
Public port and private investments in Texas ports over the last 5 years.[4]

Source: Texas Ports Mission Plan: Investment Strategy - 86th Legislature and Gulf Intracoastal Waterway Legislative Reports - 86th Legislature and 85th Legislature.[4,12,13]

Energy and Chemical Industries

- Texas leads the nation in energy production, primarily from crude oil and natural gas, providing **more than one-fifth** of U.S. domestically-produced energy.[14]
- The 29 refineries in Texas, which are clustered near Texas ports or connected to Texas ports by pipeline provide **30 percent of the nation's refinery capacity**.
- Texas has one-fourth of the nation's natural gas reserves and provides **one-fourth of the nation's production**, much of which is consumed in industrial facilities along the Texas coast.[14]
- The state's chemical manufacturing industry (including petrochemicals) is supported by lower costs resulting from the proximity of the GIWW and deep-draft shipping from the Gulf of Mexico. Texas' petrochemical facilities are clustered near deep water ports in the Sabine-Neches, Galveston-Houston, Corpus Christi and Matagorda sectors.

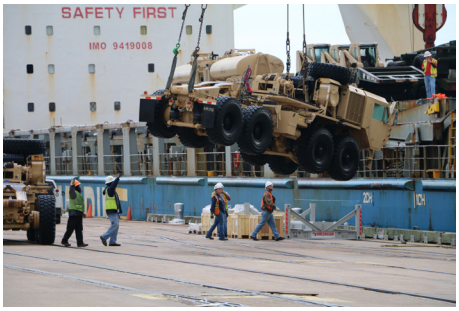


Source: U.S. Energy Information Administration, 2018[14]

The energy and chemical industries in Texas support local jobs. Enhancing resiliency along the coast not only lowers the risk of national energy supply shortages during extreme events but also provides the families who are employed there with a safer coastal community to live in.

Did You Know?

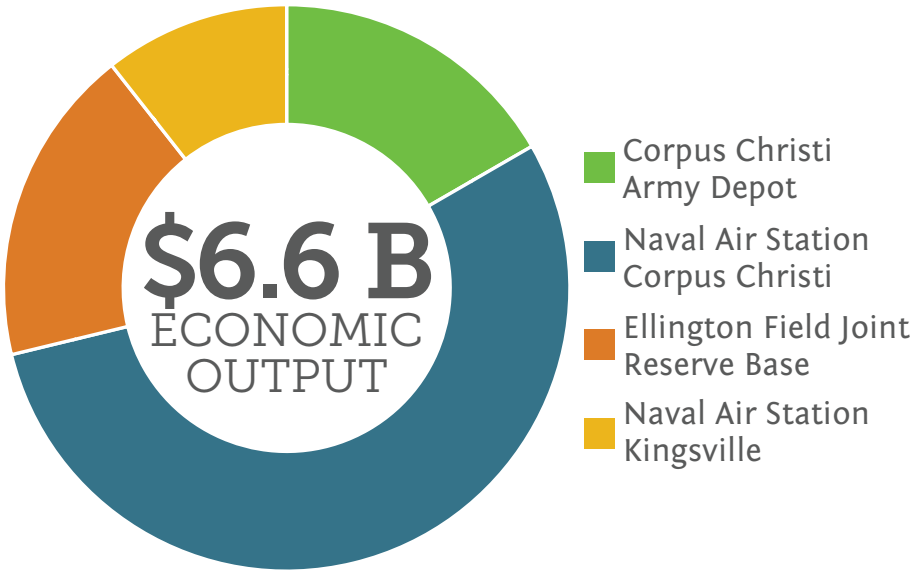
Our coast is critical to our military, providing both security to our state and nation as well as valuable jobs to Texas families.



Military shipments also occur at multiple Texas ports, including the Port of Port Arthur, as shown (Photo Credit: Port of Port Arthur)

Military

Military bases in the coastal region generate at least **$6.6 billion** in economic activity on an annual basis and create **$2.95 billion** in disposable personal income.[15]



Source: Texas Comptroller of Public Accounts, 2017[15]

A HISTORY OF SUCCESS

South Padre Island Gulf Shoreline

South Padre Island's beaches and dunes are a widely recognized symbol of the South Texas coastline and have been partially preserved through the beneficial use of dredged material (BUDM) from the Brownsville Ship Channel since 1988. Work is currently ongoing to better plan for annual beach renourishment along this eroding shoreline using placement based on maximum potential yield (MPY), or placement that leads to the sand being in the local system the longest. Authorized by the City of South Padre Island, a sand tracer study is underway to track the long-term movement of sediment particles through the Gulf of Mexico to determine a regional sediment management scheme that results in MPY. In some instances, for example, it may be beneficial to place sand in accreting areas with the knowledge that this sand will be transported by Gulf currents to eroding areas.

The Gulf shoreline erosion rate throughout much of South Padre Island averages between 10 feet and 15 feet per year. Cameron County is currently investing close to $24 million in public beach access improvements to lessen human causes of shoreline erosion. Promoting a healthy beach and dune system is key to responsible development for the entire island in the future.

(Photo Credit: Texas General Land Office)

Commercial & Recreational Fishing

Commercial Fishing - Commercial revenue is **$173 million**, of which approximately 83 percent of revenue is from shrimp, and 90 percent of revenue is from all shellfish.[16]

$966 million	$351 million	14,500 jobs
commercial sales	*income*	*in 2015*

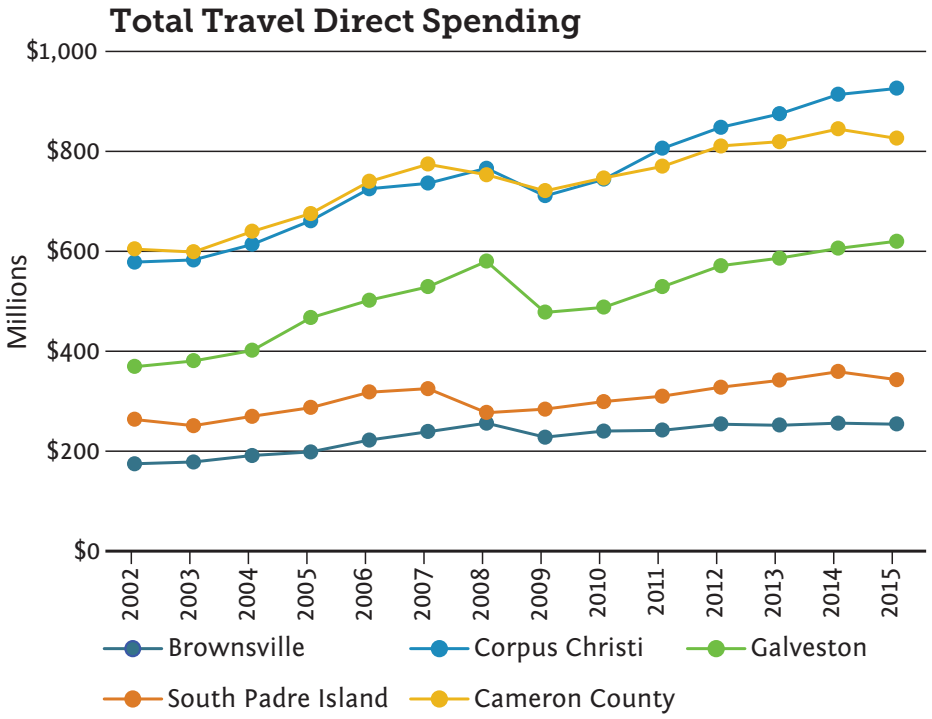
Recreational Fishing - Over **$1.3 billion** were spent in 2015 on durable goods expenditures (fishing tackle, boat and other expenses) by recreational fishers.[17]

$1.94 billion	$726 million	15,300 jobs
recreational sales	*income*	*in 2015*

Source: U.S. Department of Commerce, 2017 [16]

Tourism and Nature Tourism

- In 2017, the tourism industry employed over 1/3 of Galveston Island residents.[18]
- The Port of Galveston is the sole cruise port in Texas. In 2017, there were 255 cruise ship calls with nearly **934,000 embarkations**, a 51 percent increase from 2006.[18]
- On South Padre Island, total direct travel spending has **increased from $263 million to $343 million** (*see figure*) from 2002 to 2015, including $93 million spending on hotel rooms.[19]



Source: Galveston Island Convention & Visitors Bureau, 2017[18] *and the South Padre Island Economic Development Corporation, 2017*[19]

Habitat Type	Average Value (per Acre)	Primary Benefits of Healthy Systems
COASTAL BOTTOMLAND FORESTS	$6,300	Nutrient control
	$5,400	Storm protection and water supply - *rural areas*
	$9,500	Storm protection and water supply - *urban and suburban areas*
MANGROVES	$91,400	Erosion control, nutrient cycling, carbon sequestration, food production, habitat, biodiversity and recreation
	$2,600	Storm protection - *mangroves near infrastructure*
SEAGRASS	$26,300	Erosion control, nutrient cycling, carbon sequestration, habitat, biodiversity and recreation
OYSTER REEFS	$46,300	Provisioning, nutrient control and supporting services
	$39,000	Erosion control - *reefs used near developed shorelines in lieu of engineered systems*
COASTAL WETLANDS	$14,900	Provisioning, water filtration, nutrient control, carbon sequestration, habitat, recreation, biodiversity and aesthetics
	$6,700	Storm protection - *wetlands near infrastructure*
COASTAL PRAIRIES	$6,300	Nutrient control, endangered habitat protection
BEACHES AND DUNES	$19,400	Recreational value - *beaches*
	$5,300	Recreational value - *dunes*
	$33,600	Storm protection and erosion control - *dunes that protect property*

Source: A complete list of all references is provided in the Technical Report.

Ecosystem Services: A new way to think about the value of our coast

Ecosystem services are non-traditional economic valuations that demonstrate the benefits (or services) provided by the natural environment that support, sustain and enrich human life. The services described above are not an exhaustive list, and ecosystem service values vary significantly by location.

Marsh Mania Planting Event at Moses Lake (Photo Credit: Galveston Bay Foundation)

Photo Credit: Texas General Land Office

The interconnection between all aspects of the Texas coast is complex.

It is impossible to separate the environment from the economy, or the people throughout the state from the coastal infrastructure – both natural and built. In other words, it is impossible to separate Texas from its coast.

Safeguarding the Coast with Multiple Lines of Defense

The state's coast is vulnerable to tropical storms, hurricanes, extreme weather events, erosion, less accessible or degraded sources of water, environmental changes, and other nature-based or human-induced changes due to a complex web of drivers, pressures and Issues of Concern. ***Drivers*** can be social, economic or natural, and are largely external to the coastal system. They are instigated by need, such as demand for food, clean water or energy. ***Pressures*** are the strain placed on natural and human resources resulting from these drivers. The build-up of pressures leads to ***Issues of Concern*** along the coast (of which eight primary Issues of Concerns are identified in the Resiliency Plan), which directly disturb the established natural and built environments.

For instance, social drivers, such as an increase in the number of people moving to the coastal region for jobs or a different lifestyle, can create pressures on the coastal system by expanding development in natural areas. If responsible development practices are not integrated in a community's expansion or redevelopment, this can create or exacerbate certain Issues of Concern, such as impacts on water quality and quantity. Economic drivers, such as increased oil and gas exploration along the coast, can create pressures on coastal environments through increases in exploration and industry activities that can lead to altered, degraded or lost habitats. Natural drivers, like long-term changes in weather patterns, can result in pressures such as sea level rise and shifts in precipitation and storm intensities, which in turn can lead to more frequent and severe coastal flood damage. The Coastal Resiliency Framework shown, in part, to the right illustrates the Resiliency Plan's foundational planning process, which begins with examining the drivers and pressures that cause the Issues of Concern to negatively impact the Texas coast.

Understanding the coastal Issues of Concern and their underlying causes provides a window to the ***Current Condition*** of the coast and where the Issues of Concern are the greatest threat. Likewise, understanding the entire coastal system and the interplays between human and natural environments is key to determining the most resilient way to protect the coast.

Most Issues of Concern are created by multiple drivers and pressures, such as wetland habitat that is lost or degraded through both sea level rise and increased coastal development. Because of this, the solutions required to give long-term defense or, ideally, mitigate root causes of the Issues of Concern, are multi-faceted. In Section 3, the Resiliency Plan recommends projects and programs that will take a multiple lines of defense approach to improve coastal resilience. In the Resiliency Plan, this means that the recommended projects and programs for community- and ecosystem-based implementation will work together to counteract the Issues of Concern. It also means that, where possible, the recommended solutions will aim to mitigate as many of the causes of the problems as possible. These overarching needs will be determined by assessing the coastal system as a whole.

A multiple lines of defense strategy entails layering recommended solutions so that the Issues of Concern are mitigated from more than one angle.

The Texas Coastal Resiliency M

A Path Forward to Implement Projects that will Mitigate or Eli

Bay Shoreline Erosion

Issue of Concern: Relative sea level rise, loss of shoreline vegetation and increasing vessel size traffic along the Gulf Intracoastal Waterway – combined with volatile weather patterns – increases erosion along the bay shoreline.
Solutions: Incorporate living shorelines. Maintain/Create seagrasses, oyster reefs, estuarine wetlands and rookery islands. Increase sediment supply.

Impact on Water Quality and Quantity

Issue of Concern: Water quantity is reduced for bays as freshwater is used upstream for residential, farming, ranching and industrial activities. Water quantity has become more volatile, with more frequent droughts and extreme rainfall events. Water quality is also degraded by runoff from these same activities.
Solutions: Maintain/Create healthy estuarine and freshwater wetlands. Reduce upstream runoff pollution. Identify opportunities to normalize freshwater inflows.

Coastal Flood Damage

Issue of Concern: As sea levels rise, land subsides and coastal development increases, more communities will be at risk from nuisance flooding and extreme rainfall events.
Solutions: Elevate buildings. Incorporate into development rain gardens, bioswales, permeable pavers and native planted areas. Create flood resilient parks and recreational spaces. Retain and restore open space. Maintain/Create freshwater wetlands and coastal prairies.

Altered, Degraded or Lost Habitat

Issue of Concern: Changes to water quality, land use, sea level, water supply, sediment supply and topography deteriorate coastal ecosystems and decrease, or even eliminate, the value they provide. These changes also weaken the natural defenses from storm surge or other coastal flood events provided by wetlands, mangroves and coastal prairies.
Solutions: Improve water quality and quantity. Increase sediment supply. Maintain/Create wetlands and coastal prairies. Identify opportunities to assist these ecosystems in adapting to changing conditions.

Existing and Future Coastal Storm Surge Damage

Issue of Concern: Coastal storm surge can cause significant negative impacts on Gulf and bay shorelines, coastal communities and ecosystems. As barrier islands, beaches and dunes erode, and habitats diminish, more wave energy and surge can propagate inland.
Solutions: Renourish beaches and dunes. Elevate buildings. Enhance/Protect evacuation routes. Install storm surge barrier.

Impact on Coastal Resources

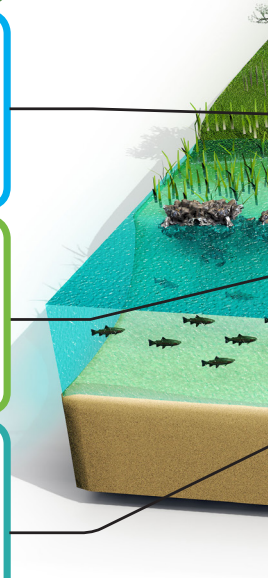
Issue of Concern: Depleted freshwater inflows, degraded water quality, habitat erosion, industrial activity and certain community development can impair the growth of oysters, turtles, birds, fish, crabs and endangered species.
Solutions: Incorporate living shorelines. Maintain/Create seagrasses, oyster reefs, estuarine wetlands and rookery islands. Reduce upstream runoff pollution. Enhance coastal resource monitoring.

Abandoned or Derelict Vessels, Structures and Debris

Issue of Concern: Abandoned vessels, structures, wells, platforms and debris can endanger natural resources, the public's health and safety, and create navigation hazards.
Solutions: Report abandoned vessels and structures to authorities. Responsibly remove abandoned structures. Educate community stakeholders and implement protective measures.

Gulf Beach Erosion and Dune Degradation

Issue of Concern: Barrier islands, Gulf beaches and dunes—frequently the first line of defense from coastal storms—are prone to erosion, overwash and breaching. Loss of these systems places homes, businesses, industry and exposed ecosystems at risk of the negative impacts from high tides and storm surge.
Solutions: Renourish beaches and dunes. Elevate buildings. Identify mechanisms to sustain sediment movement.

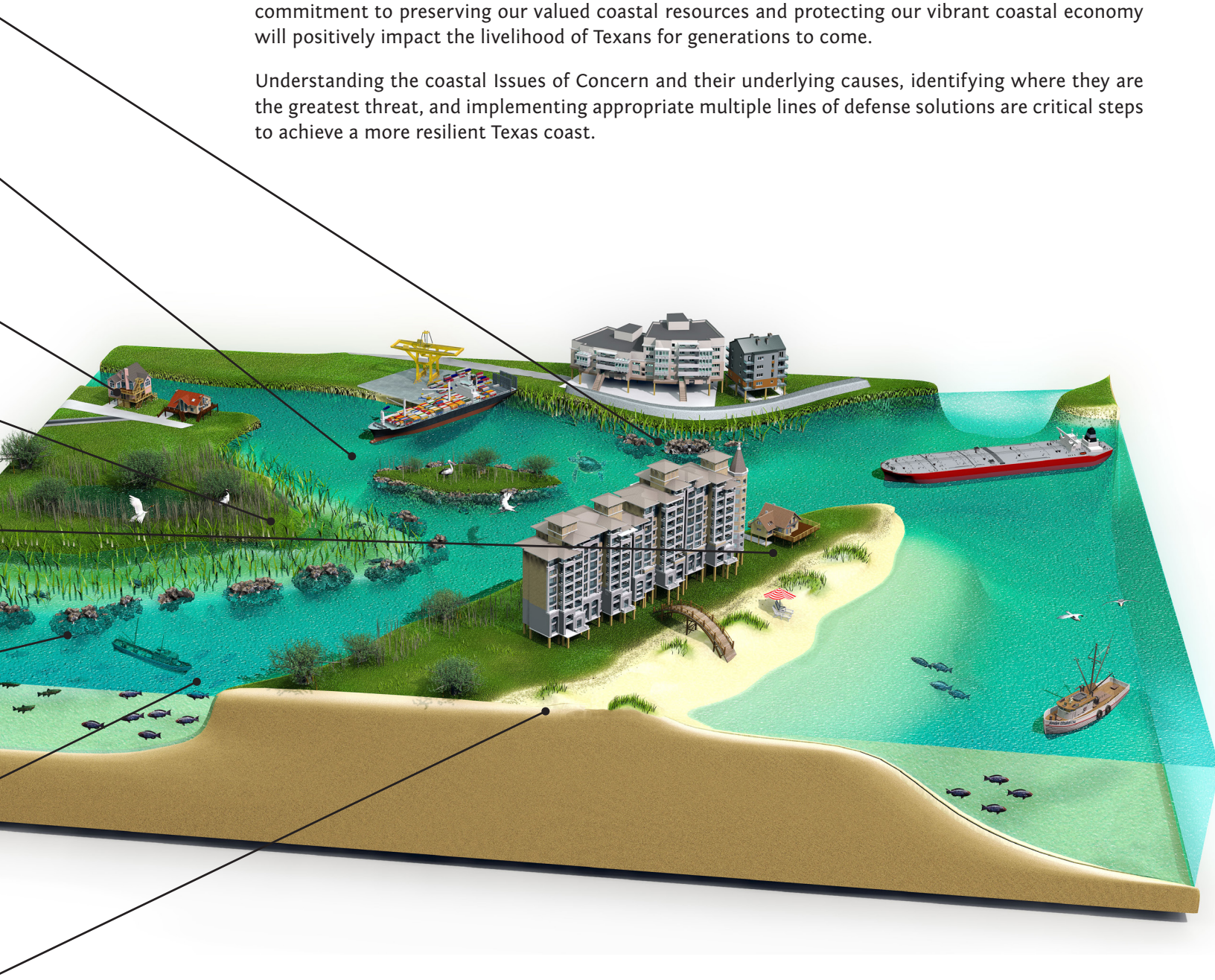


laster Plan:

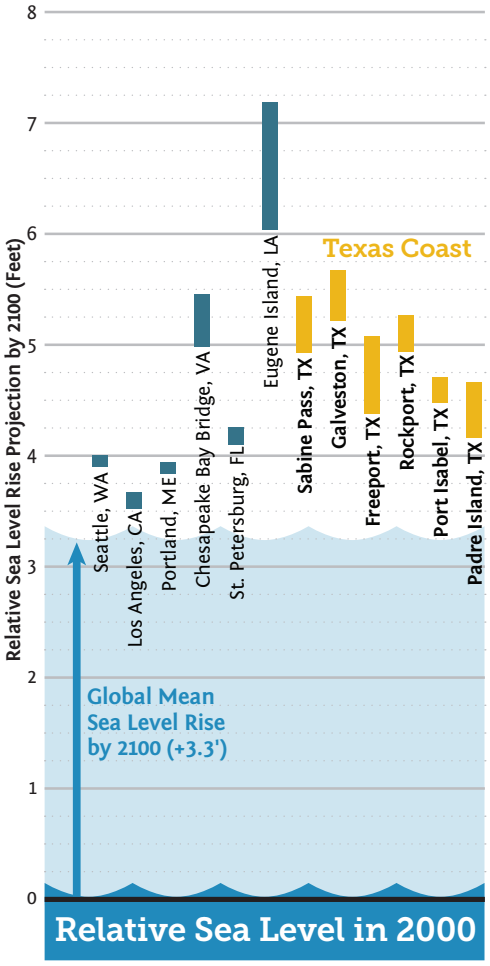
minate the Coastal Issues of Concern

Coastal Issues of Concern can adversely impact the state's coastal environment and economy. But by taking a multiple lines of defense approach to coastal planning, opportunities to mitigate these issues exist. The Texas Coastal Resiliency Master Plan recommends Actions, Strategies and vetted projects to holistically address natural and human-induced disturbances that threaten the Texas coast. This commitment to preserving our valued coastal resources and protecting our vibrant coastal economy will positively impact the livelihood of Texans for generations to come.

Understanding the coastal Issues of Concern and their underlying causes, identifying where they are the greatest threat, and implementing appropriate multiple lines of defense solutions are critical steps to achieve a more resilient Texas coast.



U.S. Relative Sea Level Trends[20]



The bars shown represent RSLR trends, which are based on the 95 percent confidence intervals in feet per century, developed by NOAA using periods of record of at least 30 years, added to the moderate projection for GMSLR by 2100.

2019 Resiliency Plan RSLR Planning Values Since Year 2000

Region	2020	2050	2100
1*	+0.2' – +0.9'	+0.7' – +2.5'	+2.5' – +6.0'
2	+0.8'	+2.1'	+5.2'
3	+0.7'	+1.9'	+5.0'
4	+0.6'	+1.7'	+4.6'

**Region 1 RSLR values are spatially variable based on a subsidence rate grid, and represent an average from tide gauge data. Refer to the Technical Report for full detail.*

Using Data and Science to Inform Coastal Management

To better understand the causes of the risks to the Texas coast, thorough and current science is needed to guide coastal resilience planning in Texas toward scientifically-supported and achievable solutions to bring about greater protection from the coastal Issues of Concern. To achieve this, the GLO Planning Team utilized both local studies and developed new models to further comprehend and predict potential future scenarios for sea level rise, coastal storm and flood risk, and infrastructure impacts – all of which should be standard considerations for effective coastal planning. Furthering the knowledge and available data for coastal Issues of Concern that exist now—and will likely worsen in the future if no action is taken—is critical to improving coastal resiliency.

Our Rising Seas

Sea level is rising globally and is driven by increases in global temperatures that cause sea water to expand and glaciers and ice sheets to melt. Through compilations of data and scientific literature, NOAA predicts global mean sea level will continue to rise by 1 to 8.2 feet by the year 2100.[21] NOAA's analysis also predicts relative sea level rise (RSLR), which is how sea level will change relative to specific land areas and is a combination of global mean sea level and regional, non-climatic factors, such as land subsidence, which impacts coastal cities differently across the country (see figure to the left). In fact, largely because of land subsidence caused by natural compaction of sediments and extraction of groundwater, oil and gas, sea level along the Texas coast is projected to be about 2 feet higher by 2100 than the level caused by global mean sea level rise (GMSLR) alone (see yellow bars in figure).[21,22,23]

For the modeling in this Resiliency Plan, a moderate projection for GMSLR of 3.3 feet by 2100 is used (see waterline in figure), as it represents a conservative approach suitable to high level planning.[21] This GMSLR projection assumes greenhouse gas emissions will continue to increase until 2100. To arrive at the RSLR scenario required for the modeling, GMSLR is added to the amount of regional change in land elevation, which depends on the location in Texas and ranges regionally from 1 to 3 feet by 2100.[21] The table to the left shows the regional average values utilized within the modeling analysis noted in the Plan. More detail on how the sea level rise scenarios were chosen is included in the *Technical Report* to the 2019 Texas Coastal Resiliency Master Plan.

Our Increasing Vulnerability to Coastal Storms and Flooding

Historically and currently, the Texas coast is vulnerable to tropical storms and hurricanes that take human life, flood homes and businesses, and damage coastal ecosystems. NOAA ranks Texas as the third most vulnerable U.S. state to hurricanes in terms of property value ($1.17 trillion).[24] This also is evident as two of the 10 costliest U.S. hurricanes to date impacted Texas, with Hurricane Harvey (#2) in 2017 and Hurricane Ike (#7) in 2008.[25]

In recent decades, extreme weather events, such as floods and high tides, are occurring more frequently and with greater intensity. The damages from hurricanes and tropical storms could become more severe as wind speed is projected to increase with higher sea levels and rising ocean temperatures. In recent memory, Hurricane

Harvey was the most economically destructive hurricane in Texas history, with damage estimated to exceed $125 billion.[26] The damage estimate includes losses of $200 million for agriculture and livestock,[27] $58 million for fisheries,[28] and significant damages across the ports and navigation industry. These included $25 million in damages to the Port of Corpus Christi[29], $30 million in damages to the Port of Beaumont,[30] and emergency dredging for many of the state's waterways.[31] The storm brought down more than 20 percent of U.S. petroleum refining capacity and gasoline prices rose by more than 5 percent nationwide, during which the Port of Beaumont, a major petroleum exporter, reported losses of over $1 billion in revenue.[31,32] The physical impacts of hurricanes and tropical storms are devastating to the coastal communities in their path and can also cripple the state and nation economically. Hurricane Harvey brought Category 4 speed winds (130 miles per hour sustained winds and a maximum wind speed of 145 miles per hour)[33] when it made landfall near Rockport on August 25, 2017 and caused catastrophic flooding in the Houston region where it dropped an average of 52 inches of rain.[34] The flooding and wind damage displaced nearly 39,000 people and damaged or destroyed over 200,000 homes and businesses.[35]

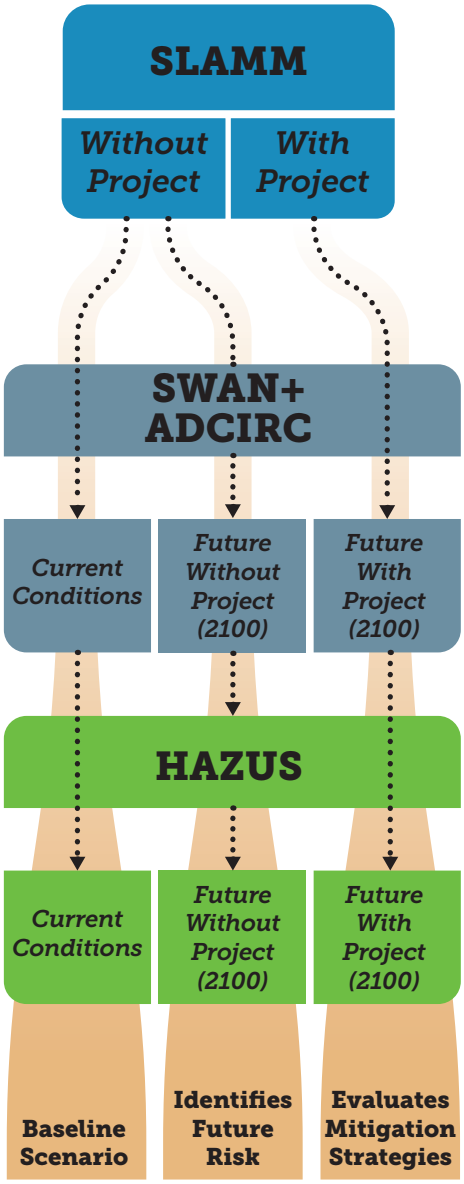
As coastal flooding is expected to become a more frequent occurrence, driven by higher sea levels, land subsidence, erosion, wetland loss, development in low lying areas, higher than typical tide events, and storm surge from coastal storms, flooding in the coastal region is projected to be the natural hazard of greatest economic threat in Texas from 2018 to 2023 causing an expected $5.6 billion in property losses and accounting for 34 percent of all weather-related economic losses.[36] Of the 18 coastal counties, only one has experienced fewer than 13 flooding events between 1960 and 2008, with the average number of major or minor floods per county ranging from 25 to 41 over that same time period.[37] In Harris County, where the population totals over 4.5 million and includes the City of Houston,[1] there have been close to 30 major floods since the late 1930s, and based on recent statistics, the County suffers a major flood somewhere within its boundaries every 2 years.[38]

Rebuilding following a hurricane can be a long and arduous process. The GLO is committed not only to helping improve the efficiency of this process, but also to recommend and champion projects, policies and programs that are technically sound, socially and environmentally responsible, and capable of reducing the number of Texans that are displaced or are in immediate danger of loss of life during future storms.

Modeling Our Future Coastline

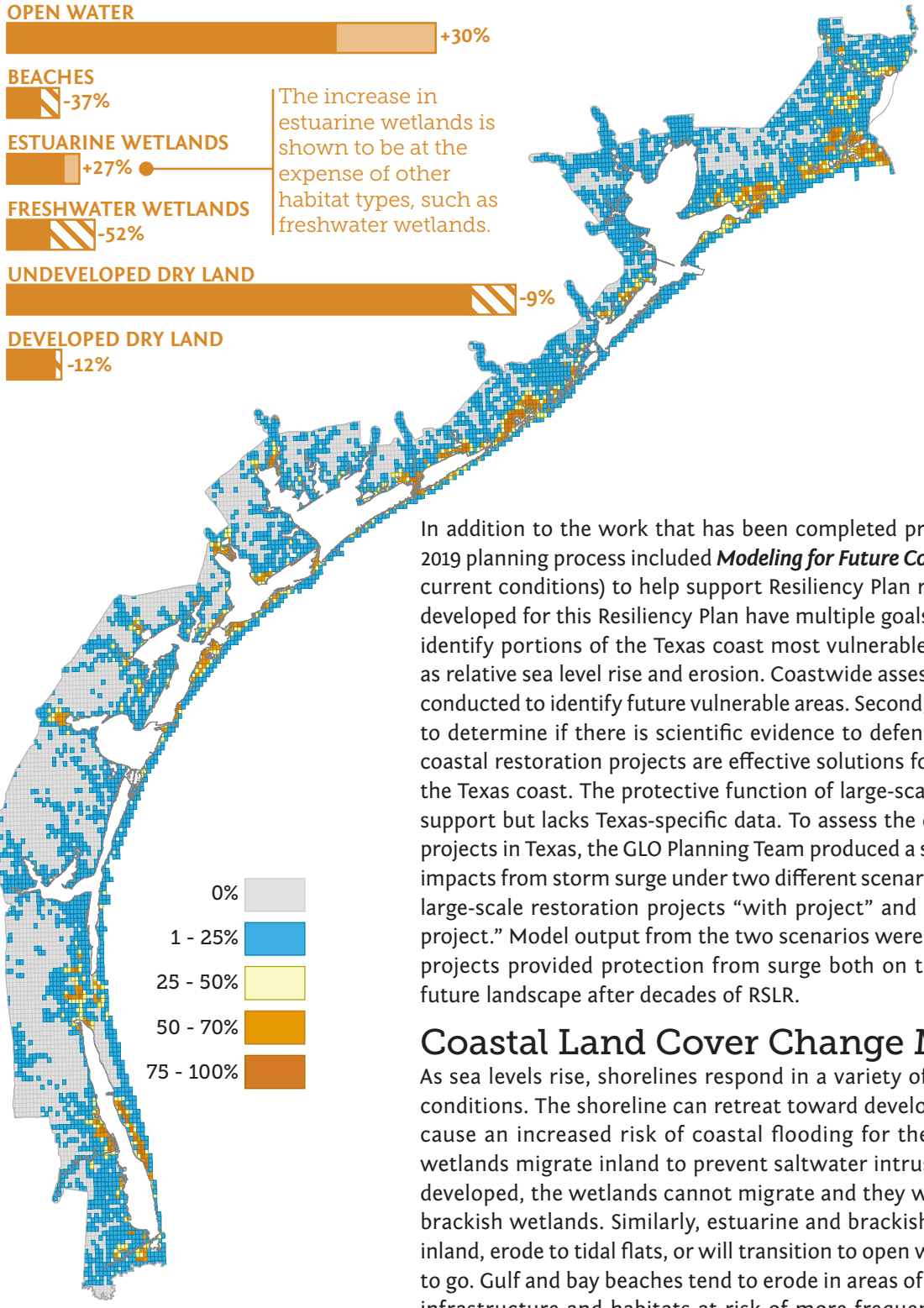
Mitigating flooding impacts from relative sea level rise and increasingly volatile coastal storms is a tall order that calls for collaboration and commitment from governments, industry, organizations and individuals. Much work has already been done in Texas to better quantify the impacts that future climate conditions might have on Texas coastal environments, industry and communities, ranging from global climate models to storm surge assessments over the entire Texas coast. This work ranges from large-scale studies, such as the USACE Coastal Texas Study, which assesses storm surge reduction for the Texas coast, to post-storm assessments of hurricane impacts on Texas businesses, to statewide and regional models of coastal resources, including oysters and bird rookery islands. The Resiliency Plan leverages the findings of these data to focus the project and program recommendations made in this Resiliency Plan on areas of the Texas coast with the greatest need.

Modeling Process Flowchart



The GLO Planning Team used the Sea Level Affecting Marshes Model (SLAMM) to estimate future habitat changes, the Simulating Waves Nearshore (SWAN) model coupled with the ADvanced CIRCulation (ADCIRC) model to estimate storm surge inundation areas, and FEMA's Hazus model to estimate potential losses in current, future without projects, and future with project conditions.

Coastwide Habitat Change from 2007 to 2100 due to RSL Rise



Percent of Land Converted to Open Water by 2100 due to Relative Sea Level Rise

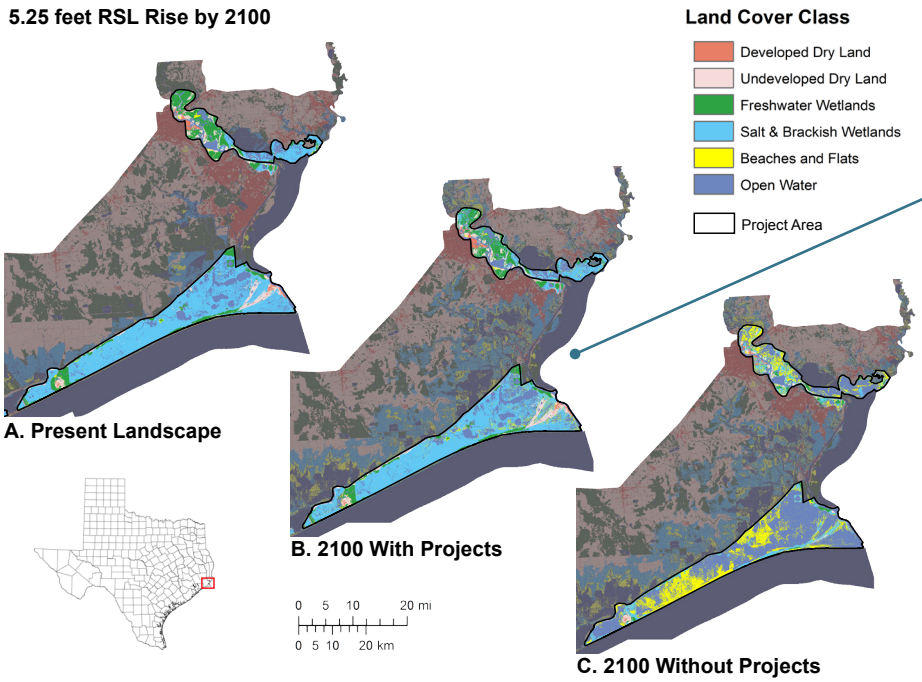
In addition to the work that has been completed prior to this Resiliency Plan, the 2019 planning process included ***Modeling for Future Conditions*** (and comparison with current conditions) to help support Resiliency Plan recommendations. The models developed for this Resiliency Plan have multiple goals. First, the models are used to identify portions of the Texas coast most vulnerable to long-term processes, such as relative sea level rise and erosion. Coastwide assessments of these changes were conducted to identify future vulnerable areas. Second, the GLO is utilizing the models to determine if there is scientific evidence to defend the concept that large-scale coastal restoration projects are effective solutions for reducing the vulnerability of the Texas coast. The protective function of large-scale restoration work has global support but lacks Texas-specific data. To assess the effectiveness of these types of projects in Texas, the GLO Planning Team produced a series of models comparing the impacts from storm surge under two different scenarios: with modeled hypothetical large-scale restoration projects "with project" and if no action is taken "without project." Model output from the two scenarios were compared to test whether the projects provided protection from surge both on the present landscape and the future landscape after decades of RSLR.

Coastal Land Cover Change Modeling

As sea levels rise, shorelines respond in a variety of ways based on their existing conditions. The shoreline can retreat toward developed portions of the coast and cause an increased risk of coastal flooding for these communities. Freshwater wetlands migrate inland to prevent saltwater intrusion, but if the inland space is developed, the wetlands cannot migrate and they will transition to estuarine and brackish wetlands. Similarly, estuarine and brackish wetlands will either migrate inland, erode to tidal flats, or will transition to open water if they have nowhere else to go. Gulf and bay beaches tend to erode in areas of development, placing existing infrastructure and habitats at risk of more frequent inundation, and potentially interrupting farming or fishing industries, tourism and quality of life.

The land cover change models provide baseline conditions and predict future ecological trends based on rising sea levels. The figure to the left shows the percent of land converted to open water by 2100 due to RSLR. There are some limitations to

Model Results for Large-Scale Beneficial Use of Dredged Material Marsh Restoration
Present Landscape versus 2100, With and Without Projects



The outcomes from the landscape change analysis demonstrate that coordinating beneficial use placement of dredge material could be an effective project solution. The model results to the left show the present landscape versus a 2100 scenario with and without a hypothetical large-scale marsh restoration project.

these models, which are outlined in detail in the *Technical Report*. The limitations include the data used to initialize the model, assumptions about how much and how quickly sea level will rise, and the limited ability to model all pertinent physical and hydrodynamic processes that will occur up until the year 2100. However, the models show that in this century and with no mitigating action taken, significant portions of the Texas coast will be at risk of land loss, converting current habitats and low-lying communities into open water.

The models also predict whether restoration projects can improve the state of the future landscape. The models were adjusted to simulate several large-scale marsh restoration projects that would simulate placing sediment, which increases the elevation of the bay bottom incrementally to offset the rate of subsidence (the "with project" scenario). These projects, while they are not intended to directly represent the projects in this Resiliency Plan, were chosen because they could be representative of the type of large-scale sediment planning that is proposed conceptually by many of the 2019 Tier 1 projects. Several of the modeled projects showed encouraging results closely replicating the present-day landscape. One example is shown in the above figure.

This is good news. The outcomes from the landscape change analysis demonstrate that beneficial use placement of dredged material could be an effective project solution. This type of project, while it would not prevent relative sea level rise, shows positive indicators of successfully counteracting the habitat changes anticipated due to relative sea level rise and provides a potential future solution to the wetland loss issues with reasonable expectation for success. This means that there is still time to respond and protect critical coastal habitats, such as estuarine wetlands, and the birds, fish, crustaceans, and other species these habitats support. The 2019 Resiliency Plan includes several projects that propose using this or similar methods to keep marshes and other wetlands from being lost due to rising sea levels. The challenge will be to coordinate funding, dredge cycles, and interagency participation to make these projects a reality.

A HISTORY OF SUCCESS

A Multi-jurisdictional Approach to Floodplain Management

The GLO partnered with Texas Sea Grant to develop a Floodplain Management Plan for the City of Rockport. After a series of public meetings, and with interest from local community leadership, the scope was expanded to create a Multi-Jurisdictional Floodplain Management Plan for Aransas County, the City of Rockport, the Town of Fulton and the City of Aransas Pass.

The City of Rockport leveraged the floodplain management plan, as part of its application to the Federal Emergency Management Agency to enter the Community Rating System (CRS). The CRS is a voluntary incentive platform, under the National Flood Insurance Program (NFIP), that recognizes communities for implementing floodplain management practices that exceed the Federal minimum requirements of the NFIP to provide protection from flooding. In exchange for a community's proactive efforts to reduce flood risk, policyholders can receive reduced flood insurance premiums.

Storm Surge Modeling

Several Category 2 hurricane tracks were superimposed over the landscape change models previously developed. These modeled storms do not represent any actual single storm event, but are synthetically designed Category 2 storms created for modeling purposes. There were several reasons for choosing a Category 2 storm, over a major hurricane. First, storms with lower intensities are seen more frequently in Texas than major storms. Second, extreme storms are already modeled extensively, particularly for designing hurricane flood protection measures, since they provide the maximum defense extents to be considered. Third, the maximum envelope of possible damage is often cost-prohibitive to plan for, whereas smaller storms give a better picture of probable repetitive losses related to flooding – which are of primary concern in the coastal region.

For these modeling scenarios, six storms were selected so that at least one major metropolitan area from each region was located within an area of elevated storm surge impacts (Houston/Galveston, Beaumont/Port Arthur/Orange, Freeport, Calhoun/Matagorda, Corpus Christi/Coastal Bend, South Padre Island). The models looked at current conditions (land cover type, number and location of buildings, sea level) to establish baseline damage estimates, as well as 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 Planning Team then ran the same storms over the "with project" scenarios that were used for predicting land change to determine the benefits of these projects on future storms. Initial results indicate that there are benefits to using large-scale beneficial use of dredged material to reduce storm surge damage for immediate project vicinities, with residual adjacent benefits of wave height reduction in some cases. The GLO Planning Team will continue to enhance these analyses to further inform coastal resiliency decision making in the future.

Economic Impact Modeling

Finally, the GLO Planning Team analyzed areas impacted by storm surge using Hazus, a software developed and used by the Federal Emergency Management Agency (FEMA) for quantifying potential damages to infrastructure during natural disasters. This model determines the physical damage to residential and commercial buildings, schools, critical facilities and infrastructure.

The percent increase in damaged buildings, estimated by Hazus along the entire Texas coast, between current conditions and 2100 "without project" conditions is considerable. The approximate number of buildings damaged by each storm model show percent increases of nearly 200 percent in all cases, and up to 958 percent in the Calhoun/Matagorda metropolitan area. The total value of damage in U.S. dollars (USD) increases an average of $9.2 billion across the six metropolitan areas studied, with year 2100 damages ranging from $5.4 billion on the low end to $24.6 billion in the extreme. These estimates would be expected to be even greater in the event that a Category 3, 4 or 5 hurricane impacted the same locations.

The model results indicate that the combined impacts of RSLR, wetland loss and expanded development will increase the number of buildings at risk and magnify the effect of future coastal storms on both human health and safety, as well as the state and national economies. Furthermore, the damage values showing total property losses may not give the full picture. In 2008, Hurricane Ike – a Category 2 storm – caused $29.5 billion worth of property damage due to extreme surge levels on Bolivar Peninsula, indicating that these models may underestimate the magnitude of damage that the Texas coast could experience from future storms.[39] The "no action" scenario is one that Texas and the nation cannot afford.

The figure on the following page shows the maximum storm surge inundation extents for four of the six Category 2 storms that were modeled as part of this planning effort.

Storm Surge Economic Model Results

Primary Metro Area of Storm Landfall	Number of Buildings Damaged*		Percent Increase in Buildings Damaged	Total Value of Damage in USD**	
	Current Conditions	2100 No Action		Current Conditions	2100 No Action
Beaumont/Port Arthur/Orange	4,150	28,600	589%	$3.3 billion	$16.8 billion
Houston/Galveston	6,200	26,700	331%	$4.2 billion	$15.9 billion
Freeport	15,150	44,500	194%	$8.9 billion	$24.6 billion
Calhoun/Matagorda	850	9,000	958%	$459 million	$5.6 billion
Corpus Christi/Coastal Bend	2,150	10,300	379%	$1.8 billion	$6.3 billion
South Padre Island	1,000	8,750	775%	$849 million	$5.4 billion

**Damages are approximate and are not necessarily limited to the listed metro area; **Estimated 2019 dollars*

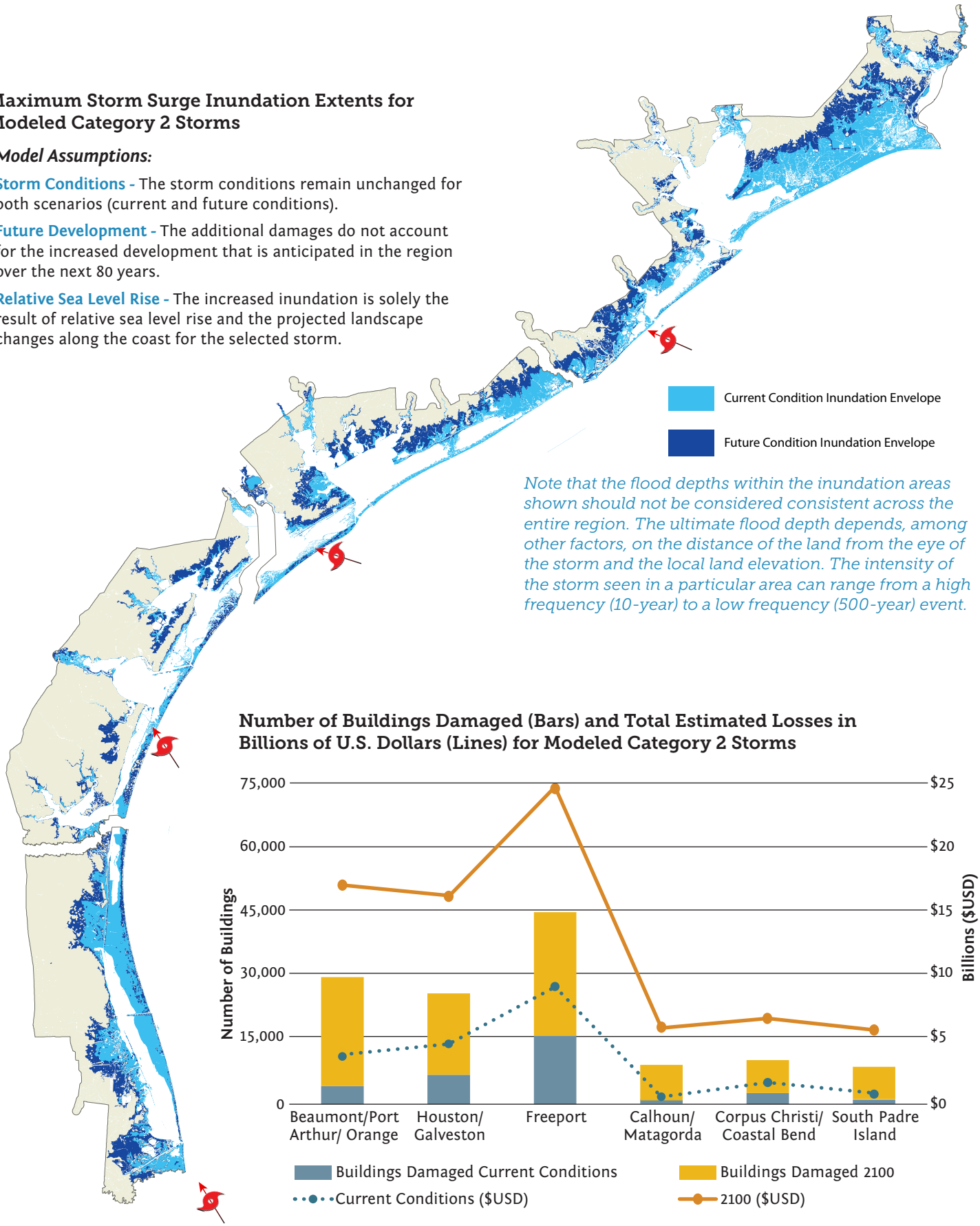
Maximum Storm Surge Inundation Extents for Modeled Category 2 Storms

Model Assumptions:

Storm Conditions - The storm conditions remain unchanged for both scenarios (current and future conditions).

Future Development - The additional damages do not account for the increased development that is anticipated in the region over the next 80 years.

Relative Sea Level Rise - The increased inundation is solely the result of relative sea level rise and the projected landscape changes along the coast for the selected storm.



Note that the flood depths within the inundation areas shown should not be considered consistent across the entire region. The ultimate flood depth depends, among other factors, on the distance of the land from the eye of the storm and the local land elevation. The intensity of the storm seen in a particular area can range from a high frequency (10-year) to a low frequency (500-year) event.

Number of Buildings Damaged (Bars) and Total Estimated Losses in Billions of U.S. Dollars (Lines) for Modeled Category 2 Storms

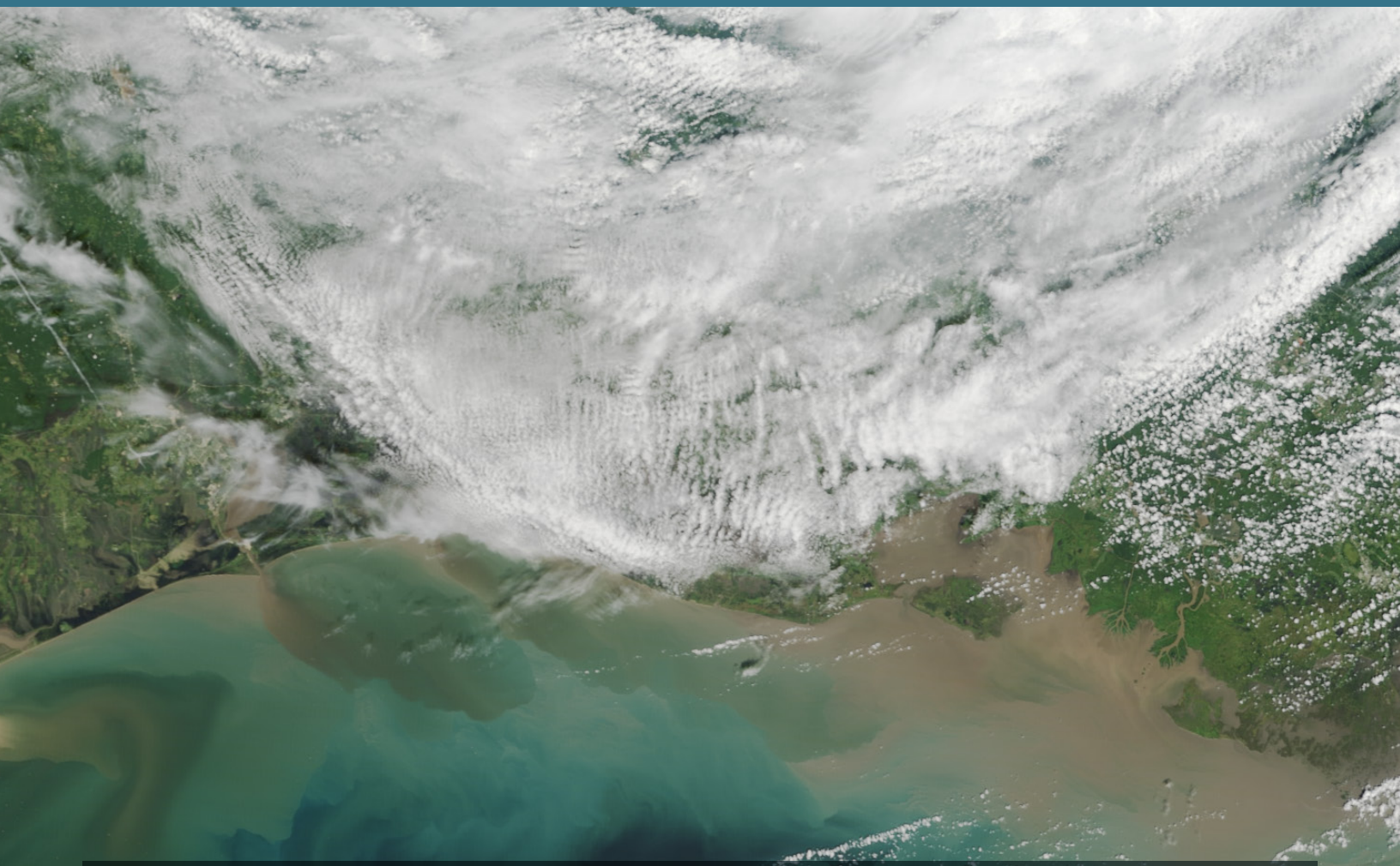
Hurricane Harvey Highlights Need for Coastal Resiliency

Hurricane Harvey claimed the lives of 103 people.[35] It devastated homes and homeowners, public and private property, communities, industries and coastal environments, exposing a widespread and urgent need for coastal resiliency.

FEMA reported that Hurricane Harvey caused over 780,000 Texans to evacuate their homes.[35] It produced a 1000-year flood event in Houston, flooded a quarter of a million cars, and damaged or destroyed more than 200,000 structures.[35,40] It knocked out power grids, water supplies and critical facilities. Despite the many system and program failures, some positive lessons were learned. Thousands of first-responders and volunteers were able to mobilize quickly to rescue and assist others in recovery. Some industries, such as construction, will benefit in the long run from increased business revenues related to storm recovery. This rebound effect will offset much of the $16.8 billion loss to the 2017 state economy.[41] However, the storm unveiled holes in storm protection, infrastructure, communication and recovery systems coastwide, revealing the major need for widespread investment in Texas coastal resiliency.

Catastrophic flooding in the Houston-Galveston region is being called a **1000-year event**. Typically, public infrastructure is designed to accommodate storms within the 10-to 100-year range.[35]

Harvey made landfall on the undeveloped San Jose barrier island, where robust natural beach and dune systems helped to protect the communities of Rockport and Fulton by blocking the storm's main Gulf storm surge. The surge had the energy to displace **7.5 million cubic yards** of sand, enough to fill over half a million dump trucks.[41]



Environment

- Hurricane Harvey led to 266 hazardous spills and discharges and mixed nearly **500 million gallons** of industrial wastewater with storm water on the upper coast.
- Higher than normal sedimentation in the bays caused **50 to 100 percent mortality** among oysters in East and West Galveston Bay. Despite die-off, recovery has been better than expected.
- Health advisories were posted to warn the public about contact with floodwaters, which contained sewage, motor oil, household chemicals and other toxins.

Infrastructure

- Harvey caused **$2.8 billion** in damage to public property, including government buildings, roads, bridges, water facilities and electric utilities.
- Beaumont, a city with a population of over 100,000 people, **lost its main and secondary water supplies** when the city's water pumps incurred storm damage.
- The City of Houston estimates 60 percent of its drainage infrastructure needs repairs, which would cost **approximately $650 million annually**.

Industry

- Hurricane Harvey caused closures of **24** hospitals, **23** ports and **781** roads. Business closures lasted, on average, 15 days for manufacturing, 4 days for hospitals, and 7 days for all other industries.
- Harvey deposited as much as 10 feet of silt into parts of the Houston Ship Channel (HSC). A loss of just one foot of access depth in the HSC can equate to losses of **$281 million per year**.
- The agricultural industry suffered **losses of $200 million** in crops and livestock.

Image Source: NASA, 2017. Data Sources: Rebuild Texas - Hurricane Harvey Eye of the Storm[35]; Texas Comptroller of Public Accounts Fiscal Notes, Feb 2018, "A Storm to Remember: Hurricane Harvey and the Texas Economy"[40]

Enhancing Our Coastal Infrastructure

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. Takes into account 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.

Studies show that the risks associated with building and rebuilding on the coast using non-resilient standards are increasing and the negative impacts from the coastal Issues of Concern 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 Texas General Land Office 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.

Evacuation Routes, Critical Facilities and Coastal Infrastructure

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 the future development of communities as well as guide needed improvements to existing infrastructure. For this Resiliency Plan, the GLO assessed coastal roadways and other infrastructure at risk 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 33.

An inundated deck during a highwater event. (Photo Credit: Texas General Land Office)

The Future of Storm Surge Protection in Texas

Considering the people, communities and industries at risk, there are several ongoing efforts to improve regional storm surge protection along the coast. The U.S. Army Corps of Engineers (USACE) and the GLO are undertaking a 5-year planning study to improve storm surge protection.[42] The Tentatively Selected Plan for the Coastal Texas Study, released in October 2018, recommends large-scale storm surge protection in the form of a coastal barrier system for the Houston-Galveston area, large-scale beach and dune nourishment for South Padre Island, and a series of coastwide ecosystem restoration projects targeted at restoring coastal wetlands and improving hydrology to benefit ecosystems and fish and wildlife habitats. The Sabine Pass to Galveston Bay Study, also put forward by USACE and the GLO, recommends storm surge protection levee system improvements for

Orange, Jefferson and Brazoria counties. These recommendations were approved in 2018 and included nearly $4 billion in federally-appropriated funding.[43] Regional improvements related to storm surge protection are shown in the recommended projects tables in Section 3.

Beyond these identified needs, the entire Texas coast is burdened by the risk of catastrophic storm surge events. **With new data and models providing insight to these risks, constant enhancements for the coast's protection from storm surge is an imperative element to coastal resiliency.** Understanding how communities are potentially exposed to bay-generated surge events in addition to Gulf-generated events is important to not only identify the areas of vulnerability, but also in identifying new ways to merge green and gray infrastructure to promote resiliency.

Leveraging Our Natural Infrastructure Protection

Serving as a key complement to our built infrastructure, natural infrastructure provides effective protection to built environments against coastal storms and other disaster events. When Hurricane Harvey made landfall north of Port Aransas, it unleashed the full force of its impact on San Jose Island, an uninhabited barrier island in the Gulf of Mexico. **The beaches and dunes on San Jose Island are healthy and robust and, as a result, knocked down a significant amount of storm surge produced by the hurricane – absorbing enough energy to displace nearly 7.5 million cubic yards of sand.**[41] The natural barrier provided by the beaches and dunes mitigated storm surge damage to communities throughout Aransas County along the inhabited mainland. In fact, most of the damage in Aransas County was due to the hurricane-strength winds and bayside flooding, rather than Gulf-side storm surge.[35,41] Natural infrastructure can also be useful during high frequency flooding events, like those that occur in coastal cities due to extensive rainfalls or high tides, by retaining rainfall to reduce flooding, attenuating wave energy, and filtering pollutants from storm water before it can drain into bays.

Natural infrastructure protection can take many forms. Throughout this Resiliency Plan, the GLO is recommending nature-based projects, as well as projects that combine traditional infrastructure with natural features in a hybrid approach (refer to the project type table on page 62). Three common examples in the Resiliency Plan of natural infrastructure or hybrid approaches include:

- **Beach Nourishment -** Beach nourishment places sand to replenish and widen existing beaches. This can counteract erosion, reduce storm surge heights and improve infrastructure protection during tropical storms and hurricanes.
- **Land Acquisition or Conservation Easement -** Conserving coastal lands can help prevent coastal flood impacts on homes and businesses by avoiding development in flood-prone areas and regulating the speed at which floodwaters can travel downstream.
- **Living Shoreline -** Living shorelines are shoreline stabilization measures that incorporate nature-based solutions to fully or partially reduce the impact from erosive forces on the shoreline to protect bay-front property.

A HISTORY OF SUCCESS

Arturo Galvan Coastal Park Living Shoreline, 2015

With funding from the GLO and the City of Port Isabel, a living shoreline was constructed along approximately 2,000 feet of shoreline at the Arturo Galvan Coastal Park adjacent to the Lower Laguna Madre within the City of Port Isabel. The 8-acre park serves as a place for waterfront recreation and nature tourism for the community. Project construction consisted of debris removal along the shoreline; shoreline earthwork grading; construction of two small, low-crested rock breakwaters approximately 1,885 feet long in total; and marsh vegetation transplanting and seeding. The breakwaters protect an inter-tidal area planted with native low marsh vegetation to provide shoreline stabilization by reducing shoreline erosion. Planning is underway for Phase II of this project, which will add more public amenities and a kayak launch with a TPWD grant and other funding.

(Photo Credit: Texas General Land Office)

A HISTORY OF SUCCESS

Mad Island Shoreline Protection

Wetlands within the Mad Island Wildlife Management Area, bordering the GIWW, are important nursery grounds for recreationally and commercially important aquatic species including shrimp, finfish and crabs. Historically, this shoreline was losing its wetlands at a rate of approximately 1 foot to 3 feet annually due to boat and barge wake action along the GIWW, threatening more than 1,000 acres of estuarine wetlands and surrounding prairie. In 2011, the GLO and The Nature Conservancy installed a 3.5-foot-high, 1.8-mile-long, rock breakwater to protect 197 acres of adjacent inland wetlands and freshwater ponds from further saltwater intrusion and wetland habitat loss from wave energy. In 2017, the GLO and the TPWD completed an additional mile of breakwater along this shoreline. Future work is targeted at protection of the wetland shoreline near the mouth of Mad Island Lake Bayou, within the Mad Island Marsh Preserve.

(Photo Credit: Texas General Land Office)

Protecting and Managing our Natural Resources

To be good stewards of the coastal environment, the GLO seeks to better understand and manage natural resources that benefit human activities, such as freshwater and sediment distribution, and coastal resources.

Ecosystem Services

Texas coastal environments provide economic benefits to society, which are referred to as Ecosystem Services. The services from these nature-based features include provisioning (providing resources, such as food, water, wood and other natural materials), regulating (improving water quality, air quality and erosion), supporting (creating habitat for flora and fauna), and cultural services (providing areas for recreation, such as hunting or fishing). The value of ecosystem services provided by habitats along the Texas coast is dependent on the location, quality and type of habitat. It is difficult to assess the full value of the economic benefits that ecosystems provide to society, but current research justifies that protecting and preserving these resources is beneficial to human society.[44]

Freshwater

The State of Texas is prone to droughts, which strain 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. 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, as documented by the Texas Water Development Board, lead to land subsidence.[45]

Beaches and Dunes

Another primary pressure on the Texas coast is our eroding Gulf beaches and bay shorelines. According to data collected by the University of Texas Bureau of Economic Geology between the 1930s and 2012, about 62 percent of the Texas Gulf coast is eroding at a rate of greater than two feet per year due to waves, subsidence and shoreline development.[46] **Texas beaches and dunes are the first line of defense against the destructive impacts of hurricanes and tropical storms on inland communities and sensitive coastal environments.** Healthy beach and dune systems also drive the Texas tourism economy, in addition to preventing flooding, purifying stormwater runoff and providing habitat and foraging areas for wildlife. 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 in the Gulf. Each year, however, the federal government dredges millions of cubic yards of sand and sediment from Texas ship channels as routine maintenance.[47] Although there have been some successes in placing these materials back on beaches or in other beneficial use areas, there is not a statewide, concerted effort to coordinate more of these activities with federal dredge cycles. The GLO and other stakeholders are in the early stages of sediment management planning that aim for long-term, statewide coordination of valuable sand and sediment materials.

Coastal Resources

Building from the 2017 Texas Coastal Resiliency Master Plan, this Resiliency Plan aims to better protect coastal resources that support the Texas economy and culture. These resources are diverse and include wildlife, oysters, fish, crabs, shrimp, sea turtles, birds and endangered species. Coastal resources contribute significantly to the Texas economy through direct sales and nature tourism. **For instance, in 2016, commercial fishing accounted for $195 million in landings revenue, with an additional $425 million spent on saltwater fishing trips.**[28] 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 and restoration activities to improve and stabilize resource populations are key recommendations in this Resiliency Plan.

Coastal Environments

As shown by the land cover change assessments described previously, Texas coastal environments face significant pressures related to relative sea level rise and storm surge. These environments also are impacted by increased human development, which breaks up ecological corridors that are essential habitat for birds and wildlife and provide ecosystem services, such as provisioning and regulating. Conserving sensitive habitats will become even more critical in the future to preserve remaining contiguous upland prairies and forests, floodplains, natural stream deltas, and wetland migration corridors.

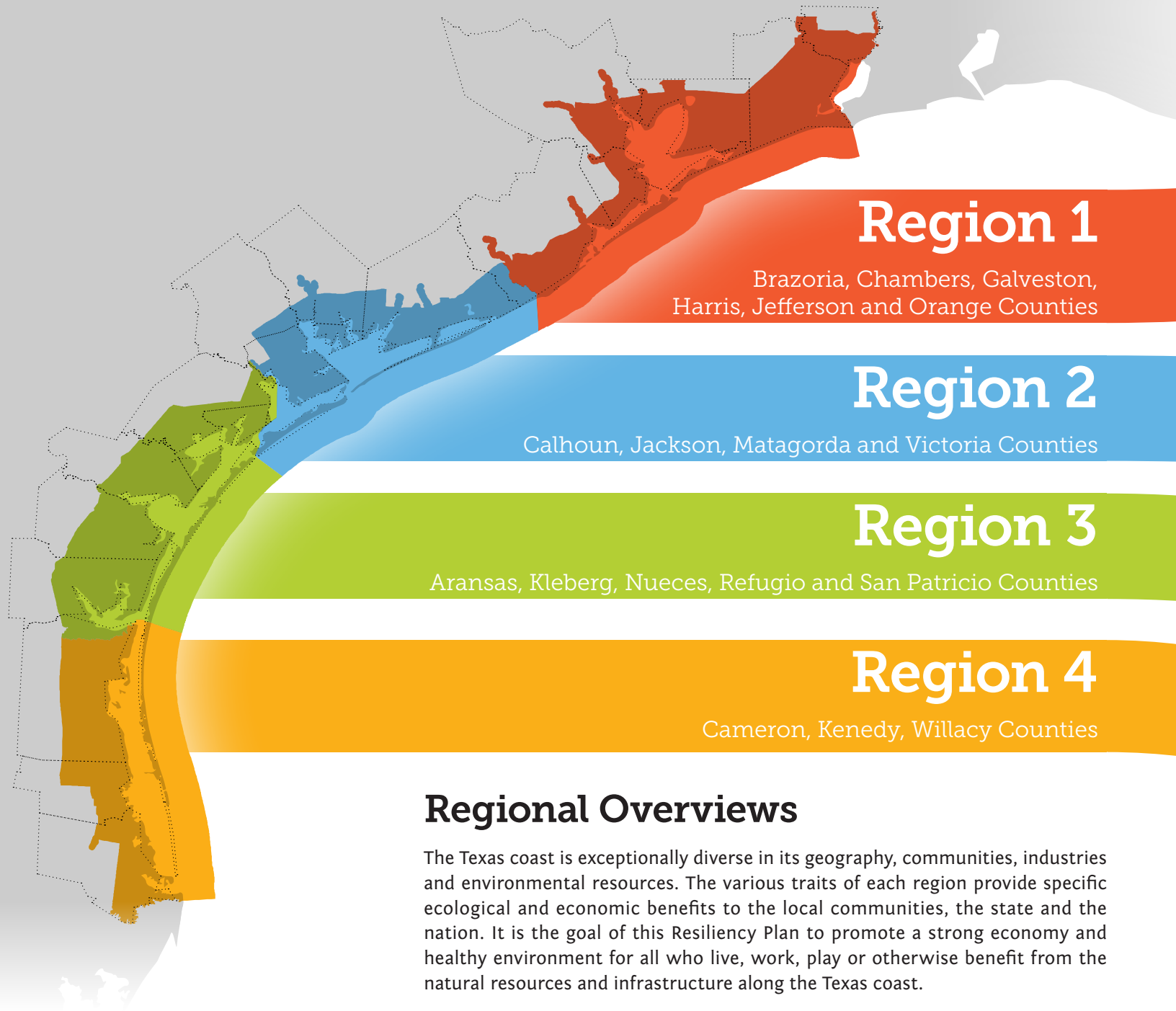
Other ecologically important habitats are the six barrier islands along the Texas Gulf shoreline. Barrier islands are not static landforms. They naturally shift and migrate on a geologic timescale as sand is moved by waves, tides, currents and rising sea levels. The barrier islands absorb the brunt of a hurricane's storm surge force, which helps to protect the inland communities on the bay side. Barrier islands also allow the formation of estuaries and wetlands behind them, which provide critical habitat for fish, shellfish and birds. Development is occurring on several of the state's barrier islands, which limits the natural dynamic process of the islands. This, in turn, will make the islands themselves, the communities on the barrier island, and the coastal communities behind the barrier islands more vulnerable to the negative impacts from storm surge and coastal flooding.

A HISTORY OF SUCCESS

McFaddin National Wildlife Refuge Beach Ridge Restoration, 2013-2016

With funding from GLO grants and federal Deepwater Horizon funds, the McFaddin National Wildlife Refuge Beach Ridge Restoration project constructed a new dune stretching 14 miles from the eastern end of the wildlife refuge. This dune slows coastline retreat and provides a natural line of defense against saltwater intrusion and destructive storm surge for the upland marsh. A healthy marsh system now helps filter the surrounding air and water. There has been an outstanding resurgence of wildlife to the marsh over the past several years, helping to revive nearby commercial fisheries. The newly constructed dune was put to the test in August 2017, when Hurricane Harvey struck the Texas coast. The restored salt marshes held up against the powerful waves and wind of this historic event, proving the project's success.

(Photo Credit: U.S. Fish & Wildlife Service)

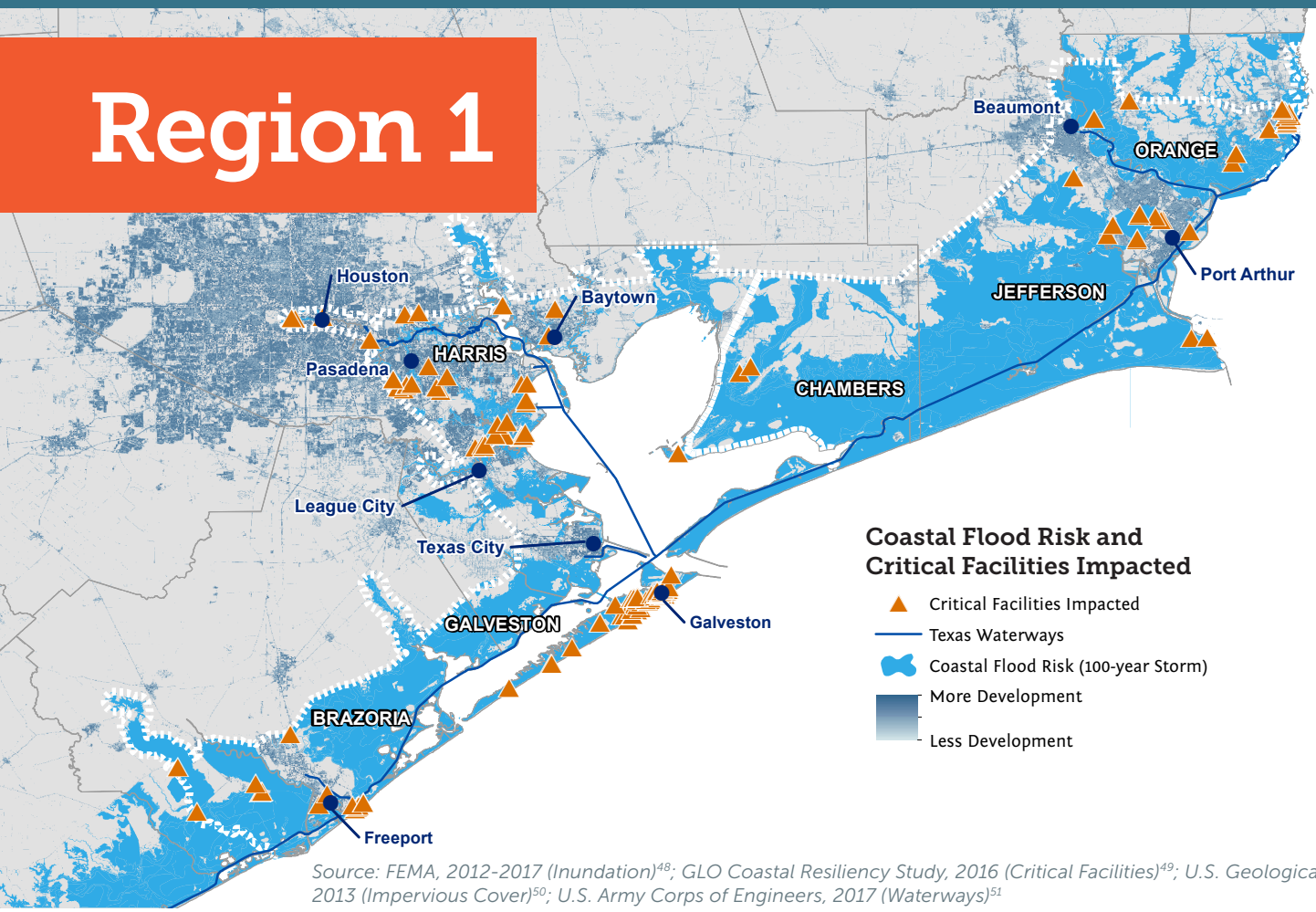


Regional Overviews

The Texas coast is exceptionally diverse in its geography, communities, industries and environmental resources. The various traits of each region provide specific ecological and economic benefits to the local communities, the state and the nation. It is the goal of this Resiliency Plan to promote 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.

#LoveGalveston
IT'S
ISLAND
TIME

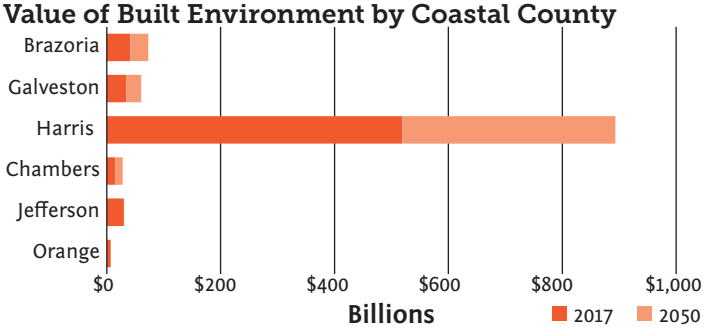
Region 1



Source: FEMA, 2012-2017 (Inundation)[48]; GLO Coastal Resiliency Study, 2016 (Critical Facilities)[49]; U.S. Geological Survey, 2013 (Impervious Cover)[50]; U.S. Army Corps of Engineers, 2017 (Waterways)[51]

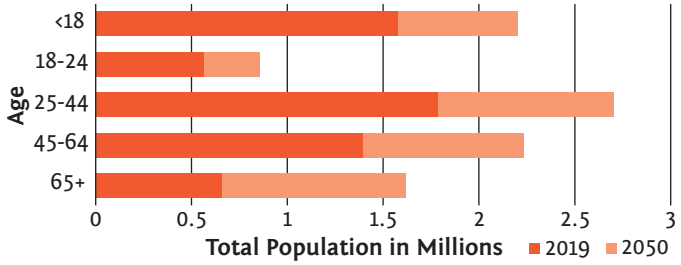
Socioeconomic Overview

Value of Built Environment by Coastal County



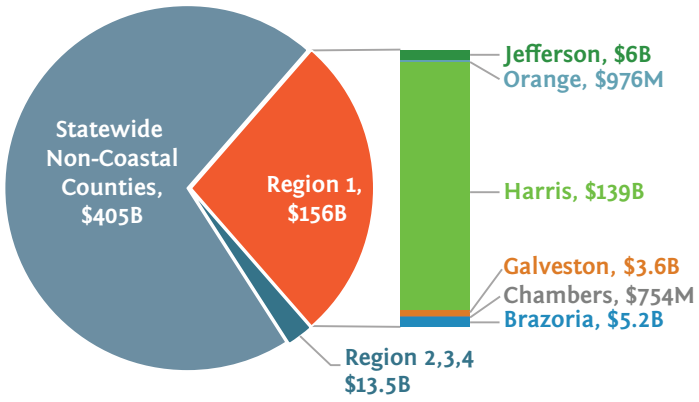
Source: Texas Comptroller of Public Accounts, 2017[52]

Demographic Snapshot



Source: Texas State Demographer, 2019[53]

Annual Average Total Wages by Coastal County, 2017, All Industries

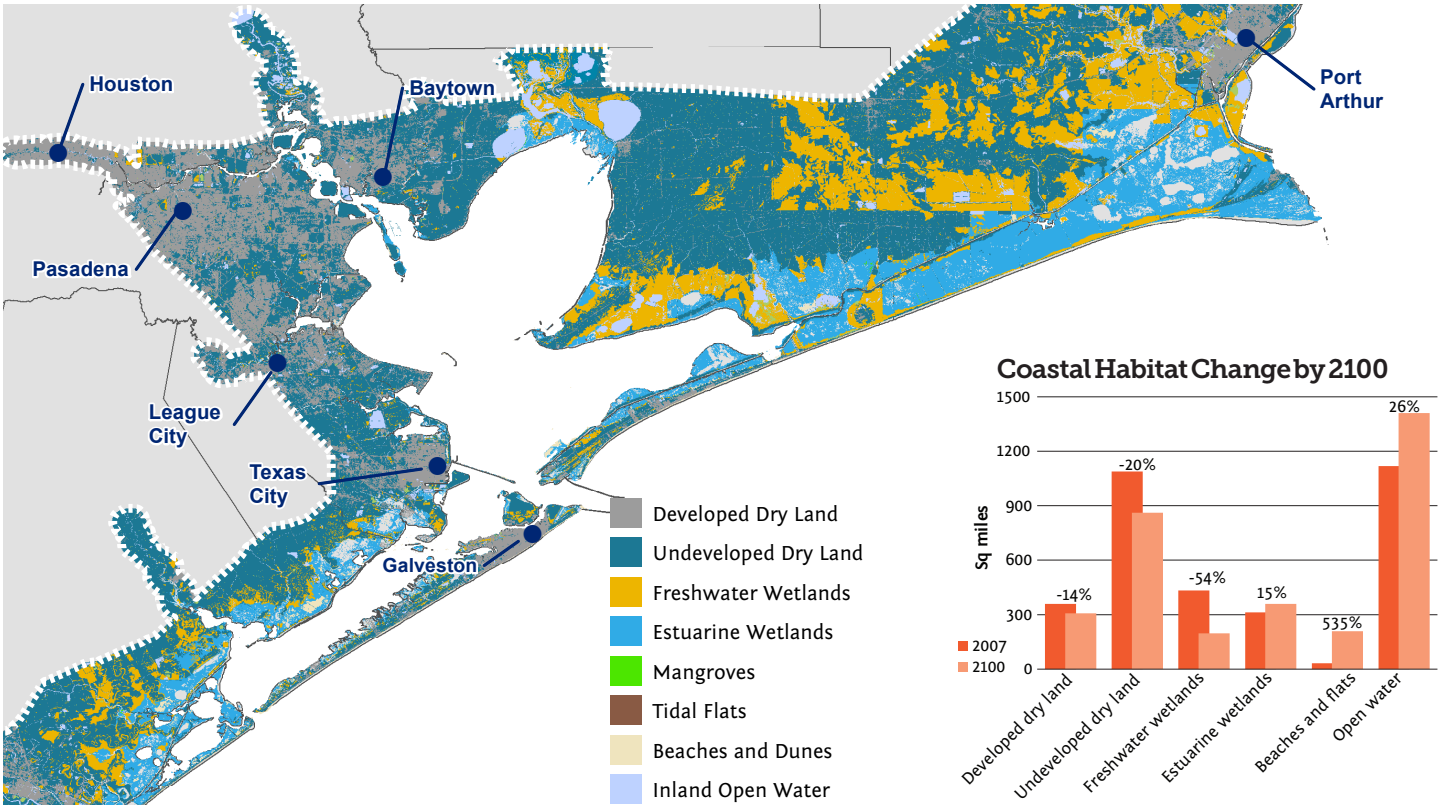


Source: Bureau of Labor Statistics, 2017[7]

The top industries for this region are **pipeline transportation, miscellaneous manufacturing,** and **chemical manufacturing.**[7]

Ecological Overview

Coastal Habitats



Source: National Wetlands Inventory, 2017 (some classifications consolidated for simplicity)[54]

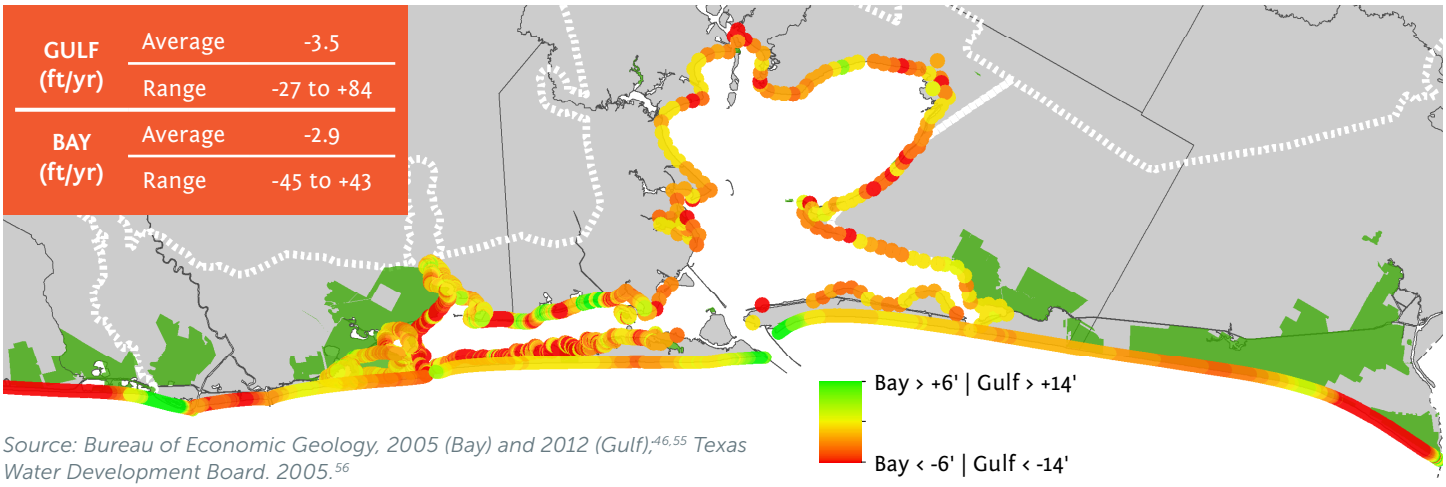
Regional Issues of Concern

Lesser Concern ● ○ ○ ○ Greater Concern ● ● ● ●

● ● ● ○ Altered, Degraded or Lost Habitat	● ● ● ◐ Gulf Beach and Dune Erosion
● ● ○ ○ Bay Shoreline Erosion	● ● ◐ ○ Impact on Coastal Resources
● ● ◐ ○ Coastal Flood Damage	● ● ◐ ○ Impact on Water Quality and Quantity
● ● ◐ ○ Storm Surge Damage	● ○ ○ ○ Abandoned and Derelict Structures and Debris

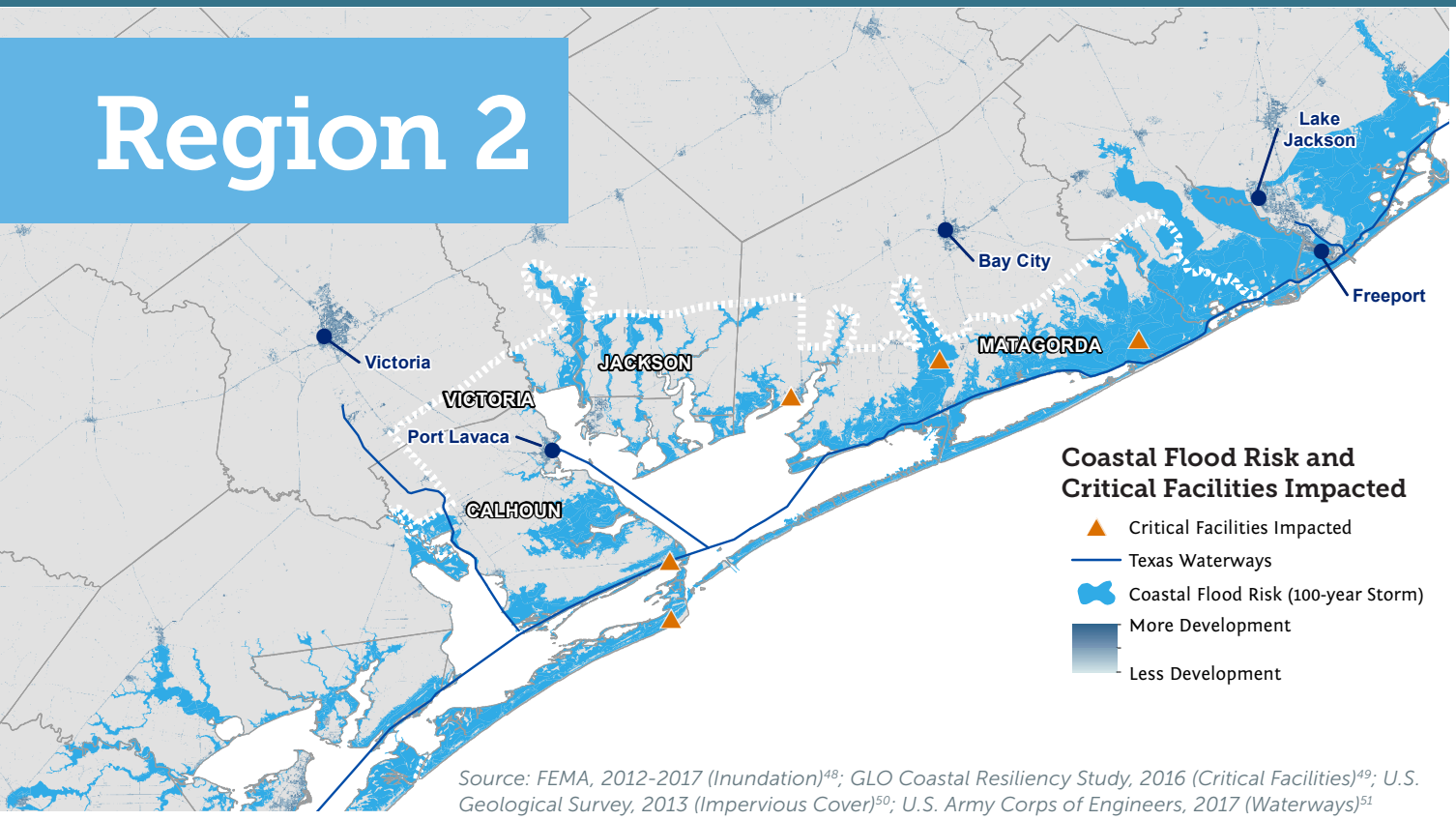
Historical Regional Shoreline Change Rates

GULF (ft/yr)	Average	-3.5
	Range	-27 to +84
BAY (ft/yr)	Average	-2.9
	Range	-45 to +43



Source: Bureau of Economic Geology, 2005 (Bay) and 2012 (Gulf);[46,55] *Texas Water Development Board. 2005.*[56]

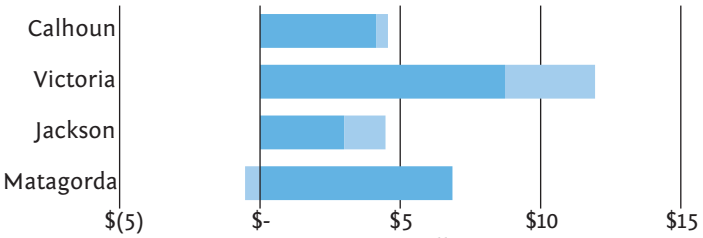
Region 2



Source: FEMA, 2012-2017 (Inundation)[48]; GLO Coastal Resiliency Study, 2016 (Critical Facilities)[49]; U.S. Geological Survey, 2013 (Impervious Cover)[50]; U.S. Army Corps of Engineers, 2017 (Waterways)[51]

Socioeconomic Overview

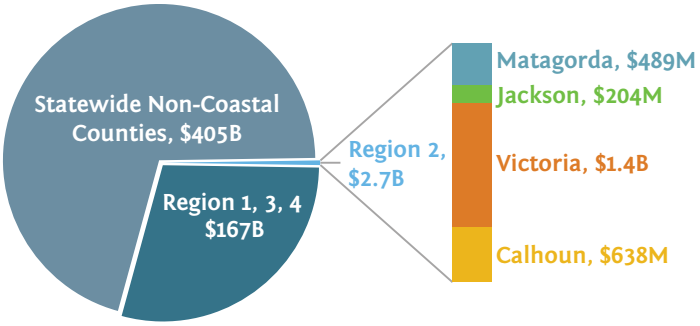
Value of Built Environment by Coastal County



Negative quantities indicate a projected decrease in property value by 2050

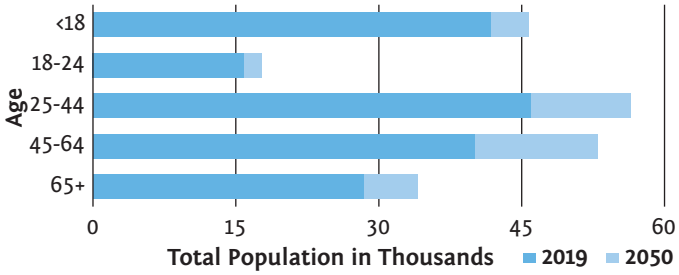
Source: Texas Comptroller of Public Accounts, 2017[52]

Annual Average Total Wages by Coastal County, 2017, All Industries



Source: Bureau of Labor Statistics, 2017[7]

Demographic Snapshot

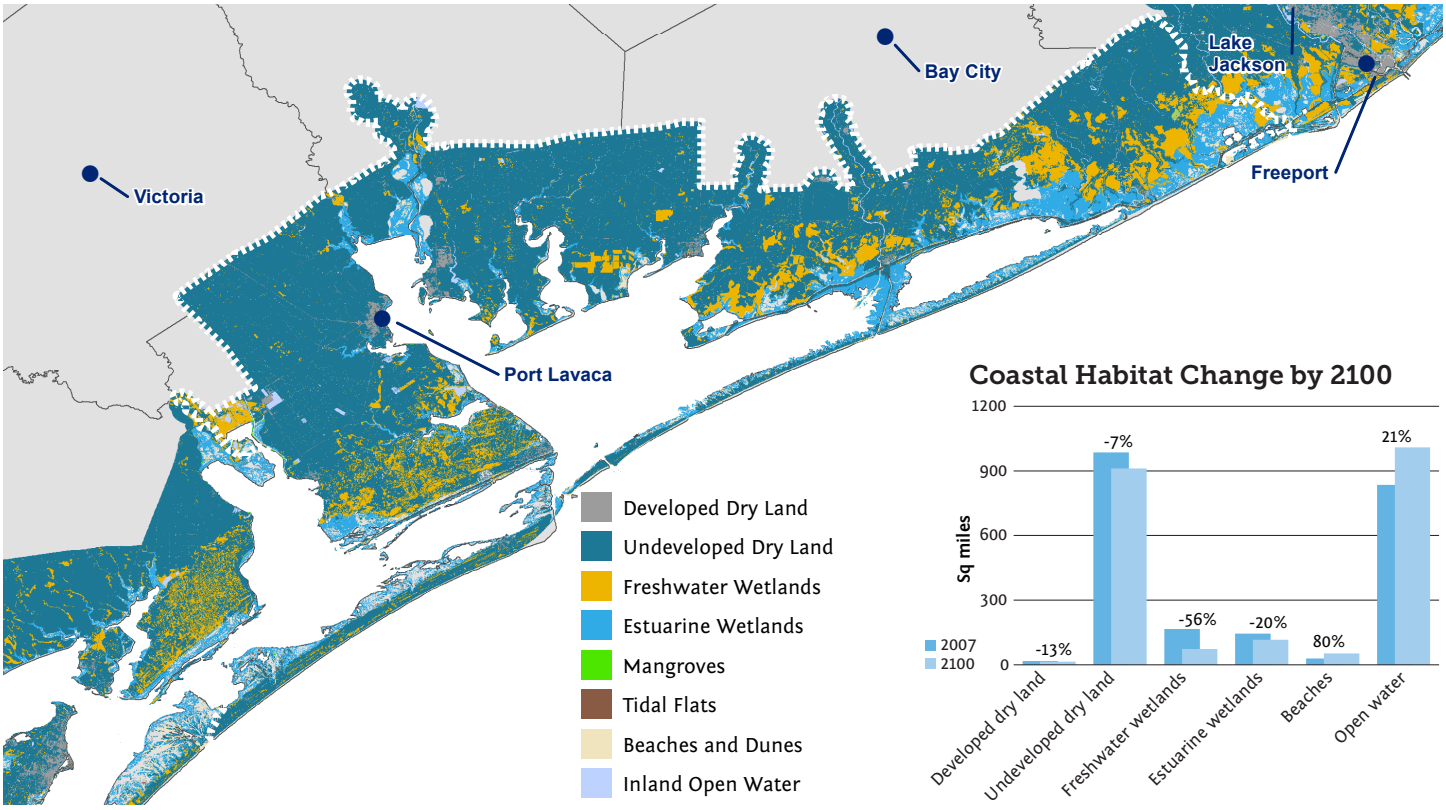


Source: Texas State Demographer, 2019[53]

The top industries for this region are **pipeline transportation, chemical manufacturing,** and **support activities for mining.**[7]

Ecological Overview

Coastal Habitats



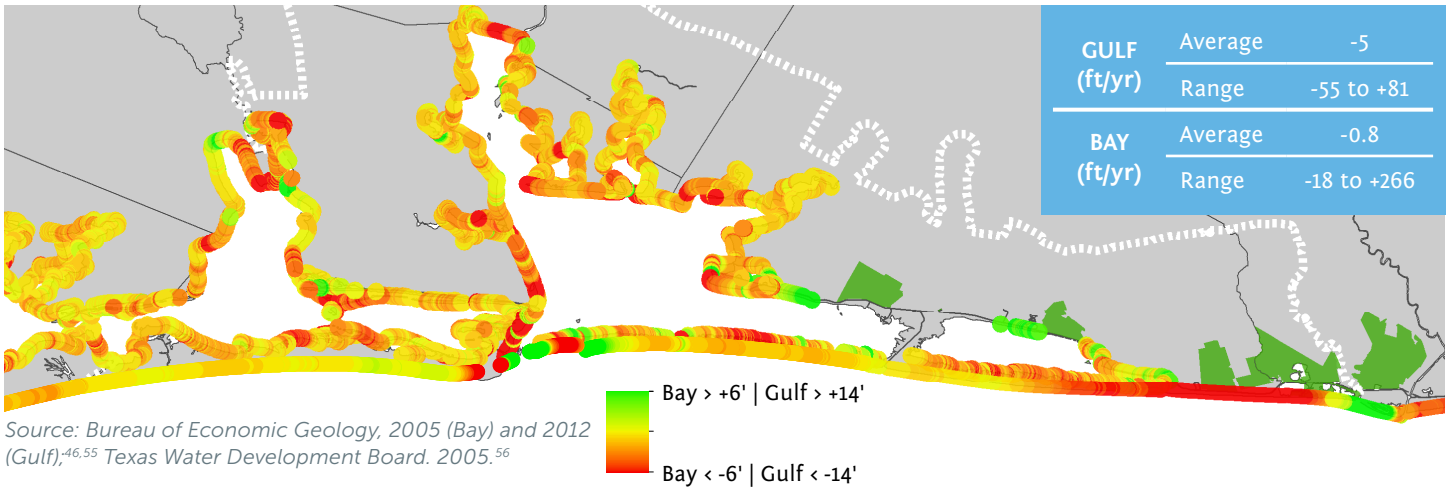
Source: National Wetlands Inventory, 2017 (some classifications consolidated for simplicity)[54]

Regional Issues of Concern

Lesser Concern ● ○ ○ ○ Greater Concern ● ● ● ●

● ● ◐ ○ Altered, Degraded or Lost Habitat	● ● ◐ ○ Gulf Beach and Dune Erosion
● ● ○ ○ Bay Shoreline Erosion	● ● ◐ ○ Impact on Coastal Resources
● ● ○ ○ Coastal Flood Damage	● ● ◐ ○ Impact on Water Quality and Quantity
● ● ○ ○ Storm Surge Damage	● ○ ○ ○ Abandoned and Derelict Structures and Debris

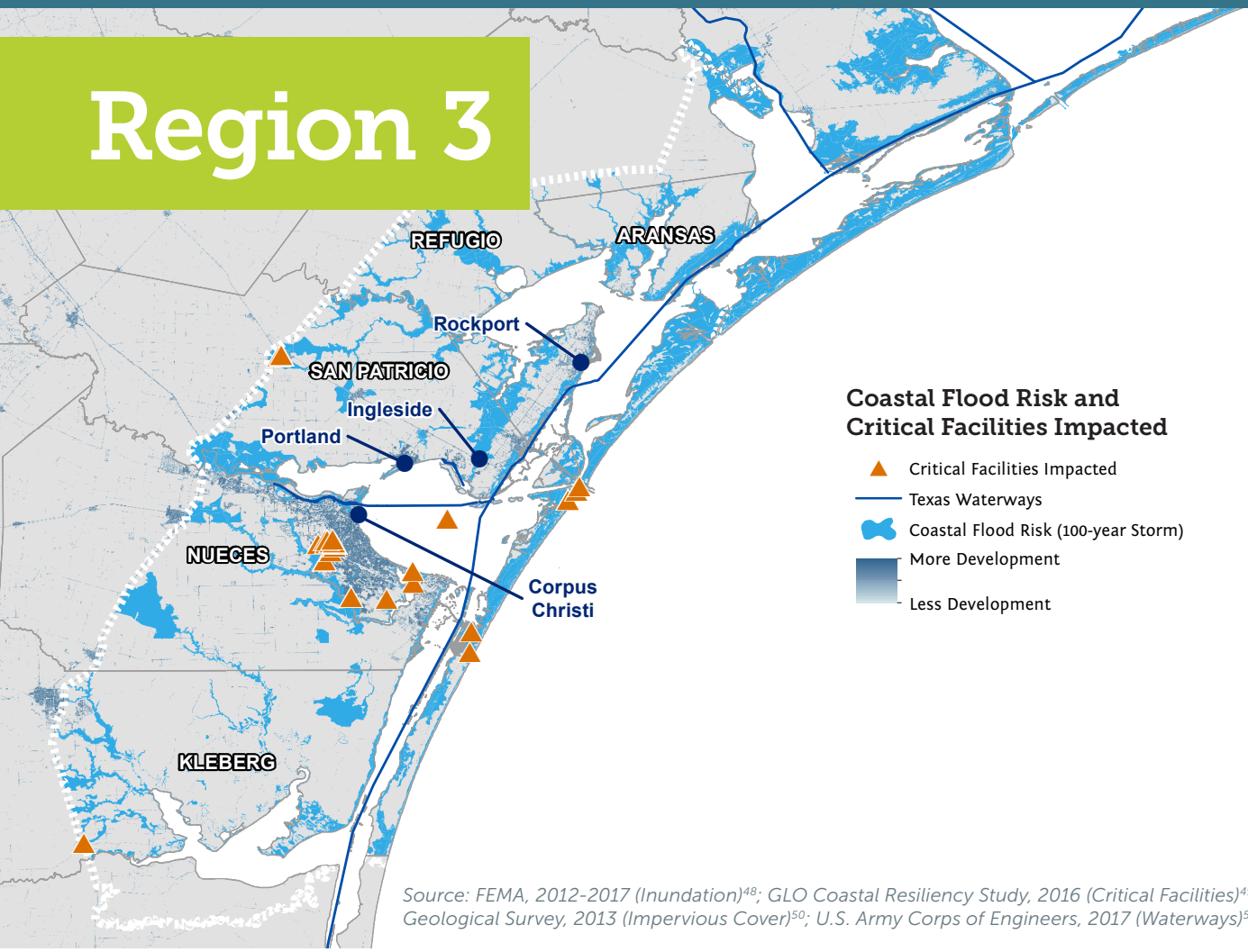
Historical Regional Shoreline Change Rates



GULF (ft/yr)	Average	-5
	Range	-55 to +81
BAY (ft/yr)	Average	-0.8
	Range	-18 to +266

Source: Bureau of Economic Geology, 2005 (Bay) and 2012 (Gulf);[46,55] *Texas Water Development Board. 2005.*[56]

Region 3



Source: FEMA, 2012-2017 (Inundation)[48]; GLO Coastal Resiliency Study, 2016 (Critical Facilities)[49]; U.S. Geological Survey, 2013 (Impervious Cover)[50]; U.S. Army Corps of Engineers, 2017 (Waterways)[51]

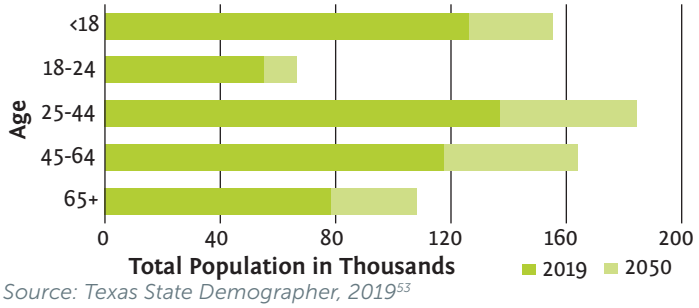
Socioeconomic Overview

Value of Built Environment by Coastal County

Negative quantities indicate a projected decrease in property value by 2050

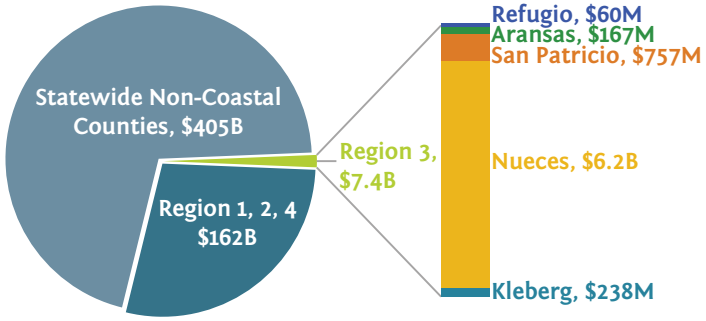
Source: Texas Comptroller of Public Accounts, 2017[52]

Demographic Snapshot



Source: Texas State Demographer, 2019[53]

Annual Average Total Wages by Coastal County, 2017, All Industries

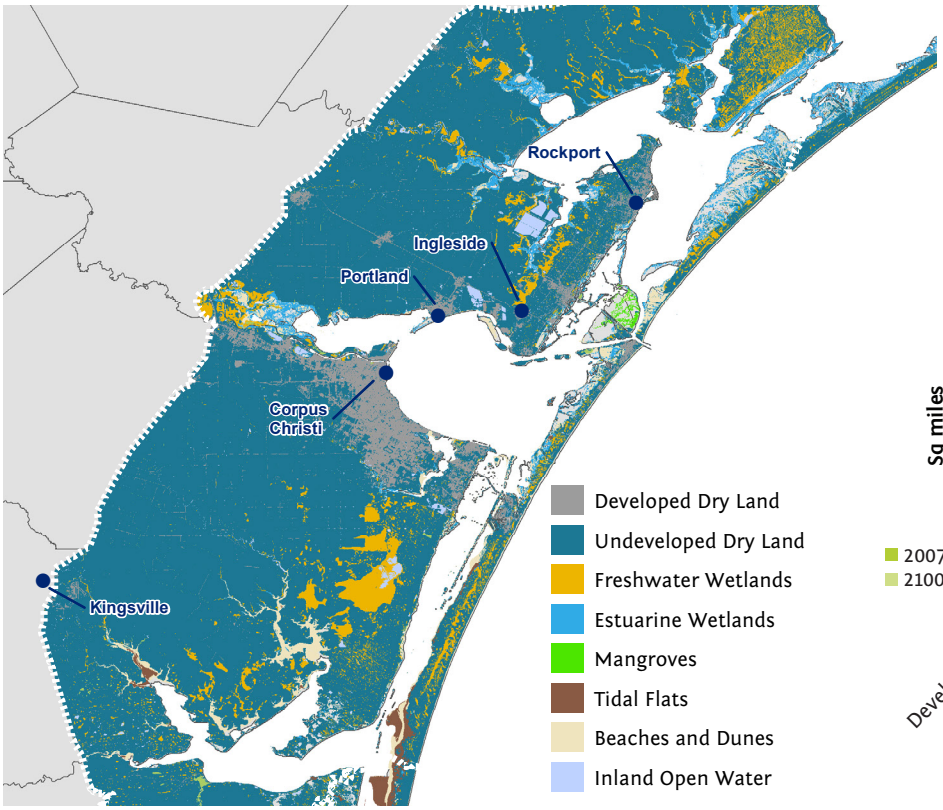


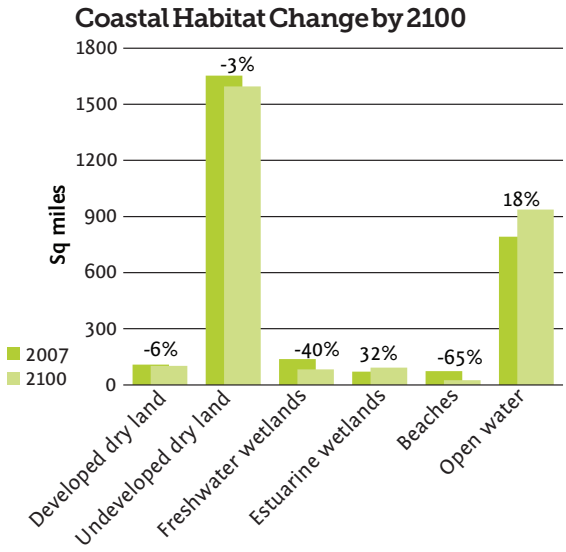
Source: Bureau of Labor Statistics, 2017[7]

The top industries for this region are **fishing, hunting and trapping, pipeline transportation,** and **heavy construction.**[7]

Ecological Overview

Coastal Habitats





Source: National Wetlands Inventory, 2017 (some classifications consolidated for simplicity)[54]

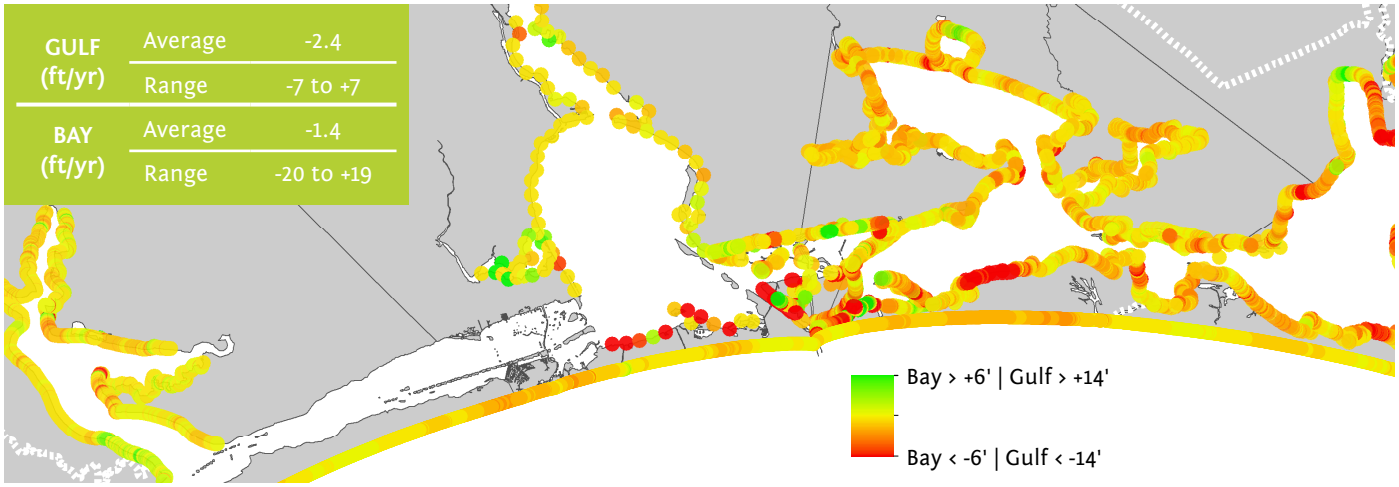
Regional Issues of Concern

Lesser Concern ● ○ ○ ○ Greater Concern ● ● ● ●

● ● ◐ ○ Altered, Degraded or Lost Habitat	● ● ○ ○ Gulf Beach and Dune Erosion
● ◐ ○ ○ Bay Shoreline Erosion	● ● ○ ○ Impact on Coastal Resources
● ◐ ○ ○ Coastal Flood Damage	● ● ◔ ○ Impact on Water Quality and Quantity
● ◐ ○ ○ Storm Surge Damage	● ○ ○ ○ Abandoned and Derelict Structures and Debris

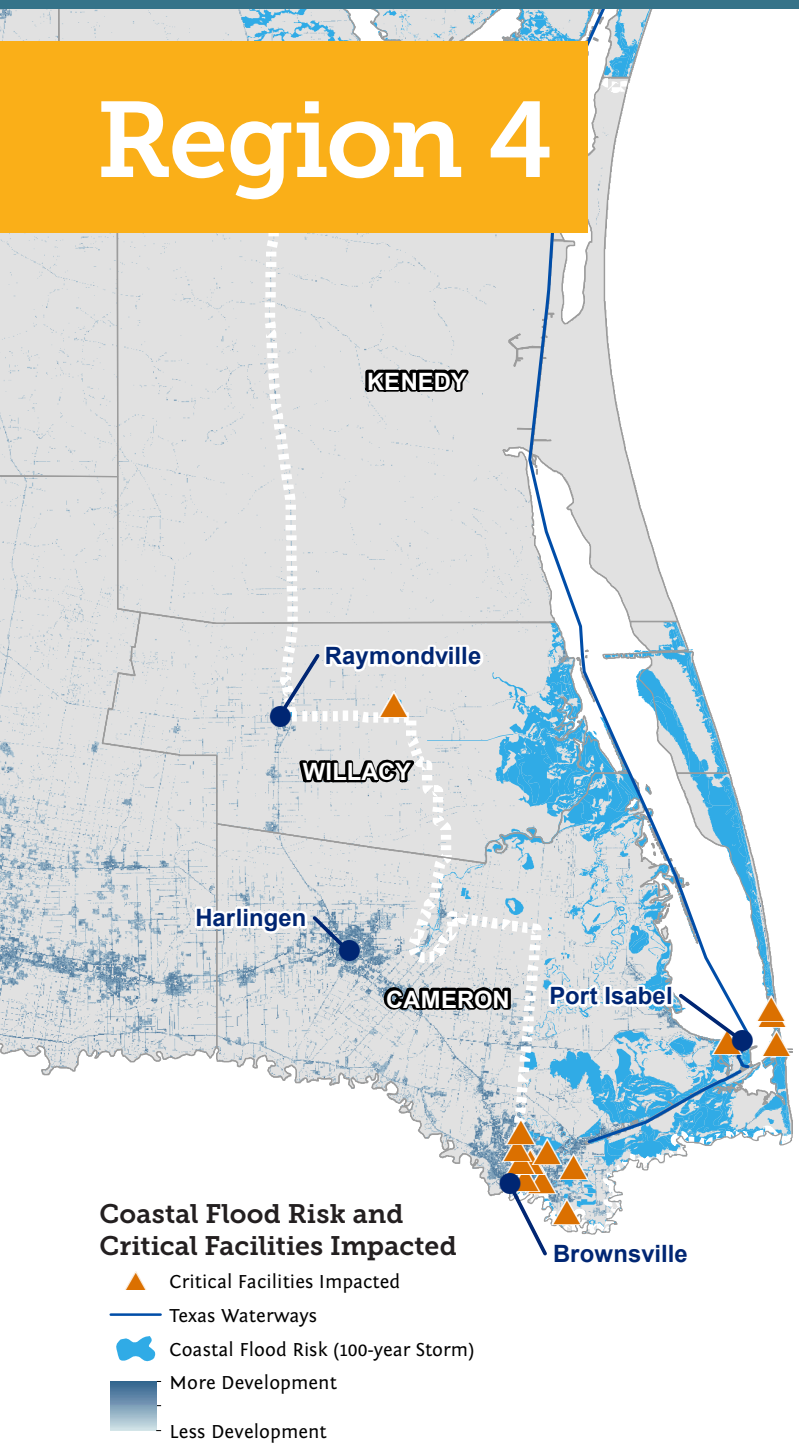
Historical Regional Shoreline Change Rates

GULF (ft/yr)	Average	-2.4
	Range	-7 to +7
BAY (ft/yr)	Average	-1.4
	Range	-20 to +19



Source: Bureau of Economic Geology, 2005 (Bay) and 2012 (Gulf),[46,55] *Texas Water Development Board. 2005.*[56]

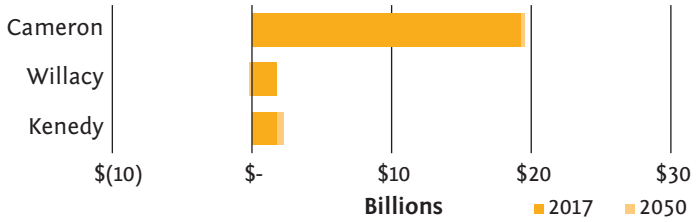
Region 4



Source: FEMA, 2012-2017 (Inundation)[48]; GLO Coastal Resiliency Study, 2016 (Critical Facilities)[49]; U.S. Geological Survey, 2013 (Impervious Cover)[50]; U.S. Army Corps of Engineers, 2017 (Waterways)[51]

Socioeconomic Overview

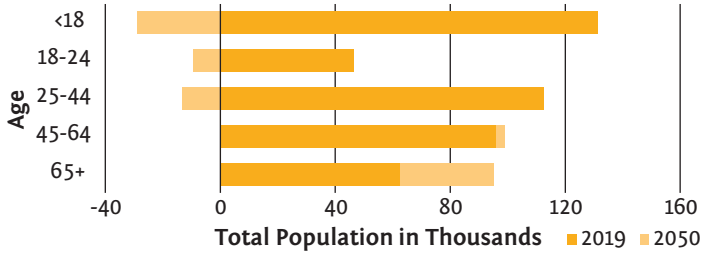
Value of Built Environment by Coastal County



Negative quantities indicate a projected decrease in property value by 2050

Source: Texas Comptroller of Public Accounts, 2017[52]

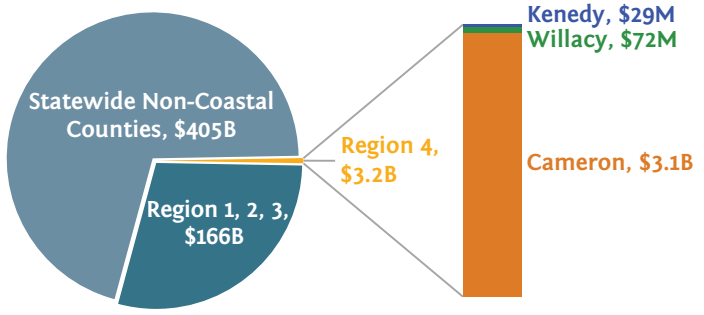
Demographic Snapshot



Negative values indicate the magnitude of population decrease by 2050

Source: Texas State Demographer, 2019[53]

Annual Average Total Wages by Coastal County, 2017, All Industries

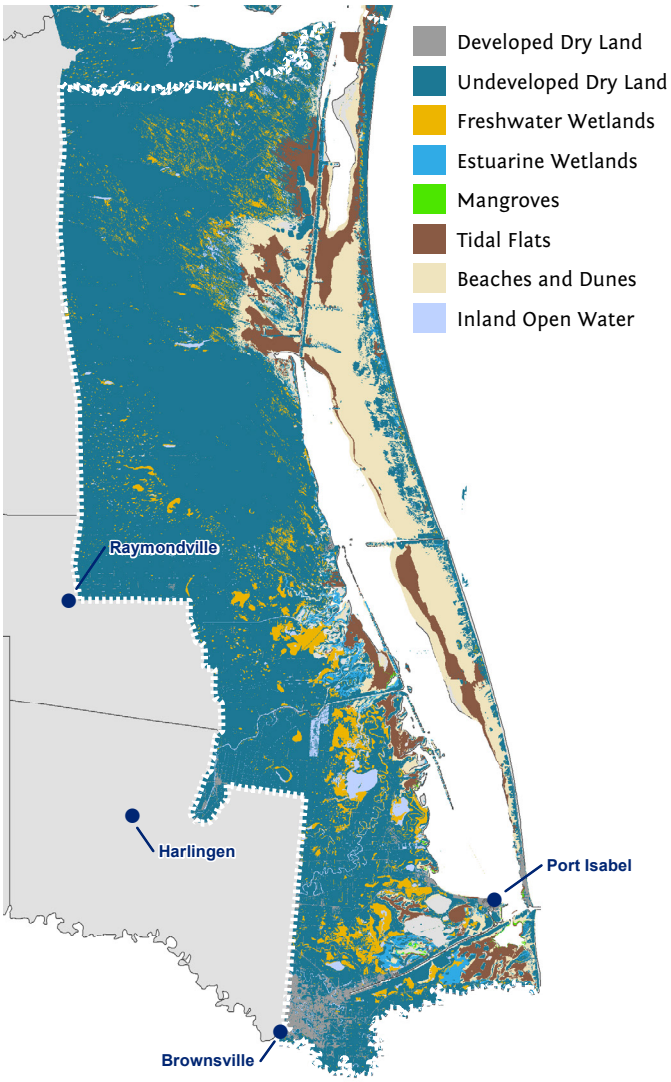


Source: Bureau of Labor Statistics, 2017[7]

The top industries for this region are **animal production** and **aquaculture, agriculture and forestry**, and **crop production**.[7]

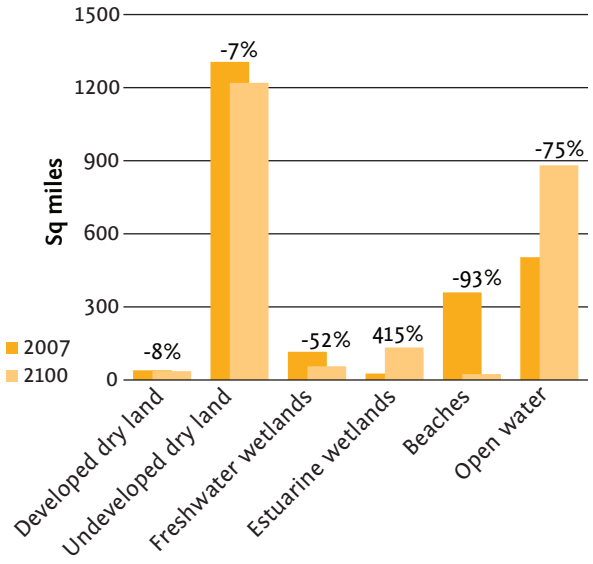
Ecological Overview

Coastal Habitats



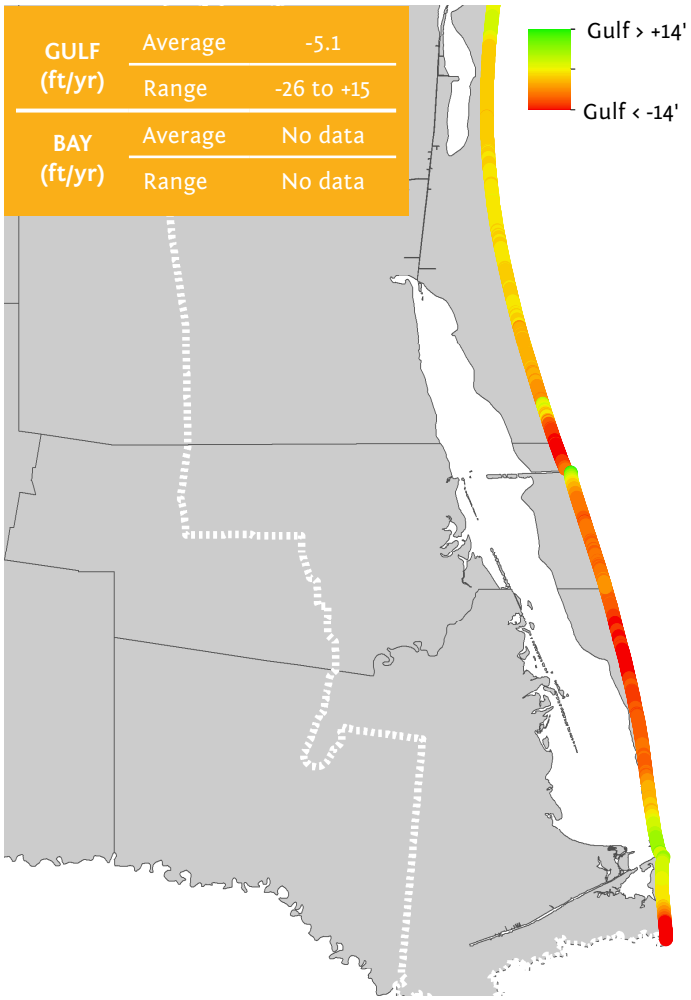
Source: National Wetlands Inventory, 2017 (some classifications consolidated for simplicity)[54]

Coastal Habitat Change by 2100



Historical Regional Shoreline Change Rates

GULF (ft/yr)	Average	-5.1
	Range	-26 to +15
BAY (ft/yr)	Average	No data
	Range	No data



Source: Bureau of Economic Geology, 2005 (Bay) and 2012 (Gulf);[46,55] *Texas Water Development Board. 2005.*[56]

Regional Issues of Concern

- Altered, Degraded or Lost Habitat
- Bay Shoreline Erosion
- Coastal Flood Damage
- Storm Surge Damage
- Gulf Beach and Dune Erosion
- Impact on Coastal Resources
- Impact on Water Quality and Quantity
- Abandoned and Derelict Structures and Debris

Lesser Concern ● ○ ○ ○ **Greater Concern** ● ● ● ●

Coastal Community Best Practices– Steps Your Community Can Take

At the local level, communities can build physical resiliency practices that make infrastructure more able to withstand the effects of climate conditions while also supporting valuable habitat, improving aesthetics, and providing opportunity for recreation. This Resiliency Plan can be used as a starting point for identifying at-risk areas, reviewing project data and status, and incorporating climate-informed design – including planning for sea level rise – into future projects.

PLAN ▶ IMPLEMENT ▶ MAINTAIN

Policy and Planning

Risk avoidance is the safest and most cost-effective way to keep communities and families protected. Policies should protect natural habitats that buffer communities and provide important ecosystem benefits.

- Limit or preclude development or redevelopment in at-risk areas along the coast and within floodplains.
- Develop and enforce setbacks from shorelines and dunes.
- Protect wetlands and marsh migration corridors from development.
- Promote and incentivize urban infill and multi-unit housing to reduce pressure on natural areas.
- Include greenways and open space, which can double as flood protection and recreational spaces, in coastal plans.
- Regulate public beach access and install dune walkovers to protect the dunes and limit erosion.
- Develop and annually update a community Emergency Response Plan.

Design and Construction

Accounting for climate conditions during design and construction can make structures more resilient. Native habitats provide flood control, refuge for local species and are more able to adapt. Designing storm and wastewater systems to accommodate increased floods is essential.

- Elevate roadways and structures to account for storm surge plus anticipated sea level rise.
- Incorporate wildlife crossings into linear projects (e.g. roadways, railways).
- Promote low impact design practices.
- Use storm proofing measures and materials.
- Incorporate softscapes, such as habitat transitional areas, and bioengineering stabilization techniques.
- Install vegetated buffers between row crops or developed areas and waterbodies to promote natural filtration and improve water quality.
- Replace impervious surfaces with permeable ones.
- Convert septic and groundwater systems to storm sewers and supplied water.

Public Engagement, Stewardship and Management

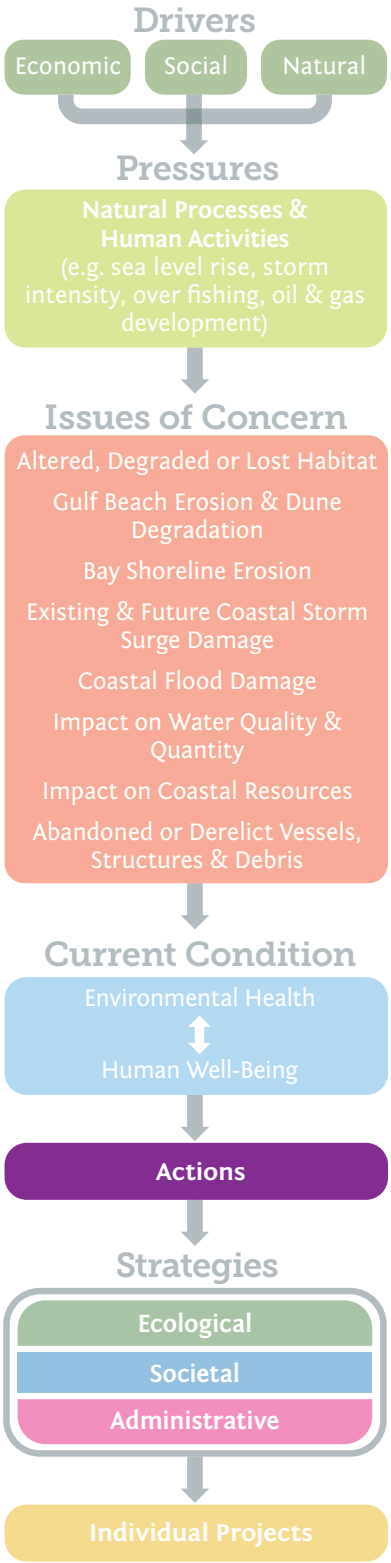
Maintaining habitat buffers and storm water systems is equally important to planning and construction. Homeowners and developers can multiply the impact of local governments through stewardship actions at the parcel level.

- Keep drains clear of debris blockages that can exacerbate flooding.
- Prepare educational materials for homeowners and developers, including information on grant and incentive programs, that promote water reduction and climate-informed building practices.
- Provide funding for clean and resilient marinas.
- Host public shoreline clean-up and restoration events, and encourage student participation.
- Landscape with climate-smart native plants that are adapted to local conditions, support wildlife, are resilient to disturbance, and are tolerant of drought and salinity.

3. Moving Toward a Resilient Coast

Understanding that the Texas coast is an invaluable asset is only the beginning of advancing resiliency. Implementing projects to mitigate our coast's risks and fortify the coast's resiliency is a critical next step to achieving the goals of this Resiliency Plan. This can only be accomplished through coordination, cooperation and the efforts of all the people of Texas. This section of the Resiliency Plan will outline what needs to occur at the state and local level, and how to improve the resiliency of the entire Texas coast.

Actions



Implementing the Texas Coastal Resiliency Master Plan requires multiple levels of response, beginning with what should happen at a statewide level and continuing on to what needs to happen at a local level. The framework used for the 2019 Resiliency Plan, as shown to the left, defines these necessary responses as *Actions*. In most cases, the Actions are presented as collections of individual projects in a specific area that all function together to mitigate the coastal pressures and Issues of Concern, which will ultimately improve one aspect of coastal resiliency. The Actions are developed based on distinct statewide, regional and/or local needs, derived from coastal problems identified during regional discussions with the Technical Advisory Committee. All of the projects needed to fully address the Actions may not currently be identified. Rather, the Actions show areas of need for the state to focus on to fund and implement resiliency projects now and into the future. *The maps of Actions within this section present, first, Actions that have complementary projects identified within this Resiliency Plan, and second, maps displaying Actions without currently identified projects.*

The following descriptions provide an overview of the 11 Actions presented in the 2019 Resiliency Plan, which includes two coastwide Actions described on the next page. Further details on each Action below are provided in the regional summaries.

Beach and Dune Sustainability
Keeping sand on Texas beaches and maintaining dunes.

Coastal Storm Risk Management
Protecting coastal communities from storm surge.

Delta Management
Keeping the bay systems functioning properly by ensuring their deltas are healthy and productive.

Oyster Reef Enhancement
Helping Texas rebuild its once teeming oyster population and improving overall bay ecosystems in the process.

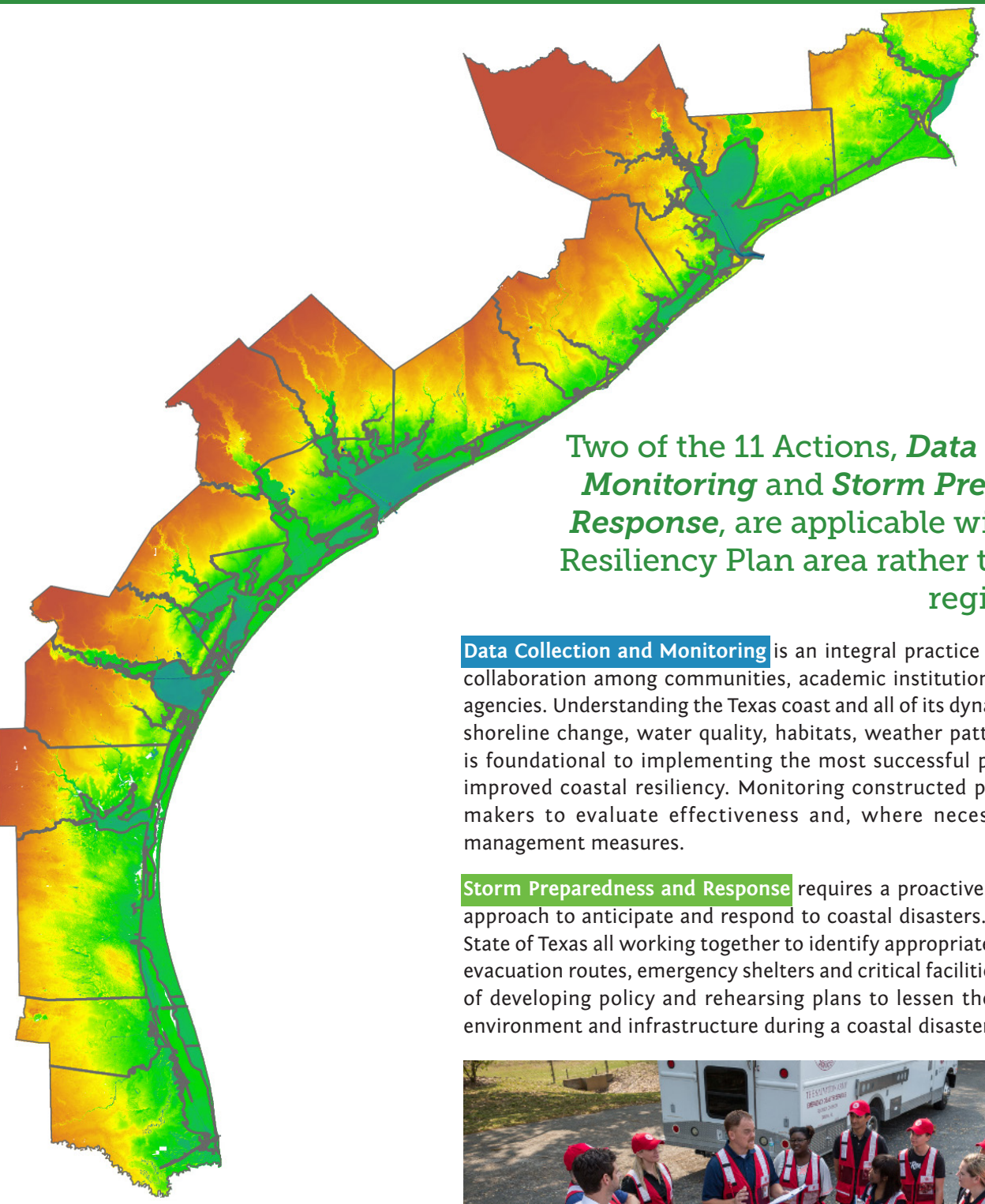
Regional Infrastructure Improvements
Making roads, channels, sewers and other infrastructure more resilient to coastal hazards.

Responsible Development
Restructuring the way communities think about developing Texas coastlines for future generations.

Rookery Island Enhancement
Protecting and restoring bird habitats along the coast.

Watershed Planning
Improving freshwater and stormwater inflows and outflows to and from the watersheds.

Wetland Protection and/or Shoreline Stabilization
Preventing coastal shoreline erosion and freshwater/estuarine wetland loss.



Two of the 11 Actions, ***Data Collection and Monitoring*** and ***Storm Preparedness and Response***, are applicable within the entire Resiliency Plan area rather than at specific regional locations.

Data Collection and Monitoring is an integral practice that requires significant collaboration among communities, academic institutions, and state and federal agencies. Understanding the Texas coast and all of its dynamic elements (including shoreline change, water quality, habitats, weather patterns) with current data is foundational to implementing the most successful projects as we strive for improved coastal resiliency. Monitoring constructed projects allows decision-makers to evaluate effectiveness and, where necessary, employ adaptive management measures.

Storm Preparedness and Response requires a proactive administrative planning approach to anticipate and respond to coastal disasters. Cities, counties and the State of Texas all working together to identify appropriate emergency responders, evacuation routes, emergency shelters and critical facilities demonstrate the value of developing policy and rehearsing plans to lessen the impact on Texans, the environment and infrastructure during a coastal disaster.

Emergency response personnel prepare for mobilization (Photo Credit: The Salvation Army. 2017. Available at: http://www.salvationarmytexas.org/blog/respond-to-tropical-storm-harvey/overhead-shot-eds-workers-in-a-meeting/)

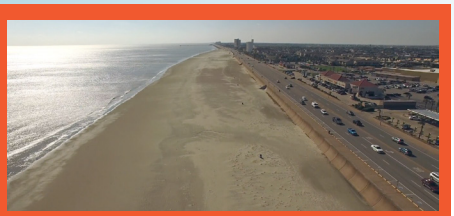
Region 1 Action Locations

Region 1 is heavily developed and home to several large cities and industrial centers. Because of this, Region 1 will benefit from Actions that are large-scale and collaborative among multiple agencies and authorities. The Actions will focus on restoring and rebuilding natural habitats to better protect and support communities, as well as improving regional resiliency related to coastal storms and other Issues of Concern that negatively impact the area.

Beaumont

Galveston

Freeport



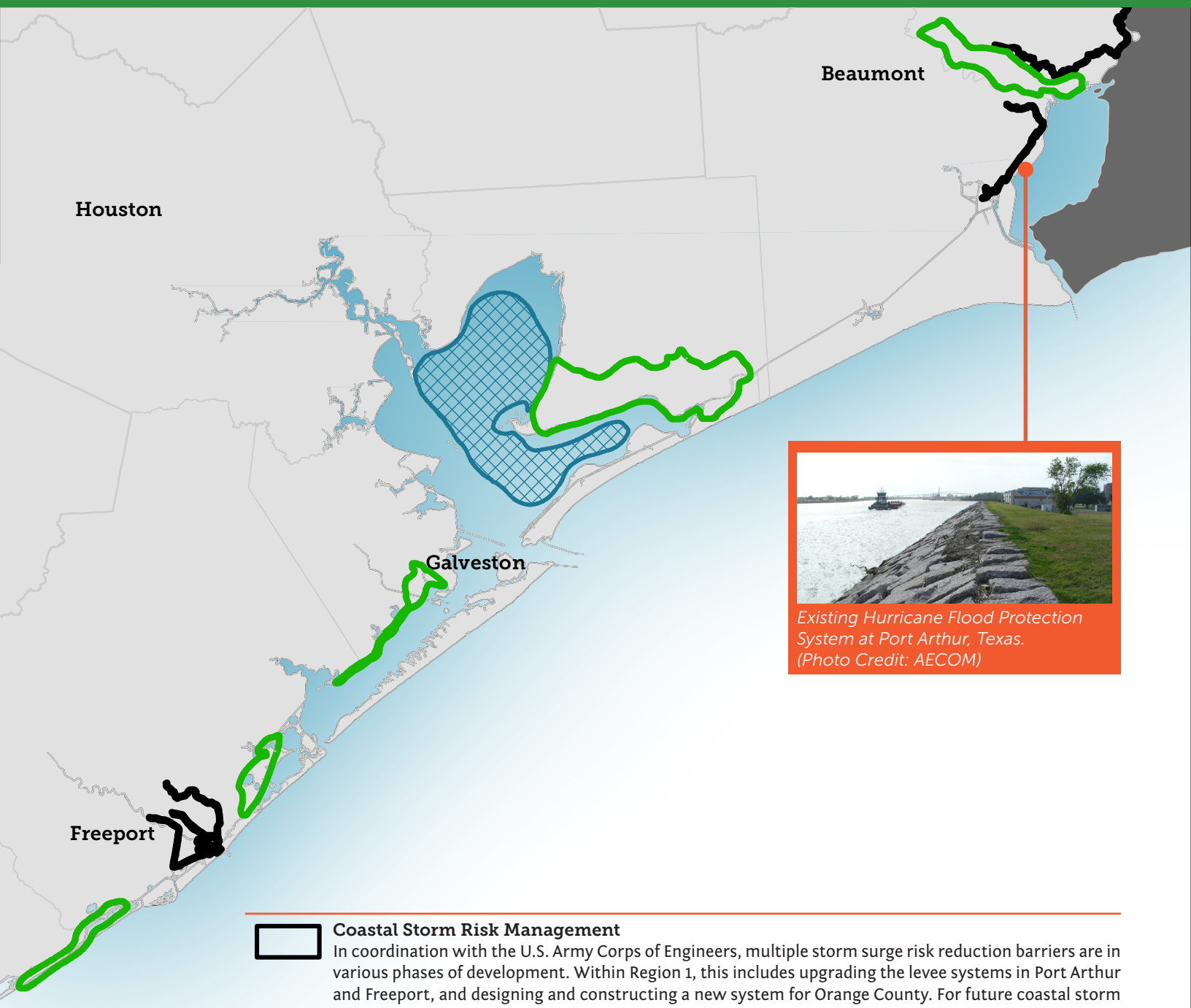
2015 beach nourishment at Babe's Beach in Galveston, Texas. (Photo Credit: Galveston Park Board)

Beach and Dune Sustainability
The majority of Gulf shorelines in this region are eroding faster than they can be maintained, and long-term dredged material placement partnerships are necessary for these beaches and dunes to thrive. Elevated needs exist for most of Region 1, extending as far south as Surfside then extending across Follet's Island and Galveston Island. Mainland Gulf shoreline beginning near McFaddin and ending at Texas Point also are identified within this Action.

Regional Infrastructure Improvements
Improving critical facility flood mitigation and capacity is a crucial step for the region's infrastructure network, particularly in Jefferson County and Orange County, where Hurricane Harvey caused massive pump failures and knocked out water supplies. Regional planning is important, because upstream water management practices have downstream consequences. A regional solution for community infrastructure issues, particularly related to drainage and water supply systems, is proposed for Jefferson County and Orange County to make the area more resilient for future storms.

Watershed Planning
The identified watersheds in Harris County and Galveston County have little undeveloped space remaining, thus requiring a focused effort to preserve natural habitat and transition developed areas to work with nature (such as by introducing bioswales or expanding buffer and floodwater storage areas). The Salt Bayou Watershed in Jefferson County has been altered over years of farming, ranching and construction of the GIWW. The wetlands in this area will benefit greatly from continuing work to restore the hydrology to natural conditions while, as the watershed is highly vulnerable to sea level rise, monitoring future changes.

Rookery Island Enhancement
Region 1 is home to critically important rookery island habitat to support a range of avian species throughout portions of Sabine Lake, Galveston Bay, West Galveston Bay and East Galveston Bay. These islands have suffered erosion and degradation through impacts from vessel traffic and wind-driven waves. Rookery islands are excellent candidates for beneficial use of dredged material, providing both ecological and maritime benefits, such as on the northern border of Sabine Lake.



Existing Hurricane Flood Protection System at Port Arthur, Texas. (Photo Credit: AECOM)

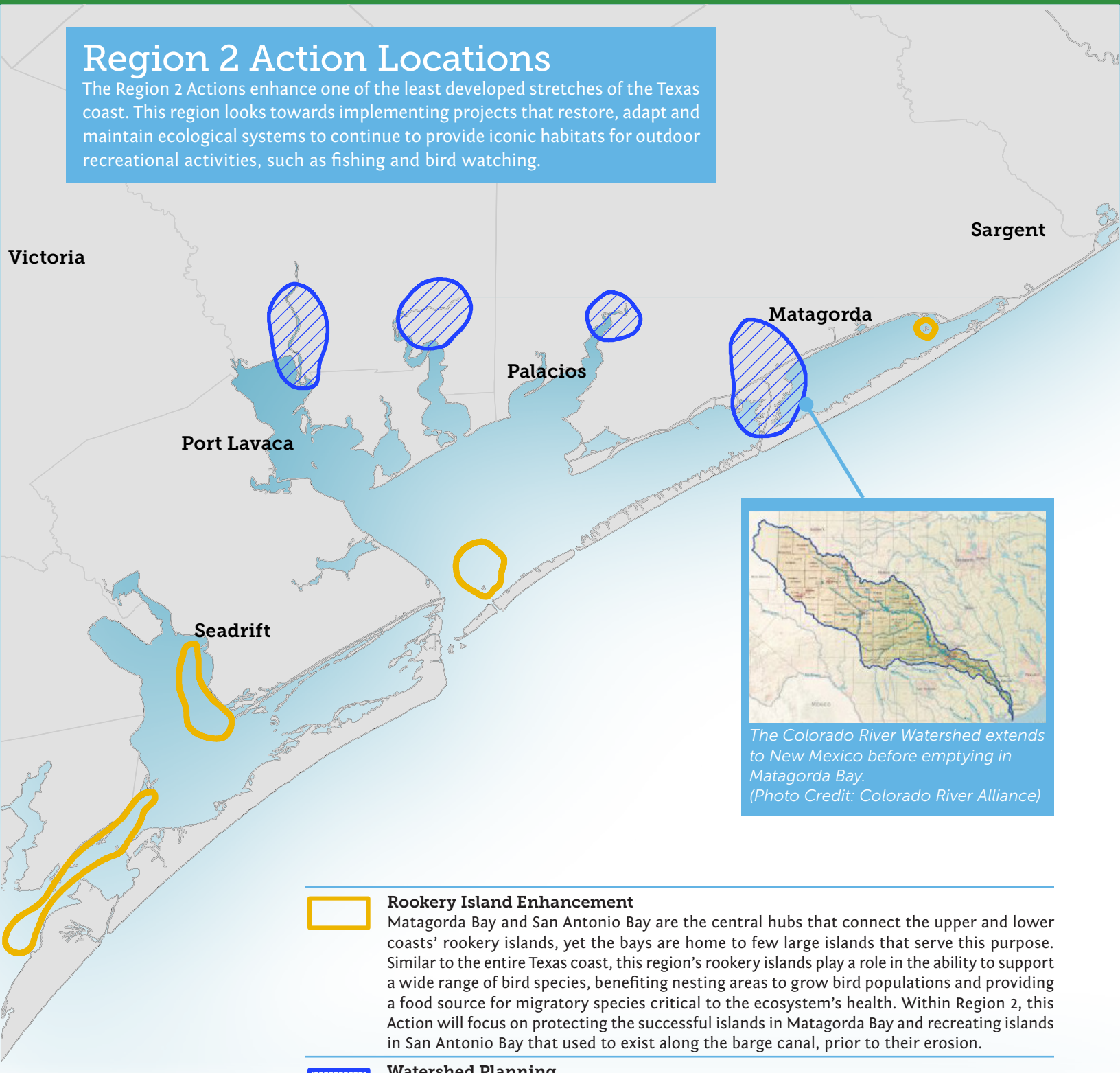
Coastal Storm Risk Management
In coordination with the U.S. Army Corps of Engineers, multiple storm surge risk reduction barriers are in various phases of development. Within Region 1, this includes upgrading the levee systems in Port Arthur and Freeport, and designing and constructing a new system for Orange County. For future coastal storm risk management projects, developing systems that reduce risk (to flooding and storm damage) should consider the community's priorities and work within the needs of the natural systems.

Oyster Reef Enhancement
Oyster reefs are a longstanding natural feature of the Galveston Bay system, extending far into Trinity Bay and East Galveston Bay. The oyster reefs play an ecological role in a healthy bay ecosystem and an economic role supporting the commercial and recreational fishing industries. The oyster reef systems have been greatly stressed by catastrophic events such as Hurricane Ike, which buried many reefs in sediment, and Hurricane Harvey, which damaged the reefs by flooding the area with freshwater and reducing salinity to dangerously low levels. This Action is focused on continuing to support and grow efforts to restore these oyster reefs through studies and projects.

Wetland Protection and/or Shoreline Stabilization
Every coastal region in Texas is suffering from bay shoreline erosion and wetland loss. Within Region 1, this includes large complexes along the Chenier Plain and along the GIWW. Working to stabilize these shorelines and looking for available opportunities to beneficially use dredged material to restore and maintain wetlands is critical to preserve healthy wetland systems.

Region 2 Action Locations

The Region 2 Actions enhance one of the least developed stretches of the Texas coast. This region looks towards implementing projects that restore, adapt and maintain ecological systems to continue to provide iconic habitats for outdoor recreational activities, such as fishing and bird watching.



The Colorado River Watershed extends to New Mexico before emptying in Matagorda Bay.
(Photo Credit: Colorado River Alliance)

Rookery Island Enhancement
Matagorda Bay and San Antonio Bay are the central hubs that connect the upper and lower coasts' rookery islands, yet the bays are home to few large islands that serve this purpose. Similar to the entire Texas coast, this region's rookery islands play a role in the ability to support a wide range of bird species, benefiting nesting areas to grow bird populations and providing a food source for migratory species critical to the ecosystem's health. Within Region 2, this Action will focus on protecting the successful islands in Matagorda Bay and recreating islands in San Antonio Bay that used to exist along the barge canal, prior to their erosion.

Watershed Planning
One of the greatest needs for the region is to determine a sustainable path forward for Matagorda Bay's freshwater inflows. The numerous watersheds that feed the bay are under stress from pesticides, pollutants and water consumption, both from agricultural and urban communities. More extreme weather patterns have created cyclical drought and flood conditions, weakening the bay's ecological systems. This Action will focus on a collaborative effort between state agencies, researchers and communities. Leveraging the studies and monitoring that are underway will benefit development of a comprehensive path forward to stabilize and adapt the Matagorda Bay system to current and future inflow conditions.

Half Moon Reef in Matagorda Bay serves as an example of oyster restoration. (Photo Credit: The Nature Conservancy)

Wetland Protection and/or Shoreline Stabilization
Every coastal region in Texas is suffering from bay shoreline erosion and wetland loss. Within Region 2, this is prolific along the GIWW and other narrow stretches of bay shoreline that currently provide areas of sheltered waters, but are at risk of breaching. Working to stabilize these shorelines and looking for available opportunities to beneficially use dredged material to restore and maintain wetlands are critical steps to maintain the health of these systems.

Delta Management
The Guadalupe River Delta is a major source of freshwater for San Antonio Bay and is home to diverse ecosystems, but it is subject to pressures along both the San Antonio River and Guadalupe River. Freshwater inflows are becoming less reliable with evolving weather patterns. Wetlands along the delta also are experiencing erosion from the adjacent barge canal. To mitigate these pressures, holistic planning for the delta is required to understand how it can be adapted to provide essential nutrients, sediment and freshwater inflows despite changing conditions.

Oyster Reef Enhancement
Commercial and recreational fishing are key industries within Region 2 that require a healthy bay ecosystem. Matagorda Bay has seen past successes in large-scale oyster reef restoration, which have not only created new oyster habitat, but also have been a boon to fishing communities. Building from the knowledge of what worked well during recent restoration efforts at Half Moon reef, additional projects are proposed in Matagorda Bay and East Matagorda Bay.

Region 3 Action Locations

The Region 3 Actions tell the story of a genuinely mixed environment: a coastline peppered with development ranging from small fishing and tourist communities to larger metropolitan centers, surrounded by vast expanses of protected land. This region will benefit from management practices that consider development within the natural protections afforded by the region's robust barrier islands, for the most effective protection of coastal residents and industries.

Monitoring work by the Baffin Bay Study Group. (Photo Credit: Coastal Bend Bays & Estuaries Program)

Rookery Island Enhancements

The Coastal Bend Region is home to some of the most productive rookery islands on the Texas Gulf Coast that allow bird populations to forage, roost and migrate. While the region benefits from the provisioning, supporting and cultural services provided by the islands, the rookery islands are continually stressed by erosion or habitat degradation. Under this Action, work will continue to establish partnerships to take full advantage of dredged material resources, as well as implement shoreline protection and vegetation to enhance the habitat. These rookery islands often provide shallow habitat for fish and they attenuate waves from passing vessels. This exemplifies the mutually beneficial role the rookery islands play in coastal resiliency by providing advantages for both the natural and built environments.

Watershed Planning

Baffin Bay is a rural bay that drains into the hypersaline Laguna Madre and has remained largely undeveloped. Baffin Bay, though, is confronted by unique challenges related to water quality (agricultural pesticide runoff) and quantity (any spikes or decreases has downstream impacts to the hypersaline lagoon). Regional and local authorities, scientists and environmental activists have made impressive "grassroots" strides to collect data, monitor water quality and inflows, and lay out best management practices for ranchers and farmers. Under this Action, continued support for these efforts are encouraged as well as the expansion to a more comprehensive approach to increase the resiliency of the watershed.

Responsible development includes ensuring that healthy dune systems can remain a first line of defense against coastal storms. (Photo Credit: Texas General Land Office)

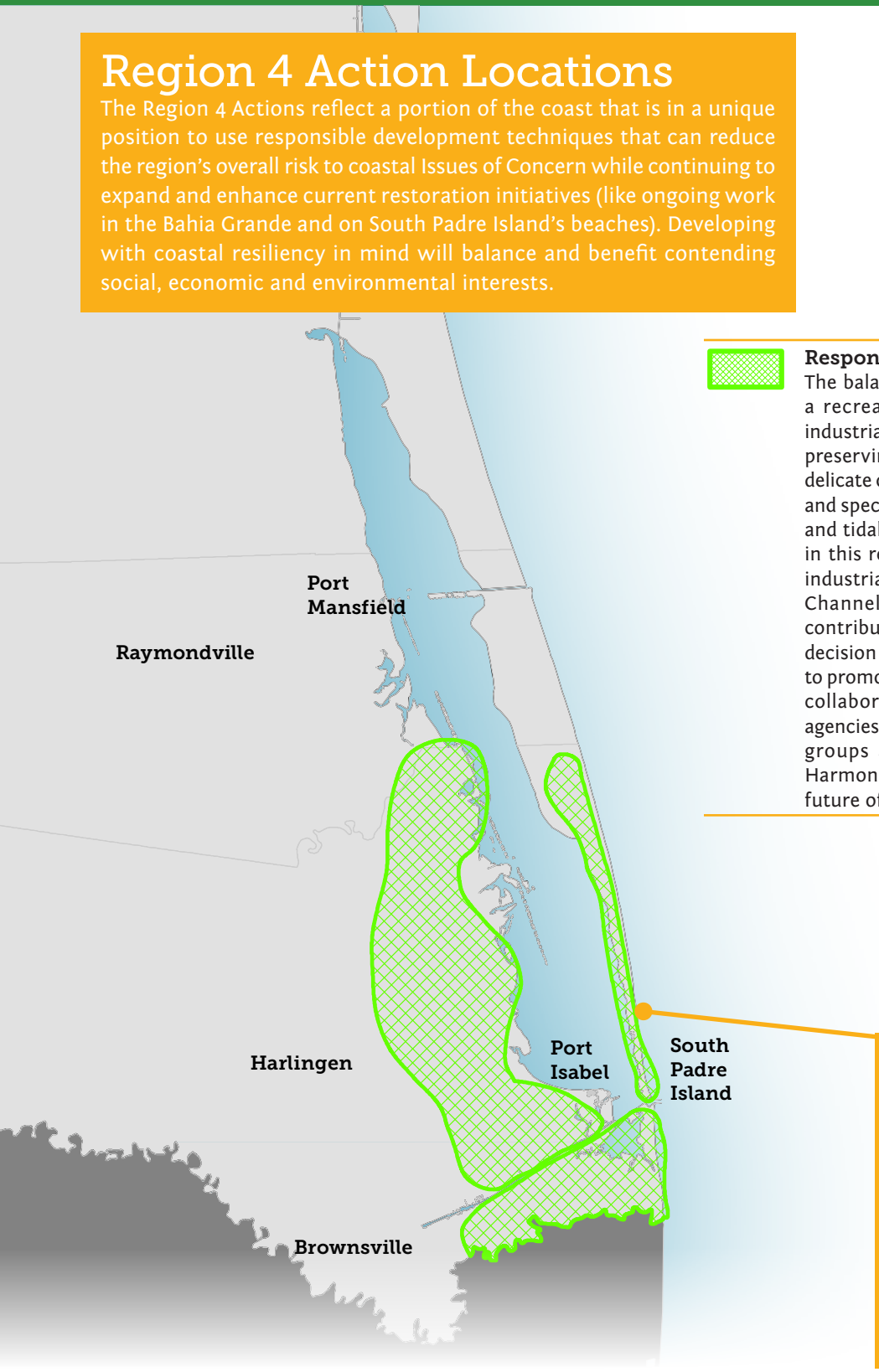
Wetland Protection and/or Shoreline Stabilization
Many of the Region 3 bay shorelines suffer continual erosion, exposing both communities and ecosystems to the significant forces of the waves generated throughout the bays. Bolstering the region's natural environments by engineering with nature will make coastal roadways and other shorefront infrastructure more resilient to these issues, while providing ecological services. Living shorelines, or shorelines that combine stone armoring with vegetative buffers for two levels of stabilization, are recommended improvements.

Delta Management
As the Nueces River goes, so goes the health of the entire Corpus Christi Bay system. At present, the river and delta are stressed by variability in the water quantity (either excessive flooding or extreme drought) and repeated water quality issues (including high levels of bacteria, raising concerns for drinkability), in addition to progressing wetland erosion along the bay shoreline. This Action recommends increasing work to restore inflows, to protect water quality and leave room for the consideration of the delta in future development plans.

Responsible Development
Mustang Island is a unique area of development mixed with native barrier island ecosystems. The manner that development inevitably proceeds on the island will define the area's coastal resiliency. Finding balance between human development and preserving untouched natural systems is a major consideration. Building residential and commercial developments that work with the natural protections afforded by coastal ecosystems – such as expansive Gulf-facing beaches and high dunes that protect against storm surge or bayside wetlands that hold and filter floodwaters – deserves the utmost consideration and necessitates a multi-disciplinary approach.

Region 4 Action Locations

The Region 4 Actions reflect a portion of the coast that is in a unique position to use responsible development techniques that can reduce the region's overall risk to coastal Issues of Concern while continuing to expand and enhance current restoration initiatives (like ongoing work in the Bahia Grande and on South Padre Island's beaches). Developing with coastal resiliency in mind will balance and benefit contending social, economic and environmental interests.

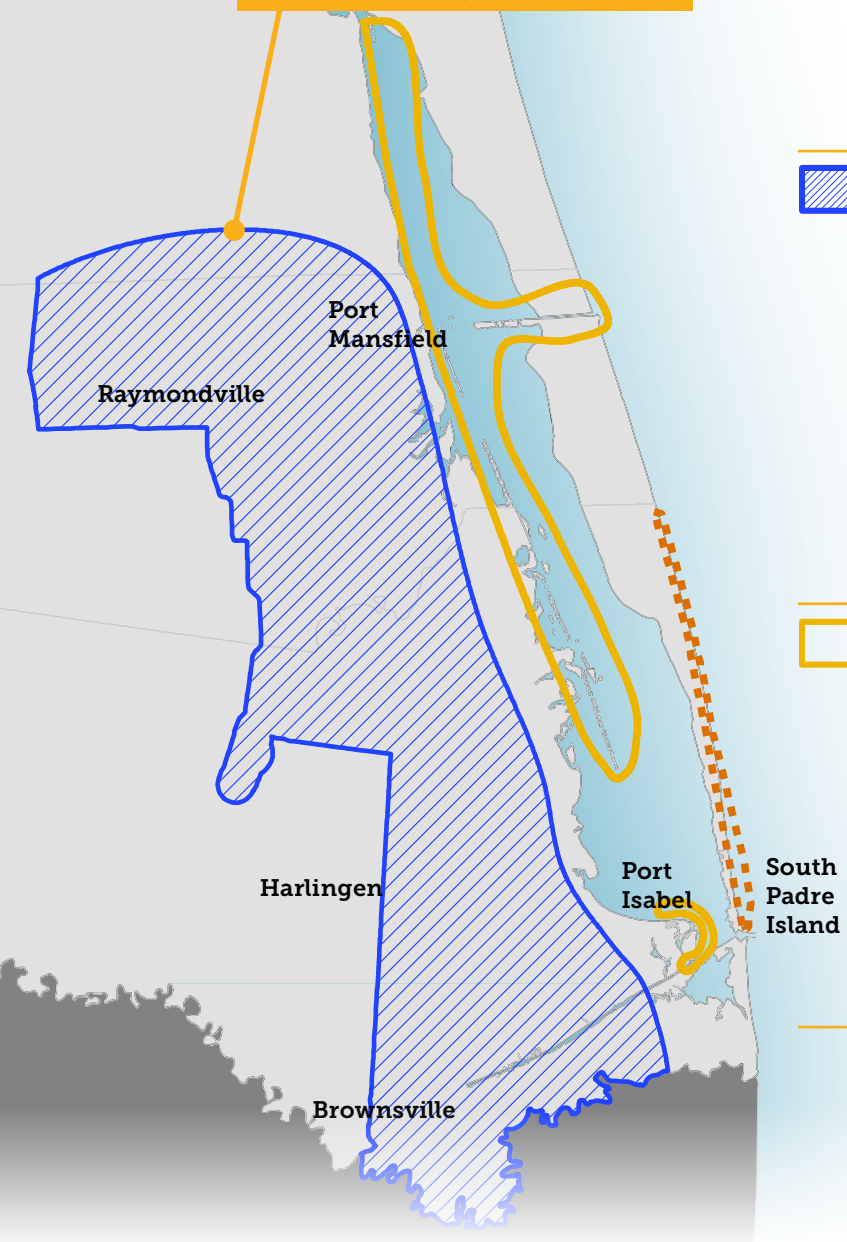


Responsible Development

The balance between stimulating development – with a recreational focus on South Padre Island and an industrial focus on the Cameron County mainland – and preserving the lower coast's trademark ecosystems is a delicate one. In addition to irreplaceable coastal habitats and species, such as mangroves, the endangered ocelot, and tidal flats, tourism and recreational opportunities in this region are unmatched in all of Texas. From an industrial standpoint, the deep-draft Brownsville Ship Channel supports industrial interests that are big contributors to the region's economy. To better equip decision makers with the information and justifications to promote progress in a responsible manner, significant collaboration is required between federal and state agencies, planners, scientists, engineers, environmental groups and other stakeholders across the region. Harmonizing these competing interests will define the future of coastal resiliency in this region.

State Park Road 100 overrun by dune sands as natural systems and infrastructure intersect. (Photo Credit: Texas General Land Office)

Watershed planning will improve regional issues related to flooding and water quality. (Photo Credit: Texas General Land Office)



Beach and Dune Sustainability

Across the State of Texas, many will first think of white sand beaches and tourist destinations when asked about the southern Texas coastline. Gulf-facing beaches are the main economic driver for the region's booming tourism industry. However, most would not know, though, that much of the beach area on the lower coast is actually eroding. Past projects to renourish the beaches have mitigated some of the erosion, but expanding development in the region and rising sea levels are increasing stress on these shorelines. Expanding past work to nourish beaches and restore dunes will be required to extend the life cycle of these improvements, reduce erosion rates and make the Gulf shoreline more resilient to coastal storms. The region has successfully built partnerships to beneficially use dredged material, and this Action will build on these past successes.

Watershed Planning

Watershed planning within the Rio Grande Valley presents particular challenges resulting from negligible elevation change across the region. Due to vast expanses of low-lying land, flooding throughout the watershed is a continuous consideration. Any inflows from the region have the potential to greatly impact the Lower Laguna Madre, as the bay sees minimal freshwater inflow on the whole. During flood events, this magnifies water quality concerns related to runoff from developed areas. As a result, developing a region-wide approach to better understand these concerns is a necessary step forward to improve the region's coastal resiliency. This Action will support regional planning and mitigation efforts to address water quality and quantity issues.

Rookery Island Enhancement

The rookery islands in Region 4 are major stopover points for birds beginning or ending their migration in the Gulf of Mexico. Serving as the southernmost rookery islands in the state, these islands are essential habitat for a wide range of species that call Texas home for parts of the year, including neotropical species. Under this Action, work will continue to establish partnerships to take full advantage of available dredged material resources and to rebuild eroding islands. Many of the islands in this region were originally created when the GIWW was dredged. The rookery islands provide additional wave attenuation benefits for vessels transiting the waterway, benefiting both natural and built environments.

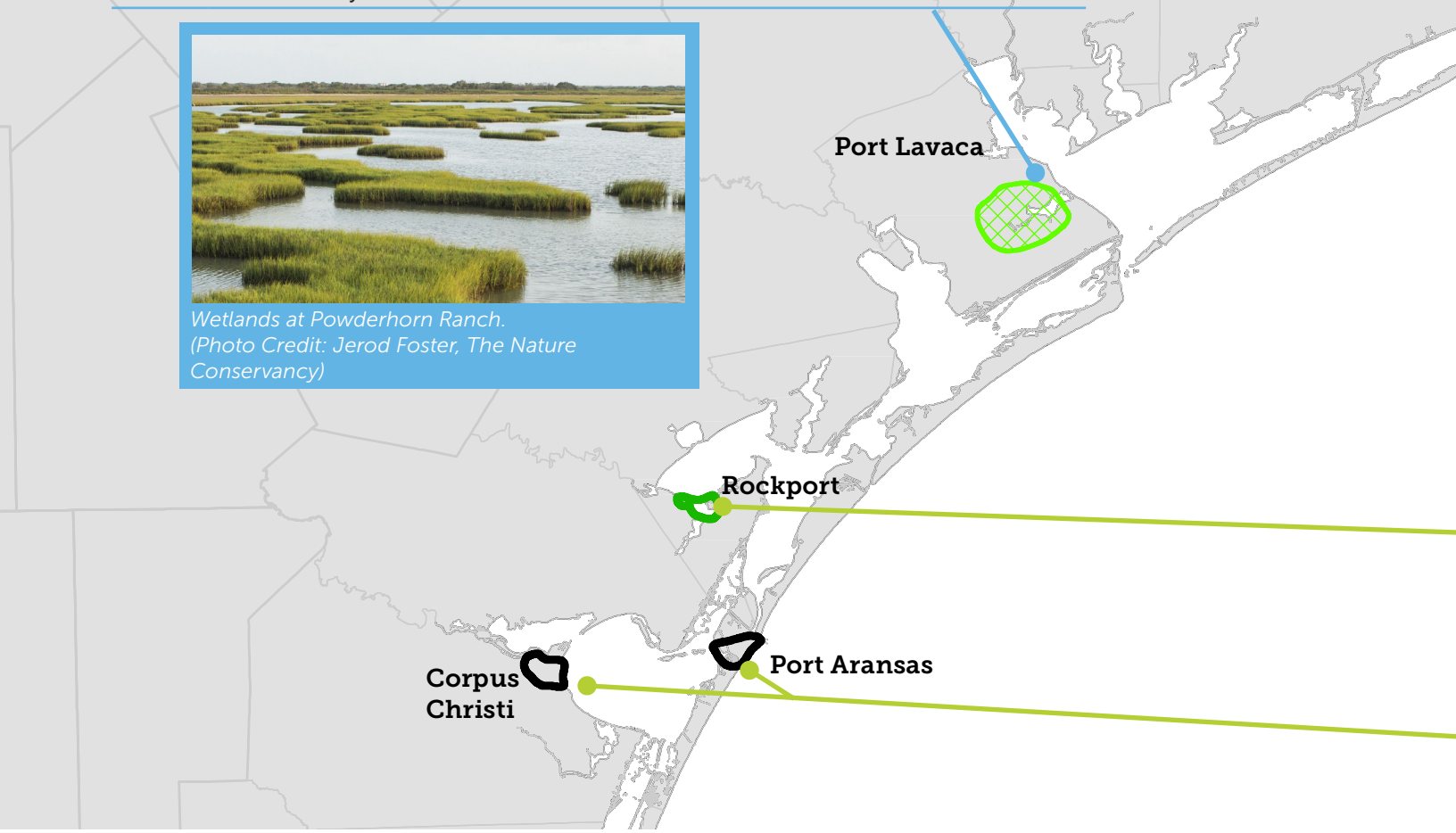
Action Locations Without Individual Projects

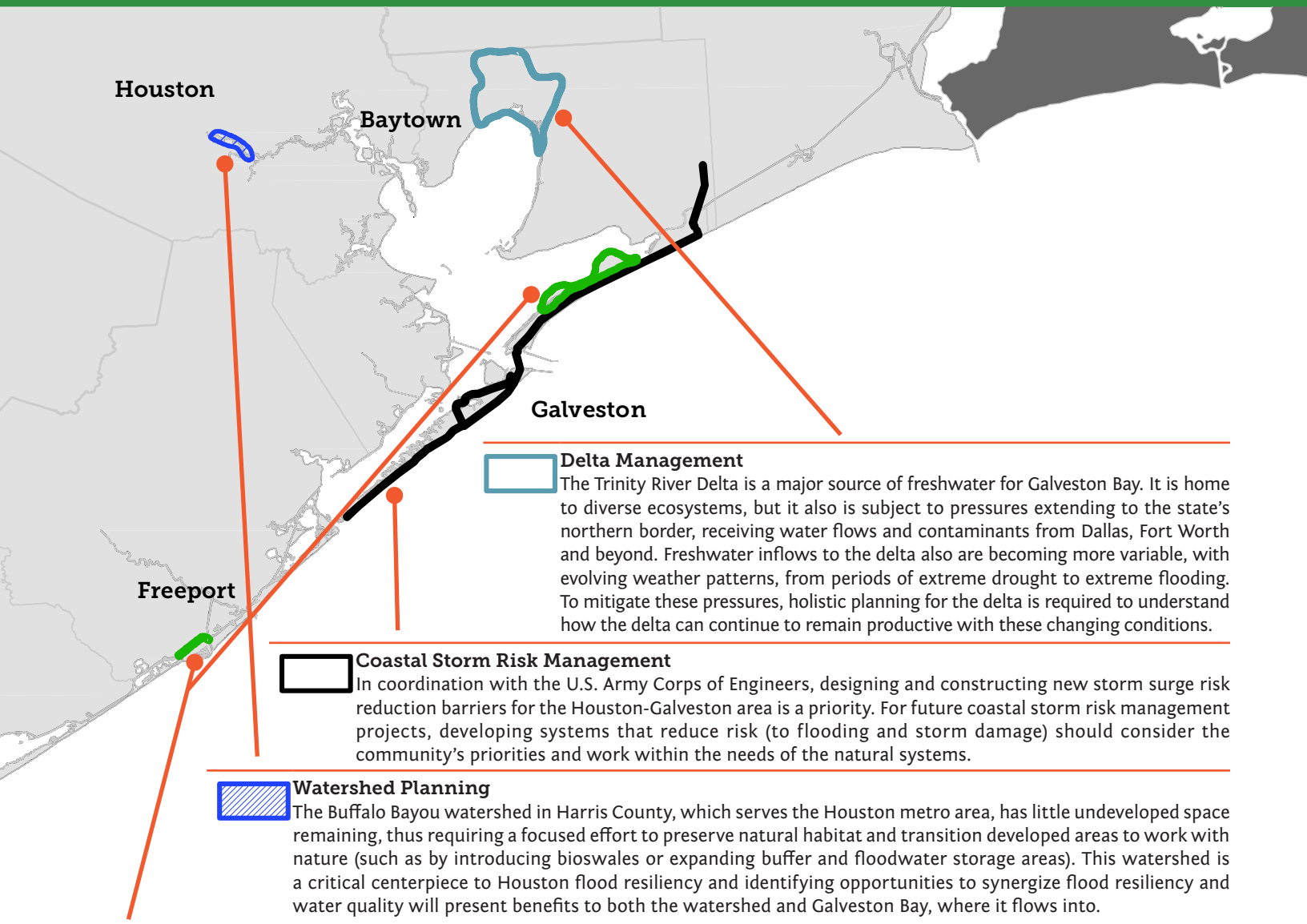
The majority of Actions identified in the Resiliency Plan coincide with recommended individual projects, as highlighted later in this section. This results in the Actions having, at a minimum, some mitigating implementation proposed. Within this map though, are Actions that currently do not have projects identified within the Resiliency Plan. These are locations where activities could be in early stages of development under other planning activities, or there could be a lack of interested stakeholders to champion a project. Either way, these Action locations remain a priority, and future planning activities will focus on identifying individual projects for implementation.

Responsible Development

The area surrounding Powderhorn Lake is one of the biggest undeveloped coastal prairies in Texas, providing significant ecological value. Recently, it was part of the largest conservation investment in Texas history through the purchase of over 17,000 acres of land. Under this Action, there will be continued work to enhance and restore the surrounding area adjacent to Powderhorn Lake. Monitoring and adaptive measures will be used to preserve the ecological and recreational value of this area for years to come.

Wetlands at Powderhorn Ranch. (Photo Credit: Jerod Foster, The Nature Conservancy)





Delta Management
The Trinity River Delta is a major source of freshwater for Galveston Bay. It is home to diverse ecosystems, but it also is subject to pressures extending to the state's northern border, receiving water flows and contaminants from Dallas, Fort Worth and beyond. Freshwater inflows to the delta also are becoming more variable, with evolving weather patterns, from periods of extreme drought to extreme flooding. To mitigate these pressures, holistic planning for the delta is required to understand how the delta can continue to remain productive with these changing conditions.

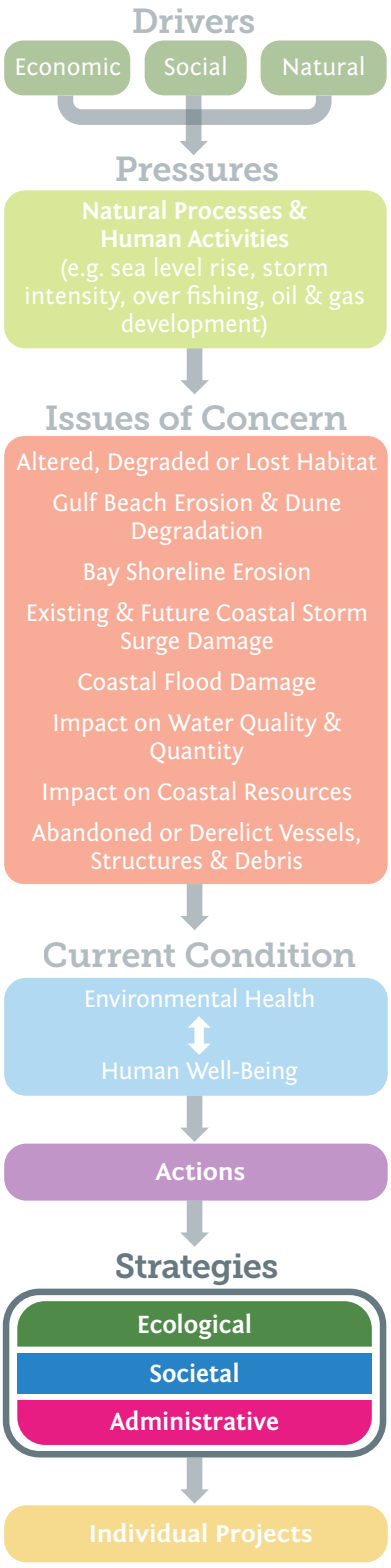
Coastal Storm Risk Management
In coordination with the U.S. Army Corps of Engineers, designing and constructing new storm surge risk reduction barriers for the Houston-Galveston area is a priority. For future coastal storm risk management projects, developing systems that reduce risk (to flooding and storm damage) should consider the community's priorities and work within the needs of the natural systems.

Watershed Planning
The Buffalo Bayou watershed in Harris County, which serves the Houston metro area, has little undeveloped space remaining, thus requiring a focused effort to preserve natural habitat and transition developed areas to work with nature (such as by introducing bioswales or expanding buffer and floodwater storage areas). This watershed is a critical centerpiece to Houston flood resiliency and identifying opportunities to synergize flood resiliency and water quality will present benefits to both the watershed and Galveston Bay, where it flows into.

Wetland Protection and/or Shoreline Stabilization
Every region in Texas is suffering from bay shoreline erosion and wetland loss. Within Region 1, this includes large complexes along the Gulf Intracoastal Waterway near Bolivar Peninsula and near the Brazos River. Working to stabilize these shorelines and looking for available opportunities to beneficially use dredged material to restore and maintain wetlands is critical to preserve healthy wetland systems.

Wetland Protection and/or Shoreline Stabilization
Many of the Region 3 bay shorelines suffer continual erosion, exposing both communities and ecosystems to the significant forces of the waves generated throughout the bays. Inland shorelines of Copano Bay are no exception to this physical energy. In the region of Port Bay, Aransas County serves a mixture of natural wetlands and scattered development, both of which were impacted by Hurricane Harvey, exposing a need for increased resiliency for the wetland complex and bay shoreline. Identifying solutions that mimic the ecological systems of the area will benefit both the environment and people who live nearby.

Coastal Storm Risk Management
Region 3 was the first to witness the destruction Hurricane Harvey imposed on Texas. The hurricane gave evidence of two resiliency needs that require further attention regarding storm surge. First, the robust natural beach and dune systems on Mustang Island, San Jose Island and Matagorda Island exhibited high levels of resiliency by absorbing the massive storm surge propagating from the Gulf of Mexico. Second, and in contrast to this, Port Aransas and other bayside communities were vulnerable to flooding from storm surge originating in Corpus Christi Bay. Downtown Corpus Christi is situated in a low-lying district that is protected to some degree by an existing floodwall and levee system but is nonetheless susceptible to storm surge that develops in the bay. The levee system would benefit from improvements to enhance resiliency and lessen the risk of storm surge inundation.



Strategies

Actions lay out a roadmap for future efforts that the GLO and other state partners can pursue along the Texas coast to enhance long-term coastal resiliency. In other words, the Actions provide a blueprint of what should occur to alleviate the impacts of the Issues of Concern. There also are a series of strategies that describe the various restoration methods that can be used to achieve the larger Action.

The strategies describe, in detail, recommended methods of restoration and protection for coastal resiliency that have been demonstrated to be successful in the Texas coastal environment. Most of the projects in the Resiliency Plan use one or more of the strategies to better address Issues of Concern through proven methods, science and technologies. This multi-faceted approach – for instance, combining ecological and administrative strategies – in many cases creates a more comprehensive implementation.

There are three overarching categories of resiliency strategies: ecological, societal and administrative.

ECOLOGICAL RESILIENCY

- Beach Nourishment and Dune Restoration
- Wetland Planning, Restoration and Monitoring
- Upland Planning, Conservation and Monitoring
- Oyster Reef Planning, Restoration and Monitoring
- Rookery Island Protection, Restoration and Creation
- Freshwater Inflow and Tidal Exchange Enhancement

SOCIETAL RESILIENCY

- Storm Surge Suppression
- Water-Based Transit Enhancement
- Land-Based Transit Enhancement
- Community Infrastructure Planning and Development

ADMINISTRATIVE RESILIENCY

- Plan
- Policy
- Program
- Study

STRATEGY CATEGORIES

Ecological Resiliency

Ecological resiliency strategies describe potential enhancements to coastal environments and species, ranging from beach nourishment to supporting wildlife populations.

Societal Resiliency

Societal resiliency strategies outline possible improvements to the human or built environments, such as community infrastructure upgrades or development planning.

Administrative Resiliency

Administrative resiliency strategies describe opportunities to enhance program-level aspects of coastal resiliency, like policy making or regional planning.

Ecological Resiliency Strategies

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

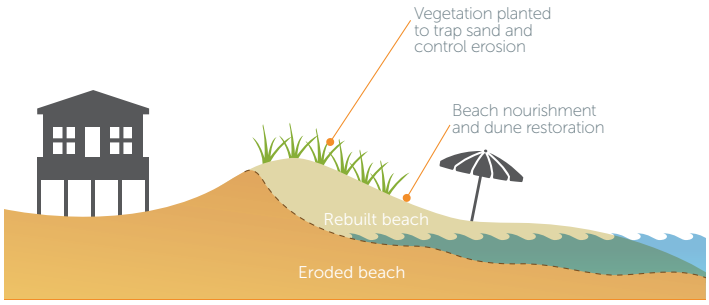
Wetland Planning, Restoration and Monitoring
Restores, conserves and protects ecologically significant wetlands to address habitat degradation, erosion and channelization.
- Shoreline protection and material placement
- Hydrologic restoration

Upland Planning, Conservation and Monitoring
Restores, conserves and protects ecologically significant coastal uplands.
- Land acquisition and conservation easement
- Hydrologic restoration

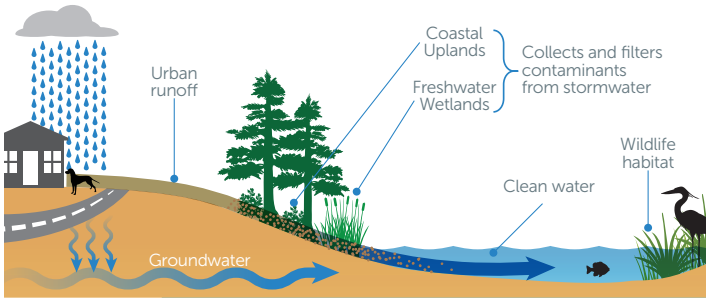
Oyster Reef Planning, Restoration and Monitoring
Restores or re-establishes productive oyster reefs.
- Studying optimal locations
- Recycling oyster shell or cultch

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

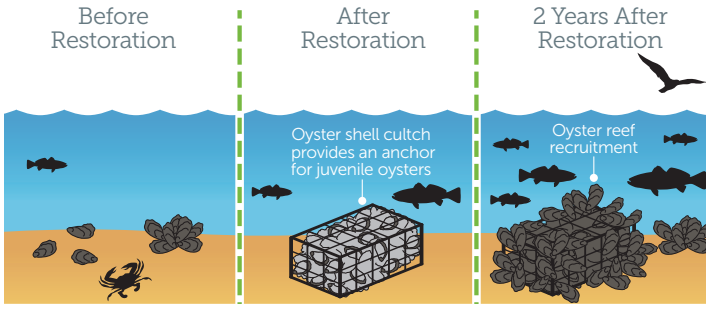
Freshwater Inflow and Tidal Exchange Enhancement
Mitigates hydrologic and water quality impairments within the major delta, lagoon and bay systems along the coast.
- Watershed and land-use planning
- Nonpoint source pollution prevention



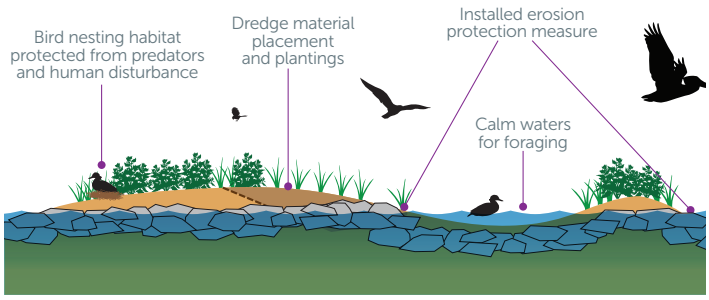
Beach Nourishment and Dune Restoration



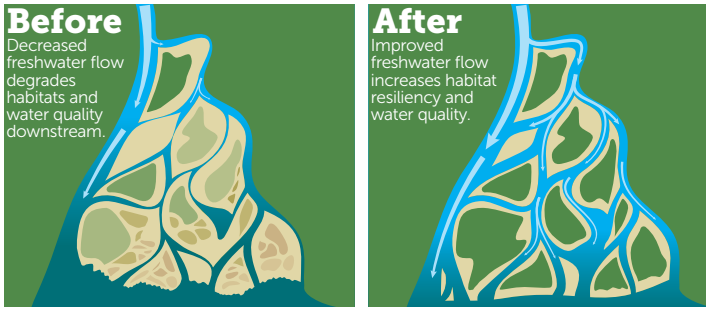
Planning, Restoration/ Conservation and Monitoring



Oyster Reef Planning, Restoration and Monitoring



Rookery Island Protection, Restoration and Creation



Freshwater Inflow and Tidal Exchange Enhancement

Societal Resiliency Strategies

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

Water-Based Transit Enhancement
Addresses water-based navigation infrastructure improvement needs along the coast. Includes new opportunities to support the beneficial use of dredged material in state-owned waters.
- Stabilize the Gulf Intracoastal Waterway
- Support clean and resilient marinas

Land-Based Transit Enhancement
Addresses land-based transit infrastructure improvement needs in and around coastal communities. Identifies opportunities to incorporate future conditions and ecological considerations into final design.
- Elevate or widen evacuation routes
- Stabilize coastal roadways

Community Infrastructure Planning and Development
Proposes proactive, resilient planning opportunities in coastal communities and identifies projects 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
Develops long-term recommendations and guidance documentation for key aspects of coastal resiliency.
- Texas Coastal Resiliency Master Plan
- Coastal Texas Study
- Sediment Management Plan

Policy
Establishes or improves state regulations, administrative codes or actions related to coastal resiliency.
- Building codes
- Setback regulations

Program
Creates an ongoing, structured and regularly-funded curriculum to enhance resiliency in a particular area.
- Beach Monitoring and Maintenance Program
- Continual data collection and monitoring

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

PLANNING AND COLLABORATION: ADMINISTRATIVE RESILIENCY IN ACTION

Administrative Resiliency is founded on strong collaboration and cooperation, often between multiple groups, entities or agencies. The most comprehensive and resilient solutions come from a collective approach developed from a wide range of expertise. The Texas General Land Office has found success through collaboration in developing this Resiliency Plan, and is working towards similar successes in a partnership with the U.S. Army Corps of Engineers.

USACE, in partnership with the GLO, began a feasibility study to identify projects for coastal storm risk management and ecosystem restoration along the Texas coast in late 2015, also referred to as the Coastal Texas Study. The study will continue through 2021 and involves engineering, economic and environmental analyses on large-scale projects that will be considered by Congress for future authorization and funding. The goals of the final Coastal Texas Study recommendations will be to enhance resiliency in coastal communities and improve our state's capability to prepare for, resist, recover and adapt to coastal hazards.

While the Coastal Texas Study is not a directly component of the Resiliency Plan, or vice versa, the Resiliency Plan and the Coastal Texas Study are each conducted in a collaborative environment, where knowledge sharing and synergies can be captured. Under this approach, the Coastal Texas Study serves as a complement to the Resiliency Plan itself.

SOCIETAL RESILIENCY IN ACTION

FORTIFIED Home™ Construction Standards

FORTIFIED is a way to build a new home, re-roof or retrofit an existing home beyond typical building codes to deliver superior performance during severe weather (such as hurricanes, strong thunderstorms and lower-level tornadoes). FORTIFIED is a voluntary building method based on more than 20 years of scientific research and real-world testing by the Insurance Institute for Business & Home Safety (IBHS).

Key Allegro, Texas

In November 2017, Key Allegro, an 800-unit waterfront community in Rockport, Texas, after much consideration and support from both IBHS and Smart Home America, decided to add the FORTIFIED Home™ standard to their deed restriction and community covenants. In their words,"By doing this, we will ensure our member's residences are rebuilt resilient. The program does not dramatically increase costs, especially on how roofs are installed. However, the requirements have a dramatic effect on the performance of your residence."[57]

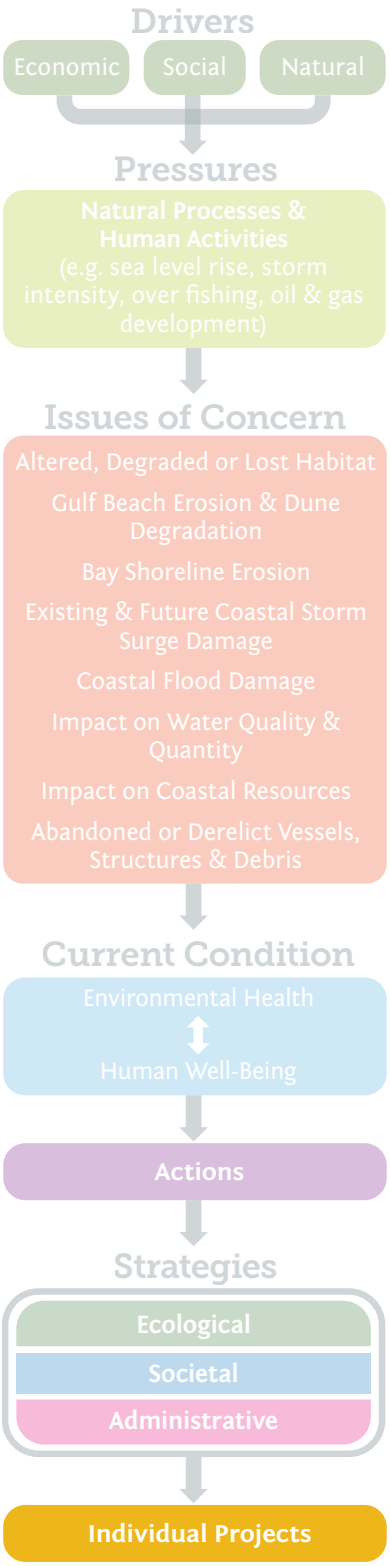
Community Development Block Grant-Disaster Recovery Program Funding

Recently, the GLO required that FORTIFIED Home™ construction standards be used for housing recovery projects through their Hurricane Harvey Disaster Recovery Housing Guidelines. Projects funded through the GLO will use nearly $4.8 billion in Federal Community Development Block Grant - Disaster Recovery funding to rebuild and repair housing damaged by Hurricane Harvey.

FORTIFIED
A PROGRAM OF IBHS
™

An example of an elevated home on Bolivar Peninsula. (Photo Credit: Texas General Land Office)

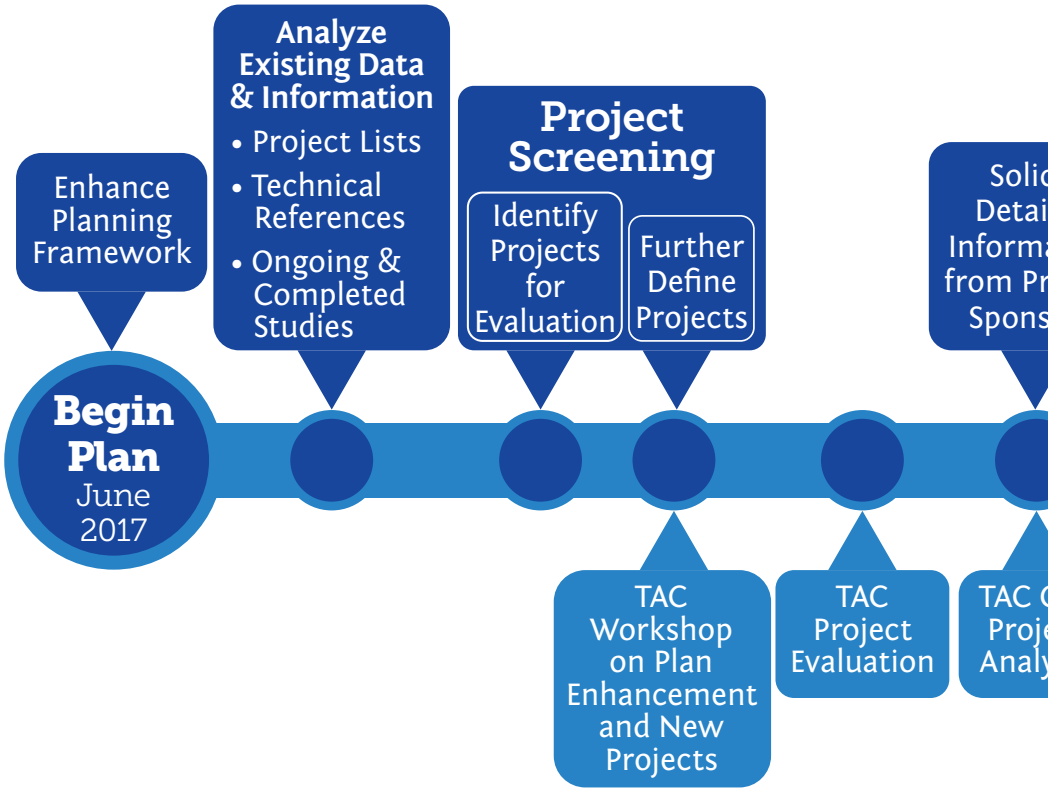
Project Identification Process



To develop the 2019 Resiliency Plan, the GLO Planning Team undertook a technical and collaborative approach to identify all potential projects that could help create and maintain a resilient Texas coast. This approach involved expert and local input through coordination with the Technical Advisory Committee for a large suite of potential projects.

Projects recommended in the 2019 Resiliency Plan were drawn from various sources including the 2017 iteration of the Resiliency Plan, state and federal project lists, and TAC input. The project scope was expanded from the 2017 Resiliency Plan to include projects addressing societal and administrative resiliency, in addition to ecological resiliency.

As developed in the 2017 Resiliency Plan, an initial project screening was run via a desktop programmatic model. The model uses an unbiased, repeatable and systematic method to calibrate relationships between anticipated physical and ecological benefits of a project in relation to the identified Issues of Concern (full details are provided in the *Technical Report*). The programmatic model was used as a decision-support tool to identify which projects were most applicable to coastal resiliency and justified detailed review by the TAC. During the fall of 2017, TAC meetings were held to identify new projects in addition to ones selected during the literature review and from the 2017 Resiliency Plan. This resulted in the selection of nearly 250 projects for full, detailed evaluation.



Project Evaluation

During a series of regional meetings in early 2018, the TAC evaluated nearly 250 projects in detail. The TAC individually assessed each project based on its overall scope and merit – considering factors such as its proposed location, expected impacts on the natural and built environments, size and scale, proposed methodology or restoration technique, feasibility of construction or completion, and overall consistency with the 2019 Resiliency Plan goals. The information and feedback received from the TAC was utilized to develop three tiers of projects, with the Tier 1 projects being recommended for implementation and serving as the focus of this Resiliency Plan.

Based on these assessments, the 2019 Resiliency Plan identifies 123 Tier 1 projects. The Project Evaluation Tables in the *Technical Report* provide data and other values related to the project screening (e.g. programmatic model results, TAC numerical valuations) for all projects identified at any level of the assessment. All projects reviewed are classified into either Tier 1, 2 or 3 classifications as documented in the Project Evaluation Tables. The typical parameters for these classifications are noted in the adjacent graphic and any variations from these standards are noted in the Project Evaluation Tables.

Project Tiers

Tier 1 Projects

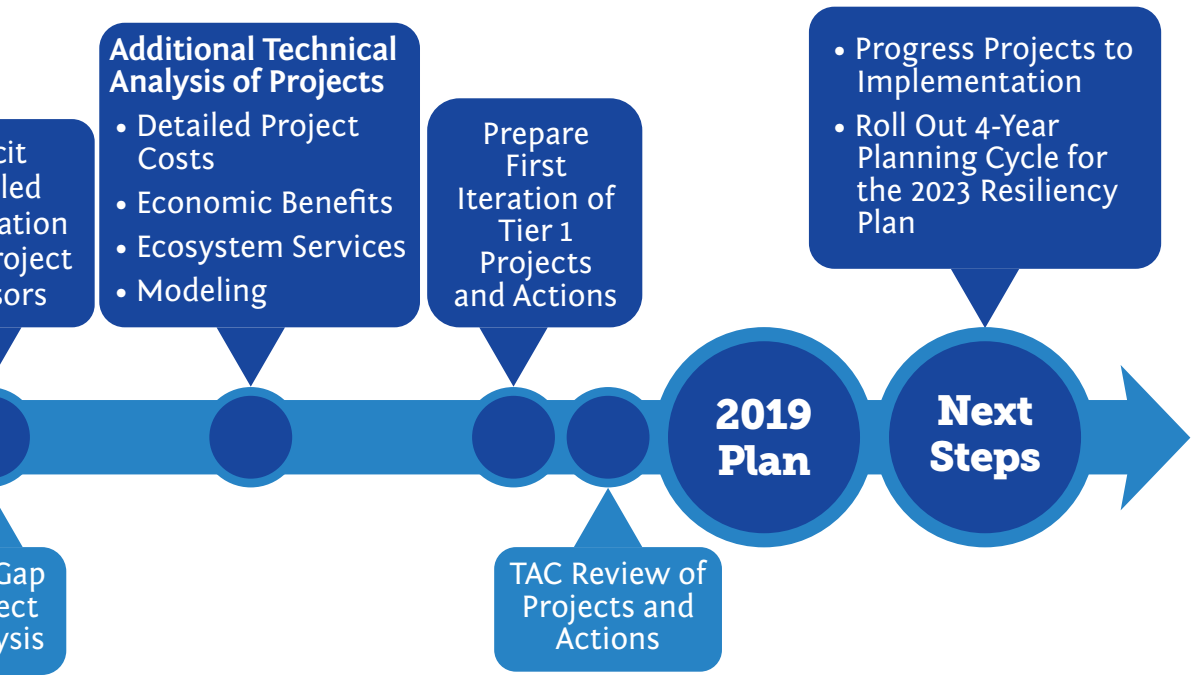
- High TAC approval ratings (typically over 80 percent)
- High feasibility
- Benefits mitigate Issues of Concern in project's subregion
- Most resilient and actionable project solutions recommended for the state

Tier 2 Projects

- Moderate TAC approval ratings (between 60 percent and 80 percent)
- Moderate feasibility projections
- Benefits address Issues of Concern in project's subregion
- May still effectively contribute to resiliency and viability of coastal zone

Tier 3 Projects

- Need further research and development in future iterations of the Resiliency Plan or already captured under another, separate project



	Project Type	Project Subtypes
Nature-Based	**Hydrologic Connectivity**	• Freshwater Inflow • Hydrologic Restoration
	Habitat Creation & Restoration	• Estuarine Wetlands • Freshwater Wetlands • Oyster Reef • Barrier Islands • Coastal Uplands • Coastal Prairies • Rookery Islands • Dredge 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 Acquisitions	• 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
Plans, Policies, Programs & Studies		

Tier 1 Projects

Through technical analyses and extensive collaboration to glean local coastal expertise across the entire Texas coast, 123 vetted Tier 1 projects were identified to be included in the 2019 Resiliency Plan, with a total project cost of $5.4 billion. These projects encapsulate the range of Actions previously described, and the GLO supports their implementation by coastal stakeholders and project partners. It is expected that many of these projects will be completed in phases and many will have additional, future phases not yet identified. Each region features a range of project types, such as those shown to the left, that correspond to and address the region's primary Issues of Concern.

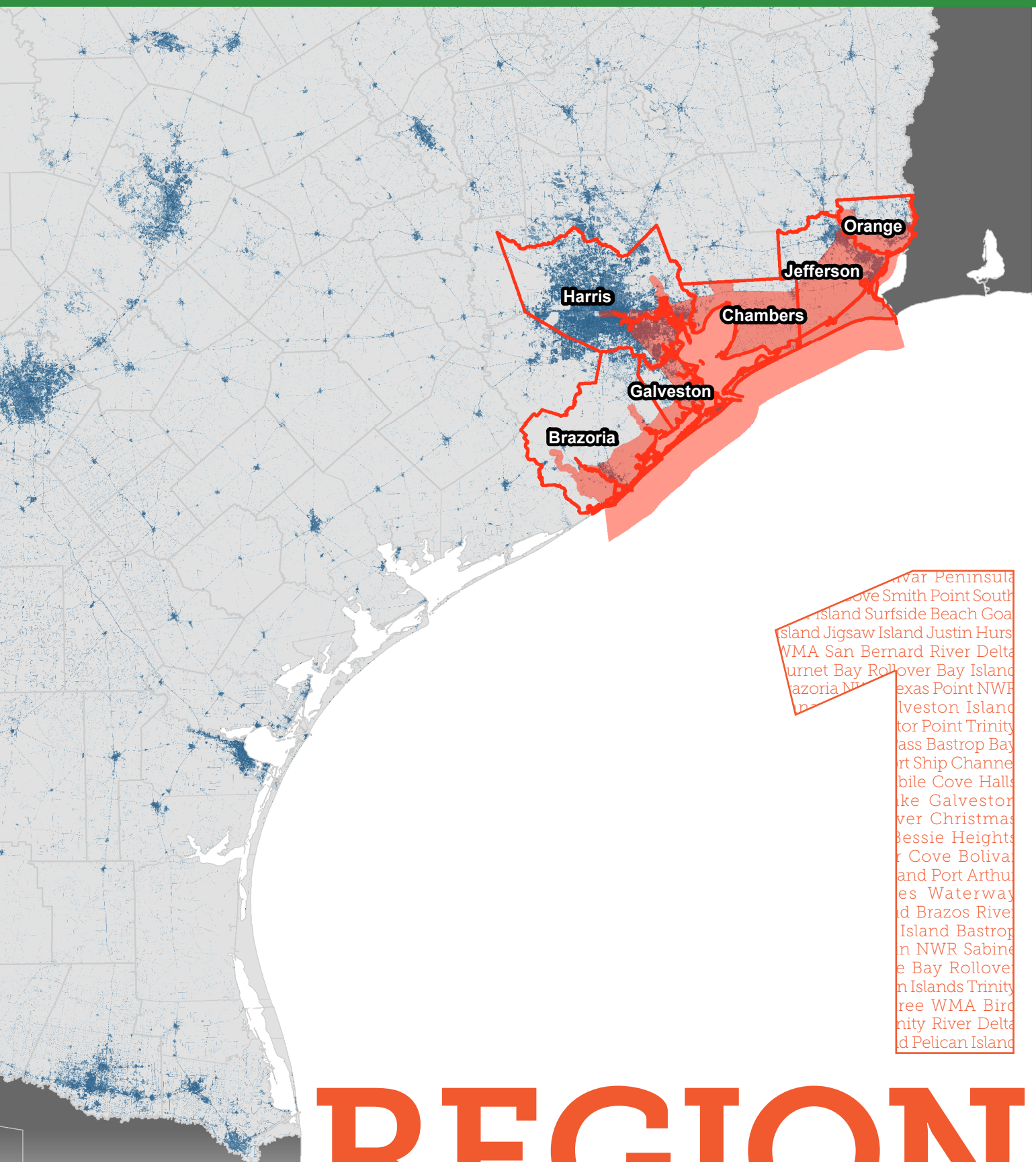
Projects identified within the Resiliency Plan span a wide range of project types with many projects including elements from multiple of the subtypes. While some projects are classified as specifically infrastructure-based or nature-based, many projects incorporate aspects that combine the two traditional classifications, creating hybrid projects, such as living shorelines. Projects that bring both traditional infrastructure and ecological elements together are frequently more resilient and adaptive to the dynamic conditions experienced on the coast. While not every project presented in the Resiliency Plan can claim this collaborative approach, many do. Additionally, there are common project elements or entire projects that fall outside of the categories that describe constructed projects, and these are typically captured under the category of Plans, Policies, Programs and Studies. These non-structural projects are often critical to proper project planning, providing integral data and laying the groundwork for stakeholder funding programs.

Tier 1 projects identified for the coastwide region, also referred to as Region 0 in their project numbers, are by and large categorized as these non-structural project types, encompassing plans, programs, studies and data collection. These project types are often most effectively managed at a coastwide level rather than from a local or regional approach. Many of the coastwide efforts presented are historically challenging to get funding for, as they are not tangible construction projects. However, these projects often reap significant benefits to project implementation in the long term, by improving data and restoration science, and developing new methods that can provide significant benefits to designing and constructing on-the-ground projects.

Coastwide Project Recommendations

Action	ID	Tier 1 Project	Estimated Annual Project Cost
	R0-1	Texas Coastal Resiliency Master Plan	$2,500,000
	R0-2	Dune Management and Access Plan	$1,000,000
	R0-3	Texas Seagrass Restoration	$2,000,000 *
STORM PREPAREDNESS AND RESPONSE	R0-4	Derelict Structure and Vessel Removal	$3,000,000
	R0-5	Abandoned and Derelict Petroleum Production Structure Removal Program	$5,000,000
	R0-6	Evacuation Route Study for Coastal Resilience	$250,000 *
WATERSHED PLANNING	R0-7	State Flood Assessment and Flood Risk Management	$600,000
	R0-8	Texas Coastal Nonpoint Source Pollution Program	$500,000
DATA COLLECTION AND MONITORING	R0-9	Sediment Management Plan	$1,000,000
	R0-10	Beach Monitoring and Maintenance Program	$1,000,000
	R0-11	Subsidence Study and Monitoring	$500,000
	R0-12	Longshore Transport Modeling	$1,000,000
	R0-13	Long-Term Hydrologic Monitoring Program	$500,000
	R0-14	Development of Optimal Coastwide Bathymetric and Topographic Models	$250,000
	R0-15	Data Collection to Support Continual Updates to the National Wetlands Inventory Dataset	$50,000
		Total Annual Cost For Coastwide Projects:	**$19,150,000**

*Initial Cost



REGION

Region 1 Project Recommendations

Action	ID	Tier 1 Project	Estimated Project Cost
WETLAND PROTECTION AND/ OR SHORELINE STABILIZATION	R1-1	Anahuac National Wildlife Refuge Living Shoreline	$60,900,000
	R1-2	Willow Lake Shoreline Stabilization	$6,600,000
	R1-3	Old River Cove Restoration	$15,200,000
	R1-4	Gordy Marsh Restoration & Shoreline Protection	$4,500,000 (PF)
	R1-5	Sabine-Neches Waterway Dredge Placement Island Habitat Restoration	$3,700,000
	R1-6	Bessie Heights Wetland Restoration	$13,500,000 (PF)
	R1-7	Moody National Wildlife Refuge Conservation and Restoration	$10,000,000 *
	R1-8	Double Bayou Habitat Preservation	$5,000,000 *
	R1-9	Chambers County Wetland Restoration	$25,000,000 *
	R1-10	Brazoria National Wildlife Refuge GIWW Shoreline Protection	$21,800,000
	R1-11	Follet's Island Wetland Restoration	$36,600,000
	R1-12	Candy Abshier Wildlife Management Area Shoreline Protection and Marsh Restoration	$1,700,000 (PF)
	R1-13	O'Quinn IH-45 Causeway Intertidal Marsh Restoration	$4,300,000
	R1-14	Galveston Island State Park Wetland Restoration & Shoreline Protection - Phase 3	$5,700,000
	R1-15	Green's Lake Shoreline Protection & Wetland Restoration - Phase 2	$4,200,000 (PF)
	R1-16	Dollar Bay Wetland Creation, Restoration and Acquisition	$5,100,000 (PF)
	R1-17	Oyster Lake - West Bay Breach Protection - Phase 3	$4,600,000 (PF)
	R1-18	East Bay Living Shorelines and Wetland Restoration	$8,900,000

*Maximum Amount **Up to $20M per Phase of Work (PF)Partially Funded

Region 1 Project Recommendations

Action	ID	Tier 1 Project	Estimated Project Cost
BEACH AND DUNE SUSTAINABILITY	R1-19	McFaddin National Wildlife Refuge Shoreline Restoration	$183,100,000 **
	R1-20	Bolivar Peninsula Beach & Dune Restoration	$81,200,000 **(PF)
	R1-21	Texas Point Beach Nourishment Project	$36,100,000
	R1-22	Galveston Island West of Seawall to 8 Mile Road Beach Nourishment	$10,500,000
	R1-23	Follet's Island Nourishment and Erosion Control	$106,400,000 **
REGIONAL INFRASTRUCTURE IMPROVEMENTS	R1-24	Sabine Pass Jetty Repair	$105,000,000
	R1-25	Sabine-Neches Channel Shoreline Protection	$10,200,000
	R1-26	Southeast Texas Regional Water Supply Study and Improvements	$1,000,000
	R1-27	Interstate 10 Drainage Improvements at Cow Bayou	$5,000,000
	R1-28	Southeast Texas Regional Wastewater Treatment Improvements	$500,000
	R1-29	Improve State Highway 73 at Bridge City	$2,800,000
	R1-30	Elevate State Highway 87 and Widen State Highway 124 to Improve Evacuation Capabilities	$21,900,000
	R1-31	Southeast Texas Regional Drainage Study and Improvements	$1,000,000
	R1-32	City of Seabrook Wastewater Treatment Plant Relocation	$34,100,000
ROOKERY ISLAND ENHANCEMENT	R1-33	Galveston Bay Rookery Island Restoration	$37,500,000
	R1-34	Dickinson Bay Rookery Island Restoration - Phase 2	$3,200,000

*Maximum Amount **Up to $20M per Phase of Work (PF)Partially Funded

Region 1 Project Recommendations

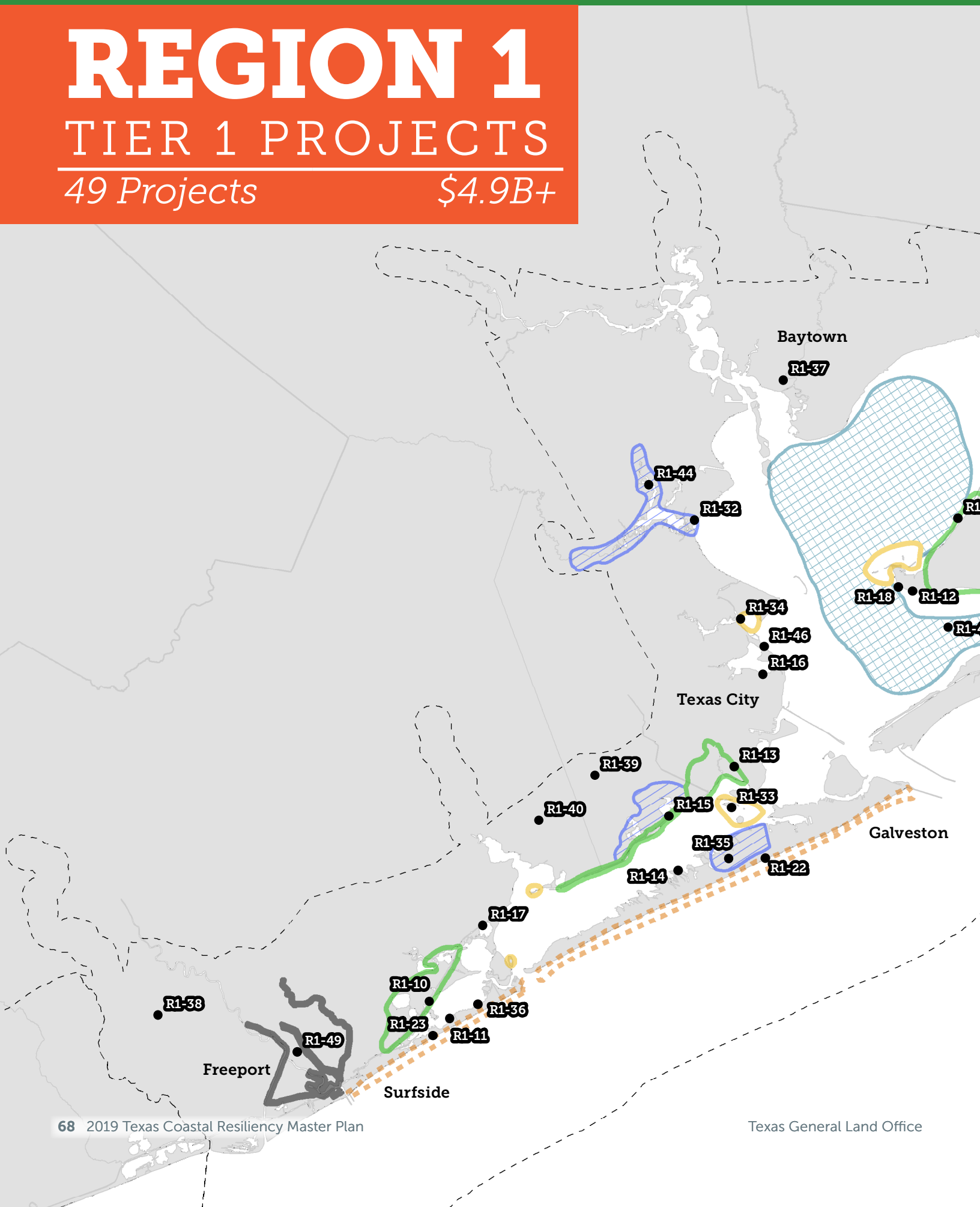
Action	ID	Tier 1 Project	Estimated Project Cost
RESPONSIBLE DEVELOPMENT	R1-35	Coastal Heritage Preserve	$28,200,000 (PF)
	R1-36	Follet's Island Conservation Initiative	$7,600,000
	R1-37	Cedar Bayou Acquisitions	$10,000,000 *
	R1-38	Columbia Bottomlands Preservation	$18,800,000 (PF)
	R1-39	East and West Galveston Bay Watershed, Wetland and Habitat Conservation	$15,600,000 (PF)
	R1-40	West Galveston Bay Acquisition Program	$25,000,000 *
WATERSHED PLANNING	R1-41	Salt Bayou Siphons	$4,500,000
	R1-42	Replace Water Control Structure at Star Lake	$2,100,000
	R1-43	The Marshland Restoration Project at Anahuac National Wildlife Refuge	$7,500,000 *
	R1-44	Greater Armand Bayou Preservation Project	$10,000,000 *
OYSTER REEF ENHANCEMENT	R1-45	Galveston Bay Oyster Reef Planning & Restoration	$2,500,000 (PF)
	R1-46	Texas City Levee Erosion Control and Marsh and Oyster Reef Restoration	$2,800,000
COASTAL STORM RISK MANAGEMENT	R1-47	Orange County Hurricane Flood Protection Levee	$2,363,600,000 (PF)
	R1-48	Port Arthur Hurricane Flood Protection Levee	$881,900,000 (PF)
	R1-49	Freeport Hurricane Flood Protection Levee	$711,800,000 (PF)
		Total For Region 1 Projects: $4,968,700,000* (PF)	

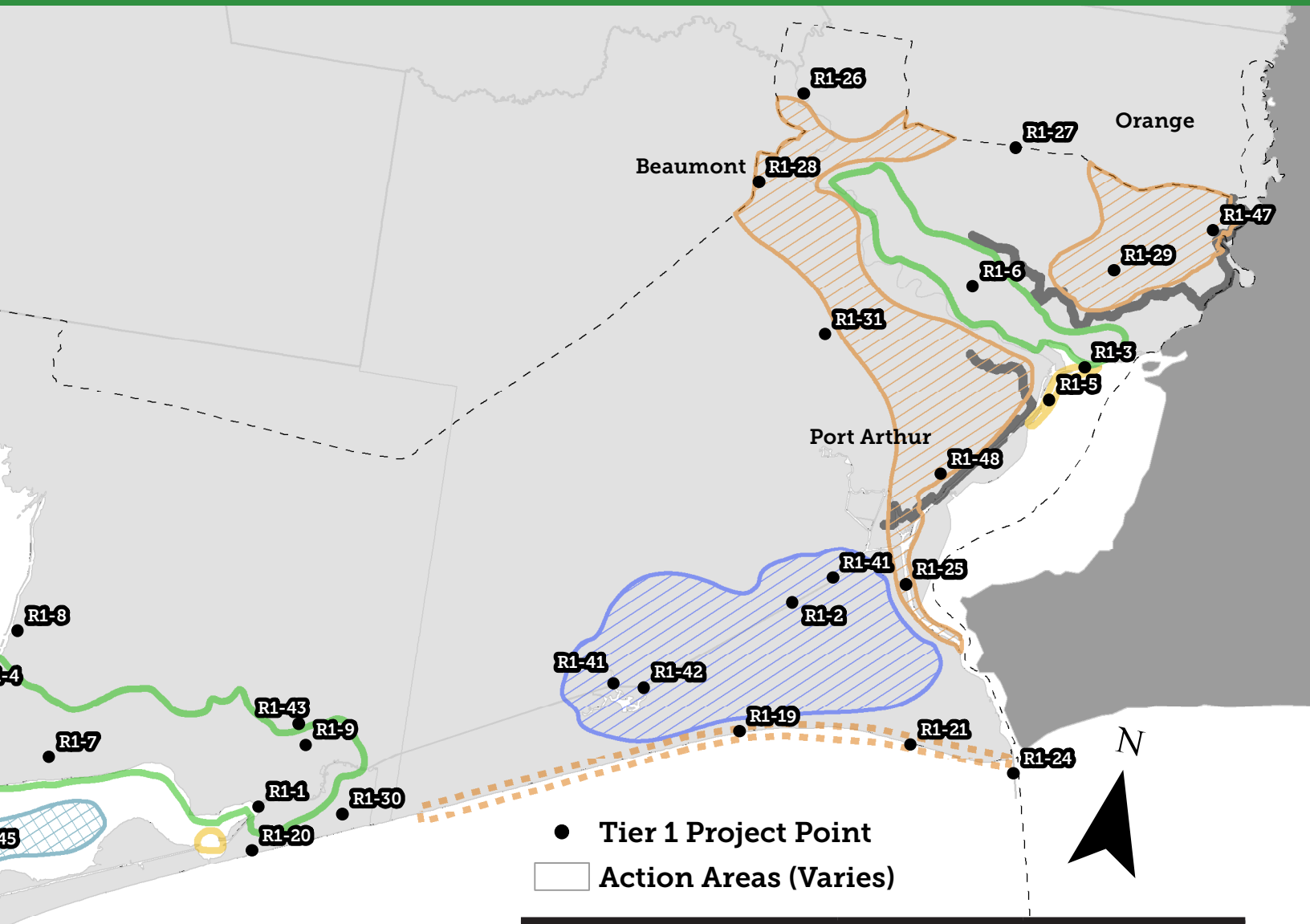
*Maximum Amount **Up to $20M per Phase of Work (PF)Partially Funded

REGION 1

TIER 1 PROJECTS

49 Projects *$4.9B+*





Action	Projects	Cost
WETLAND PROTECTION AND/ OR SHORELINE STABILIZATION	18	$237.3M
BEACH AND DUNE SUSTAINABILITY	5	$417.3M
REGIONAL INFRASTRUCTURE IMPROVEMENTS	9	$181.5M
ROOKERY ISLAND ENHANCEMENT	2	$40.7M
RESPONSIBLE DEVELOPMENT	6	$105.2M
WATERSHED PLANNING	4	$24.1M
OYSTER REEF ENHANCEMENT	2	$5.3M
COASTAL STORM RISK MANAGEMENT	3	$3.9B

REGION 2

Region 2 Project Recommendations

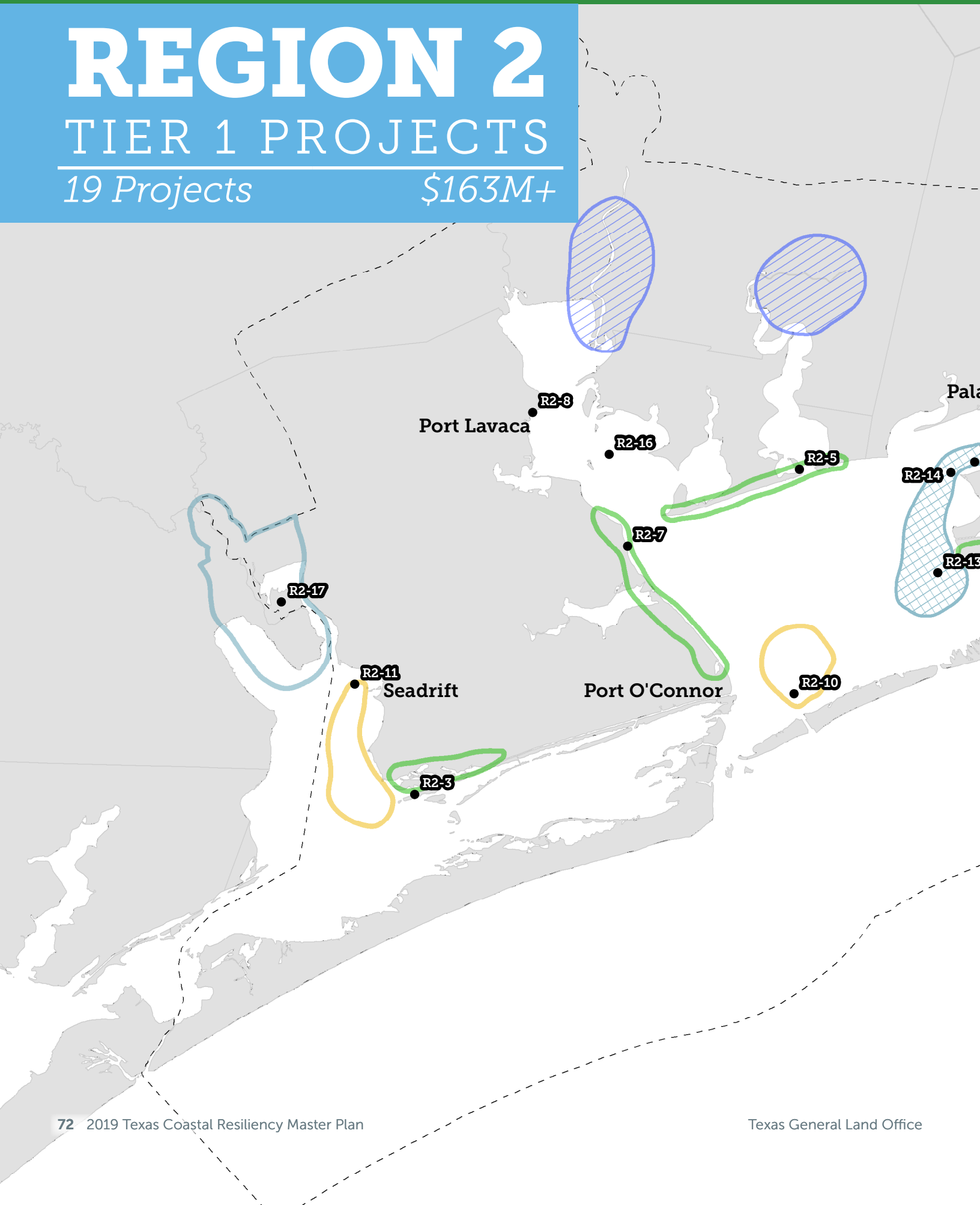
Action	ID	Tier 1 Project	Estimated Project Cost
WETLAND PROTECTION AND/ OR SHORELINE STABILIZATION	R2-1	Brazos River to Cedar Lake Creek GIWW Stabilization	$35,800,000 (PF)
	R2-2	Boggy Cut GIWW Stabilization	$9,300,000
	R2-3	Welder Flats Wildlife Management Area	$1,600,000
	R2-4	Sargent Beach & Dune Restoration	$66,300,000
	R2-5	Redfish Lake Living Shoreline	$4,700,000
	R2-6	Mad Island Shoreline Protection and Ecosystem Restoration	$7,400,000 (PF)
	R2-7	Ocean Drive Living Shoreline	$4,500,000
	R2-8	Port Lavaca Living Shoreline	$2,400,000
	R2-9	Palacios Shoreline Revitalization Project	$4,400,000
ROOKERY ISLAND ENHANCEMENT	R2-10	Chester Island Restoration	$4,500,000
	R2-11	San Antonio Bay Rookery Island Restoration	$9,600,000 (PF)
	R2-12	Coon Island Restoration	$5,500,000
OYSTER REEF ENHANCEMENT	R2-13	Half Moon Oyster Reef Restoration - Phase 3	$2,300,000
	R2-14	Oliver Point Oyster Reef Restoration	$1,400,000 (PF)
	R2-15	Chinquapin Oyster Reef Restoration	$1,400,000
	R2-16	Lavaca Bay Oyster Reef Restoration	$1,300,000
DELTA MANAGEMENT	R2-17	San Antonio Bay Hydrologic Regional Watershed Plan	$250,000
WATERSHED PLANNING	R2-18	Matagorda Bay Regional Inflow Study	$250,000 (PF)
	R2-19	Brazos River and San Bernard River Restoration Strategy and Management Plan	$325,000 (PF)
		Total For Region 2 Projects: $163,225,000 (PF)	

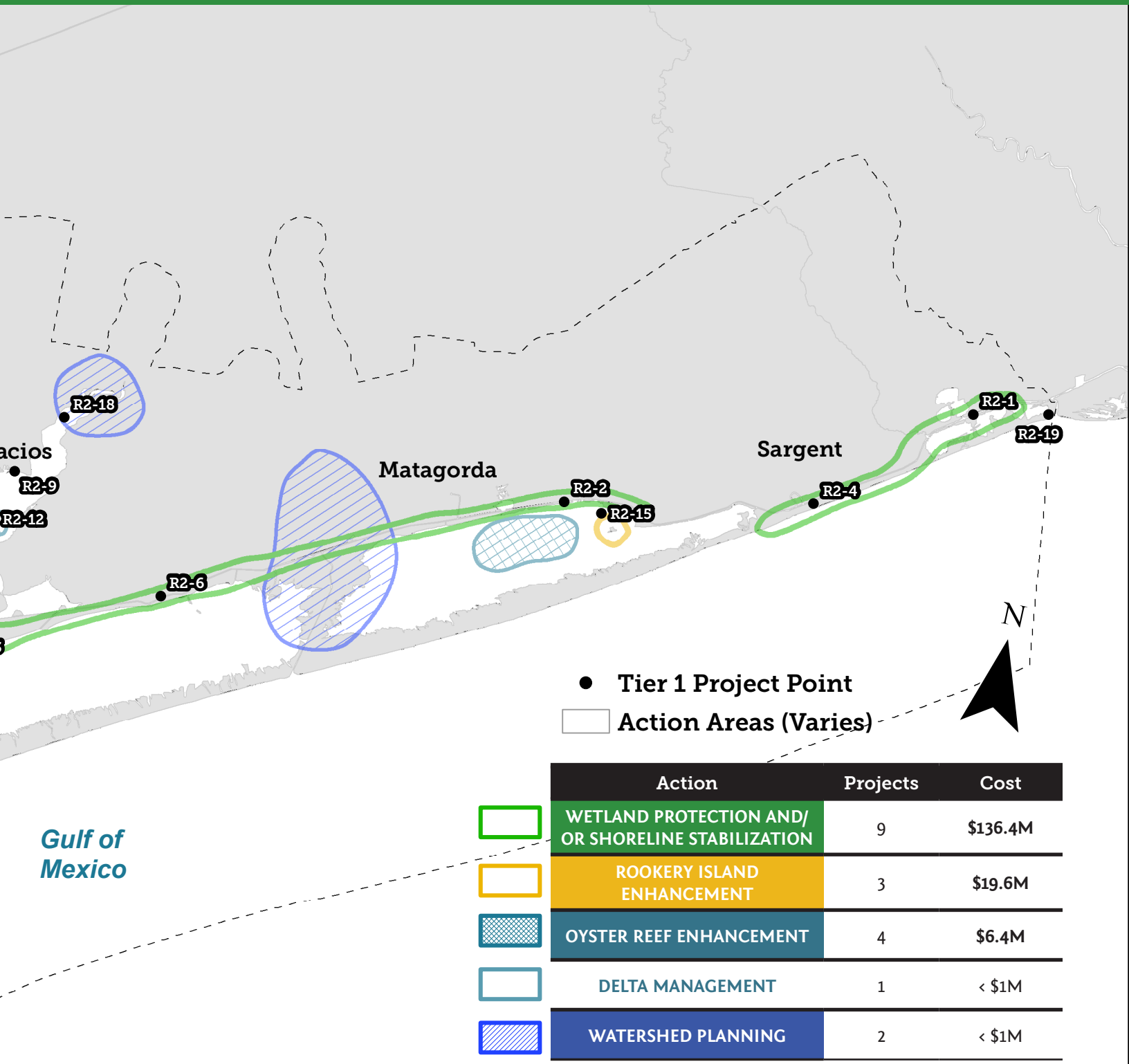
(PF)Partially Funded

REGION 2

TIER 1 PROJECTS

19 Projects *$163M+*





Action	Projects	Cost
WETLAND PROTECTION AND/ OR SHORELINE STABILIZATION	9	$136.4M
ROOKERY ISLAND ENHANCEMENT	3	$19.6M
OYSTER REEF ENHANCEMENT	4	$6.4M
DELTA MANAGEMENT	1	< $1M
WATERSHED PLANNING	2	< $1M

REGION 3

Region 3 Project Recommendations

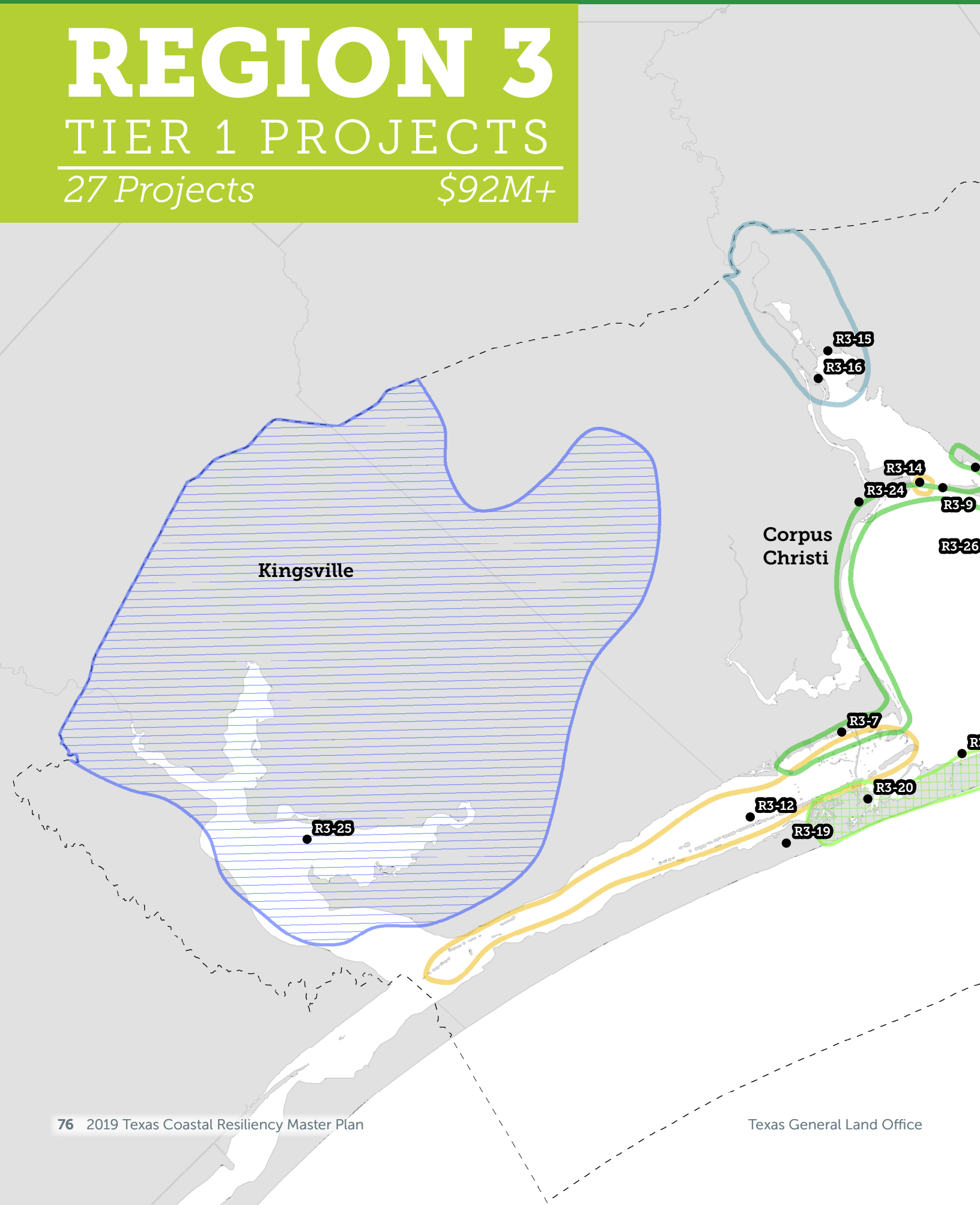
Action	ID	Tier 1 Project	Estimated Project Cost
WETLAND PROTECTION AND/OR SHORELINE STABILIZATION	R3-1	Goose Island State Park Habitat Restoration and Protection	$1,400,000
	R3-2	Fulton Beach Road Protection	$3,200,000
	R3-3	Aransas National Wildlife Refuge Dagger Point Shoreline Preservation	$2,600,000 (PF)
	R3-4	Portland Living Shoreline	$3,000,000
	R3-5	Shell Point Ranch Wetlands Protection	$5,000,000
	R3-6	Lamar Beach Road Protection	$3,500,000
	R3-7	Flour Bluff Living Shoreline	$3,400,000
	R3-8	Newcomb's Point Shoreline Stabilization	$2,700,000
	R3-9	Indian Point Marsh Area Living Shoreline	$2,800,000
ROOKERY ISLAND ENHANCEMENT	R3-10	Long Reef and Deadman Island Shoreline Stabilization and Habitat Protection	$3,400,000
	R3-11	Shamrock Island Restoration – Phase 2	$3,000,000 (PF)
	R3-12	Tern Island and Triangle Tree Island Rookery Habitat Protection	$3,600,000
	R3-13	Dagger Island Shoreline Protection	$2,000,000
	R3-14	Causeway Island Rookery Habitat Protection	$2,700,000
DELTA MANAGEMENT	R3-15	Nueces River Delta Shoreline Stabilization	$3,500,000
	R3-16	Nueces County Hydrologic Restoration Study	$200,000 (PF)
	R3-17	Guadalupe Delta Estuary Restoration	$3,900,000
	R3-18	Guadalupe River and Delta Wildlife Management Area Acquisition	$3,000,000
RESPONSIBLE DEVELOPMENT	R3-19	Coastal Bend Gulf Barrier Island Conservation	$500,000
	R3-20	Packery Channel Nature Park Habitat Restoration - Phase 2	$2,500,000
	R3-21	Little Bay Restoration Initiative	$14,400,000
	R3-22	Restore Barrier Island Bayside Wetlands on Mustang Island	$8,400,000
REGIONAL INFRASTRUCTURE IMPROVEMENTS	R3-23	Port Aransas Nature Preserve Stabilization and Restoration	$4,400,000 (PF)
	R3-24	Corpus Christi Bay Wastewater, Stormwater Quality and Pollution Management Improvements	$1,000,000
WATERSHED PLANNING	R3-25	Baffin Bay Watershed Monitoring and Management Plan	$2,500,000
OYSTER REEF ENHANCEMENT	R3-26	Corpus Christi & Nueces Bays Oyster Reef Restoration	$700,000
	R3-27	Copano Bay Oyster Reef Restoration	$5,300,000
		Total For Region 3 Projects: $92,600,000 (PF)	

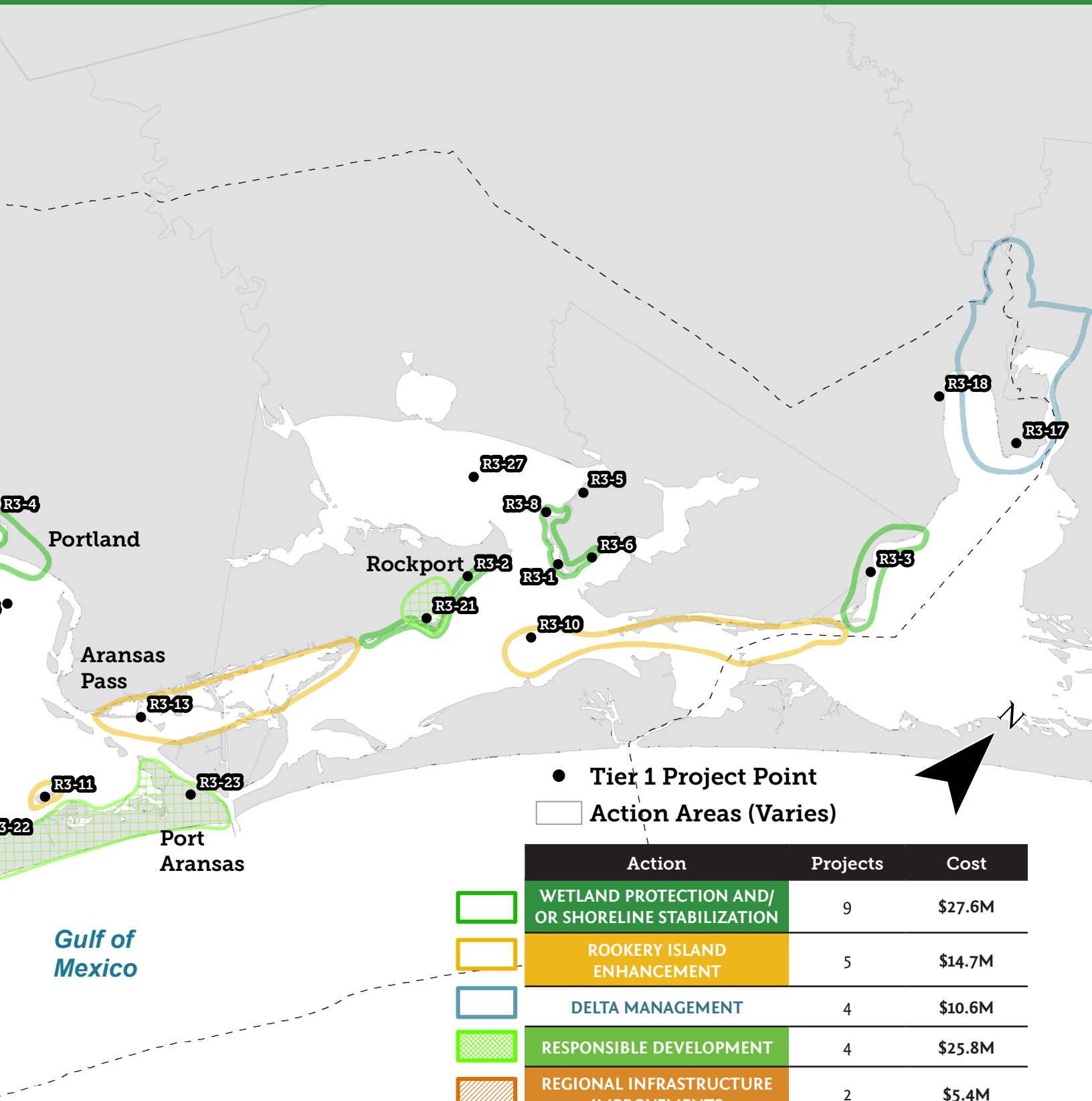
(PF)Partially Funded

REGION 3

TIER 1 PROJECTS

27 Projects *$92M+*





Action	Projects	Cost
WETLAND PROTECTION AND/ OR SHORELINE STABILIZATION	9	$27.6M
ROOKERY ISLAND ENHANCEMENT	5	$14.7M
DELTA MANAGEMENT	4	$10.6M
RESPONSIBLE DEVELOPMENT	4	$25.8M
REGIONAL INFRASTRUCTURE IMPROVEMENTS	2	$5.4M
WATERSHED PLANNING	1	$2.5M
OYSTER REEF ENHANCEMENT	2	$6M

4 REGION

Region 4 Project Recommendations

Action	ID	Tier 1 Project	Estimated Project Cost
WATERSHED PLANNING	R4-1	Bahia Grande Hydrologic Restoration	$5,300,000
	R4-2	Paso Corvinas Wetlands & Hydrologic Restorations	$2,700,000 (PF)
	R4-3	Development of the Lower Laguna Madre and Brownsville Ship Channel Watershed Protection Plan	$600,000 (PF)
BEACH AND DUNE SUSTAINABILITY	R4-4	South Padre Island Beach and Dune Management and Restoration	$74,100,000 **
ROOKERY ISLAND ENHANCEMENT	R4-5	Bird and Heron Islands Restoration	$7,100,000 (PF)
	R4-6	Restore Laguna Madre Rookery Islands	$12,100,000
	R4-7	Mansfield Rookery Island Shoreline Protection	$3,800,000
WETLAND PROTECTION AND/OR SHORELINE STABILIZATION	R4-8	Bahia Grande Living Shoreline	$5,400,000
	R4-9	Restore Barrier Island Bayside Wetlands on South Padre Island	$5,500,000
RESPONSIBLE DEVELOPMENT	R4-10	South Padre Island Coastal Beach Protection	$25,000,000 *(PF)
	R4-11	City of South Padre Island Living Shoreline	$2,600,000
	R4-12	South Padre Island Park Development	$1,100,000
DATA COLLECTION AND MONITORING	R4-13	Laguna Madre Relative Sea Level Rise Monitoring and Adaptive Management	$500,000

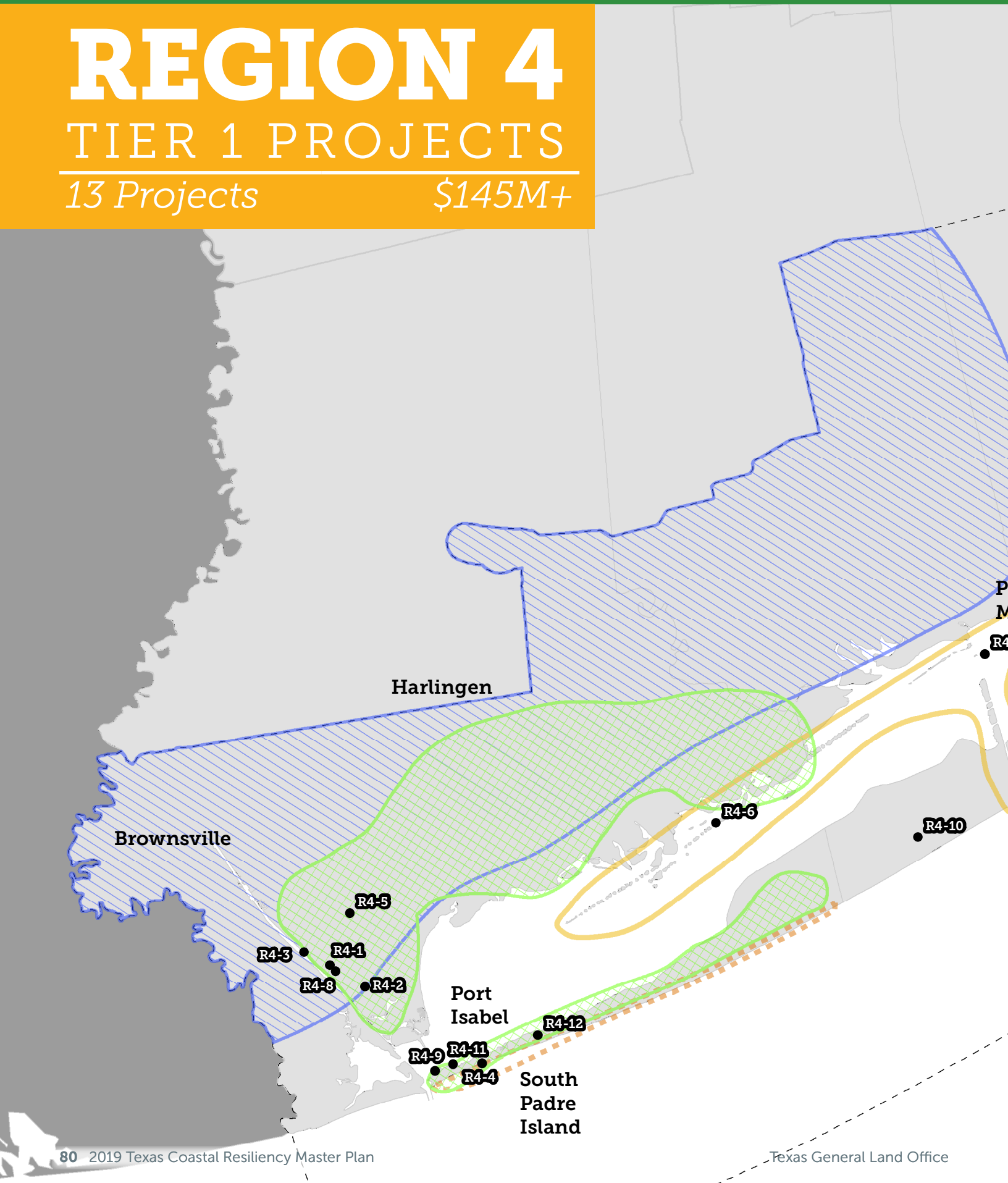
Total For Region 4 Projects: $145,800,000* (PF)

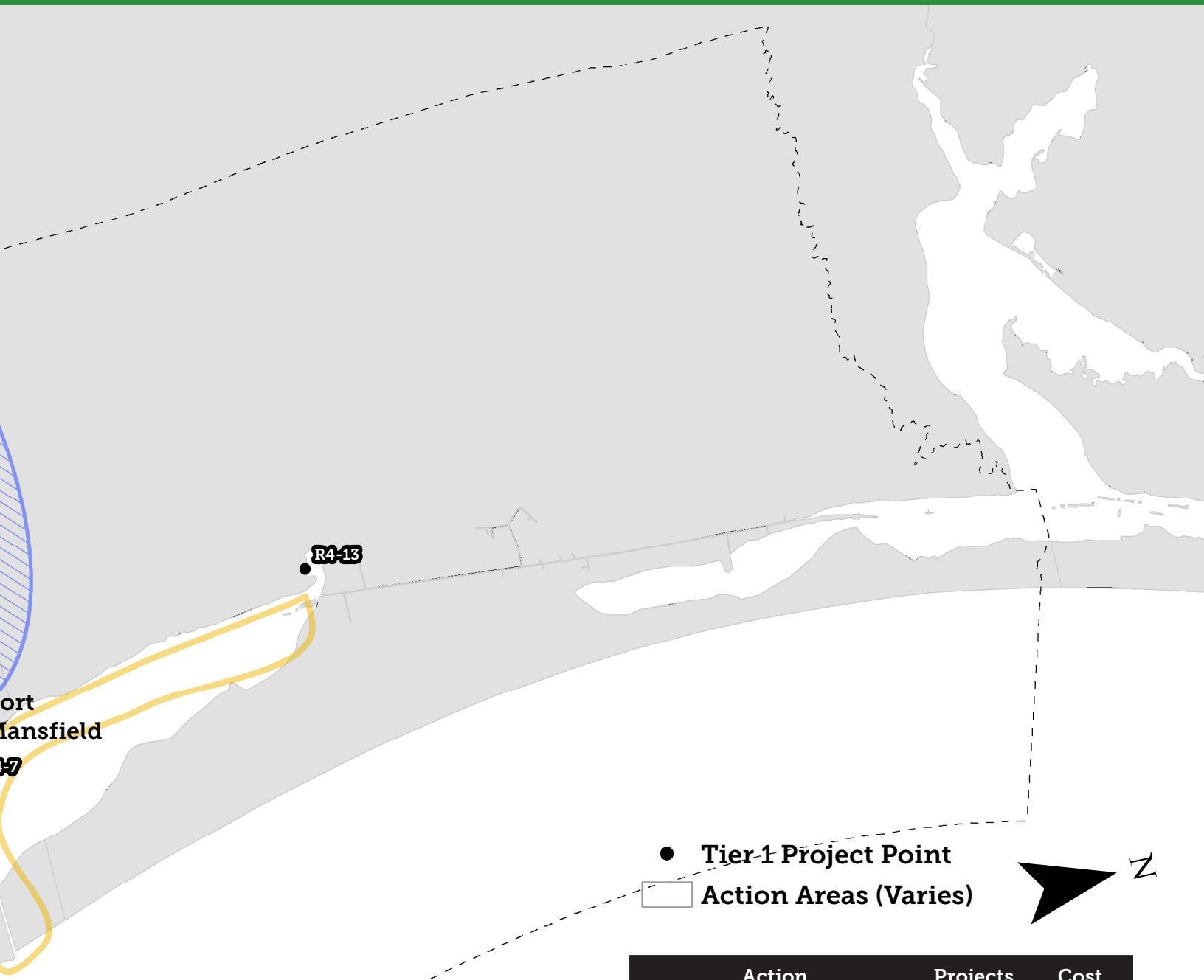
*Maximum Amount **Up to $20M per Phase of Work (PF)Partially Funded

REGION 4

TIER 1 PROJECTS

13 Projects *$145M+*





Action	Projects	Cost
WATERSHED PLANNING	3	$8.6M
BEACH AND DUNE SUSTAINABILITY	1	$74.1M
ROOKERY ISLAND ENHANCEMENT	3	$23M
WETLAND PROTECTION AND/ OR SHORELINE STABILIZATION	2	$10.9M
RESPONSIBLE DEVELOPMENT	3	$28.7M
DATA COLLECTION AND MONITORING	1	< $1M

4. Achieving Our Vision

Developing a Resiliency Plan, identifying prioritized projects and collaborating with local experts and stakeholders are all critical steps towards a resilient Texas coast. Equally important though, is including a path forward toward Resiliency Plan implementation, stakeholder buy-in and a process for continued Resiliency Plan improvements. This section highlights continuing efforts at Resiliency Plan implementation, and describes how recommended projects will be implemented in the future.

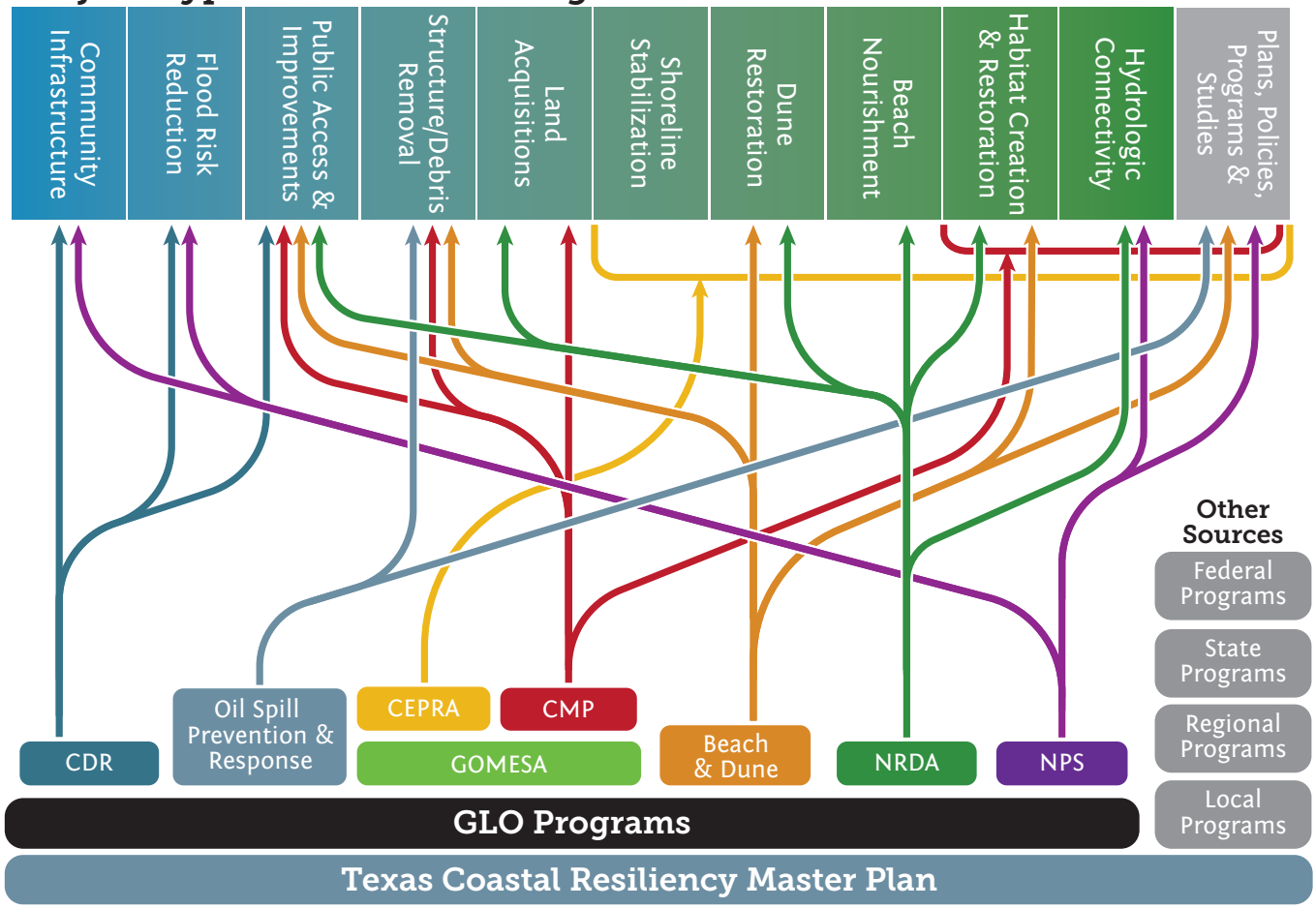
GLO Resiliency Plan Implementation

To better align internal programs and policies with implementing the Resiliency Plan, the GLO has begun the process to specifically fund Tier 1 projects. While the GLO coastal programs will continue to competitively evaluate project applications outside of the Texas Coastal Resiliency Master Plan process, this effort will now be informed by the Resiliency Plan to assist with project funding prioritization. This is primarily applicable to CEPRA, CMP and GOMESA funding activities, but also includes considerations for funds from entities such as NRDA and the National Fish and Wildlife Foundation.

By coordinating across multiple funding streams, the GLO is working to better leverage local, state and federal funds for project implementation. This is especially important as Texas does not provide a dedicated funding stream for coastal resiliency planning and projects, creating the need for a versatile approach that can maximize applicable funding. This streamlined method to enact coastal resiliency projects is another step towards a resilient coast. Furthermore, not every program or funding stream can fund every type of coastal resiliency project. Typically, funding programs are limited by project type, scale, outputs or other factors. While the limitations of each funding program are nuanced, a general representation of the projects that can be funded by the GLO under various mechanisms are shown graphically, below.

A further consideration to this is that the GLO cannot do this alone. Technical and financial collaboration is critical, particularly when realizing that many of the GLO's coastal programs are restricted in the types of projects they can fund. Understanding these constraints and considering the wide range of project types necessary for comprehensive improvements to coastal resiliency, it is obvious that this is an effort that goes beyond one agency. This is especially true as the Resiliency Plan champions cross-platform projects that embrace community-based and ecologically-focused needs throughout the coastal zone. The GLO will continue to collaborate with all identified agencies and stakeholders to achieve the vision of the Resiliency Plan.

Project Types for GLO Funding



Motivating Stakeholders

While the GLO continues to work to implement projects in the Resiliency Plan, engaging and enabling coastal stakeholders to be a part of the process is paramount to success. This means the state's coastal communities must serve as champions of the coast, working to implement the most innovative projects and practices, taking proactive measures and collaborating across the coast as a cohesive group. Often, however, communities experience challenges to incentivize new approaches to responsible development practices, such as those that consider population growth as well as ecological responsibility, but that may have a higher upfront cost.

Planning for coastal resiliency involves establishing incentives for projects that provide ecological enhancements. Coastal resiliency includes improving the ability to withstand storms, being adaptable to sea level rise, mitigating natural erosive forces and retaining a healthy and productive landscape in the face of other natural and man-made changes. Incorporating natural elements and ecological enhancements into project designs can serve to both enhance the environment and improve resiliency and adaptability.

Projects that draw on the inherent ecosystem functionality are often referred to as natural infrastructure or green infrastructure (green infrastructure is generally specific to stormwater management). This natural infrastructure approach, which may involve the use of a stand-alone natural ecosystem or may consist of a hybrid solution that combines a natural system and gray (man-made) infrastructure to perform a desired function, provides numerous benefits when compared to traditional gray infrastructure projects.[58]

Implementing the types of projects prioritized within this Resiliency Plan can produce many additional community benefits beyond primary project goals, such as:

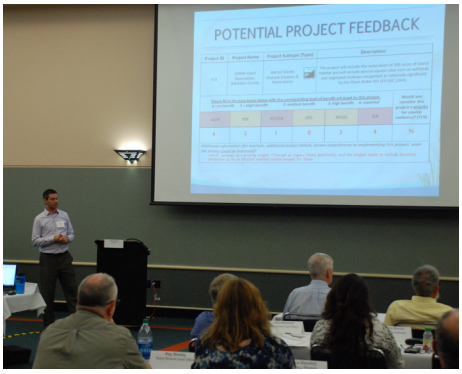
- Incorporating natural resiliency and infrastructure protection into project design;
- Supporting economically important fisheries;
- Creating recreation opportunities and supporting the ecotourism/outdoor economy;
- Increasing public awareness, education and support for coastal resilience;
- Improving water quality;
- Providing community flood insurance savings;
- Increasing carbon capture and storage;
- Supporting species resilience; and
- Integrating restoration into project design rather than mitigating elsewhere, inherently reducing net project impacts and habitat loss.

Stakeholders also should be aware that incorporating restoration into project designs can create opportunities to streamline the environmental permitting process, and invest at the project site rather than mitigating elsewhere. It also can raise awareness and build capacity within regulatory agencies, and support policies that facilitate the permitting and project implementation process.[58]

Ultimately, encouraging coastal stakeholders to implement coastal resiliency projects that take into account science, engineering, planning and public usage comprehensively will create a healthier coastline for the people, wildlife and habitats that populate it.

Community Resilient Solutions:

1. Improve performance of both the natural and built environments by maximizing the functionality provided by each;
2. Maintain the viewshed of the natural landscape and the intrinsic value it contributes to society;
3. Provide financial, permitting, technical and leadership opportunities;
4. Reduce overall project impacts by creating restoration and enhancement opportunities; and
5. Consider long-term cost effectiveness and value of incorporating natural infrastructure.



Technical Advisory Committee meeting in Texas City.

"...the conceptual underpinnings of adaptive management are simple; there will always be inherent uncertainty and unpredictability in the dynamics and behavior of complex social-ecological systems, but management decisions must still be made, and wherever possible, we should incorporate learning into management."

– Adaptive management for a turbulent future, Allen et al. 2011[59]

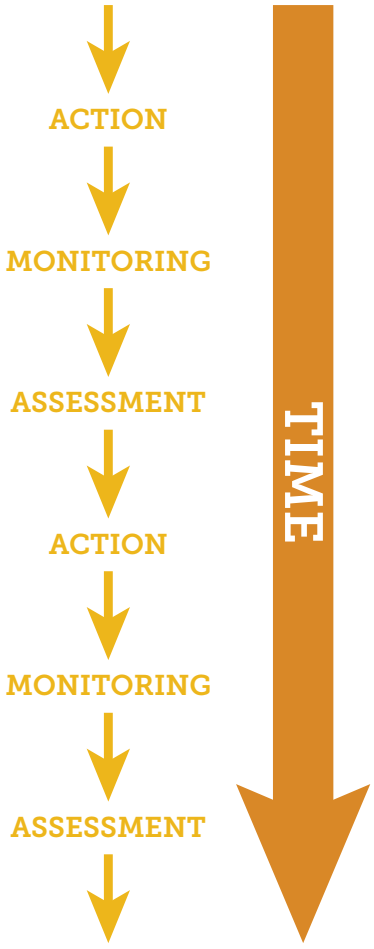
Adaptive Management

Adaptive management is an interdisciplinary management approach and an iterative learning process that promotes flexible decision making in the face of uncertainties.[60,61] While that is a rather technical definition, it is necessary to incorporate adaptive management techniques into the Resiliency Plan's development.

At the core of adaptive management is the iterative approach of modifying existing strategies and implementing new management strategies as additional information is learned.

In fact, adaptive management is fundamental to the planning process for the Resiliency Plan. As outcomes from management actions, policy changes and project implementation become better understood, the process outlined in the Resiliency Plan can be improved over time.

Adaptive management differs from a traditional trial-and-error management approach because it emphasizes 'learning by doing' with a formal, iterative approach, thereby reducing uncertainty in future success.[60,61,62] The approach, at a program level, includes carefully explaining planning goals, identifying management objectives and hypotheses of causation (for instance, related to Issues of Concern), and developing procedures for collecting data, followed by evaluation and reiteration.[60] Some of these procedures are already in place, emphasized by the GLO's breadth of coastal programs, but they can continue to be bolstered and improved. The main elements of project-level adaptive management are similar to the programmatic framework described above, but the nature of the interactions is different. For each project, a specific adaptive management plan should be developed, for which templates or guidelines can be developed to ensure consistency of an approach across projects.[63]



The Iterative Adaptive Management Process adapted from Williams et al. 2009[64]

Implementation will involve action, monitoring and assessment over time, which can be accomplished by these steps, modeled after those found in The Water Institute of the Gulf's Adaptive Management Framework for Coastal Louisiana:[63]

1. Integrate adaptive management into the development of the Resiliency Plan itself and associated technical analyses.
2. Support the role of science in decision making.
3. Encourage learning throughout the adaptive management process, including to continue developing and applying a transparent decision making process.
4. Initiate the principles of adaptive management in existing programs and projects.
5. Develop a governance structure that facilitates adaptive management implementation.

Successful implementation of adaptive management will ensure that efforts being done for the overall Resiliency Plan and individual projects (a) contribute to greater coastal resiliency, including vulnerable undeveloped areas and (b) are consistently improving over time.

Long-Term Monitoring

To effectively employ adaptive management, long-term monitoring programs are vital to assess the health of the ecosystem and the long-term success of projects. Typically, long-term monitoring programs are challenged by lack of allocated funding necessary to maintain the programs for a consistent period, which impacts their ability to provide meaningful data. Monitoring can be done on a project or site-specific scale, where data collected is aimed at answering questions around the effectiveness of a project or the need for an action. This is typically achieved through a project-specific Monitoring and Adaptive Management Plan. Alternatively, monitoring can be conducted at a larger, regional scale across numerous sites to answer questions around regional trends.

Living shorelines along the Texas City Prairie Preserve at Moses Lake. (Photo Credit: Texas General Land Office)

The first step in developing a long-term, regional monitoring program for the GLO is to establish program goals and identify objectives that can be implemented to reach those goals. The goal(s) of the monitoring program will be based on the questions that the program aims to address, as well as the scale, time-frame and available resources anticipated. Developing an effective and cost-efficient program will require:

- Development and consensus around program goals, guidelines and standards;
- Identifying the scale and time frame of the program;
- Reaching out to potential partner organizations;
- Establishing a shared data platform and a stakeholder collaboration process;
- Coordination with regulatory and permitting agencies; and
- Identifying funding.

Achieving a collaborative monitoring program will provide a wealth of information and data that will not only inform future versions of this Resiliency Plan, but a wide array of activities, studies and programs up and down the coast.

Looking to the Future

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 unknown storms, changing sea levels and continued development is a challenge that is being accepted by coastal stakeholders across the State of Texas. Progress is possible by working together to learn from both past successes and failures, understanding the Issues of Concern and investing in our future now.

Public access point to Port Aransas beach. (Photo credit: Texas General Land Office)

The 2019 Texas Coastal Resiliency Master Plan lays an ever-growing foundation for Actions, Strategies and Projects to be undertaken along the entire Texas coast. The Resiliency Plan captures the unique needs and characteristics of the different regions that all make up a diverse coastline. Understanding that we need to continually be informed and learn about our coast to better care for it also includes improving our coastal monitoring and data collection. The GLO is committed to continuing to plan for these steps and to be a voice for the coast alongside others.

The Resiliency Plan will continue its evolution through a next iteration in 2023. To achieve the desired results along the coast, focus will be put on funding and implementing Tier 1 projects now, and proactively planning to shore up the future of the Texas coast.

5. Individual Projects

Understanding Project Cut Sheets

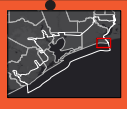
The following is meant to serve as a guide to understanding the information presented on each individual project cut sheet.

This is where you will find the project name, as well as the project ID number.

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

The top of each cut sheet is color-coded by region.

Texas Point Beach Nourishment Project
(Project ID R1-21)



Basic information such as project location, status and key project stakeholders can be found in the left column of each sheet.

Region: 1
Location:
Gulf shoreline of the Texas Point National Wildlife Refuge
County:
Jefferson
Status:
Conceptual
Stakeholders:
- U.S. Fish and Wildlife Service

This section contains project classification information, including project type, action and resiliency strategy.

Project Type:
Beach Nourishment, Dune Restoration
Action:
Beach and Dune Sustainability
Resiliency Strategy:
Ecological Resiliency (Beach Nourishment and Dune Restoration)

This represents the number of jobs created statewide during project construction or implementation. Further detail can be found in the Technical Report.

Jobs Created:
Creates approximately 424 jobs during construction.

Project Description
This project would conduct beach restoration at Texas Point 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 Study planning efforts.

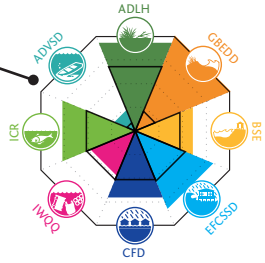
Project Need
Except for the area directly adjacent to the Sabine Pass jetties, this shoreline has experienced severe erosion based on short- and long-term shoreline change monitoring.

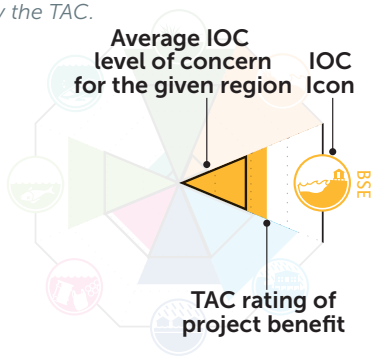
Project Benefit
This project would restore the beach at Texas Point from its currently severely eroded state. The shoreline along the Texas Point National Wildlife Refuge is a first line of defense for the refuge that serves as protection against storm surge and coastal flooding events. Restoring the beach in this area would ensure a healthy shoreline and would protect the wetlands in the refuge from saltwater intrusion.

This graph depicts how well the project addresses each Issue of Concern (IOC), as evaluated by the Technical Advisory Committee (TAC). The colored area of each "wedge" shows how the TAC rated the effectiveness of the project at addressing a specific IOC. The area outlined in black represents the regional average level of concern (how prominent is the IOC across the region) for each IOC, as evaluated by the TAC.

Project Benefits Per Issues of Concern

Project Specific
Average for Region 1





Estimated Total Project Cost: $36,091,000

This column contains a detailed map depicting the location of the individual project, a brief project description, the need the project aims to address, project benefits, and the estimated total project cost.

Construction-type project costs include design, construction and maintenance costs and are developed using cost templates included in the Technical Report. For non-construction projects, project costs are estimated based on input from stakeholders. When partial funding for the project has been identified (for instance, if grant funding is known to have been awarded to the project), it will be identified with an asterisk.

Texas General Land Office — 2019 Texas Coastal Resiliency Master Plan

COASTWIDE

TIER 1 PROJECTS

19 Projects *$19M+*

Texas Coastal Resiliency Master Plan *(Project ID R0-1)*

Region: 0

Location:
Coastwide

County:
Coastwide

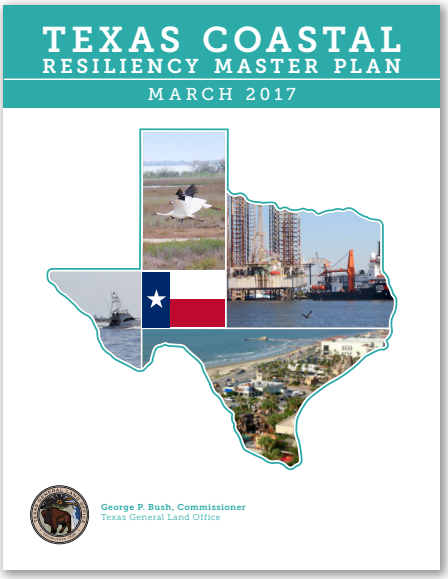
Status:
Ongoing

Stakeholders:
- Texas General Land Office

Project Type:
Study, Policy, Plan or Program

Action:
None

Resiliency Strategy:
Administrative Resiliency (Plan)



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.

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.

Project Benefit

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.

Estimated Total Project Cost: $2.5 million per year

Did You Know?

"The need for the Texas Coastal Resiliency Master Plan has never been greater, and the commitment to the Texas coast has never been stronger. While our response in the face of disaster is important, it's equally important to have a plan for mitigation of impact. The Texas Coastal Resiliency Master Plan does that, and it will continue to evolve as the needs and vulnerabilities of the coast change; ensuring a strong coast for a strong Texas, now and in the future." – *Commissioner George P. Bush*

Source: Texas General Land Office. 2017. Texas Coastal Resiliency Master Plan. Available at: http://www.glo.texas.gov/coastal-grants/projects/files/Master-Plan.pdf (accessed Feb 20, 2019)

Dune Management and Access Plan *(Project ID R0-2)*

Region: 0

Location:
Coastwide

County:
Coastwide

Status:
Conceptual

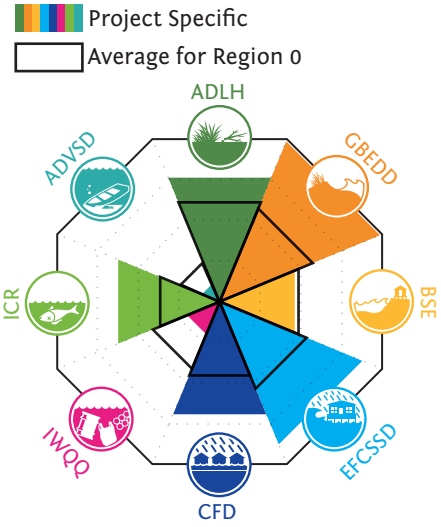
Stakeholders:
- Texas General Land Office

Project Type:
Study, Policy, Plan or Program; Dune Restoration

Action:
None

Resiliency Strategy:
Administrative Resiliency (Plan); **Ecological Resiliency** (Beach Nourishment and Dune Restoration); **Societal Resiliency** (Storm Surge Suppression)

Project Benefits Per Issues of Concern



Project Description

This project proposes to develop a comprehensive dune management plan and identify a set of desired future conditions that would support adequate dune protection for geographic areas along the coast. The plan's developers would identify opportunities to coordinate with state and regulatory agencies to prepare for current and future needs of dune restoration along the coast, while keeping the Open Beaches Act and other statutes in mind.

Project Need

This plan would take concepts from existing coastal community Erosion Response Plans and consolidate them into an updated dune management strategy based on current conditions.

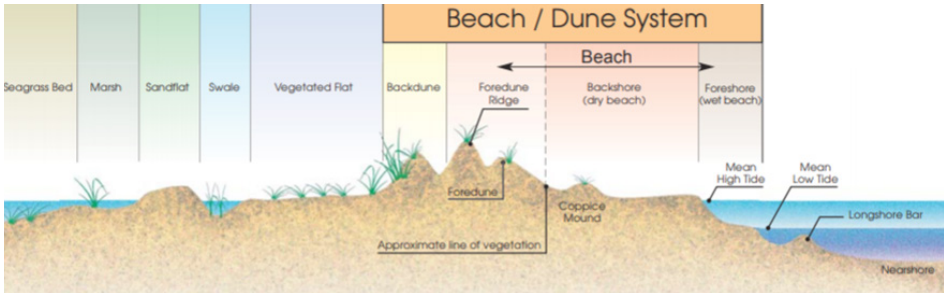
Project Benefit

This comprehensive dune management plan also would include recommendations targeted towards each geographic area of the coast with the purpose of improving local governments' dune protection plans based on Federal Emergency Management Agency data and storm surge modeling.

Estimated Total Project Cost: $1 million per year

Did You Know?

The beach/dune system includes all land from the line of mean low tide to the landward limit of dune formation. The photo above shows the typical cross section of a Texas barrier island.



Source: Texas General Land Office. n.d. Dune Protection and Improvement Manual for the Texas Gulf Coast, Fifth Edition. Available at: http://www.glo.texas.gov/coast/coastal-management/forms/files/dune-protection-manual-gpb.pdf (accessed Feb 20, 2019)

Texas Seagrass Restoration *(Project ID R0-3)*

Region: 0

Location:

Coastwide

County:

Coastwide

Status:

Shovel-ready

Stakeholders:

- Texas Parks & Wildlife Department
- Texas General Land Office
- Greater Caribbean Energy & Environment Foundation

Project Type:

Habitat Creation & Restoration; Study, Policy, Plan or Program

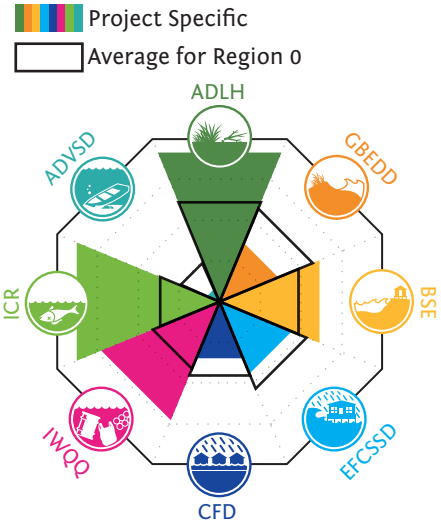
Action:

None

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Administrative Resiliency** (Plan)

Project Benefits Per Issues of Concern



Project Description

Texas needs an overall plan to restore the ecosystem services provided by seagrasses, which include stabilizing bay shorelines, enhancing fish nurseries, nutrient recycling, creating clearer water and producing buried carbon. This buried carbon is a natural seagrass process that sequesters carbon dioxide by extracting excess carbon dioxide from air and water (from emissions of power plants, oil refineries and vehicles). There are three goals for this project:

1. To stabilize areas proximate to shorelines
2. To create lost fish nurseries beneficial to recreational fishing, commercial fishing and tourism; and
3. To create long-term carbon sequestration at sites and sell as carbon credits to offset the Texas carbon emission footprint.

This project has been permitted in hand and is shovel-ready where testing for seagrass restoration has been completed (Laguna Madre, Corpus Christi Bay, Galveston Bay, St. Charles Bay and Aransas Bay).

Project Need

In Texas bays, 80 percent or more of seagrass has been destroyed by industrial and urban development. Only 233,000 acres of the seagrasses remain from the state's original 1,922,500 acres of seagrass at the turn of the last century (the greatest total loss of seagrass for a U.S. state in the Gulf of Mexico).

Project Benefit

Strengthening the resilience of Texas shorelines and bay bottom sediments entails reviving the important services of seagrass ecosystems. Seagrass grows rapidly and can replace marsh and mangrove habitats when sea levels rise, is resilient to storm surge and helps improve habitat biodiversity within bays.

Estimated Total Project Cost: $2 million

Did You Know?

There are five species of seagrass along the Texas coast.

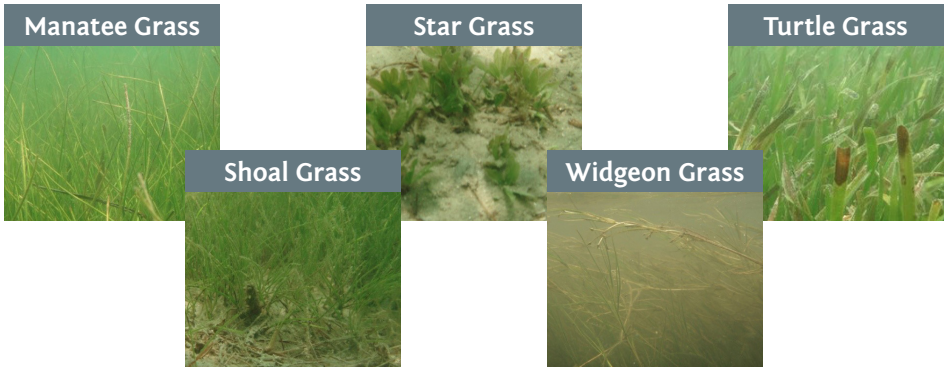


Photo credit: Texas Parks & Wildlife Department. n.d. Seagrass Types. Available at: https://tpwd.texas.gov/landwater/water/habitats/seagrass/seagrass-types (accessed Feb 20, 2019)

Derelict Structure and Vessel Removal Program
(Project ID R0-4)

Region: 0

Location:
Coastwide

County:
Coastwide

Status:
Ongoing

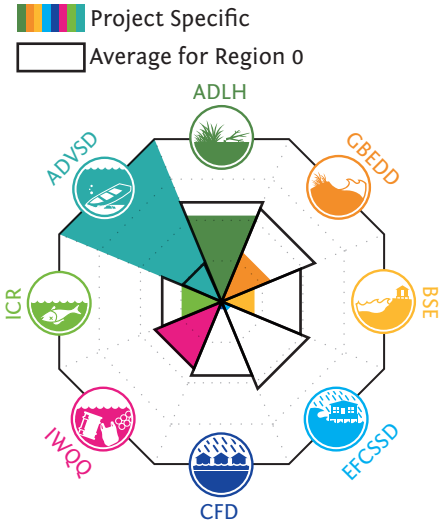
Stakeholders:
- Texas General Land Office

Project Type:
Structure/Debris Removal; Study, Policy, Plan or Program

Action:
Storm Preparedness and Response

Resiliency Strategy:
Administrative Resiliency (Program)

Project Benefits Per Issues of Concern



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. Following this legislation, the Texas General Land Office created the Derelict Structure and Vessel Removal Program to identify, prioritize, remove and properly dispose of derelict and abandoned vessels and structures along the entire Texas coastline.

Project Need
The size of derelict and abandoned vessels addressed by this program range from a 12-foot recreational vessel to a 77-foot steel hulled commercial fishing vessel, and up to 100-plus foot barges. Derelict structures in need of removal include piers, docks, pilings and debris.

Project Benefit
This program would improve the quality of the environment along the Texas coast and increase public safety by removing derelict and abandoned vessels along the coastline.

Estimated Total Project Cost: $3 million per year

Did You Know?
One of the first documented examples of abandoned vessels in the Texas coastal area are 16 World War I wooden-hulled freighters scuttled in the Sabine River in 1921. Each ship was 270 feet long, 45 feet wide and 3,500 tons.

Source: Texas General Land Office. 2016. Abandoned Vessel & Structure Removal Program. Available at: http://www.setwac.org/docs/2016/07_July/Abandoned_Vsl_Removal_7-28-16.pdf (accessed Feb 20, 2019)

Abandoned and Derelict Petroleum Production Structure Removal Program *(Project ID R0-5)*

Region: 0

Location:
Coastwide

County:
Coastwide

Status:
Ongoing

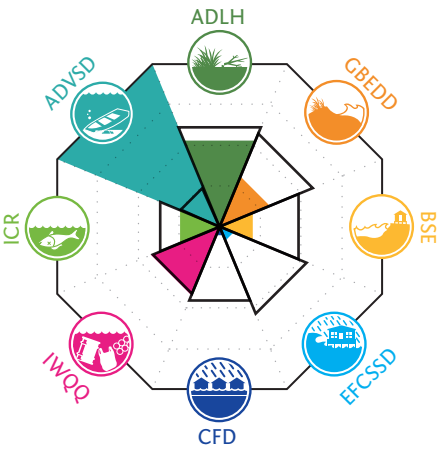
Stakeholders:
- Texas General Land Office

Project Type:
Structure/Debris Removal; Study, Policy, Plan or Program

Action:
Storm Preparedness and Response

Resiliency Strategy:
Administrative Resiliency (Program)

Project Benefits Per Issues of Concern



Project Description

The Texas General Land Office identifies, prioritizes, removes and properly disposes of abandoned or unauthorized petroleum production 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.

Project Need

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. Abandoned wells and their surrounding structures also pose a navigational hazard for recreational and commercial vessels.

Project Benefit

The removal of abandoned or unauthorized petroleum production 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.

Estimated Total Project Cost: $5 million per year

Did You Know?

The photo below shows an abandoned petroleum structure on Bolivar Peninsula.

Source: Texas General Land Office. 2017. Texas Coastal Resiliency Master Plan Executive Summary. Available at: http://www.glo.texas.gov/coastal-grants/projects/files/Executive-Summary.pdf (accessed Feb 20, 2019)

Evacuation Route Study for Coastal Resilience
(Project ID R0-6)

Region: 0

Location:

Roads and Highways Coastwide

County:

Coastwide

Status:

Conceptual

Stakeholders:

- Texas General Land Office
- Texas Department of Transportation

Project Type:

Study, Policy, Plan or Program; Community Infrastructure

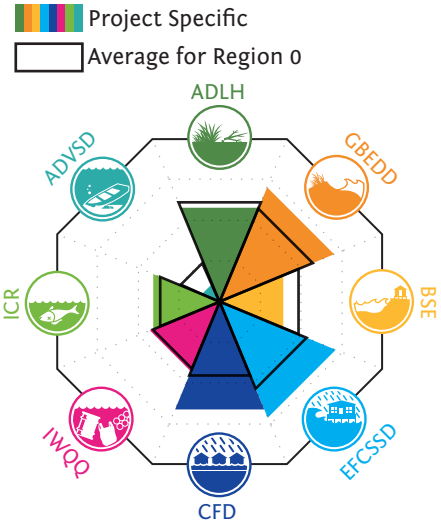
Action:

Storm Preparedness and Response

Resiliency Strategy:

Societal Resiliency (Land-Based Transit Enhancement)

Project Benefits Per Issues of Concern



Project Description

This project would conduct a coastwide study to identify evacuation routes that are at risk of being inundated during large rainfall events and coastal storms, or that are at risk of being flooded due to relative sea level rise. The most current data and models would be used to identify the areas at risk of flooding. The study would then recommend evacuation routes in need of improvement based on these expected future hazards.

Project Need

Many evacuation routes along the Texas coast are at risk for inundation during large rainfall events or flooding due to relative sea level rise. It is a public safety issue for these roadways to be improved so that evacuation efforts are not hindered in future coastal flooding events.

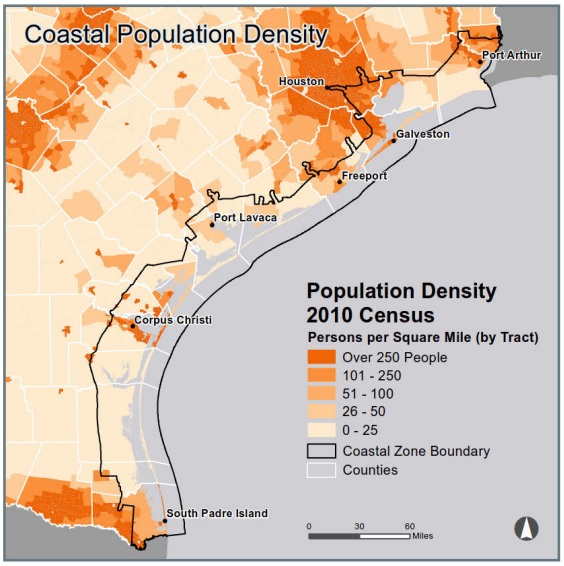
Project Benefit

The study would help the state ensure that roadways used as evacuation routes during flooding and storm events are improved, elevated, or relocated prior to future evacuation events.

Estimated Total Project Cost: $250,000

Did You Know?

The average population density of the 18 Texas coastal counties is more than four times greater than the average of Texas as a whole. The two largest population centers on the Texas coast are the greater Houston area, the fourth largest metropolitan complex in the United States, and Corpus Christi, the eighth largest city in Texas.



Source: Texas General Land Office. 2017. Texas Coastal Resiliency Master Plan. Available at: http://www.glo.texas.gov/coastal-grants/projects/files/Master-Plan.pdf (accessed Feb 20, 2019)

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

Region: 0

Location:

Communities Coastwide

County:

Coastwide

Status:

Ongoing

Stakeholders:

- Texas Water Development Board

Project Type:

Study, Policy, Plan or Program; Community Infrastructure

Action:

Watershed Planning

Resiliency Strategy:

Administrative Resiliency (Program); **Societal Resiliency** (Community Infrastructure Planning and Development)

Project Description

The Texas Water Development Board prepared the State Flood Assessment in 2018 that explores three key pillars of investment for a proactive, statewide floodplain management program: (1) mapping, (2) planning, and (3) mitigation. The assessment discusses the need for and benefit of comprehensive flood planning. Recommendations from the report will be considered by the 86th Texas Legislature in 2019.

Project Need

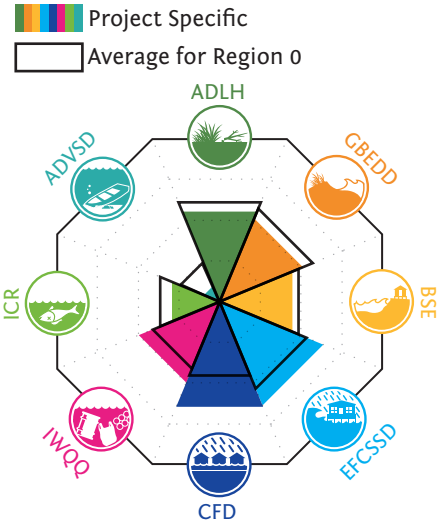
Although local planning efforts already take place across the state, there is not a unified, coordinated process to assess risk and plan for the state's flood risk goals. Much of Texas is either unmapped or uses out-of-date flood insurance rate maps, leading to widespread misunderstanding about true flood risks. Across Texas, there is a need for a long-term, affordable and sustainable method to provide financial assistance and other incentives for developing and updating flood maps, statewide flood planning and implementing flood mitigation projects that are recommended to meet state flood risk management goals.

Project Benefit

This statewide assessment is an initial step towards implementing programs across multiple agencies to assist coastal communities with improving existing infrastructure, planning for future development, and creating financial strategies to fund improvements and future flood mitigating strategies – particularly to prevent damage from and prepare for flooding events. Additional programs and planning focused on responsible development would encourage people to avoid development in flood prone areas and preserve natural floodways, which could be informed by efforts such as the State Flood Assessment.

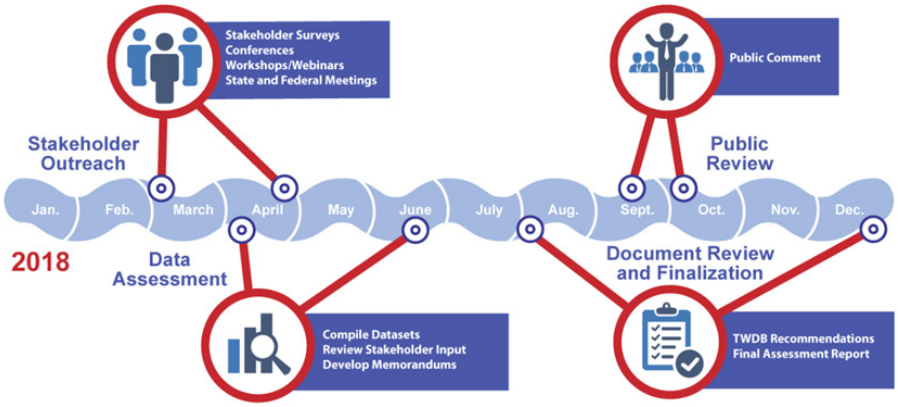
Estimated Total Project Cost: $600,000 per year

Project Benefits Per Issues of Concern



Did You Know?

The Texas Water Development Board prepared a State Flood Assessment in 2018. Stakeholder input and public comments were used to develop a statewide report published in January 2019.



Source: Texas Water Development Board. 2018. State Flood Assessment. Available at: http://www.texasfloodassessment.com/ (accessed Sept 15, 2018)

Texas Coastal Nonpoint Source Pollution Program
(Project ID R0-8)

Region: 0

Location:

Urban and urbanizing communities in the coastal zone

County:

Coastwide

Status:

Proposed

Stakeholders:

- Incorporated municipalities
- Regional and watershed planning organizations
- Texas Commission on Environmental Quality
- Texas State Soil and Water Conservation Board
- Texas General Land Office

Project Type:

Study, Policy, Plan or Program; Community Infrastructure; Hydrologic Connectivity

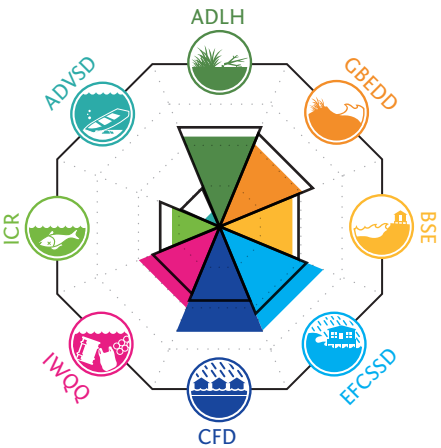
Action:

Watershed Planning

Resiliency Strategy:

Administrative Resiliency (Program); **Societal Resiliency** (Community Infrastructure Planning and Development); **Ecological Resiliency** (Upland Planning, Conservation, and Monitoring)

Project Benefits Per Issues of Concern



Project Description

The Texas Coastal Nonpoint Source Pollution Program is a partnership with multiple state agencies and coastal communities to implement programs and policies that will enhance the management and resiliency of water resources in coastal communities by decreasing stormwater flows and lessen pollutant loads. The Texas General Land Office is leading efforts to finalize the Texas Coastal Nonpoint Source Pollution Program, which is an initiative of the Texas Coastal Management Program. The program is expected to be finalized in September 2019 and full implementation will initiate thereafter.

Program goals are to manage pre-development runoff, develop water quality controls, limit 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.

Project Need

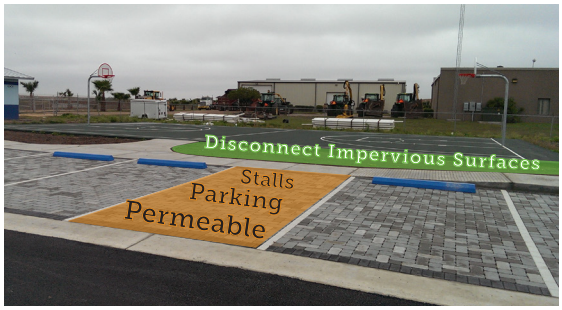
Stormwater runoff, floodplain management, and related water quality issues are critical for most urban and urbanizing areas and agriculture and grazing lands.

Project Benefit

This program would address resiliency issues focused on stormwater runoff, floodplain management and water quality for activities related to recreation, nature tourism, urban infrastructure and planning, wetlands, marinas, forestry and agriculture.

Estimated Total Project Cost: $500,000 per year

Did You Know?



As urban areas grow, the natural vegetation is often replaced with buildings, housing developments, roads and parking lots. This increases the amount of impervious cover over surfaces that once absorbed the rainfall into the soil, stored the rain as groundwater, and gradually seeped into rivers and streams. Natural drainage systems also filter pollutants to enhance water quality. This conversion of land use results in more stormwater runoff, which leads to more frequent and severe flooding.

Source: Texas General Land Office. 2014. Guidance for Sustainable Stormwater Drainage on the Texas Coast. Available at: http://www.glo.texas.gov/coastal-grants/_documents/grant-project/ciap-2008-coastal-storm-water-technical%20guidance.pdf (accessed Feb 4, 2019)

Sediment Management Plan *(Project ID R0-9)*

Region: 0

Location:

Coastwide

County:

Coastwide

Status:

Conceptual

Stakeholders:

- Texas General Land Office

Project Type:

Study, Policy, Plan or Program; Beach Nourishment; Dune Restoration; Habitat Creation and Restoration

Action:

Data Collection and Monitoring

Resiliency Strategy:

Administrative Resiliency (Plan); **Ecological Resiliency** (Beach Nourishment and Dune Restoration; Wetland Planning, Restoration and Monitoring; Rookery Island Protection, Restoration and Creation)

Project Description

A sediment management plan for the entire Texas coast is necessary to allow for the inventory and coastwide coordination of sediment resources. The ultimate goal is a full-fledged program to coordinate the beneficial use of dredged material with the U.S. Army Corps of Engineers and other identified partners.

Project Need

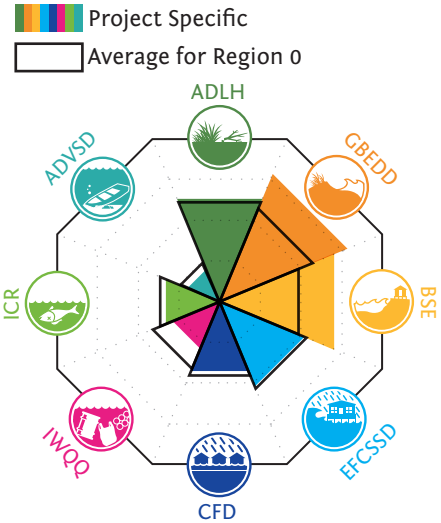
Maintaining Texas ports and navigation channels requires periodic dredging. Finding upland sites for disposal of dredged material is becoming difficult due to competition for space and increasing costs. At the same time, most of the Texas coast is eroding and in need of replacement sediment. For example, Hurricane Harvey caused erosion of over 7 million cubic yards of sand from San Jose Island alone, equivalent to over half a million dump trucks of sand.

Project Benefit

A holistic approach to sediment management along the sand-starved Texas coast could provide the umbrella for a coordinated and organized process that optimizes the use of available sediment sources for coastal management. Economic benefits would result from both maritime transportation interests and those that rely on natural resources and amenities for jobs and income.

Estimated Total Project Cost: $1 million per year

Project Benefits Per Issues of Concern



Did You Know?

This sediment transport model shows how sediment has moved along Galveston Island shorelines over the last 20 years.

Source: Texas General Land Office. 2016. Texas Coastal Sediment Sources. Available at: http://www.glo.texas.gov/coastal-grants/_documents/grant-project/13-333-sediment-study.pdf (accessed Feb 20, 2019)

Beach Monitoring and Maintenance Program
(Project ID R0-10)

Region: 0

Location:

Gulf and Bay Engineered Beaches in the State of Texas

County:

Coastwide

Status:

Ongoing

Stakeholders:

- Texas General Land Office

Project Type:

Study, Policy, Plan or Program; Beach Nourishment; Dune Restoration

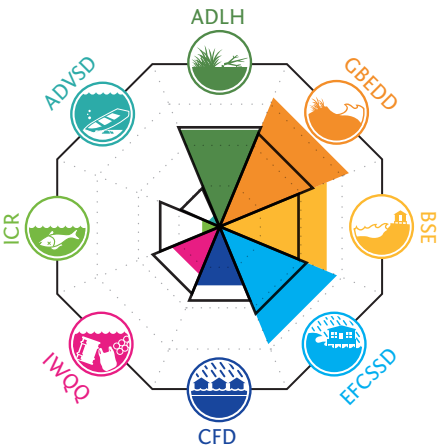
Action:

Data Collection and Monitoring

Resiliency Strategy:

Administrative Resiliency (Program); **Ecological Resiliency** (Beach Nourishment and Dune Restoration)

Project Benefits Per Issues of Concern



Project Description

The Texas General Land Office's (GLO's) Beach Monitoring and Maintenance Plan (BMMP) was established to provide ongoing monitoring and analysis for the GLO to prioritize the need for maintenance renourishment of designated bay shore and Gulf-facing beaches enhanced through engineering along the Texas coast. Under the BMMP, annual monitoring surveys are conducted for all BMMP engineered beach sites. When tropical storm events occur, a set of post-storm surveys are conducted at the sites determined by the GLO as likely to have sustained impacts. The resulting analysis of post-storm vs. annual survey data forms the basis for the GLO's damage assessment concerning beach volume loss. 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 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 administration of the BMMP, the GLO, with funding through the Coastal Erosion Planning and Response Act Program, tracks and collects this information to accurately identify the areas impacted and the amount of sand lost during natural disasters. Without a BMMP in place, the beach would not be eligible for FEMA's PA program funding, which covers 90 percent of the costs for repairs to the identified areas. A key component of the BMMP, therefore, is the ability to regularly monitor and record engineered beach sand loss.

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 costs relating to the replacement of sand on engineered public beaches impacted by tropical storms significant enough to warrant a federal disaster declaration.

Project Benefit

This program would continue to monitor and improve the quality of Texas beaches. As a first line of defense, healthy beaches are important to maintaining a resilient coast with the risk of future coastal storm events and sea level rise. Protecting and improving Texas beaches also would provide benefits to the tourism industry coastwide. Additionally, the program allows Texas to remain eligible to receive funding under the FEMA PA program.

Estimated Total Project Cost: $1 million per year

Subsidence Study and Monitoring *(Project ID R0-11)*

Region: 0

Location:
Coastwide

County:
Coastwide

Status:
Conceptual

Stakeholders:
- Texas General Land Office

Project Type:
Study, Policy, Plan or Program

Action:
Data Collection and Monitoring

Resiliency Strategy:
Administrative Resiliency (Program)

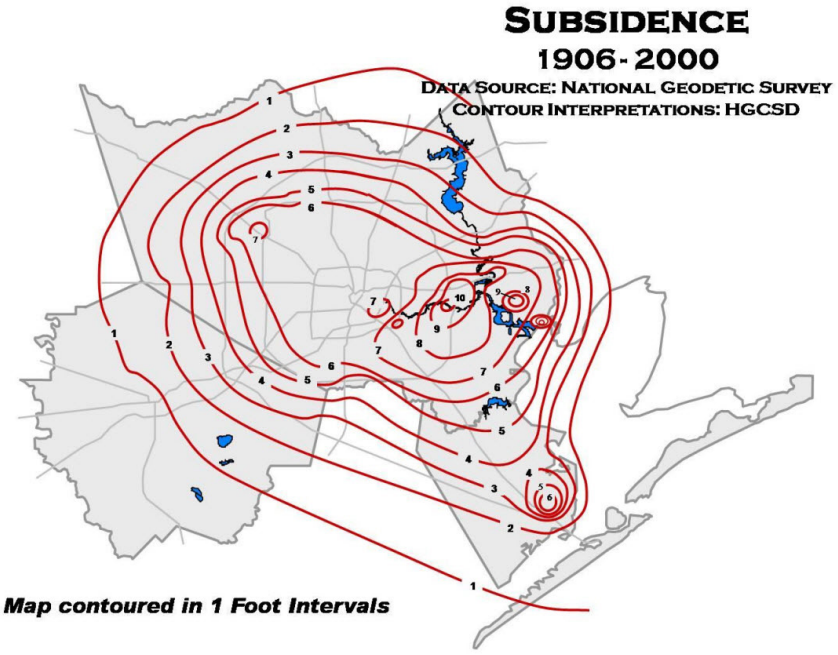
Project Description
This program would include monitoring of coastwide subsidence in Texas and a corresponding study to understand subsidence patterns along the coast.

Project Need
There are limited amounts of subsidence data currently available for the entire Texas coast.

Project Benefit
Funding for a coastwide subsidence study would enhance existing subsidence monitoring programs. These efforts would help coastal communities to understand historical subsidence rates and future patterns of subsidence. This data also would be useful to model past, present and future conditions along the coast. Coastal communities and stakeholders could then use this information to guide policy and management decisions to bolster coastal resiliency.

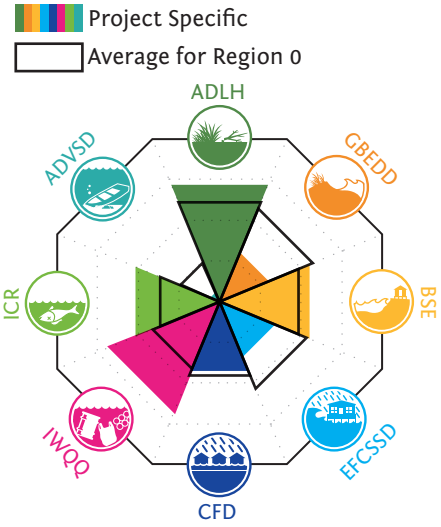
Estimated Total Project Cost: $500,000 per year

Did You Know?
The map below depicts subsidence levels for Harris and Galveston counties between 1906 and 2000. Some communities experienced up to 10 feet of subsidence during this 94-year period, an average of over a tenth of a foot per year.



Source: Harris-Galveston Subsidence District. 2013. Subsidence Contour Map 1906-2000. Available at: https://hgsubsidence.org/wp-content/uploads/2013/07/SubsidenceMap1906-2000.pdf (accessed Feb 20, 2019)

Project Benefits Per Issues of Concern



Longshore Transport Modeling *(Project ID R0-12)*

Region: 0

Location:

Gulf Shoreline Coastwide

County:

Coastwide

Status:

Conceptual

Stakeholders:

- Texas General Land Office

Project Type:

Study, Policy, Plan or Program; Beach Nourishment

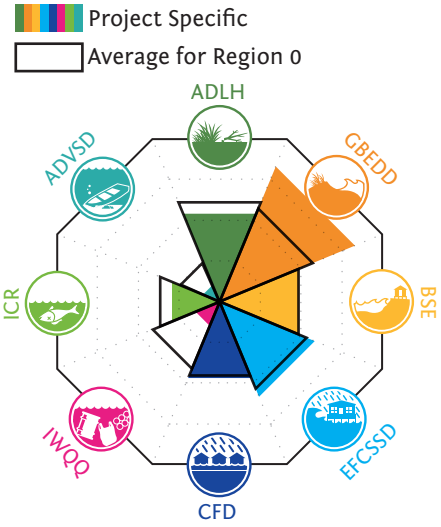
Action:

Data Collection and Monitoring

Resiliency Strategy:

Administrative Resiliency (Study); **Ecological Resiliency** (Beach Nourishment and Dune Restoration)

Project Benefits Per Issues of Concern



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.

Project Need

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.

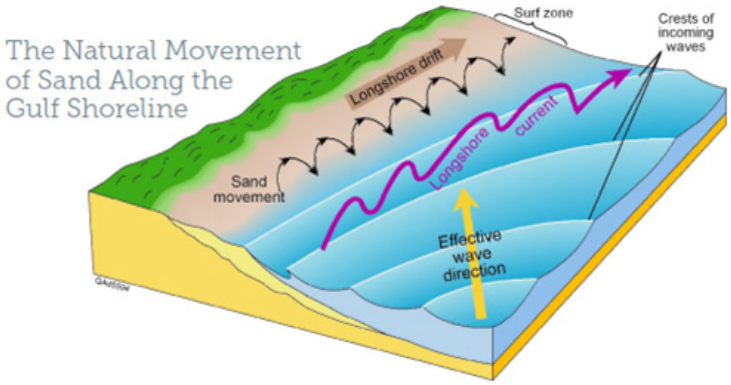
Project Benefit

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.

Estimated Total Project Cost: $1 million per year

Did You Know?

Sand moves along the Gulf shoreline of Texas in a constant onshore-offshore direction to and from the beach in a process known as longshore sediment transport. The movement of sand and water along the shoreline is caused by waves approaching at an angle to the shoreline, and tidal currents and wind pushing water along the beach. Longshore currents move parallel to the shoreline and longshore sediment transport is the movement of sand and sediment along the shoreline.



Source: Texas General Land Office. 2017. Texas Coastal Resiliency Master Plan. Available at: http://www.glo.texas.gov/coastal-grants/projects/files/Master-Plan.pdf (accessed Feb 20, 2019)

Long-Term Hydrologic Monitoring Program
(Project ID R0-13)

Region: 0

Location:

Coastwide

County:

Coastwide

Status:

Monitoring

Stakeholders:

- Texas Water Development Board
- U.S. Geological Survey
- National Oceanic and Atmospheric Administration
- U.S. Army Corps of Engineers

Project Type:

Study, Policy, Plan or Program; Hydrologic Connectivity

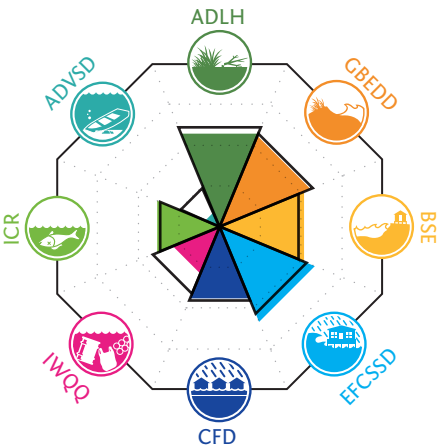
Action:

Data Collection and Monitoring

Resiliency Strategy:

Administrative Resiliency (Program), **Ecological Resiliency** (Freshwater Inflow and Tidal Exchange Enhancement)

Project Benefits Per Issues of Concern



Project Description

Funding for a coastwide long-term hydrologic monitoring program would provide for the installation of permanent monitoring stations at key areas to be determined along the coast to collect long-term data for freshwater inflows and other parameters, such as wind speed, rainfall, evaporation, riverine and groundwater inputs, water level, and also could include air quality. Construction would take advantage of the existing infrastructure when relevant, such as the Estuary Monitoring Program administered by the Texas Water Development Board, and the Texas Coastal Ocean Observing Network (TCOON) funded by the U.S. Army Corps of Engineers and presently managed by the National Oceanic and Atmospheric Administration. U.S. Geological Survey, state agency and river authority measuring stations also would be utilized as appropriate.

Project Need

Freshwater inflow determines salinity in bays, estuaries and near shore, forming the basis for many coastal management decisions. Sound decisions need long-term data sets including trends and characterization of spatial variability. For example, flooding along the shores from storm surge is strongly affected by wind. At present, Texas Water Development Board models the freshwater influx using simulations, however, there has been very little empirical data to substantiate the simulations. In addition, models that simulate storm surge are driven mostly by analysis of wind speed, yet there is a lack of local wind speed information to check the analysis over many areas.

Project Benefit

Being able to measure and track freshwater inflow, wind and water quality variables would help inform stakeholders, such as local water managers and state agencies, about the measures needed to retain the salinity levels in lakes and estuaries. It also would help estimate sediment load and inform mitigation plans to stem the load. Having accurate freshwater inflow, salinity and water quality data would benefit the economy indirectly by providing the information on the infrastructure needed to maintain the health of bays and estuaries, which play a vital role in the state's coastal fishing, farming and tourism industries.

Estimated Total Project Cost: $500,000 per year

Development of Optimal Coastwide Bathymetric and Topographic Models *(Project ID R0-14)*

Region: 0

Location:
Coastwide

County:
Coastwide

Status:
Conceptual

Stakeholders:

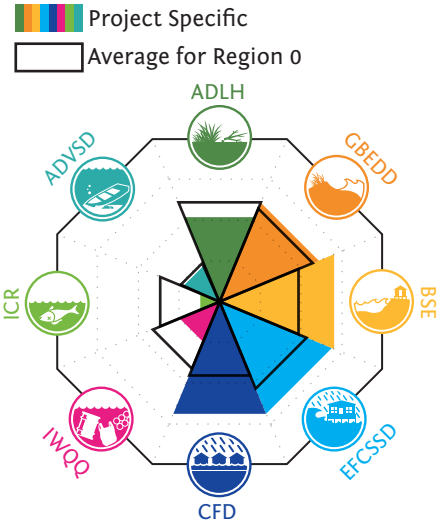
- Harte Research Institute
- Texas General Land Office

Project Type:
Study, Policy, Plan or Program

Action:
Data Collection and Monitoring

Resiliency Strategy:
Administrative Resiliency (Plan)

Project Benefits Per Issues of Concern



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.

Project Need

Currently, there are no single, consistent and full-coverage bathymetric or topographic surveys of the Texas coastal zone. Recently, the Harte Research Institute compiled and merged the best available Light Detection and Ranging (LiDAR) data into a topographic model that required consideration of about a dozen datasets acquired since 2006. A continuous bathymetric model of Texas bays requires inclusion of multiple survey data acquired since the 1960's. 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 and developing coastwide topographic/bathymetric models using the best available data.

Project Benefit

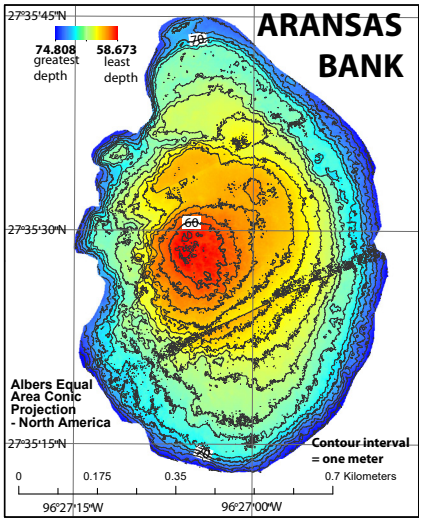
Detailed and accurate topographic and bathymetric data are required for mapping coastal habitats, geoenvironments, and built environments in the coastal zone. These data are also needed for measuring coastal change and modeling floods, storm surges and sea level rise impacts. Therefore, to understand 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.

Estimated Total Project Cost: $250,000 per year

Did You Know?

Bathymetric data (or "bathymetry") shows the topography of the ocean floor. Bathymetric maps have applications in ocean engineering and construction, managing habitat for fish and marine organisms, ocean research and exploration, storm surge prediction models, sea level rise prediction, and many other applications. To the right is a bathymetric map of Aransas Bank in the northwest Gulf of Mexico.

Source: Texas Sea Grant. 2012. Individual Maps of South Texas Banks. Available at: http://texasseagrant.org/assets/uploads/resources/Aransas_Bank.pdf (accessed Feb 20, 2019)



Data Collection to Support Continual Updates to the National Wetlands Inventory Dataset *(Project ID R0-15)*

Region: 0

Location:

Coastwide

County:

Coastwide

Status:

Conceptual

Stakeholders:

- Texas General Land Office
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration; Study, Policy, Plan or Program

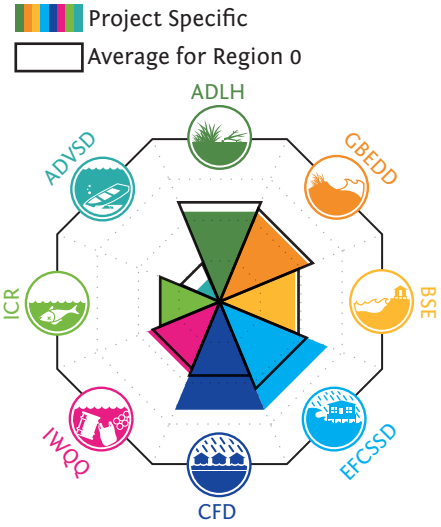
Action:

Data Collection and Monitoring

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Administrative Resiliency** (Program)

Project Benefits Per Issues of Concern



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).

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. The U.S. Fish and Wildlife Service (USFWS) estimates that over half of the wetlands in the United States have been lost since 1780.

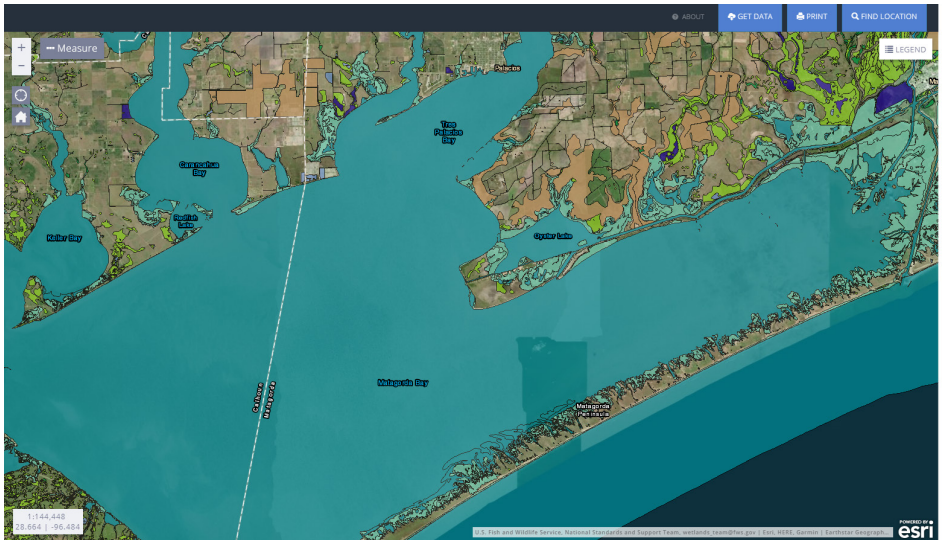
Project Benefit

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.

Estimated Total Project Cost: $50,000 per year

Did You Know?

NWI data is sometimes used in emergency situations. In response to the Deepwater Horizon oil spill disaster in 2010, USFWS developed a fish and wildlife resource area mapper that showed the oil plume and shoreline oil locations. The NWI incorporated a layer for wetlands in the response map.

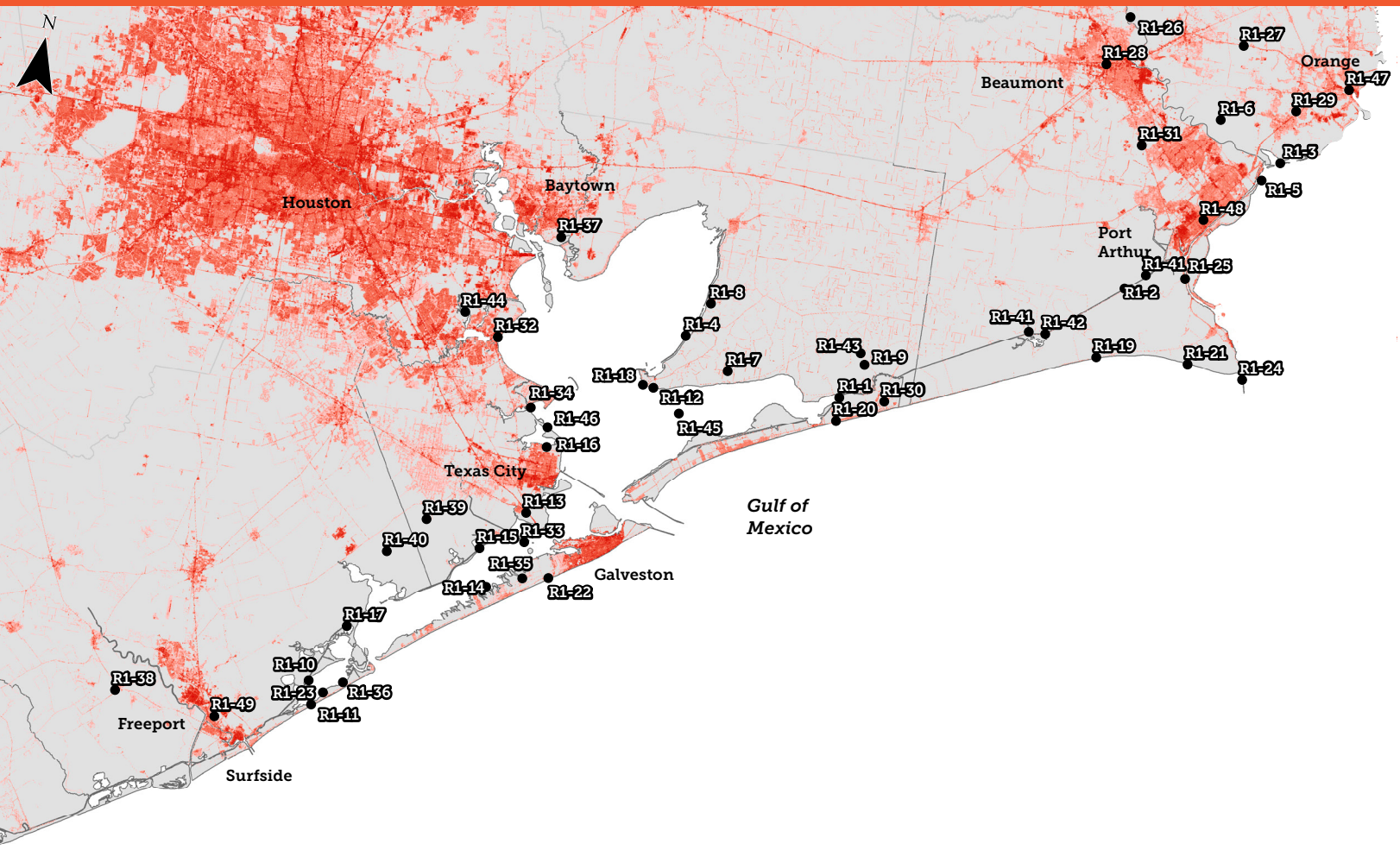


Source: U.S. Fish and Wildlife Services. 2018. National Wetlands Inventory Program Overview. Available at: https://www.fws.gov/wetlands/nwi/Overview.html (accessed Feb 20, 2019)

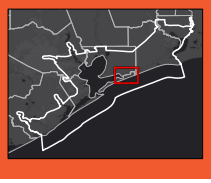
REGION 1

TIER 1 PROJECTS

49 Projects *$4.9B+*



Anahuac National Wildlife Refuge Living Shoreline
(Project ID R1-1)



Region: 1

Location:

Shoreline along Easy Bay at Anahuac National Wildlife Refuge

County:

Chambers, Galveston

Status:

Conceptual

Stakeholders:

- U.S. Fish and Wildlife Service
- Chambers County
- Galveston County
- Galveston Bay Estuary Program
- Galveston Bay Foundation
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Water-Based Transit Enhancement)

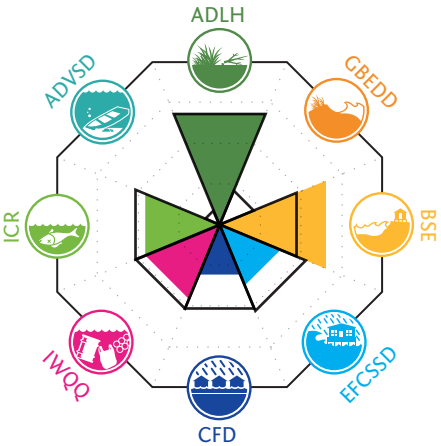
Jobs Created:

Creates approximately 61 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 1



Project Description

This project would restore estuarine wetland habitat along the Gulf Intracoastal Waterway (GIWW) using a living shoreline construction for up to 9 miles of eroding shoreline. This project also could beneficially use dredged material from the GIWW.

Project Need

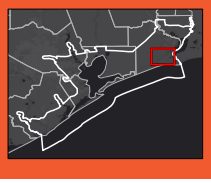
Abutting the Anahuac National Wildlife Refuge, this eroding portion of the GIWW is an important wildlife conservation area and wave action is only expected to increase as it serves a critical commercial navigational channel. As a result, strengthening the shoreline itself is the most effective erosion mitigation approach.

Project Benefit

Stabilizing the banks of the GIWW promotes navigational safety and efficiency of barges that carry approximately 103 million tons of cargo across this segment of the GIWW annually. Wetland protection and restoration would enhance and create habitat for recreationally and commercially important aquatic and avian species.

Estimated Total Project Cost: $60,900,000

Willow Lake Shoreline Stabilization *(Project ID R1-2)*



Region: 1

Location:

Shoreline along the Gulf Intracoastal Waterway, approximately 6 miles west of Port Arthur

County:

Jefferson

Status:

Engineering & Design

Stakeholders:

- Ducks Unlimited
- McFaddin National Wildlife Refuge
- Jefferson County

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Hydrologic Connectivity

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring; Freshwater Inflow and Tidal Exchange Enhancement)

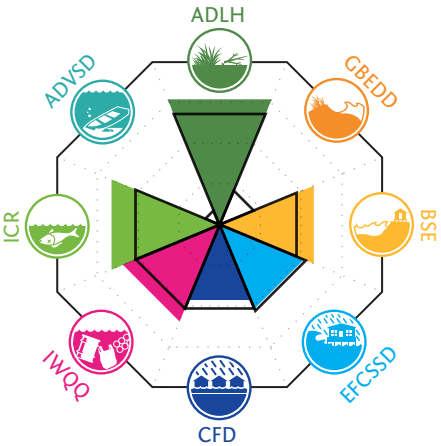
Jobs Created:

Creates approximately 82 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 1



Project Description

The project would construct approximately 6,000 linear feet of breakwater structures along the Gulf Intracoastal Waterway (GIWW). The project also would construct more than 20,000 linear feet of marsh terraces, a 1,000-foot-long inverted siphon, and a 2,200-foot-long diversion ditch on the south side of the GIWW to deliver freshwater to the higher elevations of the lower Willow Lake Watershed in the McFaddin National Wildlife Refuge. Permitting and construction are pending for this project.

Project Need

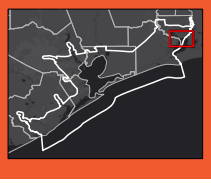
The estuarine wetlands along the Willow Lake shoreline are degrading due to erosion, increased salinity and increased pollutant levels from navigational movement along the GIWW. In some locations, erosion has widened original access channels by as much as five times their original widths. The increased salinity has severely impacted the vegetation, decreasing available food for waterfowl and leaving shorelines more prone to habitat degradation. In addition, freshwater wetlands north of the GIWW are being converted from emergent marsh into shallow open water.

Project Benefit

The siphon would transport freshwater from north of the GIWW to the south, restoring the natural hydrology of the system. This project would restore more than 150 acres of estuarine wetland habitat and protect 3,600 acres of existing coastal wetlands from degradation.

Estimated Total Project Cost: $6,600,000

Old River Cove Restoration *(Project ID R1-3)*



Region: 1

Location:

Cove in North Sabine Lake, east of Humble Island

County:

Orange

Status:

Conceptual

Stakeholders:

- U.S. Army Corps of Engineers
- Orange County
- Texas Department of Transportation
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

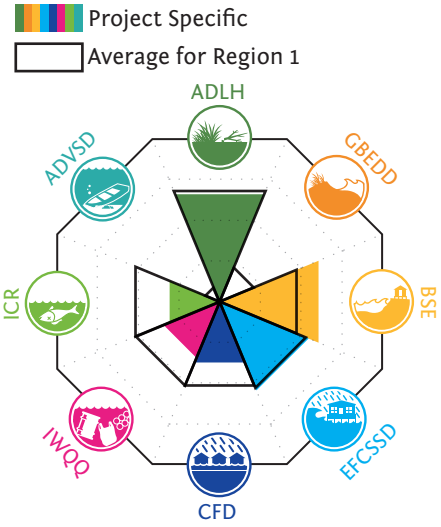
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Water-Based Transit Enhancement)

Jobs Created:

Creates approximately 79 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would rebuild up to 131 acres of degraded islands—Sydnes and Stewts Islands—that once protected the Sabine-Neches Waterway at the northern end of Sabine Lake in front of Old River Cove. Once the islands are stabilized, the project would use additional beneficial use of dredged material to restore portions of the Lower Neches Wildlife Management Area's (LNWMA) 640 acres of estuarine wetlands, 140 acres of shallow-water habitat and 430 acres of freshwater wetlands or uplands.

Project Need

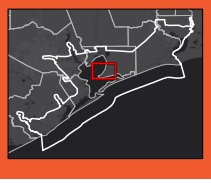
The Sydnes and Stewts Islands, created from spoils during construction and channel maintenance dredge events at Old River Cove, have eroded significantly and no longer provide adequate protection for the Gulf Intracoastal Waterway. In addition, the islands historically provided shelter from waves coming from the south across Sabine Lake for the adjacent wetlands in the LNWMA, which help protect Bridge City from storm surge, and this wetland complex is now eroding.

Project Benefit

The restored islands would protect the Old River wetlands from intrusion of higher salinity waters from the Sabine-Neches Waterway, and would protect the wetlands from erosion caused by wind fetch across Sabine Lake. This would prevent the loss and degradation of wetland vegetation from increased salinity and conversion of wetlands to open water. 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 Gulf Intracoastal Waterway annually. Furthermore, the island and wetland restoration would help safeguard Bridge City and nearby infrastructure from storm surge and flooding.

Estimated Total Project Cost: $15,200,000

Gordy Marsh Restoration and Shoreline Protection
(Project ID R1-4)



Region: 1

Location:

Southern shoreline of Trinity Bay about 5 miles north of Smith Point

County:

Chambers

Status:

Engineering & Design

Stakeholders:

- Galveston Bay Foundation
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

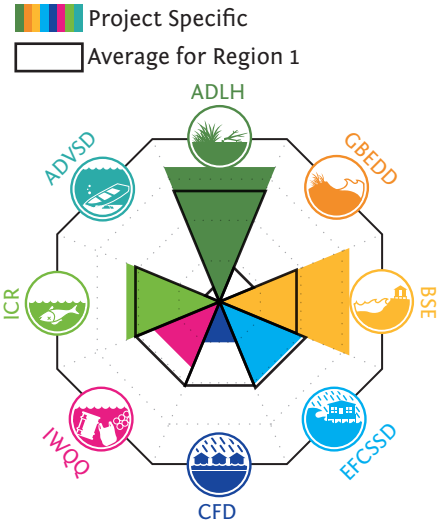
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 63 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would provide shoreline protection and estuarine wetland restoration at Gordy Marsh, a 1,700-acre coastal wetland and prairie habitat that borders Trinity Bay. Gordy Marsh is located in an area rated as a high conservation priority by Chambers County and the Galveston Bay Foundation.

Project Need

The Gordy Marsh shoreline is eroding at a rapid rate. The habitat degradation in this area would continue unless protective measures are taken. Over the next 50 years, more than 60 acres are projected to erode based on historic rates if this project does not occur.

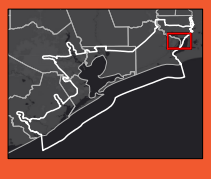
Project Benefit

This project would restore estuarine wetlands and protect the shoreline at Gordy Marsh. The project also could incorporate beneficial use of dredged material to create and restore the habitat periodically to mitigate relative sea level rise.

Estimated Total Project Cost: $4,500,000*

**Partial funding identified*

Sabine-Neches Waterway Dredge Placement Island Habitat Restoration *(Project ID R1-5)*



Region: 1

Location:

Island along Sabine-Neches Waterway, south of the Neches River

County:

Jefferson

Status:

Conceptual

Stakeholders:

- U.S. Army Corps of Engineers
- Texas Department of Transportation Maritime Division

Project Type:

Habitat Creation & Restoration

Action:

Wetland Protection and/or Shoreline Stabilization

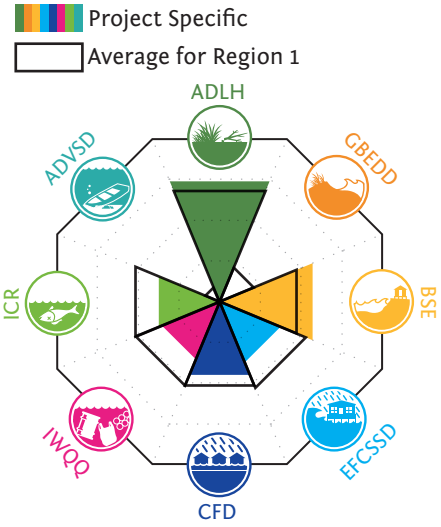
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 47 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would restore remnants of a 15-acre island that once protected the navigation channel at the northern end of Sabine Lake at Pleasure Island by using dredged material to build up the island and construct up to 2,000 feet of breakwater. The project also would restore up to 40 acres of island habitat on the Sabine-Neches Waterway in Jefferson County, along the southern boundary of the navigation channel, separating the channel from Sabine Lake. The restored habitat would contain wetlands and vegetated shallows. Based on available funding, the project also could be configured as a single breakwater without beneficial use of dredged material (BUDM) or planting, This could reduce the project cost by approximately $2.5 million.

Project Need

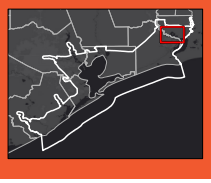
The dredged material placement islands along the Sabine-Neches Waterway are eroding due to channel use. This erosion is negatively impacting the upland habitat on the placement islands.

Project Benefit

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 habitat and protecting habitats with a breakwater would greatly increase viability of fish and bird species utilizing the area for nursing habitat. It would also provide additional soil stabilization through the root structures of restored vegetated areas.

Estimated Total Project Cost: $3,700,000

Bessie Heights Wetland Restoration *(Project ID R1-6)*



Region: 1

Location:

Lower Neches Wildlife Management Area north of Sabine Lake and SH 73

County: Orange

Status: Engineering & Design

Stakeholders:

- Texas Parks & Wildlife Department
- Texas General Land Office
- Texas Commission on Environmental Quality
- Department of the Interior
- U.S. Fish and Wildlife Service
- Ducks Unlimited
- National Oceanic and Atmospheric Administration

Project Type:

Habitat Creation & Restoration

Action:

Wetland Protection and/or Shoreline Stabilization

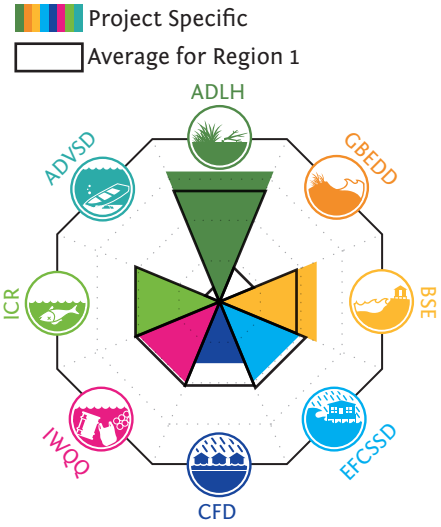
Resiliency Strategy:

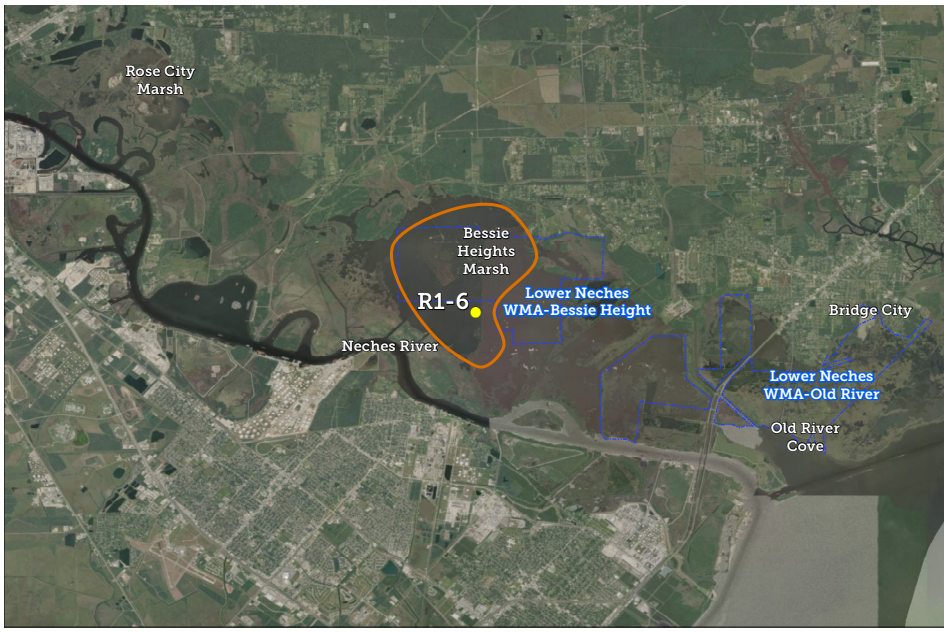
Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 48 jobs during construction.

Project Benefits Per Issues of Concern





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 expected to be successfully permitted by 2019. Funds are still needed for construction.

Project Need

Wetlands in the Lower Neches Wildlife Management Area are negatively impacted by subsidence and degradation due to natural and human causes.

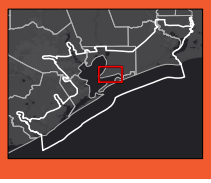
Project Benefit

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 Wildlife Management Area, 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 use beneficial use material long-term to create and restore the habitat periodically to mitigate relative sea level rise.

Estimated Total Project Cost: $13,500,000*

**Partial funding identified*

Moody National Wildlife Refuge Conservation and Restoration *(Project ID R1-7)*



Region: 1

Location:

Along the northern shoreline of East Bay and east of Lake Surprise

County:

Chambers

Status:

Conceptual

Stakeholders:

- U.S. Fish and Wildlife Service

Project Type:

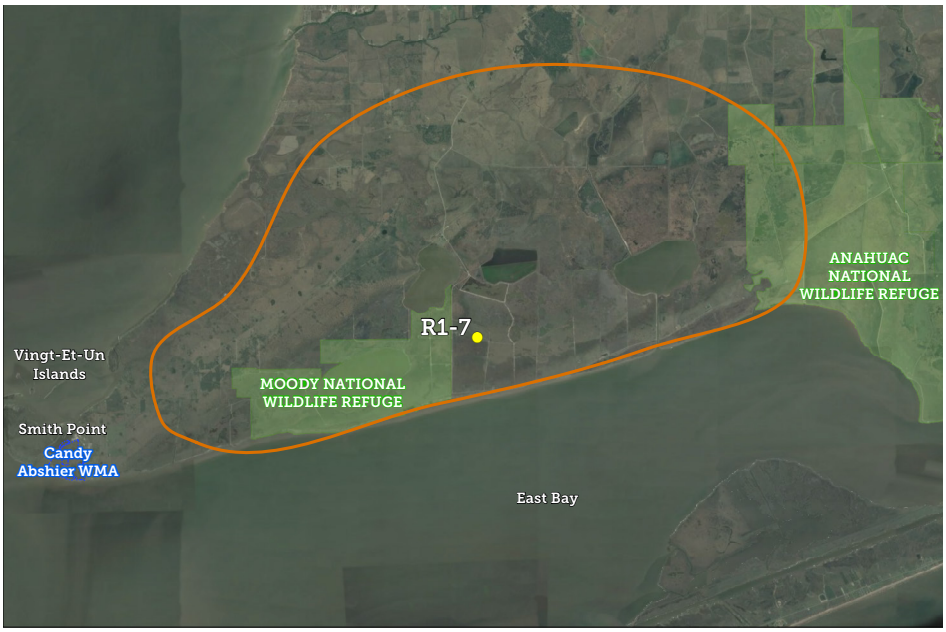
Habitat Creation & Restoration; Shoreline Stabilization; Land Acquisition

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Upland Planning, Conservation and Monitoring)



Project Description

This project would acquire additional properties to expand the Moody National Wildlife Refuge 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.

Project Need

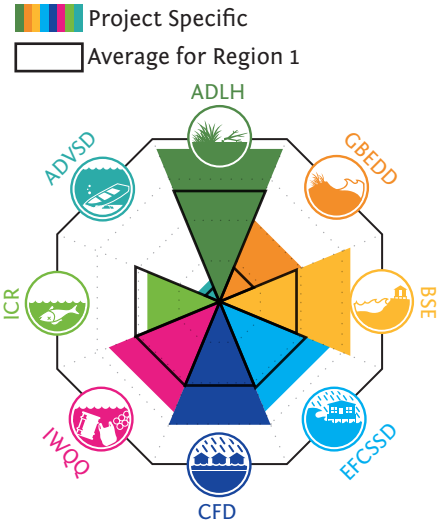
The Chambers County Greenprint for Growth and Conservation identifies critical areas for preservation, including several properties adjacent to the Moody National Wildlife Refuge that are considered moderate to high conservation priorities.[a]

Project Benefit

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.

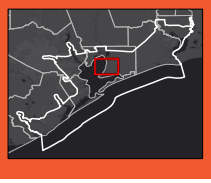
Estimated Total Project Cost: Up to $10,000,000

Project Benefits Per Issues of Concern



[a] *The Trust for Public Land. 2009. Chambers County Greenprint for Growth and Conservation. Available at: http://www.glo.texas.gov/coastal-grants/_documents/grant-project/10-058-greenprint-chambers-county.pdf (accessed Feb 21, 2019)*

Double Bayou Habitat Preservation *(Project ID R1-8)*



Region: 1

Location:

Double Bayou Watershed in East Trinity Bay

County:

Chambers

Status:

Conceptual

Stakeholders:

- Galveston Bay Estuary Program
- Texas State Soil and Water Conservation Board
- Texas Commission on Environmental Quality

Project Type:

Shoreline Stabilization; Land Acquisition

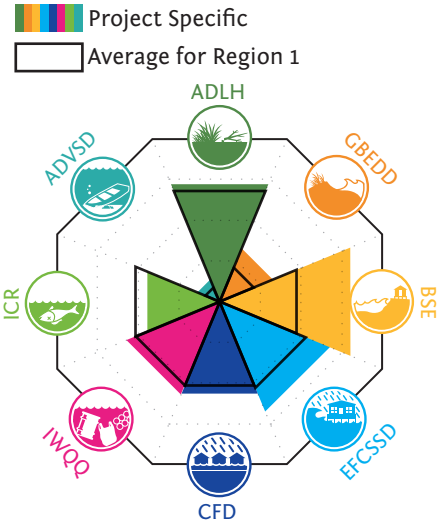
Action:

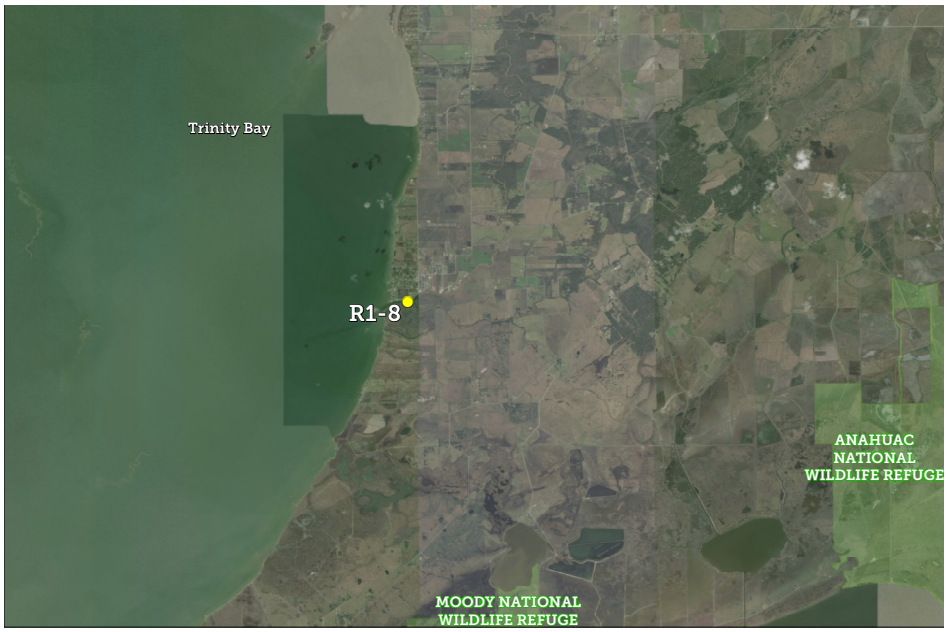
Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Project Benefits Per Issues of Concern





Project Description

The Double Bayou drains directly into Trinity Bay and is comprised of East Fork Double Bayou and West Fork Double Bayou. This project would identify land conservation and living shoreline opportunities along Double Bayou.

Project Need

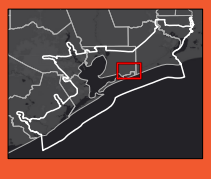
Both the East and West Forks of Double Bayou have been identified by the U.S. Environmental Protection Agency to have water quality concerns for elevated levels of bacteria and low dissolved oxygen. The West Fork of Double Bayou has been listed under the Clean Water Act Section 303(d) as an impaired water body since 2006. Double Bayou also faces shoreline erosion due to all-terrain vehicle and motorboat traffic, which damage and tear up stream beds.

Project Benefit

This project would improve the water quality of the East and West Forks of Double Bayou and mitigate the shoreline erosion in the area resulting from multiple sources.

Estimated Total Project Cost: Up to $5,000,000

Chambers County Wetland Restoration
(Project ID R1-9)



Region: 1

Location:

Texas Chenier Plain Refuge Complex in Chambers County

County:

Chambers

Status:

Conceptual

Stakeholders:

- Chambers County

Project Type:

Habitat Creation & Restoration; Land Acquisition

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring; Upland Planning, Conservation and Monitoring)

Project Description

The Texas Chenier Plain Refuge Complex supports a collection of National Wildlife Refuge systems, 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.

Project Need

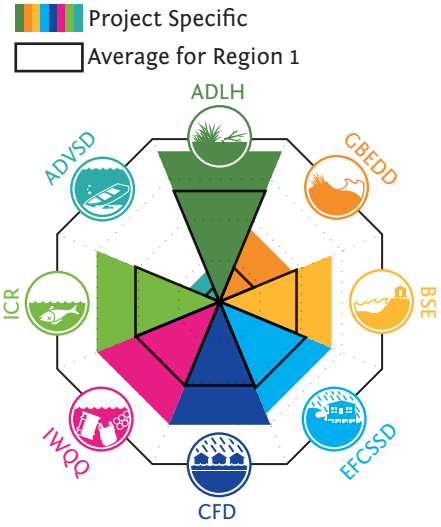
The diverse coastal wetland habitats within the Texas Chenier Plain Refuge Complex are experiencing rates of decline along the Texas coast due to changing hydrologic conditions. These complexes are some of the largest along the coast, but are also some of the most vulnerable with significant subsidence likely along the Chenier Plain.

Project Benefit

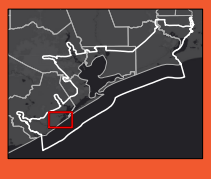
Proactively working to conserve these lands would improve the capability of natural resource agencies to protect the habitats and the various species that thrive in a healthy habitat now and in the future.

Estimated Total Project Cost: Up to $25,000,000

Project Benefits Per Issues of Concern



Brazoria National Wildlife Refuge GIWW Shoreline Protection *(Project ID R1-10)*



Region: 1

Location:

Shoreline along the GIWW at Drum Bay, Christmas Bay and Long Pond

County: Brazoria

Status: Conceptual

Stakeholders:

- U.S. Army Corps of Engineers
- Brazoria County
- Texas Department of Transportation Maritime Division
- Ducks Unlimited
- U.S. Fish and Wildlife Service
- Brazoria National Wildlife Refuge

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

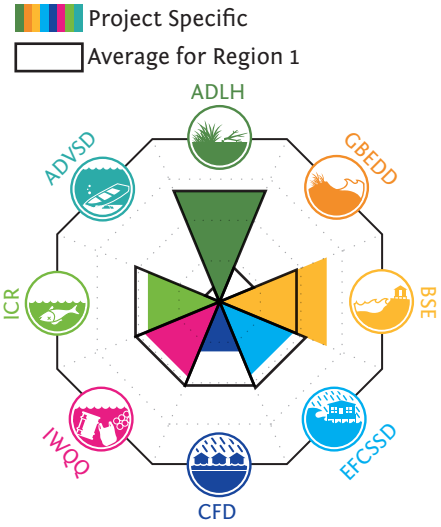
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Water-Based Transit Enhancement)

Jobs Created:

Creates approximately 89 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would reinforce the banks on the bay side of the Brazoria National Wildlife Refuge to prevent further erosion, create wetland habitat and more closely monitor erosion along the shoreline.

Project Need

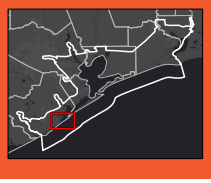
The critical and narrow stretch of land separating the Brazoria National Wildlife Refuge Gulf Intracoastal Waterway (GIWW) shoreline from Christmas Bay, Drum Bay and Long Pond is breached by erosion and is in danger of exacerbated erosion that could lead to additional breaches. Over the next 50 years, close to 200 acres are projected to erode based on historic rates if this project does not occur.

Project Benefit

The shoreline stabilization would protect the sensitive wetland shorelines from the wakes created from the cargo vessels. Stabilizing the Gulf Intracoastal Waterway promotes navigational safety and efficiency of barges that carry approximately 35 million tons of cargo across this segment of the GIWW annually.

Estimated Total Project Cost: $21,800,000

Follet's Island Wetland Restoration *(Project ID R1-11)*



Region: 1

Location:

Southwest shoreline of Christmas Bay, east of Drum Bay

County:

Brazoria

Status:

Conceptual

Stakeholders:

- Texas Parks & Wildlife Department
- Texas General Land Office
- U.S. Fish and Wildlife Service
- Brazoria National Wildlife Refuge

Project Type:

Habitat Creation & Restoration

Action:

Wetland Protection and/or Shoreline Stabilization

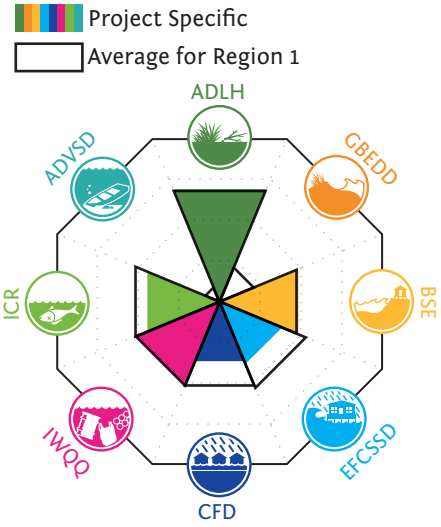
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 49 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

To protect critical habitat including estuarine wetlands, freshwater wetlands and tidal flats, this project would restore up to 2,600 acres of wetlands on Follet's Island, on the southwest side of Christmas Bay.

Project Need

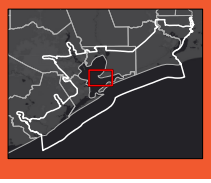
Based on coastal modeling, over 54 percent of freshwater wetlands in Region 1 are predicted to be lost by 2100 due to relative sea level rise, using a 2007 baseline. Although there is a predicted 15 percent increase in estuarine wetlands in the same region, much of this increase is due to the conversion of freshwater wetlands to estuarine wetlands, not because of improved habitat health.

Project Benefit

Restored estuarine wetlands on the island would act as buffer zones to mitigate coastal flood damages and protect shorelines from erosion by attenuating wave energy. This project could also beneficially use dredged material to create and restore the habitat periodically to mitigate relative sea level rise.

Estimated Total Project Cost: $36,600,000

Candy Abshier Wildlife Management Area Shoreline Protection and Marsh Restoration *(Project ID R1-12)*



Region: 1

Location:

Located on Smith Point at the southeastern end of Trinity Bay

County:

Chambers

Status:

Shovel-ready

Stakeholders:

- Texas Parks & Wildlife Department
- Ducks Unlimited
- Gulf Coast Bird Observatory

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

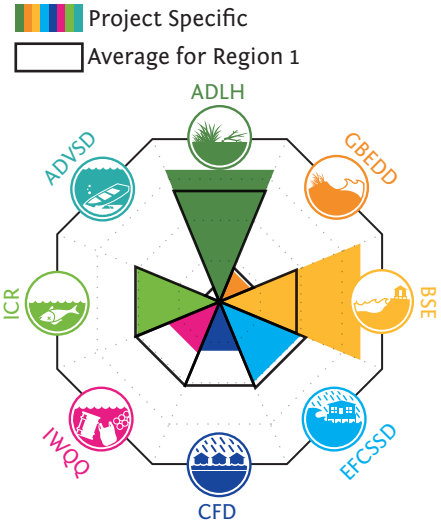
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 18 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would construct 2,660 feet of breakwaters to create up to 20 acres of coastal estuarine wetland habitat. Additionally, the investment would protect and preserve the adjacent coastal prairie within the 212-acre Candy Abshier Wildlife Management Area. Engineering and design are completed, but additional funds are needed to construct the project.

Project Need

Since 1933, various points along the Candy Abshier Wildlife Management Area shoreline has retreated between 23 feet and 196 feet based on historical aerial imagery.

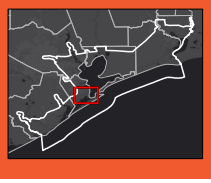
Project Benefit

This project would slow the erosion of coastal and nearshore habitats along the Candy Abshier Wildlife Management Area. The breakwater would create estuarine wetland habitat that is critical to colonial waterbirds by promoting accretion of sediment between the breakwater and the existing shoreline.

Estimated Total Project Cost: $1,700,000*

**Partial funding identified*

O'Quinn IH-45 Causeway Intertidal Marsh Restoration *(Project ID R1-13)*



Region: 1

Location:

Near the IH-45 Causeway, north of Jones Bay

County:

Galveston

Status:

Conceptual

Stakeholders:

- Scenic Galveston
- Texas Commission on Environmental Quality
- Galveston Bay Estuary Program
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

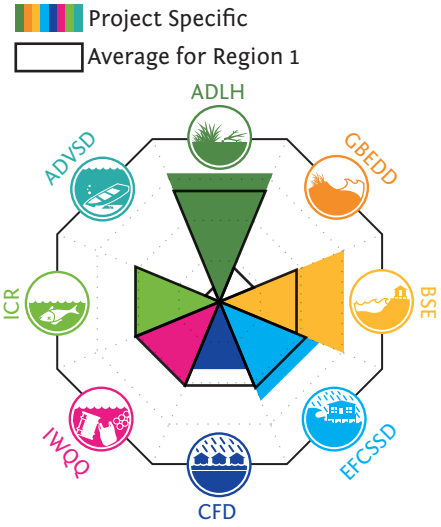
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 51 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The O'Quinn Intertidal Marsh is located near the Interstate Highway 45 (IH-45) causeway east of Bayou Vista and is part of the Virginia Point nature preserve owned by Scenic Galveston. The project area includes approximately 1.6 miles of bay shoreline protection near the junction with Jones Bay and up to 600 acres of estuarine wetland restoration, building upon previous completed restoration work in the project area.

Project Need

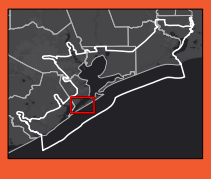
This project would provide additional habitat with the creation of estuarine wetlands. It also would protect existing habitat for commercially and recreationally valuable species that support recreational use and local economies.

Project Benefit

The existing railroad embankments provide some inherent containment for new marsh terraces, which would be beneficial during project construction. The O'Quinn marsh is located near several colonial waterbird rookeries and could serve as foraging ground for the birds. This would increase the overall biodiversity of the area. This project could incorporate beneficial use of dredged material to create the habitat and to mitigate for relative sea level rise.

Estimated Total Project Cost: $4,300,000

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



Region: 1

Location:

Bay shoreline of Galveston Island State Park on Galveston Island

County:

Galveston

Status:

Engineering & Design

Stakeholders:

- Texas Parks & Wildlife Department
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

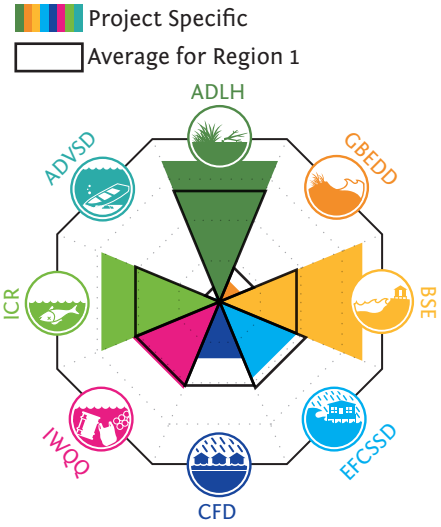
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 73 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would construct an additional 7,600 linear feet of rock breakwater to protect approximately 87 acres of existing estuarine emergent wetlands, 12 acres of existing sand and mud flats, and 311 acres of shallow open water at Galveston Island State Park.

Project Need

Galveston Island State Park is one of the last remaining strips of land on Galveston Island that represents a complete beach to bay transitional ecosystem commonly found on barrier islands. This phase of the project would add to earlier phases funded by the Gulf Environmental Benefit Fund, which designed and constructed breakwaters and provided for the placement of much needed sediment to support and sustain coastal wetlands.

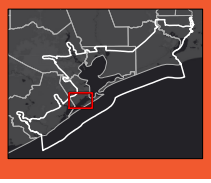
Project Benefit

The total impact of these investments for all phases would protect over 2 miles of fragile shoreline and 150 acres of estuarine emergent wetlands. The project also would support seagrass beds, which has been a habitat of high restoration concern within Galveston Bay since 1995, according to the Galveston Bay Estuary Program's 2011 State of the Bay, Third Edition report.[a]

Estimated Total Project Cost: $5,700,000

[a] *Galveston Bay Estuary Program. 2011. Chapter 7 - State of the Bay, Third Edition. Available at: https://galvbaydata.org/www.galvbaydata.org/StateoftheBay/tabid/1846/Default.html (accessed Feb 21, 2019)*

Green's Lake Shoreline Protection & Wetland Restoration – Phase 2 *(Project ID R1-15)*



Region: 1

Location:

North of West Bay between Carancahua Lake and Jones Bay

County:

Galveston

Status:

Permitted

Stakeholders:

- Ducks Unlimited
- Texas General Land Office
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

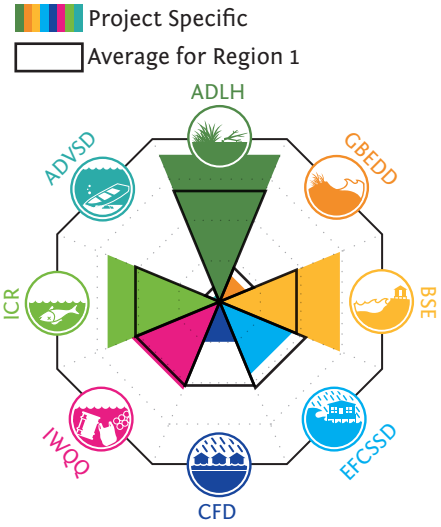
Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring; Oyster Reef Planning, Restoration and Monitoring)

Project Benefits Per Issues of Concern



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. 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 marsh 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. Prior to the 1960s, this wetland complex was primarily fresh to brackish in nature and had several large, open flats heavily used by wintering and breeding waterbirds. The intertidal habitats and the native mid-to-high marsh areas provided valuable resources for waterfowl, shorebirds, wading birds and other waterbirds. However, wetland loss and degradation due to shoreline erosion and saltwater intrusion is reducing the ecological integrity and sustainability of the Greens Lake marsh complex.

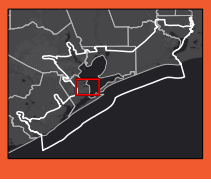
Project Benefit

Restoring the emergent wetlands would help with issues related to storm surge, relative sea level rise and coastal erosion. The project would buffer storm surge from tropical storms and hurricanes, which would significantly reduce storm impact and damage to industry and coastal communities.

Estimated Total Project Cost: $4,200,000*

**Partial funding identified*

Dollar Bay Wetland Creation, Restoration and Acquisition *(Project ID R1-16)*



Region: 1

Location: Shorelines along Dollar Bay and Moses Lake in Texas City

County: Galveston

Status: Shovel-ready

Stakeholders:

- Galveston Bay Foundation
- National Fish and Wildlife Foundation
- U.S. Fish and Wildlife Service
- Accenture
- Galveston Bay Estuary Program
- Texas Commission on Environmental Quality
- The Nature Conservancy
- Coastal Conservation Association - Building Conservation Trust
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Land Acquisition

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

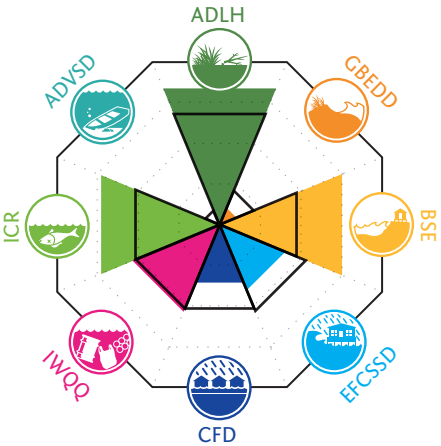
Jobs Created:

Creates approximately 22 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 1



Project Description

This project would construct marsh terraces at two sites within the Dollar Bay and Moses Lake system. Breakwaters would be constructed to protect the newly restored marsh and to provide shoreline protection in the form of a living shoreline along The Nature Conservancy's Texas City Prairie Preserve shoreline. The project would also include the acquisition of approximately 100 acres of coastal prairie habitat directly adjacent to the wetland restoration site. The parcel is owned by a willing seller and is in immediate threat of development, with permitted development plans in place.

This project and the 2017 Resiliency Plan's Moses Lake Shoreline Protection - Phase 3 project were intended to be one large project. However, due to limited construction funds, these two projects have been separated (phased). A total of $2.37 million has been invested in the two projects thus far for the engineering, design and permitting of both projects and the construction of the Moses Lake project. Additional funding is necessary to construct the Dollar Bay Wetland Restoration and Creation project, which is considered shovel-ready.

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.

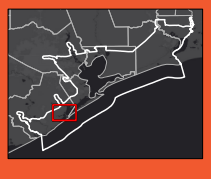
Project Benefit

This project would restore 72 acres of intertidal estuarine wetlands and provide shoreline protection for the area. The project would protect approximately 100 acres of coastal prairie that is threatened by development. This would expand the wetland corridor and better protect the overall ecological health of the area by preventing fragmentation of the wetlands.

Estimated Total Project Cost: $5,100,000*

**Partial funding identified*

Oyster Lake - West Bay Breach Protection – Phase 3
(Project ID R1-17)



Region: 1

Location:

Oyster Lake, north of Bastrop Bay

County:

Brazoria

Status:

Conceptual

Stakeholders:

- Galveston Bay Foundation
- U.S. Fish and Wildlife Service
- National Fish and Wildlife Foundation
- Coastal Conservation Association - Building Conservation Trust

Project Type:

Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

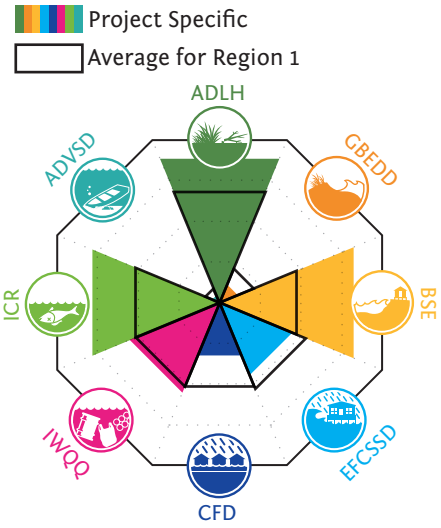
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Water-Based Transit Enhancement)

Jobs Created:

Creates approximately 51 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This phase (Phase 3) of the project would expand the previous enhancement and restoration project to directly protect an additional 10,000 to 13,000 linear feet of shoreline from erosion and habitat conversion at Oyster Lake.

Project Need

Oyster Lake is breaching, creating a need to provide additional protection or armoring between Oyster Lake and West Bay. Wind driven waves, particularly from the southeast during summer months are impacting the shoreline causing vegetation loss, soil loss and habitat conversion. Since 1995, the shoreline has eroded up to 175 feet on the West Bay side and 55 feet from the Oyster Lake side. Existing reef balls that were washed out were replaced in 2018, but additional protection is required. The eroding peninsula is owned by the U.S. Fish and Wildlife Service (USFWS) and is managed by staff from the Brazoria National Wildlife Refuge. USFWS biologists and managers expect continued emergent wetland loss without some level of immediate intervention.

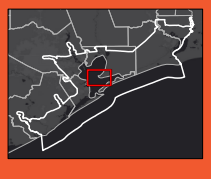
Project Benefit

The project would be designed to reduce shoreline erosion, minimize wetland loss, and provide potential opportunities to beneficially utilize dredged material from nearby dredging activities on the Gulf Intracoastal Waterway.

Estimated Total Project Cost: $4,600,000*

**Partial funding identified*

East Bay Living Shorelines and Wetland Restoration
(Project ID R1-18)



Region: 1

Location:

Smith Point and Rollover Pass in East Bay

County:

Chambers, Galveston

Status:

Conceptual

Stakeholders:

- U.S. Fish and Wildlife Service
- Chenier Plain National Wildlife Refuge Complex
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Project Description

This project would restore and maintain the wetlands near Smith Point and Rollover Pass. These efforts would complement other rookery island restoration projects proposed in the area. In addition, living shorelines would be designed in order to enhance the wetlands in the area and provide oyster reef habitat.

Project Need

The shorelines near Smith Point and Rollover Pass are experiencing losses of estuarine wetland habitat. Wetlands are important habitat for the area, as they provide water filtration and serve as a habitat for fish and other wildlife. East Galveston Bay's oyster reef population was destroyed by the effects of Hurricane Harvey in 2017. Oysters provide natural water filtration, and are important to maintain and improve the water quality of the bay.

Project Benefit

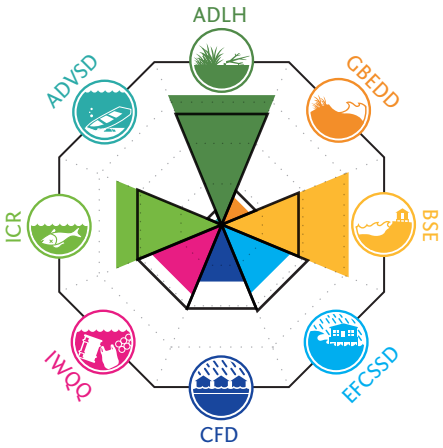
This project would provide restoration efforts for the estuarine wetland habitats near Smith Point and Rollover Pass. Additionally, living shorelines would be designed to include creation or enhancement of wetlands and oyster reefs that provide feeding and nesting sites for coastal birds.

Estimated Total Project Cost: $8,900,000

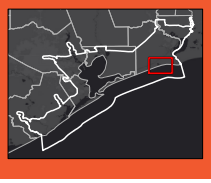
Project Benefits Per Issues of Concern

Project Specific

Average for Region 1



McFaddin National Wildlife Refuge Shoreline Restoration *(Project ID R1-19)*



Region: 1

Location:

Gulf Shoreline of McFaddin National Wildlife Refuge

County:

Jefferson

Status:

Engineering & Design

Stakeholders:

- Jefferson County
- U.S. Fish and Wildlife Service
- National Fish and Wildlife Foundation
- Texas Commission on Environmental Quality
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Structure/Debris Removal; Beach Nourishment; Dune Restoration

Action:

Beach and Dune Sustainability

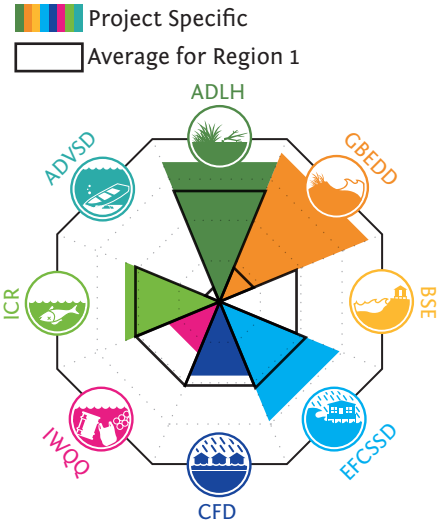
Resiliency Strategy:

Ecological Resiliency (Beach Nourishment and Dune Restoration)

Jobs Created:

Creates approximately 861 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would include beach nourishment and dune restoration along 20 miles of existing beach ridge at McFaddin National Wildlife Refuge, extending eastward to Texas Point National Wildlife Refuge. Due to lack of sediment and funding availability, a recommendation of restoring 2-mile stretches of shoreline, focused on areas of critical need, is proposed at a cost of $10 million to $20 million per phase. Concurrent with material placement, the project would include removal of abandoned oil drums and debris. The first 3 miles of nourishment are completed, but additional funding is needed to continue the project and restore the remaining 17 miles.

Project Need

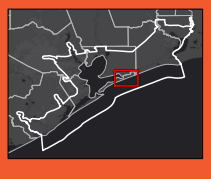
The beach ridge and dune system at McFaddin National Wildlife Refuge has been experiencing high rates of erosion in recent years. The erosion of the shoreline in this area is causing saltwater inundation into the freshwater wetlands of the refuge. Additionally, there are a number of abandoned oil drums and debris in the area that need to be removed for public safety and to improve the water quality.

Project Benefit

This project would offset the rate of shoreline and dune erosion along the McFaddin National Wildlife Refuge. This project also would protect the estuarine and freshwater wetlands of the refuge from saltwater inundation from the Gulf of Mexico. The removal of abandoned oil drums and debris would improve the surrounding habitat.

Estimated Total Project Cost: $183,100,000
($10 million to $20 million per phase)

Bolivar Peninsula Beach and Dune Restoration
(Project ID R1-20)



Region: 1

Location:

Gulf shoreline on Bolivar Peninsula from High Island on the east to Caplen on the west

County:

Galveston

Status:

Ongoing

Stakeholders:

- Galveston County
- Texas Department of Transportation
- Texas General Land Office

Project Type:

Beach Nourishment;
Dune Restoration

Action:

Beach and Dune Sustainability

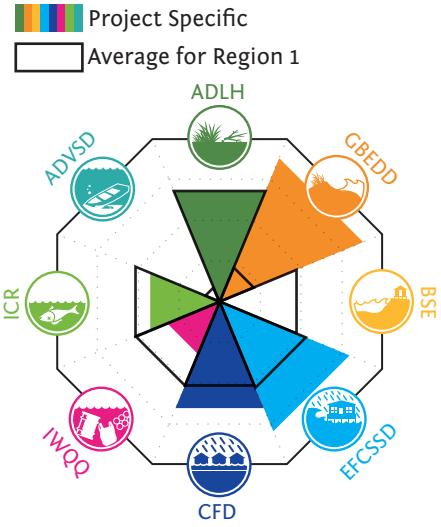
Resiliency Strategy:

Ecological Resiliency (Beach Nourishment and Dune Restoration)

Jobs Created:

Creates approximately 919 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would reconstruct severely eroded beaches and dunes along an approximately 10-mile stretch of beach on the Bolivar Peninsula Gulf-facing 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 million to $20 million per phase. Based on the findings of the two-phase North Jetty Sand Source Investigation Project, completed in December 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-Galveston Ship Channel north jetty. The project is pending a revised U.S. Army Corps of Engineers permit to expand the authorized nourishment area and add the North Jetty Sand Sources as a permitted borrow area. Once the permitting phase is completed, additional funding would be required to facilitate design and construction.

Project Need

In December 2016, the GLO and Galveston County worked on the first restoration segment of this project and utilized a nearby upland borrow source to construct approximately 1.25 miles of beach nourishment and dune restoration at Caplen Beach immediately west of Rollover Pass. This project would continue the significant resources invested in the project thus far and mitigate the severe, ongoing erosion.

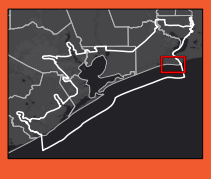
Project Benefit

This project would restore the Bolivar Peninsula Gulf-facing shoreline and nourish the existing dune system in this area. The project would indirectly address erosion via sediment transport over the entire 25-mile stretch of Gulf-facing shoreline along the peninsula extending from High Island to Bolivar Roads.

Estimated Total Project Cost: $81,200,000*
($10 million to $20 million per phase)

**Partial funding identified*

Texas Point Beach Nourishment Project
(Project ID R1-21)



Region: 1

Location:

Gulf shoreline of the Texas Point National Wildlife Refuge

County:

Jefferson

Status:

Conceptual

Stakeholders:

- U.S. Fish and Wildlife Service

Project Type:

Beach Nourishment;
Dune Restoration

Action:

Beach and Dune Sustainability

Resiliency Strategy:

Ecological Resiliency (Beach Nourishment and Dune Restoration)

Jobs Created:

Creates approximately 424 jobs during construction.

Project Description

This project would conduct beach restoration at Texas Point 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 Study planning efforts.

Project Need

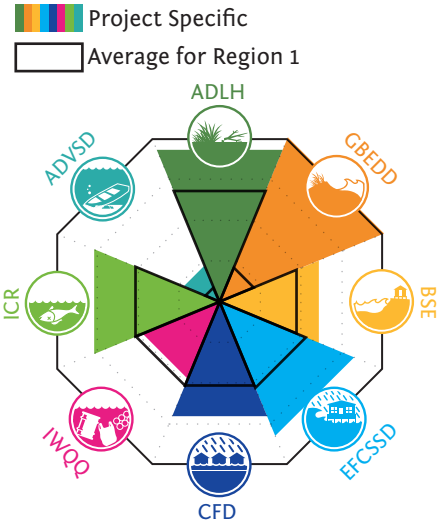
Except for the area directly adjacent to the Sabine Pass jetties, this shoreline has experienced severe erosion based on short- and long-term shoreline change monitoring.

Project Benefit

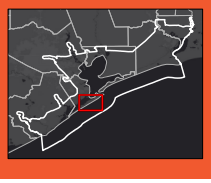
This project would restore the beach at Texas Point from its currently severely eroded state. The shoreline along the Texas Point National Wildlife Refuge is a first line of defense for the refuge that serves as protection against storm surge and coastal flooding events. Restoring the beach in this area would ensure a healthy shoreline and would protect the wetlands in the refuge from saltwater intrusion.

Estimated Total Project Cost: $36,100,000

Project Benefits Per Issues of Concern



Galveston Island West of Seawall to 8 Mile Road Beach Nourishment *(Project ID R1-22)*



Region: 1

Location:

Gulf shoreline of Galveston Island, from west of the seawall to 8 Mile Road

County:

Galveston

Status:

Shovel-ready

Stakeholders:

- Galveston Park Board of Trustees
- U.S. Army Corps of Engineers
- Texas General Land Office

Project Type:

Beach Nourishment

Action:

Beach and Dune Sustainability

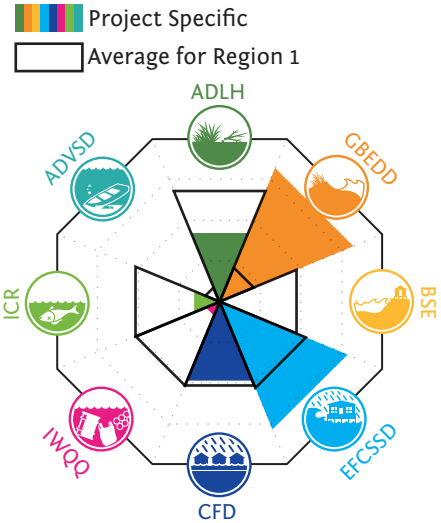
Resiliency Strategy:

Ecological Resiliency (Beach Nourishment and Dune Restoration)

Jobs Created:

Creates approximately 118 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would provide 1 mile 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 8 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.

Project Need

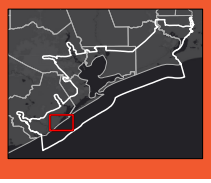
Many of the Galveston Island beaches are experiencing heavy rates of erosion with shoreline losses ranging from 1.6 feet to 11.5 feet per year since the year 2000.

Project Benefit

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.

Estimated Total Project Cost: $10,500,000

Follet's Island Nourishment and Erosion Control
(Project ID R1-23)



Region: 1

Location:

Gulf shoreline of Follet's Island

County:

Brazoria

Status:

Conceptual

Stakeholders:

- U.S. Army Corps of Engineers
- Texas General Land Office
- Brazoria County

Project Type:

Shoreline Stabilization;
Beach Nourishment

Action:

Beach and Dune Sustainability

Resiliency Strategy:

Ecological Resiliency (Beach Nourishment and Dune Restoration)

Jobs Created:

Creates approximately 1,204 jobs during construction.

Project Description

To protect the Gulf shoreline, the project would use stone groins at Surfside Beach and place beach nourishment materials at the southern end of Follet's Island. 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 promoting larger projects that benefit from a single mobilization that requires a more distant sand source. It is recommended that the region pursue projects on the scale of 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.

Project Need

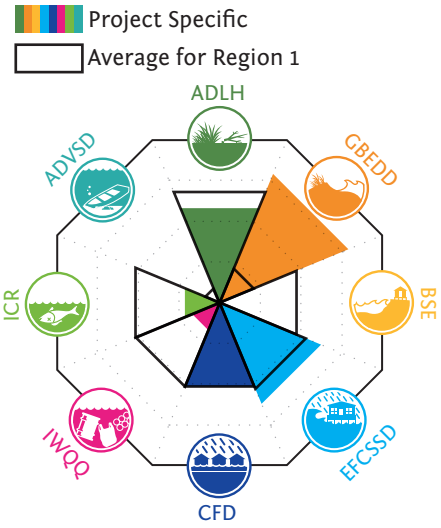
The Gulf of Mexico shoreline on Follet's Island near Surfside is eroding at a rate of 11.5 feet per year according to data collected between 2000 and 2012 by the University of Texas Bureau of Economic Geology.

Project Benefit

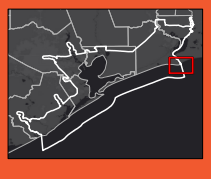
This project would provide protection for the Gulf shoreline on Follet's Island. The placement of the beach nourishment material would offset the rate of erosion and the stone groins would serve as a sand-catching mechanism to slow the rate of sand loss from the beach face.

Estimated Total Project Cost: $106,400,000
($10 million to $20 million per phase)

Project Benefits Per Issues of Concern



Sabine Pass Jetty Repair *(Project ID R1-24)*



Region: 1

Location:

The outlet of Sabine Pass to the Gulf of Mexico

County:

Jefferson

Status:

Conceptual

Stakeholders:

- Sabine-Neches Navigation District
- Texas Department of Transportation Maritime Division
- U.S. Fish and Wildlife Service
- Texas Point National Wildlife Refuge

Project Type:

Shoreline Stabilization; Study, Policy, Plan or Program

Action:

Regional Infrastructure Improvements

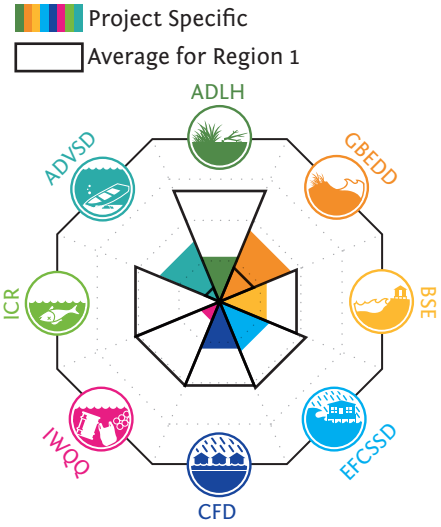
Resiliency Strategy:

Societal Resiliency (Water-Based Transit Enhancement); **Administrative Resiliency** (Study)

Jobs Created:

Creates approximately 1,235 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project proposes a study to conduct an alternatives analysis for the best methodology to repair the jetties at Sabine Pass. The jetties are large, stone structures that stabilize the entrance to the Sabine-Neches Waterway, a channel providing access to Sabine Lake. The Sabine-Neches Waterway is the third largest waterway by cargo volume and is used by commercial vessels carrying, among others, petrochemicals, liquified natural gas, bulk liquid cargo and military cargo.[a]

Project Need

The Sabine Pass jetties are in need of repair. The jetties have subsided over time and pose a navigation hazard, including being partially submerged during high tide. Based on the present configuration, there also are strong currents in the center of the channel.

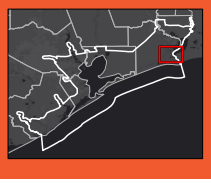
Project Benefit

The project would improve the navigational safety through the Sabine Pass jetties. Sabine Pass is the inlet that allows commercial shipping traffic to reach the Port of Beaumont, Port of Port Arthur and Port of Orange from the Gulf of Mexico. Improving this inlet would benefit many economic sectors along the upper Texas coast, including those of the shipping, refining, and industrial industries.

Estimated Total Project Cost: $105,000,000

[a] *Sabine-Neches Navigation District. 2015. The Sabine-Neches Waterway: An Improvement Project of National Significance. Available at: https://www.navigationdistrict.org/wp-content/uploads/2015/02/Sabine-Neches-Waterway-Fact-Sheet.pdf (accessed Feb 20, 2019)*

Sabine-Neches Channel Shoreline Protection
(Project ID R1-25)



Region: 1

Location:

Sabine-Neches navigation channel shoreline

County:

Jefferson

Status:

Conceptual

Stakeholders:

- U.S. Army Corps of Engineers
- Texas Department of Transportation Maritime Division

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Regional Infrastructure Improvements

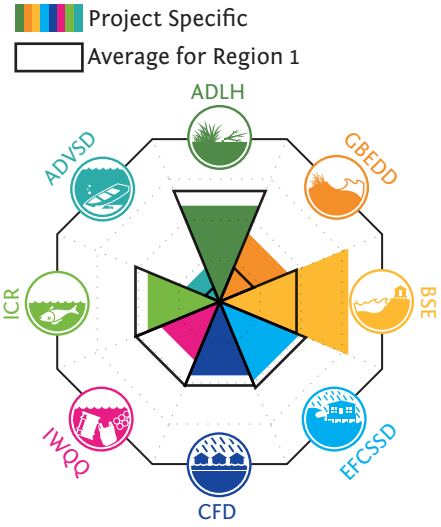
Resiliency Strategy:

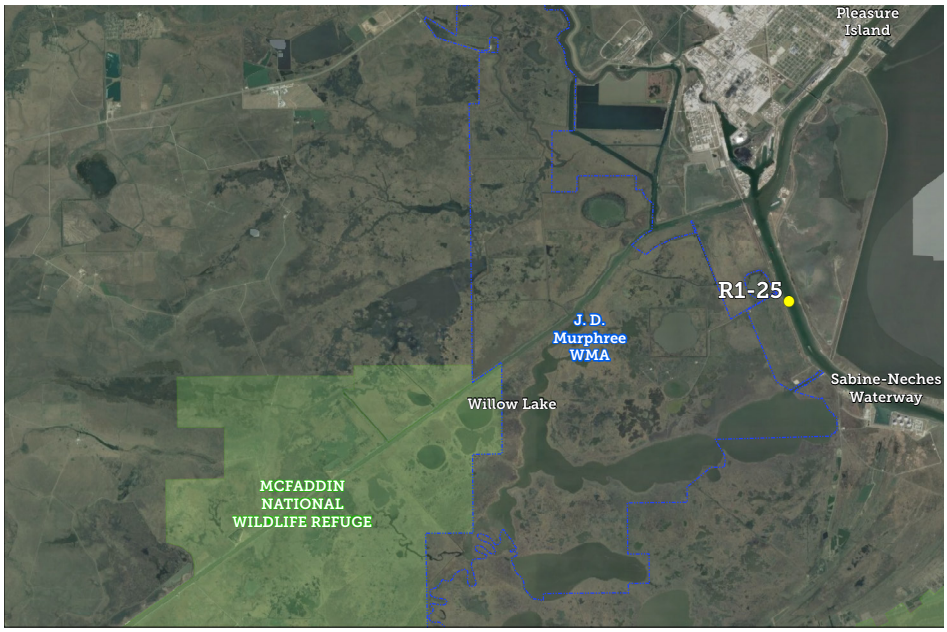
Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Water-Based Transit Enhancement)

Jobs Created:

Creates approximately 119 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

This project would place shoreline armoring along the entire Sabine-Neches navigation channel to prevent erosion caused by ship wakes.

Project Need

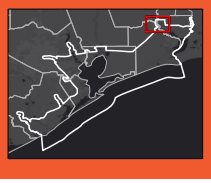
Navigational movements along the Sabine-Neches navigation channel are causing erosion along the channel shoreline. This erosion is leading to the degradation of local wetland habitats and the dredge placement islands adjacent to the channel.

Project Benefit

Shoreline armoring would protect habitats and dredge placement island shorelines adjacent to the channel. The project also would reduce the amount of shoaling in the channel and decrease the number of dredging events required to maintain the channel, benefiting the ports and commercial shipping industries.

Estimated Total Project Cost: $10,200,000

Southeast Texas Regional Water Supply Study and Improvements *(Project ID R1-26)*



Region: 1

Location:

Jefferson County and Orange County

County:

Jefferson, Orange

Status:

Conceptual

Stakeholders:

- Jefferson County
- Orange County
- Texas Water Development Board
- Texas Commission on Environmental Quality
- Texas General Land Office

Project Type:

Study, Policy, Plan or Program; Community Infrastructure

Action:

Regional Infrastructure Improvements

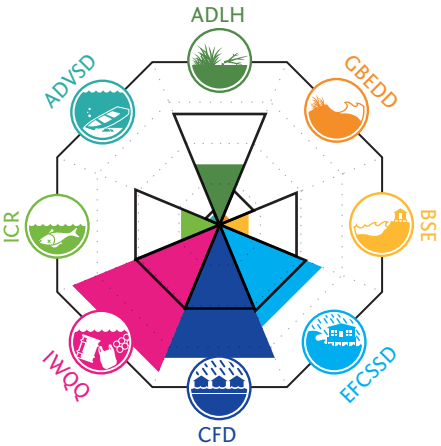
Resiliency Strategy:

Administrative Resiliency (Study); **Societal Resiliency** (Community Infrastructure Planning and Development)

Project Benefits Per Issues of Concern

Project Specific

Average for Region 1



Project Description

This project would involve conducting a multi-county water supply study for Jefferson County and Orange County to identify water quantity needs for various sectors, such as industrial, residential and commercial. This project would include planning for the design and construction of additional freshwater storage tanks/towers; assessing the viability of elevating water treatment plants and retrofitting freshwater intake pumps at the Lower Neches Valley Authority; and prioritizing critical infrastructure improvements.

Project Need

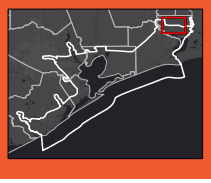
Development in this region is increasing. As a result, water supply demands are expected to grow beyond current supplies and could stress the existing freshwater treatment and distribution systems in the future. The current elevation of essential water supply assets also causes this critical infrastructure to be more vulnerable to coastal storms as extreme weather events become more frequent and more severe. The City of Beaumont, for example, lost its main and secondary water supplies for over a week during Hurricane Harvey, leaving residents without basic sanitation services.

Project Benefit

This study would identify recommendations to increase municipal, industrial, and agricultural water supply capacity to Jefferson and Orange counties, and to elevate all essential service assets above a 0.2-percent annual chance (500-year) flood level. Recommendations would ensure greater resilience during storms for these coastal communities.

Estimated Total Project Cost: $1,000,000

Interstate 10 Drainage Improvements at Cow Bayou
(Project ID R1-27)



Region: 1

Location:

Interstate 10 from Vidor to Cow Bayou

County:

Orange

Status:

Conceptual

Stakeholders:

- Texas Department of Transportation
- Orange County
- Texas Water Development Board

Project Type:

Study, Policy, Plan or Program; Community Infrastructure

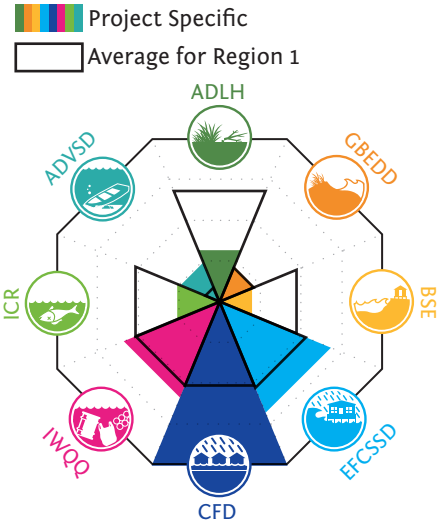
Action:

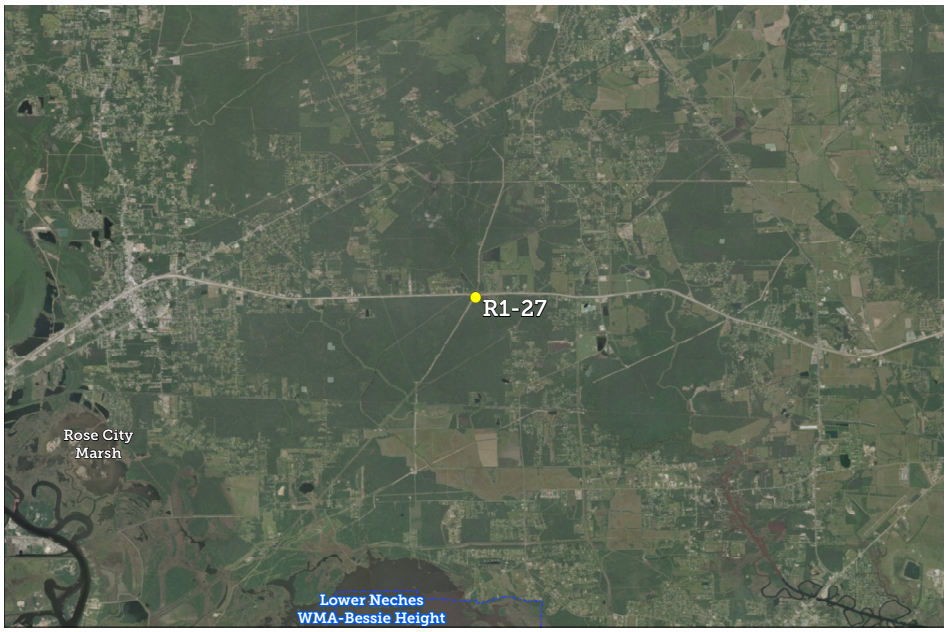
Regional Infrastructure Improvements

Resiliency Strategy:

Administrative Resiliency (Study); **Societal Resiliency** (Land-Based Transit Enhancement; Community Infrastructure Planning and Development)

Project Benefits Per Issues of Concern





Project Description

Interstate 10 from Vidor to Cow Bayou experienced severe flooding during Hurricane Harvey. This project would fund a drainage study of Interstate 10 from Vidor to Cow Bayou to determine appropriate flood control solutions, such as adding or improving culverts.

Project Need

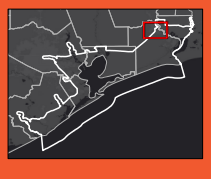
This road is a major thoroughfare that serves as an evacuation route for communities and is vital to public safety in major flooding events. It is critically important to keep the interstate accessible to allow emergency responders to access impacted areas throughout an emergency event, and to keep supply chains open to the impacted areas in the immediate aftermath of such an event.

Project Benefit

Implementation of identified solutions would mitigate future flooding occurrence, and could lessen future expenses incurred from the floods.

Estimated Total Project Cost: $5,000,000

Southeast Texas Regional Wastewater Treatment Improvements *(Project ID R1-28)*



Region: 1

Location:

Jefferson County and Orange County

County:

Jefferson, Orange

Status:

Conceptual

Stakeholders:

- Jefferson County
- Orange County
- Texas Water Development Board
- Texas Commission on Environmental Quality
- Texas General Land Office

Project Type:

Study, Policy, Plan or Program; Community Infrastructure

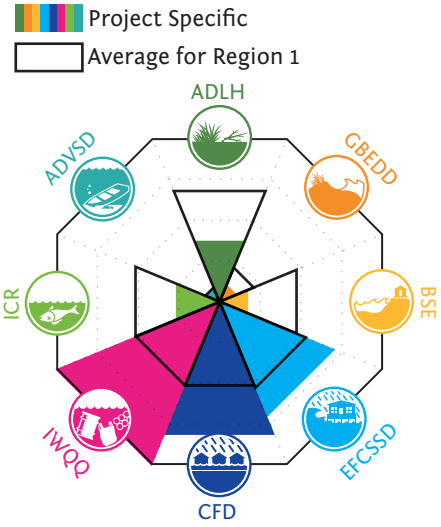
Action:

Regional Infrastructure Improvements

Resiliency Strategy:

Administrative Resiliency (Plan); **Societal Resiliency** (Community Infrastructure Planning and Development)

Project Benefits Per Issues of Concern



Project Description

This project would create a regional wastewater treatment plan for Jefferson County and Orange County to review and assess risk mitigation options for infrastructure that could be in danger of flooding or overwhelmed by large volumes of wastewater (sewage) treatment needs during peak rainfalls. The planning team would investigate an array of mitigation alternatives, including elevating lift stations, wastewater treatment facilities, and other critical infrastructure; creating new wastewater treatment facilities to improve the treatment capacity in Adams Bayou and Cow Bayou watersheds; transitioning unincorporated areas of the City of Orange from septic sewers to a centralized system; and prioritizing wastewater treatment infrastructure in need of upgrades.

Project Need

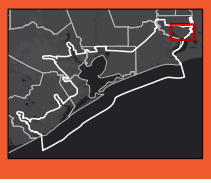
During Hurricane Harvey, many of the critical wastewater facilities in southeast Texas, such as wastewater treatment plants, were overwhelmed by flooding that reduced, severely limited, or even completely removed the infrastructure from service. This is a result of a continuing trend in the region with increasing flood events over the past decade that has exposed vulnerabilities in flood proofing for these critical facilities.

Project Benefit

A regional planning effort would determine the most appropriate wastewater distribution and treatment infrastructure improvements to mitigate risk during storm events and improve resiliency for this region. This project also would improve the treatment capacity in Adams Bayou and Cow Bayou watersheds.

Estimated Total Project Cost: $500,000

Improve State Highway 73 at Bridge City
(Project ID R1-29)



Region: 1

Location:

State Highway 73 near Bridge City

County:

Orange

Status:

Conceptual

Stakeholders:

- Texas Department of Transportation
- Bridge City
- Orange County

Project Type:

Community Infrastructure

Action:

Regional Infrastructure Improvements

Resiliency Strategy:

Societal Resiliency (Land-Based Transit Enhancement; Community Infrastructure Planning and Development)

Project Description

This project would improve drainage problems on State Highway 73 (SH 73), from Bridge City to north of the junction with State Highway 87 (SH 87) along Coon Bayou. During the design and analysis for the project, consideration would be given to the drainage of SH 87, just north of the superfund site, to ensure that no negative environmental impacts would be anticipated for flows draining from this site during or following construction.

Project Need

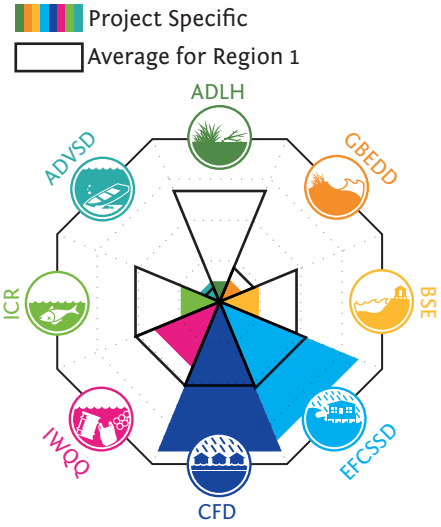
This highway, which is used as an evacuation route during coastal storms, is at risk of flooding during major rainfall events.

Project Benefit

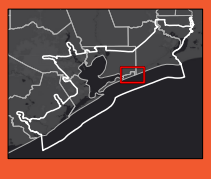
This project would protect SH 73 from the impacts of flooding events and decrease the flood risk for this evacuation route.

Estimated Total Project Cost: $2,800,000

Project Benefits Per Issues of Concern



Elevate State Highway 87 and Widen State Highway 124 to Improve Evacuation Capabilities *(Project ID R1-30)*



Region: 1

Location:

State Highway 87 on Bolivar Peninsula and State Highway 124 at High Island

County:

Galveston

Status:

Conceptual

Stakeholders:

- Texas Department of Transportation
- Anahuac National Wildlife Refuge

Project Type:

Community Infrastructure

Action:

Regional Infrastructure Improvements

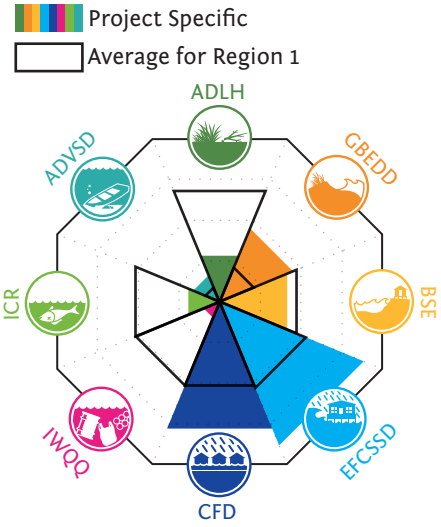
Resiliency Strategy:

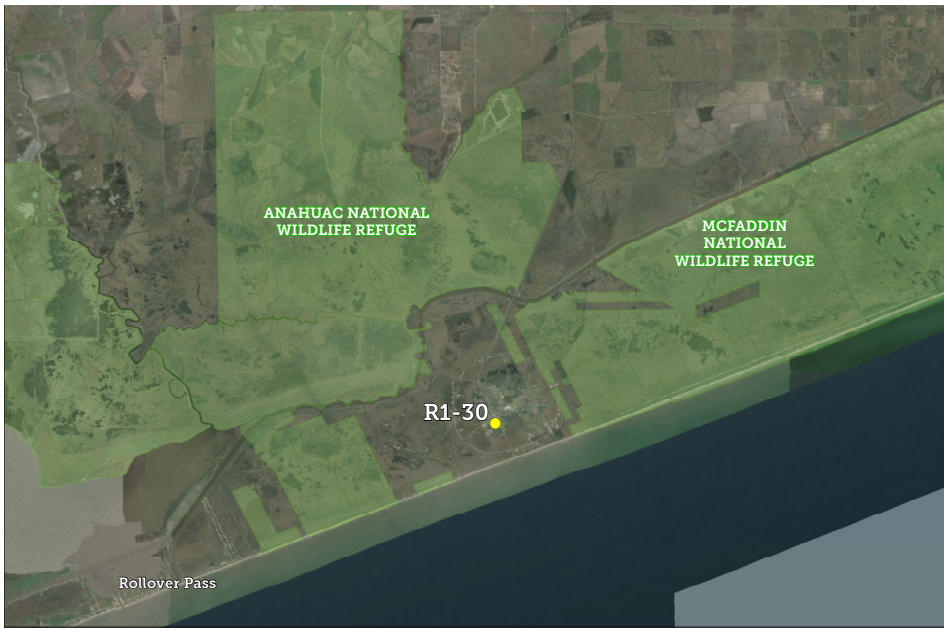
Societal Resiliency (Land-Based Transit Enhancement)

Jobs Created:

Creates approximately 123 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

State Highway 124 (SH 124) is a two-lane, divided highway as it crosses the Gulf Intracoastal Waterway (GIWW). To improve the evacuation process for High Island and Bolivar Peninsula, the project would elevate State Highway 87 (SH 87) and elevate and widen SH 124 to enhance its use as an evacuation route. The project also would evaluate the prospect of elevating low portions of SH 124 north of the GIWW.

Project Need

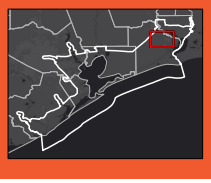
State Highway 87 is frequently overwashed due to its low elevation, proximity to the shoreline and lack of beach width protection. Previous evacuations along SH 87 and SH 124 have shown that in this geographic area, these highways are too narrow for efficient evacuation purposes.

Project Benefit

This project would improve SH 87 and SH 124 to enhance the evacuation of High Island and other communities located on the Bolivar Peninsula.

Estimated Total Project Cost: $21,900,000

Southeast Texas Regional Drainage Study and Improvements *(Project ID R1-31)*



Region: 1

Location:

Jefferson County and Orange County

County:

Jefferson, Orange

Status:

Conceptual

Stakeholders:

- Texas Water Development Board
- Texas Commission on Environmental Quality
- Jefferson County Drainage District No. 7
- Orange County Drainage District

Project Type:

Study, Policy, Plan or Program; Community Infrastructure

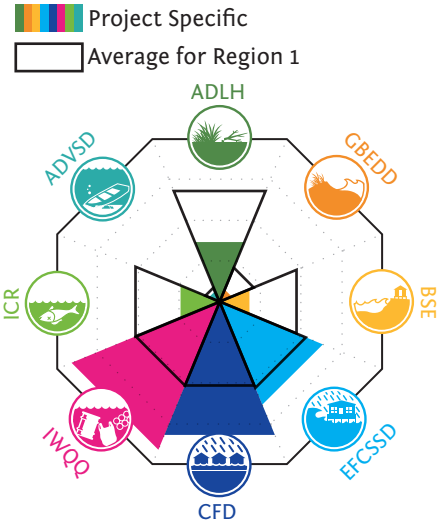
Action:

Regional Infrastructure Improvements

Resiliency Strategy:

Administrative Resiliency (Study); **Societal Resiliency** (Community Infrastructure Planning and Development)

Project Benefits Per Issues of Concern



Project Description

This project would create a regional stormwater drainage plan for Jefferson County and Orange County. The plan would include a study to look at regional drainage during small- and large-scale storm events to ensure that a holistic drainage plan is understood and able to be enacted by the affected counties. A regional planning effort would determine the most appropriate infrastructure improvements to mitigate flood risk and improve resiliency for this region.

Project Need

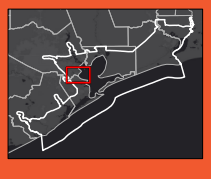
Previous hurricanes and flood events provide the need to review and assess risk mitigation options for drainage infrastructure that could be in danger of flooding or overwhelmed by large volumes of stormwater drainage needs during peak rainfalls.

Project Benefit

The study would include identifying drainage infrastructure needing increased capacity for riverine and coastal flooding; regionalizing stormwater flows from Adams Bayou and Cow Bayou; and prioritizing upgrades to stormwater conveyance infrastructure. This study also would recommend improvements to pump systems throughout Beaumont, Port Arthur and Orange, including station elevation and pump upsizing. The project would summarize pump function, capacity and disaster response improvements throughout the existing levee flood protection system. In addition, the study would include developing a pump coordination and management plan to improve drainage district coordination and planning for existing and future pumping needs.

Estimated Total Project Cost: $1,000,000

City of Seabrook Wastewater Treatment Plant Relocation *(Project ID R1-32)*



Region: 1

Location:

Less than 1000 feet from the Galveston Bay shoreline, north of Clear Lake and Kemah

County:

Harris

Status:

Permitted

Stakeholders:

- City of Seabrook

Project Type:

Community Infrastructure

Action:

Regional Infrastructure Improvements

Resiliency Strategy:

Societal Resiliency (Community Infrastructure Planning and Development)

Project Description

This project would relocate the City of Seabrook's wastewater treatment plant (WWTP) to an area further inland and better protected from storm surge and flooding. The operating capacity of the WWTP is 2.5 million gallons per day and serves Seabrook, Pasadena and parts of El Lago. The current location of the plant is 3 feet elevation and is 14 feet below base flood elevation. The proposed, new location for the plant would be at 17 feet elevation and 5 feet above base flood elevation. The City of Seabrook has a permit and has completed engineering for a capital improvement project to relocate the WWTP, but bidding and construction are on hold pending funding.

Project Need

The City of Seabrook's only wastewater treatment plant is in a low-lying area close to Galveston Bay. Due to its location, the plant is particularly vulnerable to coastal storms. In 2008, Hurricane Ike imposed over $1 million in damage at the plant. If the WWTP remains in the same location, future storms could again compromise the plant or lead to plant failure. This could result in a massive environmental cleanup and major economic damages.

Project Benefit

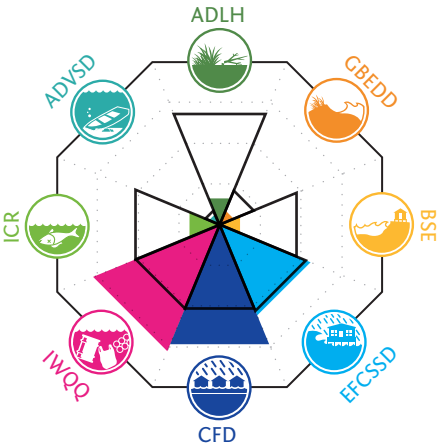
Relocating the plant would remove the possibility of contamination from wastewater entering Galveston Bay during extreme weather events and better protect the watershed by minimizing chances of contamination.

Estimated Total Project Cost: $34,100,000

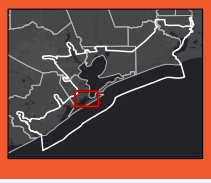
Project Benefits Per Issues of Concern

Project Specific

Average for Region 1



Galveston Bay Rookery Island Restoration
(Project ID R1-33)



Region: 1

Location:

Multiple rookery islands in Galveston Bay

County:

Galveston

Status:

Conceptual

Stakeholders:

- Audubon Texas
- Texas Parks & Wildlife Department
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Rookery Island Enhancement

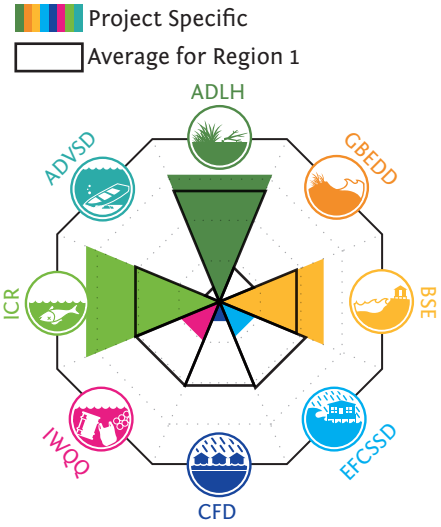
Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration, and Creation)

Jobs Created:

Creates approximately 141 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The project would prioritize, restore elevation and provide shoreline protection for several identified rookery islands in Galveston Bay.

Project Need

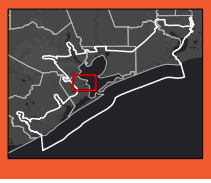
Certain islands in Galveston Bay are severely eroding and eliminating critical bird habitats that are part of the coastwide rookery island network in Texas, including—but not limited to—Jigsaw Island, Deer Islands, the Vingt-Et-Un Islands, Chocolate Point Island, West Bay Bird Island and Smith Point Island.

Project Benefit

The project would provide shoreline stabilization and create additional acres of potential nesting habitat by re-establishing estuarine wetland habitat along with other techniques. A fortified rookery island system in Galveston Bay would provide essential nesting and migratory habitat for bird populations, and could diminish bay generated storm surge for communities.

Estimated Total Project Cost: $37,500,000

Dickinson Bay Rookery Island Restoration - Phase 2
(Project ID R1-34)



Region: 1

Location:

Islands in northeast Dickinson Bay

County:

Galveston

Status:

Engineering & Design

Stakeholders:

- Texas Parks & Wildlife Department
- Galveston Bay Foundation
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration

Action:

Rookery Island Enhancement

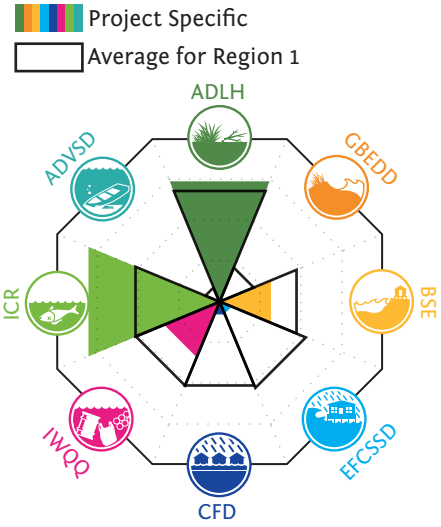
Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation; Oyster Reef Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 36 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would restore two 5- to 7-acre colonial water bird rookery islands and adjacent oyster reef habitats in Dickinson Bay, which would be Phases II and III of the original Dickinson Bay Island Marsh Restoration Project. Phase I, which was completed in the mid-2000's, restored an additional rookery island in Dickinson Bay using clean clay fill material, concrete rip-rap shoreline stabilization, and by planting new vegetation. Design and only partial funding are in place for Phases II and III. Additional funding is required to proceed to construction.

Project Need

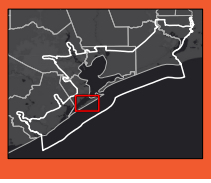
Two rookery islands in Dickinson Bay are eroding and negatively impacting populations of coastal shorebirds that rely on these islands for nesting and nursing habitat.

Project Benefit

The project would be constructed to provide multiple habitat functions, including approximately 5 acres of nesting space for colonial waterbirds and 2 acres of oyster reef. Approximately 4,000 cubic yards of suitable oyster cultch would be provided to expand the oyster reef already constructed. This would contribute to improved water quality and fish habitat in the adjacent area.

Estimated Total Project Cost: $3,200,000

Coastal Heritage Preserve *(Project ID R1-35)*



Region: 1

Location:

Conservation properties on West Galveston Island east of Jamaica Beach

County:

Galveston

Status:

Acquisition Pending

Stakeholders:

- Artist Boat
- U.S. Fish and Wildlife Service
- Texas Parks & Wildlife Department
- Galveston Bay Estuary Program
- Galveston Bay Foundation
- Texas General Land Office

Project Type:

Land Acquisition

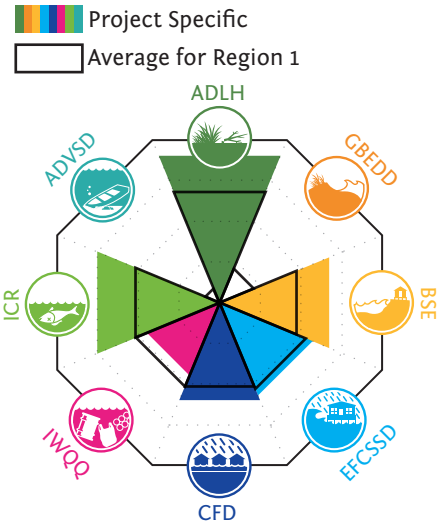
Action:

Responsible Development

Resiliency Strategy:

Societal Resiliency (Storm Surge Suppression)

Project Benefits Per Issues of Concern



Project Description

The Coastal Heritage Preserve project aims to acquire, protect, manage and enhance 1,400 acres of coastal habitat on West Galveston Island between West Galveston Bay and the Gulf of Mexico. The project would add 725 acres of new acquisitions to the existing 669 acres of coastal habitat already protected and managed as part of the preserve. This would continue the acquisition and restoration efforts that have occurred in West Bay over the last 20 years. Willing sellers are identified, but full funding for this project is the limiting factor.

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. The dune-swale complex in the preserve, which is interspersed with numerous palustrine and estuarine wetlands, and oak motte habitat found on the acquisition tracts in this project, provides biological, geochemical and physical ecosystem enhancements.

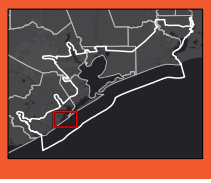
Project Benefit

The additional 725 acres would make the preserve more contiguous from bay to beach, increasing and enhancing the resource values of a larger landscape and protecting vast expanses of wetlands. This project would benefit the local economy by: securing and protecting habitat known to produce fish stocks; potentially raising property values adjacent to and surrounding conserved lands; protecting, increasing and maintaining ecosystem services for humans (flood retention and mitigation, preventing erosion and natural erosion control, and filtration of nonpoint source pollution to Galveston Bay and Beaches); and increasing tourism dollars through increased opportunities to view wildlife and participate in recreational fishing.

Estimated Total Project Cost: $28,200,000*

**Partial funding identified*

Follet's Island Conservation Initiative
(Project ID R1-36)



Region: 1

Location:

Strategic properties on Follet's Island

County:

Brazoria

Status:

Engineering & Design

Stakeholders:

- Texas Parks & Wildlife Department
- U.S. Fish and Wildlife Service

Project Type:

Land Acquisition

Action:

Responsible Development

Resiliency Strategy:

Ecological Resiliency (Upland Planning, Conservation and Monitoring)

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.

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.

Project Benefit

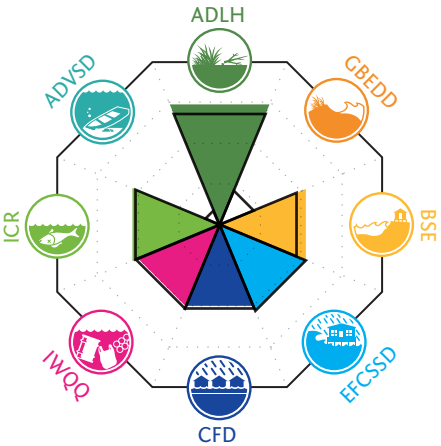
Critically important wildlife habitats on the island include tall grass prairies, estuarine and freshwater wetlands, seagrass meadows, oyster reefs, mud flats, sand dunes and Gulf beaches. Follet's Island provides an ideal environment for Kemp's ridley sea turtles, piping plovers, waterfowl, wading birds and shorebirds.

Estimated Total Project Cost: $7,600,000

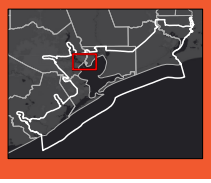
Project Benefits Per Issues of Concern

Project Specific

Average for Region 1



Cedar Bayou Acquisitions *(Project ID R1-37)*



Region: 1

Location:

Cedar Bayou Watershed

County:

Harris

Status:

Conceptual

Stakeholders:

- Texas Parks & Wildlife Department

Project Type:

Land Acquisition; Hydrologic Connectivity

Action:

Responsible Development

Resiliency Strategy:

Societal Resiliency (Community Infrastructure Planning and Development)

Project Description

This project would preserve critical natural areas in the Cedar Bayou watershed through acquisition projects. Much of the Cedar Bayou watershed is undeveloped except for the City of Baytown and the City of Mont Belvieu. The watershed is primarily rural and agricultural, with the most development activity related to large commercial grass farming operations. Development of residential housing and/or industrial and commercial facilities are expected to increase slowly. Most of the primary stream and floodplain is environmentally sensitive due to the estuarine wetlands in the lower reaches and the undeveloped natural channel reaches upstream of Baytown. The Texas Parks & Wildlife Department considers the area around the mouth of Cedar Bayou to be a critical wildlife habitat.

Project Need

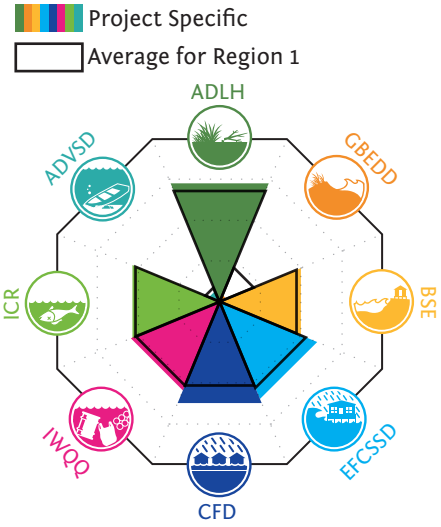
The Cedar Bayou watershed has experienced several significant flooding events during tropical storms and hurricanes, and recent rainfall events reaching 100-year levels in parts of the watershed. This has resulted in more than $13 million in damages since the late 1970's. This flooding has come from a combination of riverine overflow from Cedar Bayou and its tributaries, and coastal storm surge from Galveston Bay. Numerous smaller storms also have caused isolated damages and roadway flooding, which limits mobility in the watershed. Additionally, Cedar Bayou became listed as an impaired water body by the Texas Commission on Environmental Quality in 2006 and implementation of its Watershed Protection Plan was accepted by the U.S. Environmental Protection Agency in 2016.

Project Benefit

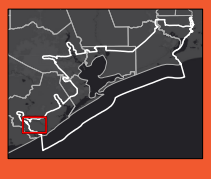
This project would be beneficial to water quality and habitats on and near Cedar Bayou and would decrease flooding in the area by protecting land from development. The project also would benefit implementing the Cedar Bayou Watershed Protection Plan, which would improve water quality and maintain a robust watershed system in the interest of sustaining a healthy local ecology.

Estimated Total Project Cost: Up to $10,000,000

Project Benefits Per Issues of Concern



Columbia Bottomlands Preservation *(Project ID R1-38)*



Region: 1

Location:

Columbia Bottomlands habitat corridor, north of Freeport

County:

Brazoria

Status:

Conceptual

Stakeholders:

- The Nature Conservancy
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration; Land Acquisition

Action:

Responsible Development

Resiliency Strategy:

Ecological Resiliency (Upland Planning, Conservation and Monitoring)

Project Description

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. Over 1,800 acres have been acquired to date, but additional funding is requested to complete the project.

Project Need

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.

Project Benefit

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 Columbia Bottomlands are bottomland hardwood forest habitats that serve as an ecosystem for native fish, resident wildlife and plants, including species that are endangered or threatened. The Columbia Bottomlands also are a critically important area for millions of migrating birds that use it as a staging area between wintering habitats in the Caribbean and South America, and breeding habitats in North America.

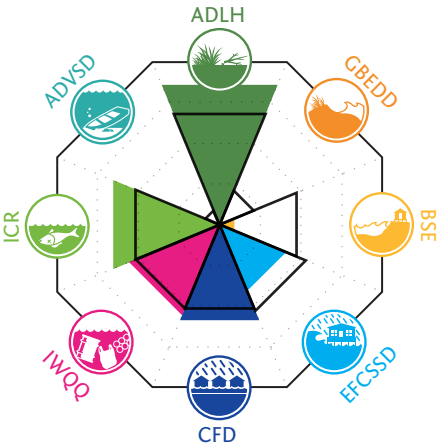
Estimated Total Project Cost: $18,800,000*

**Partial funding identified*

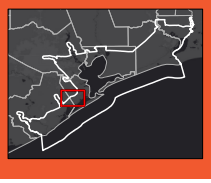
Project Benefits Per Issues of Concern

Project Specific

Average for Region 1



East and West Galveston Bay Watershed, Wetland and Habitat Conservation *(Project ID R1-39)*



Region: 1

Location:

East and West Galveston Bay Watersheds

County:

Brazoria, Galveston

Status:

Acquisition Pending

Stakeholders:

- Galveston Bay Estuary Program
- Galveston Bay Foundation
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration; Land Acquisition

Action:

Responsible Development

Resiliency Strategy:

Ecological Resiliency (Upland Planning, Conservation and Monitoring)

Project Description

The Galveston Bay Estuary Program's (GBEP's) Conservation Assistance Program identifies perpetual land conservation as one of the best strategies to protect the biodiversity and overall health of the Galveston Bay estuarine system. GBEP, Galveston Bay Foundation (GBF) and other partners would protect approximately 5,000 acres of coastal wetlands and other natural areas critical to water quality and habitat protection via conservation easements or purchasing development rights or fee titles. The project is scalable in terms of time and funding, and would ideally be implemented over a 5- to 7-year time frame at a cost of approximately $3 million per year. Administration and due diligence funding are secured from the GBEP through August 2023. Additional funds are requested to acquire several properties identified by GBEP and GBF where landowner outreach is completed.

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.

Project Benefit

This project would target land parcels that: possess unique conservation value such as wetlands, bottomland hardwood forests and floodplains; have a direct link to coastal riparian areas, coastal prairies or Galveston Bay; provide public access to Galveston Bay; or reduce or prevent nonpoint source pollution. In addition to benefiting coastal environments, this project also would benefit the economy by conserving resources of commercial (e.g. fisheries) and recreational interest.

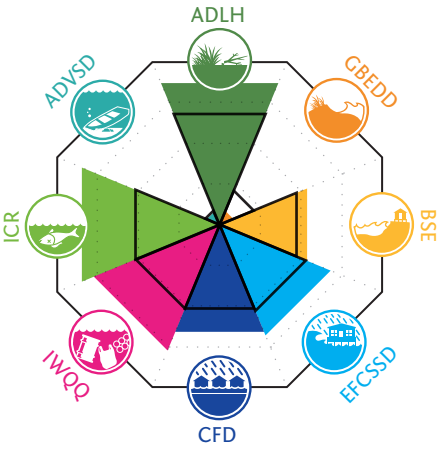
Estimated Total Project Cost: $15,600,000*
over 5 years

**Partial funding identified*

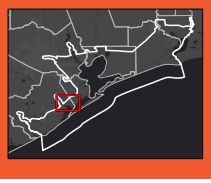
Project Benefits Per Issues of Concern

Project Specific

Average for Region 1



West Galveston Bay Acquisition Program
(Project ID R1-40)



Region: 1

Location:

Galveston Island and West Galveston Bay mainland

County:

Brazoria

Status:

Conceptual

Stakeholders:

- U.S. Fish and Wildlife Service
- Galveston Bay Foundation
- Galveston Bay Estuary Program

Project Type:

Land Acquisition

Action:

Responsible Development

Resiliency Strategy:

Societal Resiliency (Upland Planning, Conservation and Monitoring)

Project Description

This project would develop a program to provide assistance to natural resource agencies, environmental organizations and land managers to acquire available properties on the Houston-Galveston mainland and Galveston Island.

Project Need

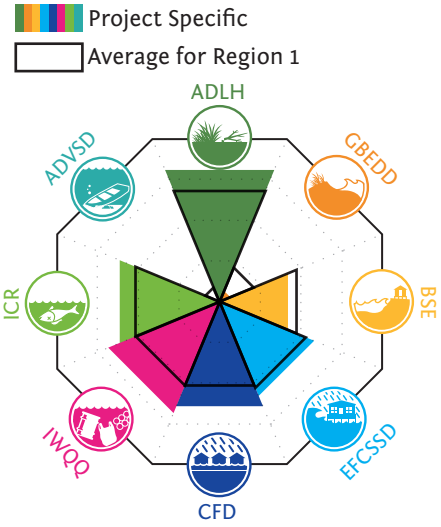
Acquisition priority would be given to strategic properties, such as those that adjoin existing conservation areas and support the non-development of river deltas and floodplains.

Project Benefit

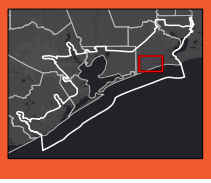
Protecting lands from future development provides numerous human and environmental benefits. This includes preventing future flood damages from storms, tides and sea level rise; improving wildlife and habitat corridors; supplying vegetated buffer areas to store flood waters; allowing natural filtration for stormwater and other surface water runoff; and maintaining habitat migration space in the coastal region.

Estimated Total Project Cost: Up to $25,000,000

Project Benefits Per Issues of Concern



Salt Bayou Siphons *(Project ID R1-41)*



Region: 1

Location:

The GIWW at the McFaddin National Wildlife Refuge and J.D. Murphree Wildlife Management Area

County: Jefferson

Status: Shovel-ready

Stakeholders:

- Jefferson County
- National Fish and Wildlife Foundation
- Texas Parks & Wildlife Department
- U.S. Fish and Wildlife Service
- McFaddin National Wildlife Refuge

Project Type:

Habitat Creation & Restoration; Hydrologic Connectivity

Action:

Watershed Planning

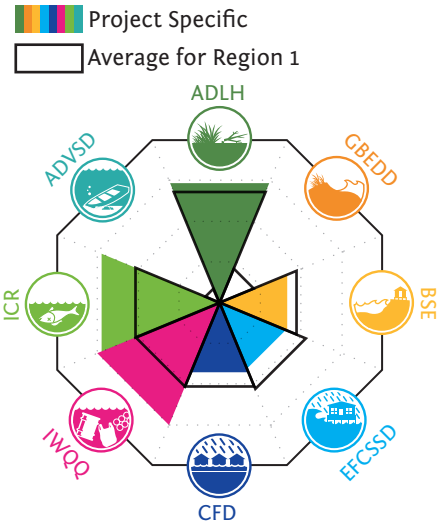
Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement; Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 86 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

Under this project, two siphons would be installed in the Salt Bayou system to restore a hydrologic connection between the freshwater wetland systems north of the Gulf Intracoastal Waterway (GIWW), and degraded wetlands south of the GIWW. Funding is secured for this project and is currently awaiting permit approval from the U.S. Army Corps of Engineers. This project is one component of larger efforts to restore the Salt Bayou Watershed, as it is also one of the goals for projects R1-2 (Willow Lake Shoreline Stabilization) and R1-42 (Replace Water Control Structure at Star Lake).

Project Need

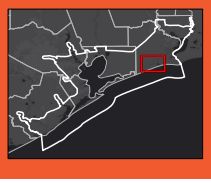
The GIWW disrupts the natural hydrology of the Salt Bayou Watershed and prevents freshwater from the northern portions of the watershed draining to the southern portions. The lack of freshwater draining to the southern portions of the watershed has severely degraded upland and wetland habitats that need freshwater inflows to survive. This in turn impacts fish, bird and wildlife populations.

Project Benefit

The project is of critical importance given the beneficial impact of improving habitat quality for wildlife populations in McFaddin National Wildlife Refuge and the J.D. Murphree Wildlife Management Area. Both are managed habitat areas that provide ecological and economic value to this region through ecosystem services, such as carbon sequestration and water filtration, hunting, fishing and recreational activities. Additionally, this project would enhance the previous state and federal investments at these sites by providing greater environmental returns through revitalizing the wetlands.

Estimated Total Project Cost: $4,500,000

Replace Water Control Structure at Star Lake
(Project ID R1-42)



Region: 1

Location:
Star Lake in Jefferson County

County:
Jefferson

Status:
Conceptual

Stakeholders:
- U.S. Fish and Wildlife Service

Project Type:
Hydrologic Connectivity

Action:
Watershed Planning

Resiliency Strategy:
Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement)

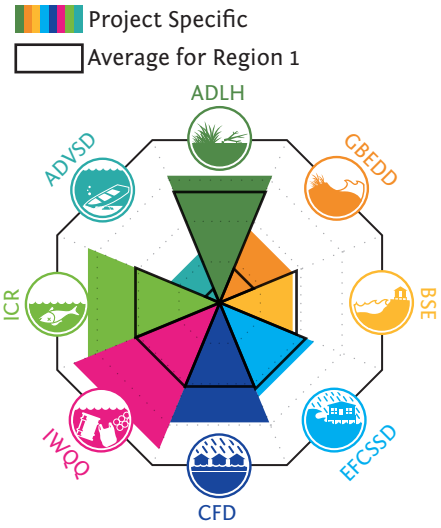
Project Description
This project would improve the Star Lake water control structure to help protect the Salt Bayou system. The water control structure helps to regulate the flow of freshwater into Star Lake, which impacts how freshwater is distributed throughout the wetlands in the adjacent area.

Project Need
According to refuge managers at the McFaddin National Wildlife Refuge, the Star Lake water control structure is past the end of its life cycle and is in need of replacement or repair. This degraded service provided by the structure inhibits the ability to properly regulate flows for the area and has negative impacts on the wetland complex it serves as it is not fully functional in preventing saltwater intrusion.

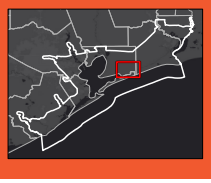
Project Benefit
Improving the flow of freshwater to Salt Bayou would enhance and maintain the wetlands that help protect the communities of Jefferson County from storm surge events, and reduce economic interruption during storm surge events. The fisheries and migratory waterfowl in the Salt Bayou estuary system, which provide outstanding hunting and fishing opportunities, also would benefit from the replacement of the water control structure at Star Lake.

Estimated Total Project Cost: $2,100,000

Project Benefits Per Issues of Concern



The Marshland Restoration Project at Anahuac National Wildlife Refuge *(Project ID R1-43)*



Region: 1

Location:

Locations within the Anahuac National Wildlife Refuge, east of East Bay

County:

Chambers

Status:

Conceptual

Stakeholders:

- The Nature Conservancy
- National Wildlife Federation
- Meadows Center for Water & The Environment
- Harte Research Institute
- Ducks Unlimited
- Anahuac National Wildlife Refuge

Project Type:

Habitat Creation & Restoration; Hydrologic Connectivity

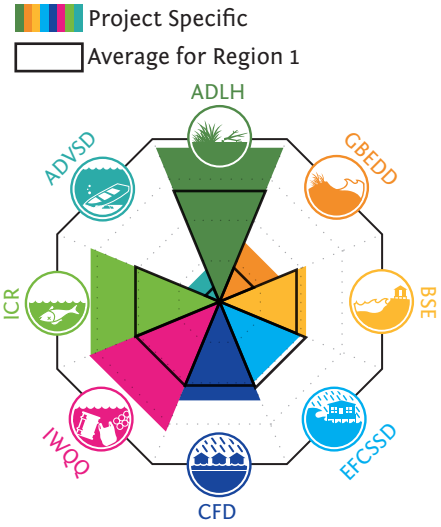
Action:

Watershed Planning

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement)

Project Benefits Per Issues of Concern



Project Description

This project would restore freshwater flows across two large tracts, totaling about 6,500 acres, at the Anahuac National Wildlife Refuge. The National Wildlife Federation and The Nature Conservancy are leading this effort, along with other partners. To achieve the restoration of the freshwater flows to the area, water would be purchased and delivered to the tracts.

Project Need

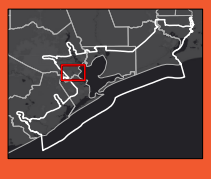
Land-use changes, such as construction of roads and ditches, have reduced overland flow of fresh water to this area of the refuge. Combined with the channelization of adjacent bayous that connect to East Galveston Bay, the reduced flow has increased salinity levels in wetland habitats, resulting in ongoing marsh degradation including the conversion of some areas to saltwater ponds.

Project Benefit

The water deliveries would restore more natural salinity gradients and inundation patterns across the tracts. This would improve and protect wetland habitat for wading birds and waterfowl. The water deliveries also would reduce salinity levels in bayous draining the tracts, especially during drought periods. This would benefit young fish, shrimp, crabs and other organisms that move between the tracts and nearby East Galveston Bay.

Estimated Total Project Cost: $2,500,000 to $7,500,000 depending on water rights and lease agreements

Greater Armand Bayou Preservation Project
(Project ID R1-44)



Region: 1

Location:

Strategic properties within the Armand Bayou Watershed

County:

Harris

Status:

Conceptual

Stakeholders:

- Armand Bayou Watershed Partnership
- Armand Bayou Nature Center
- Harris County Flood Control District

Project Type:

Habitat Creation & Restoration; Land Acquisition

Action:

Watershed Planning

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement)

Project Description

This project would allow for land acquisition and prairie preservation within the Greater Armand Bayou. Armand Bayou is a meandering estuarine stream 13 miles in length, emptying through a narrow mouth into Clear Lake, a tertiary bay of the Galveston Bay system. Its watershed encompasses 63.5 square miles of urban and suburban development, NASA's Johnson Space Center and the Bayport petrochemical complex.

Project Need

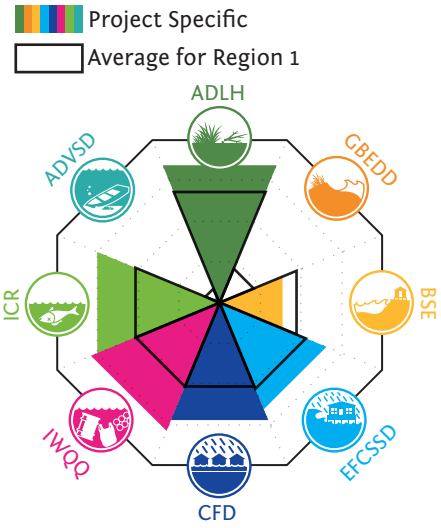
Salinity is usually stratified and highly variable, becoming increasingly fresh upstream. After large rainfall events, salinity could be depressed into the fresh to brackish range through much of its length. Armand Bayou has changed drastically during the past three decades due to a number of environmental impacts, including subsidence, loss of wetlands, poor water quality and the expansion of invasive exotic species.

Project Benefit

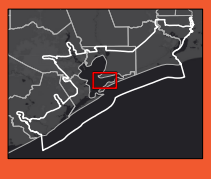
This project would improve the area's water quality, mitigate flooding and provide habitat protection.

Estimated Total Project Cost: Up to $10,000,000

Project Benefits Per Issues of Concern



Galveston Bay Oyster Reef Planning & Restoration
(Project ID R1-45)



Region: 1

Location:

Locations to be determined in Galveston Bay

County:

Galveston

Status:

Engineering & Design

Stakeholders:

- Texas Parks & Wildlife Department
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Study, Policy, Plan or Program

Action:

Oyster Reef Enhancement

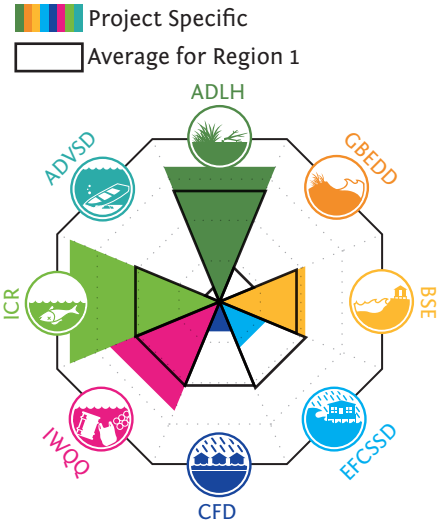
Resiliency Strategy:

Ecological Resiliency (Oyster Reef Planning, Restoration and Monitoring); **Administrative Resiliency** (Study)

Jobs Created:

Creates approximately 34 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would include a study to evaluate the best oyster reef restoration locations in Galveston Bay to ensure high returns. The project also would include survey and monitoring efforts to catalog the extents and locations of existing reefs and the success of various recruitment techniques.

Project Need

The existing oyster reefs in Galveston Bay were degraded by prior tropical storm events and persistent dredging activities that disturbed sediment in adjacent bays. In 2008, Hurricane Ike destroyed up to 60 percent of the oyster habitat in Galveston Bay. In 2017, Hurricane Harvey decimated the oyster population in Galveston Bay, particularly in Galveston East Bay. Very few oysters survived in East Bay due to the inflow of fresh water into the area, and almost all of the restoration areas in place prior to the storm were destroyed. Mortality rates for oyster beds across Galveston Bay ranged from 50 to 100 percent due to the effects of Harvey.[a]

Project Benefit

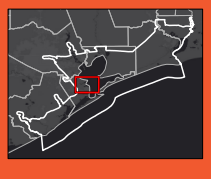
The project would restore Galveston Bay oyster reef habitats in response to large-scale impacts from Hurricane Ike and increased harvest pressures.

Estimated Total Project Cost: $2,500,000*

**Partial funding identified*

[a] *Gulf Coast Mariner Magazine. 2017. Galveston Oysters After Hurricane Harvey. Available at: http://www.gulfcoastmariner.com/galveston-oysters-hurricane-harvey/ (accessed Feb 26, 2019)*

Texas City Levee Erosion Control and Marsh and Oyster Reef Restoration *(Project ID R1-46)*



Region: 1

Location:

Galveston Bay just outside of the Moses Lake flood gate

County:

Galveston

Status:

Conceptual

Stakeholders:

- The Nature Conservancy
- Gulf Coast Bird Observatory
- U.S. Fish and Wildlife Service
- Galveston Bay Foundation
- U.S. Army Corps of Engineers
- Texas General Land Office

Project Type:

Habitat Creation & Restoration

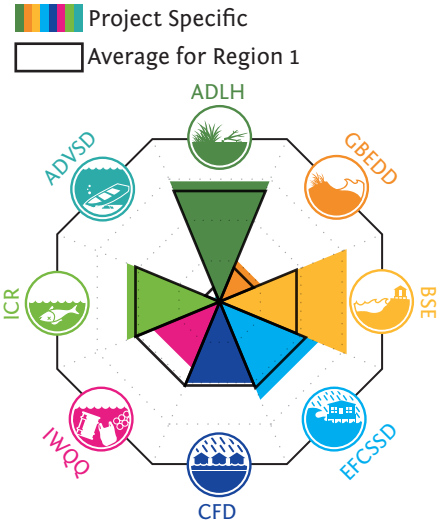
Action:

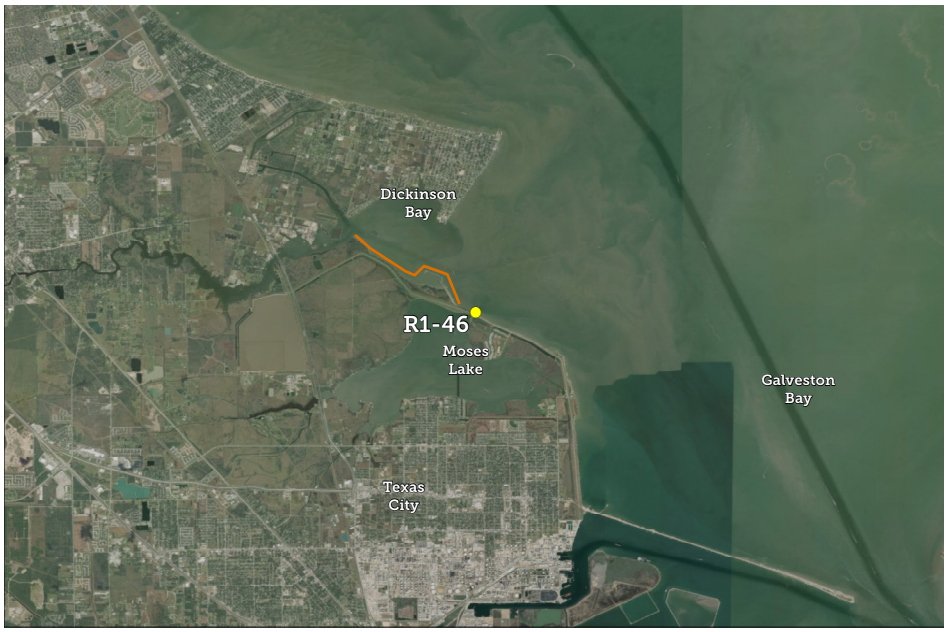
Oyster Reef Enhancement

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring; Oyster Reef Planning, Restoration and Monitoring)

Project Benefits Per Issues of Concern





Project Description

This project would include three components. The first component would construct a 6,500-foot rip-rap breakwater along the Texas City Prairie Preserve's (TCPP) Dickinson Bay shoreline to prevent further erosion and create inner tidal marshland behind the breakwater. The second component would reinforce the existing 5,000-foot shell spit, which was leveled by Hurricane Harvey. The shell spit, located just west of the Moses Lake flood gate, has proven to be American Oystercatcher nesting habitat. The shell spit also protects a marsh that is utilized by waterfowl and wading birds. An alternatives analysis would be completed to determine the best methods to restore and protect the shell spit. The third and final component would include removing two abandoned vessels in the area – a sunken sailboat and a grounded shrimping boat.

Project Need

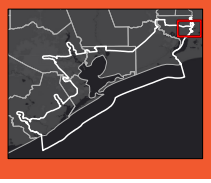
In 2011, the Gulf Coast Bird Observatory began monitoring nesting American Oystercatchers in Texas. The Oystercatcher is a U.S. Fish and Wildlife Service species of concern in part because they can only live in the coastal zone due to their diet. In Texas, they nest primarily on bay islands or shell spits that are distant enough from the mainland to alleviate the risk of mammalian predation. In 2011, the TCPP spit hosted six pairs of nesting American Oystercatchers, which fledged seven chicks. In the years since, the shell spit has eroded a little more each year until Hurricane Harvey nearly destroyed the spit. In 2018, the spit hosted only two pairs of American Oystercatchers and they fledged no chicks. The importance of suitable and predation-free nesting areas for species like the American Oystercatcher is a direct correlation to the overall health of our environment.

Project Benefit

This project would provide residual benefits to the integrity of the Texas City Dike by preventing erosion along the adjacent, leveed shoreline. Additionally, the project would protect 130 acres of marsh area and restore oyster habitat.

Estimated Total Project Cost: $2,800,000

Orange County Hurricane Flood Protection Levee
(Project ID R1-47)



Region: 1

Location:

Along the southern part of Orange County, wrapping around Orange and Bridge City

County:

Orange

Status:

Approved for Engineering & Design

Stakeholders:

- U.S. Army Corps of Engineers
- Orange County
- Texas General Land Office

Project Type:

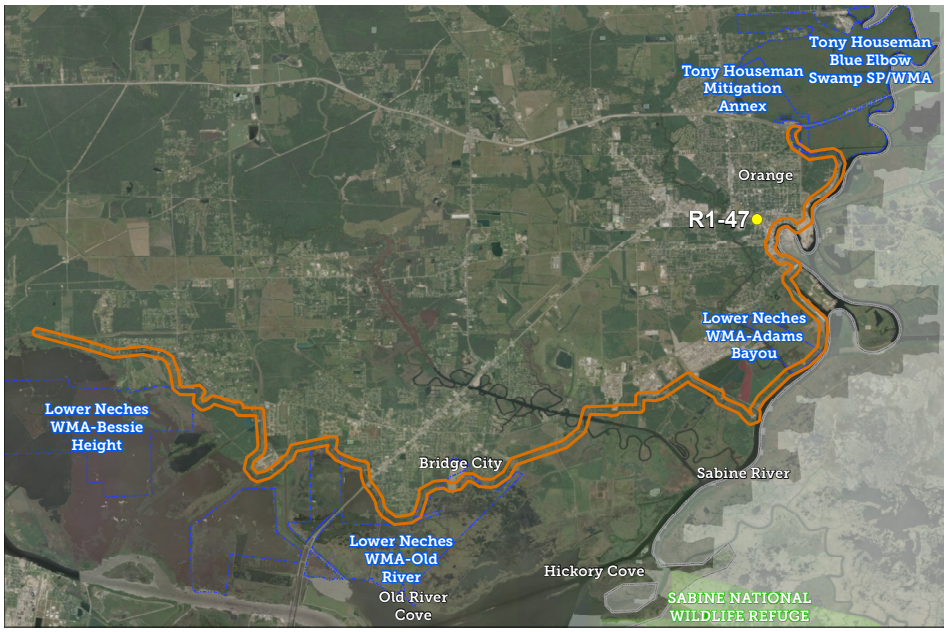
Flood Risk Reduction

Action:

Coastal Storm Risk Management

Resiliency Strategy:

Societal Resiliency (Storm Surge Suppression)



Project Description

This project is part of the U.S. Army Corps of Engineers' Sabine Pass to Galveston Bay Study, which has been approved for design and construction. The project would include construction of 27 miles of new earthen levees and concrete flood walls, along with 7 new pump stations, 56 drainage structures, and 32 closure gates in Orange County. Two navigable sector gates would be constructed in Adams Bayou and Cow Bayou to reduce surge penetration. Any environmental impacts to wetlands would be fully mitigated, including monitoring and adaptive management until the mitigation measures have been demonstrated to be successful. Orange County, the non-federal sponsor, would be responsible for paying back up to 35 percent of the total project cost over the next 30 years, or approximately $827,260,000.

Project Need

The U.S. Army Corps of Engineers evaluated the future, no-action scenario for Orange County due to coastal storm surge. Based on this evaluation, there are concerns for life-safety for over 60,000 people, as well as potential for economic damages of more than $65 million annually, damages to critical infrastructure, and impacts on significant environmental resources if the project is not completed.

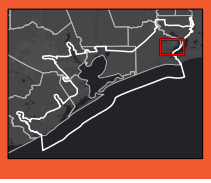
Project Benefit

The U.S. Army Corps of Engineers computed the equivalent annual net benefits for this project to exceed $15 million, with a benefit-cost ratio of 3.1 for the entire Sabine Pass to Galveston Bay Study. The project would protect people, communities, industries and environments from future hurricanes and extreme storm events.

Estimated Total Project Cost: $2,363,600,000*
Federal $1,536,340,000 | Non-Federal: $827,260,000

**Partial funding identified*

Port Arthur Hurricane Flood Protection Levee
(Project ID R1-48)



Region: 1

Location:

Along the GIWW at Port Arthur

County:

Jefferson

Status:

Approved for Engineering & Design

Stakeholders:

- U.S. Army Corps of Engineers
- Jefferson County Drainage District No. 7
- Texas General Land Office

Project Type:

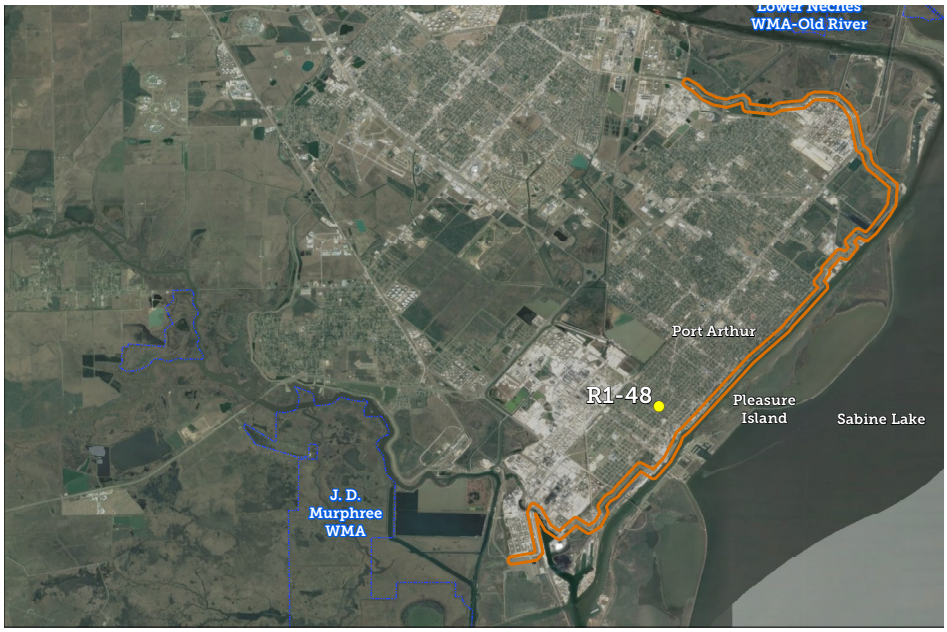
Flood Risk Reduction

Action:

Coastal Storm Risk Management

Resiliency Strategy:

Societal Resiliency (Storm Surge Suppression)



Project Description

This project is part of the U.S. Army Corps of Engineers' Sabine Pass to Galveston Bay Study, which has been approved for design and construction. The project would include raising 5.5 miles of earthen levees, construction or reconstruction of 5.7 miles of floodwall, and construction of 1,830 feet of a new earthen levee in Port Neches northwest of the existing northern terminus. Additionally, the project would replace 26 vehicle closure structures and add erosion protection. Jefferson County Drainage District No. 7, the non-federal sponsor, would be responsible for paying back up to 35 percent of the total project cost over the next 30 years, or approximately $308,665,000.

Project Need

The U.S. Army Corps of Engineers evaluated the future, no-action scenario for Port Arthur due to coastal storm surge. Based on this evaluation, there are concerns for life-safety for over 116,000 people, as well as potential for economic damages of more than $127 million annually, damages to critical infrastructure, and impacts on significant environmental resources if the project is not completed.

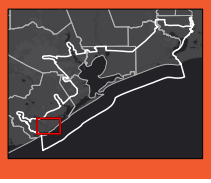
Project Benefit

This project would improve Port Arthur's floodwall and levee system and increase resiliency by installing erosion protection. The project would protect people, communities, industries and environments from future hurricanes and extreme storm events.

Estimated Total Project Cost: $881,900,000*
Federal $573,235,000 | Non-Federal $308,665,000

**Partial funding identified*

Freeport Hurricane Flood Protection Levee
(Project ID R1-49)



Region: 1

Location:

Along the Brazos River, Oyster Creek, and Freeport Navigation Channel

County:

Brazoria

Status:

Approved for Engineering & Design

Stakeholders:

- U.S. Army Corps of Engineers
- Velasco Drainage District
- Texas General Land Office

Project Type:

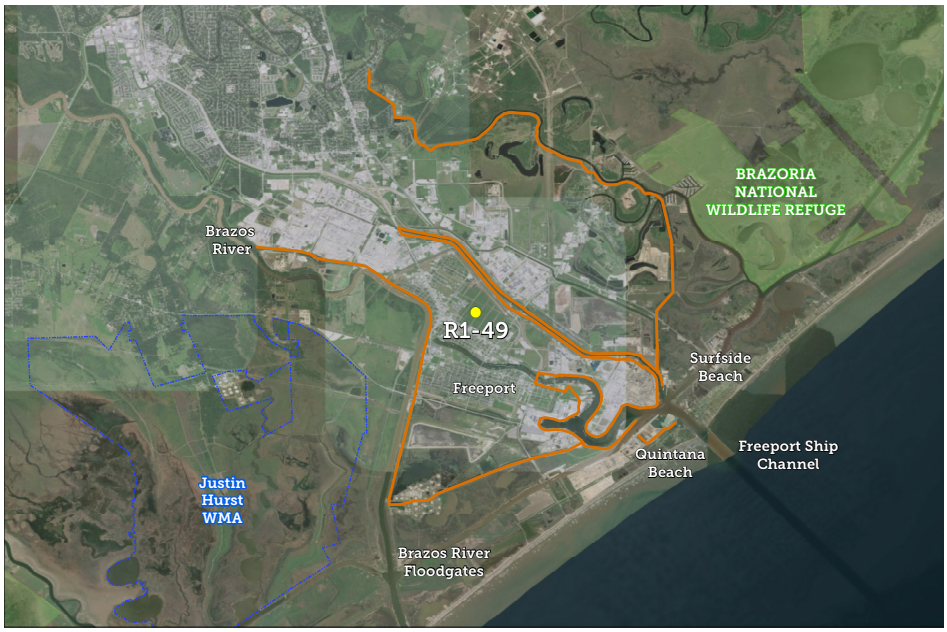
Flood Risk Reduction

Action:

Coastal Storm Risk Management

Resiliency Strategy:

Societal Resiliency (Storm Surge Suppression)



Project Description

This project is part of the U.S. Army Corps of Engineers' Sabine Pass to Galveston Bay Study, which has been approved for design and construction. The project would include raising 13.1 miles of existing earthen levees, constructing or reconstruction of 5.5 miles of floodwall, and installing navigable sector gates at the Dow Barge Canal. The project also would replace 10 vehicle closure structures at rail road crossings and add erosion protection. Additionally, the Highway 332 crossing would be raised and reconstructed, 4 drainage structures would be installed, and the floodwall at Port Freeport's Berth 5 dock would be raised. Velasco Drainage District, the non-federal sponsor, would be responsible for paying back up to 35 percent of the total project cost over the next 30 years, or approximately $249,130,000.

Project Need

The U.S. Army Corps of Engineers evaluated the future, no-action scenario for Freeport due to coastal storm surge. Based on this evaluation, there are concerns for life-safety for over 16,000 people, as well as potential for economic damages of more than $181 million annually, damages to critical infrastructure, and impacts on significant environmental resources if the project is not completed.

Project Benefit

This project would improve 43 percent of Freeport's existing 43-mile long floodwall and levee system and would increase resiliency by installing erosion protection. The installation of navigable sector gates would help reduce surge penetration at Dow Barge canal. The project also would protect people, communities, industries and environments from future hurricanes and extreme storm events.

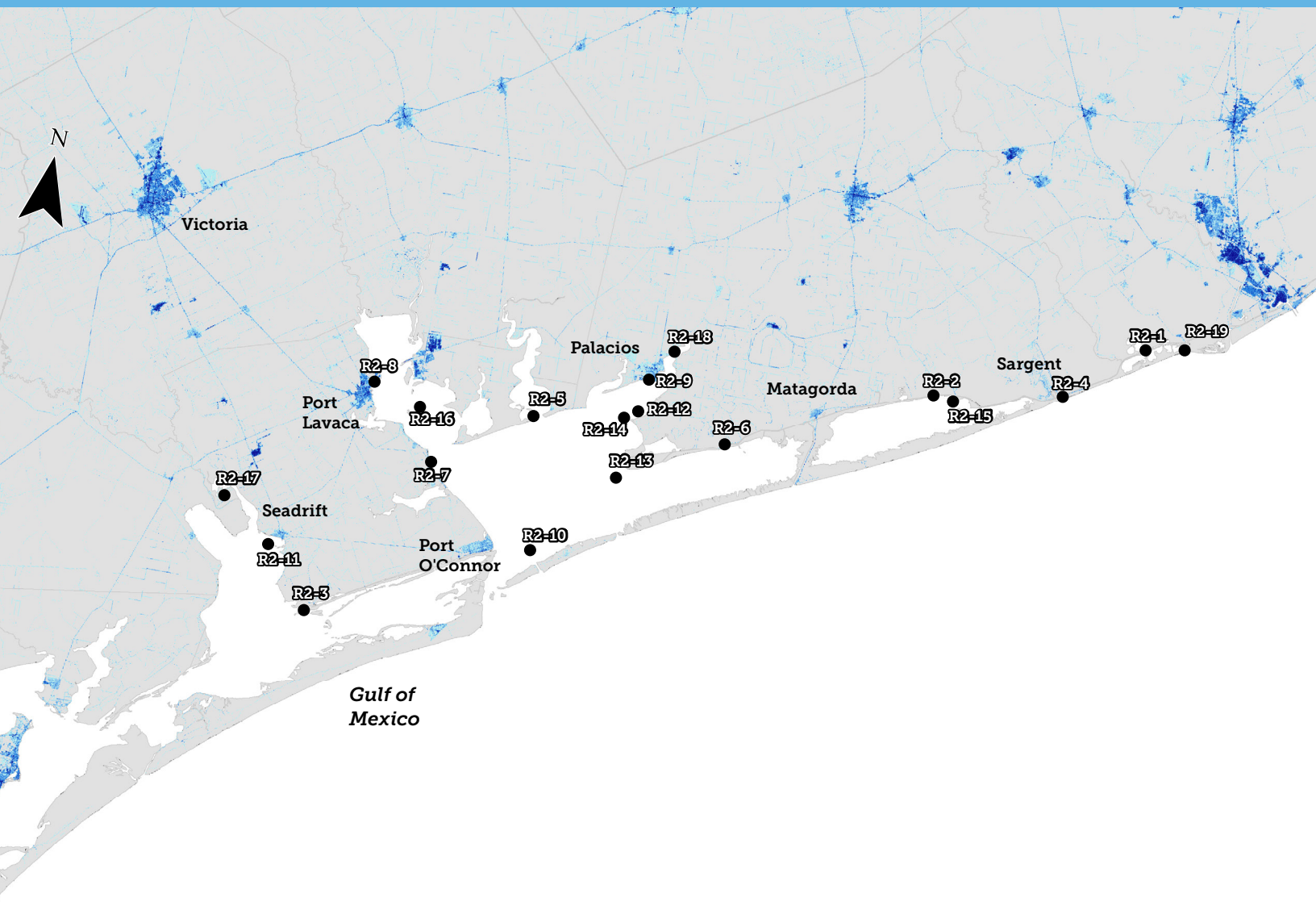
Estimated Total Project Cost: $711,800,000*
Federal $462,670,000 | Non-Federal: $249,130,000

**Partial funding identified*

REGION 2

TIER 1 PROJECTS

19 Projects *$163M+*



Brazos River to Cedar Lake Creek GIWW Stabilization
(Project ID R2-1)

Region: 2

Location:

Shoreline along the GIWW in the San Bernard National Wildlife Refuge

County:

Brazoria

Status:

Conceptual

Stakeholders:

- U.S. Fish and Wildlife Service
- U.S. Army Corps of Engineers
- Texas General Land Office
- Brazoria County
- Private Landowners

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

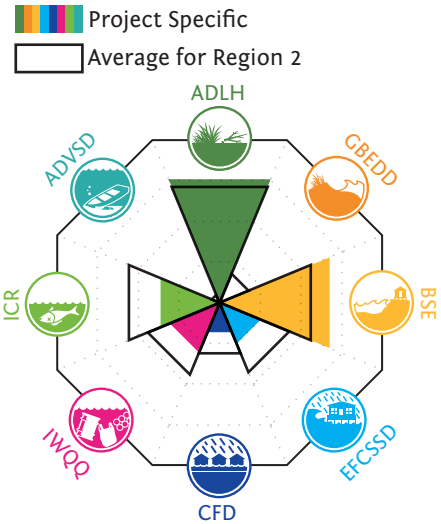
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration, and Monitoring); **Societal Resiliency** (Water-Based Transit Enhancement)

Jobs Created:

Creates approximately 128 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would construct breakwaters as a living shoreline along approximately 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, which is on U.S. Fish and Wildlife Service and privately-owned lands. Approximately 1 mile of this breakwater has been constructed. An additional 2 permitted miles are anticipated to be constructed in summer 2019, provided that sufficient matched and leveraged funds are made available.

Project Need

Bay shorelines and dredged 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.

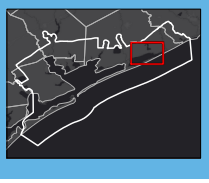
Project Benefit

While both sides of the GIWW require restoration, restoring the southern side, which shows more critical erosion and potential breach areas, would provide some secondary benefits to the northern side by reducing distances over which waves can generate. The proposed design and construction methodology would be evaluated closely to avoid adverse impacts on water circulation patterns and oyster habitat within the lakes.

Estimated Total Project Cost: $35,800,000*

**Partial funding identified*

Boggy Cut GIWW Stabilization *(Project ID R2-2)*



Region: 2

Location:

On the GIWW in East Matagorda Bay

County:

Matagorda

Status:

Conceptual

Stakeholders:

- Texas Department of Transportation
- U.S. Army Corps of Engineers
- Texas General Land Office
- Matagorda County

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Land Acquisition

Action:

Wetland Protection and/or Shoreline Stabilization

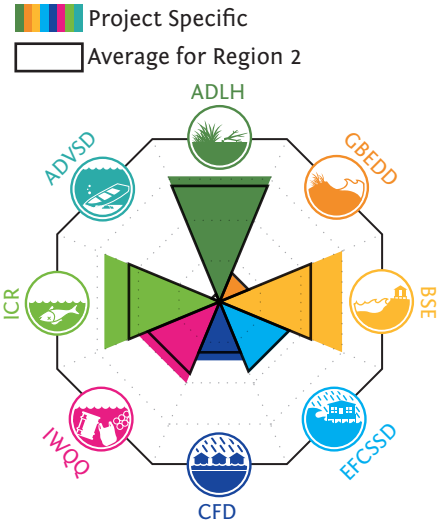
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration, and Monitoring); **Societal Resiliency** (Water-Based Transit Enhancement)

Jobs Created:

Creates approximately 26 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

To mitigate erosion in the Gulf Intracoastal Waterway (GIWW) near Boggy Cut, 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 project also could include an acquisition of private property adjacent to the GIWW, if willing sellers are established.

Project Need

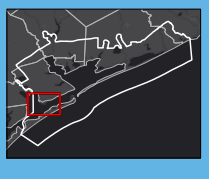
The GIWW near Boggy Cut is experiencing erosion caused by wind, waves and ship wakes, which exposes the GIWW to the larger fetch of East Matagorda Bay. This will negatively impact ship traffic, as well as the bay shoreline which will likely continue to erode.

Project Benefit

If the project does not occur, erosion in this area would worsen, and the GIWW would be further exposed to breaching from the adjacent bay systems. This would lower the efficiency of transporting cargo along the GIWW. Acquisition of private properties adjacent to the GIWW could result in the restoration of coastal habitats and create a more resilient coastline in the area.

Estimated Total Project Cost: $9,300,000

Welder Flats Wildlife Management Area
(Project ID R2-3)



Region: 2

Location:

Southern shoreline of San Antonio Bay, south of Seadrift

County:

Calhoun

Status:

Conceptual

Stakeholders:

- Texas Parks & Wildlife Department
- San Antonio Bay Partnership

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

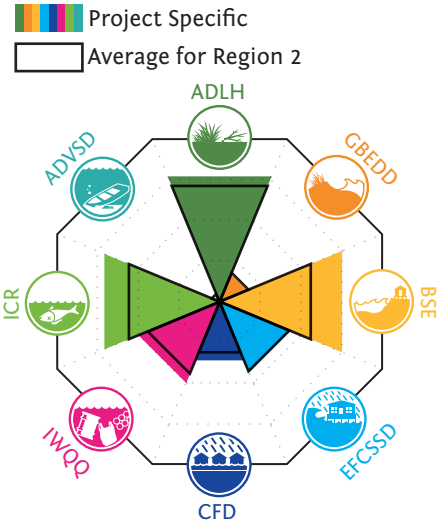
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration, and Monitoring); **Societal Resiliency** (Water Based Transit Enhancement)

Jobs Created:

Creates approximately 22 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The Welder Flats Wildlife Management Area is made up of 1,480 acres of submerged coastal wetlands that provide habitat for the endangered Whooping Crane and numerous other species of waterfowl, wading birds and fisheries. Rock breakwaters and/or a living shoreline are proposed for this area. An alternatives analysis, followed by detailed engineering and design, would be required to determine the most resilient solution for the project.

Project Need

Shoreline erosion has become a persistent problem in this Wildlife Management Area due to its proximity to the Gulf Intracoastal Waterway (GIWW).

Project Benefit

This project would help mitigate shoreline erosion caused by boats traveling along the GIWW. It also would protect this Wildlife Management Area, which is designated as critical habitat by the U.S. Fish and Wildlife Service.

Estimated Total Project Cost: $1,600,000

Sargent Beach & Dune Restoration *(Project ID R2-4)*

Region: 2

Location:

Gulf shoreline south of Sargent and east of East Matagorda Bay

County:

Matagorda

Status:

Conceptual

Stakeholders:

- Matagorda County
- Texas General Land Office

Project Type:

Beach Nourishment;
Dune Restoration

Action:

Wetland Protection and/or Shoreline Stabilization

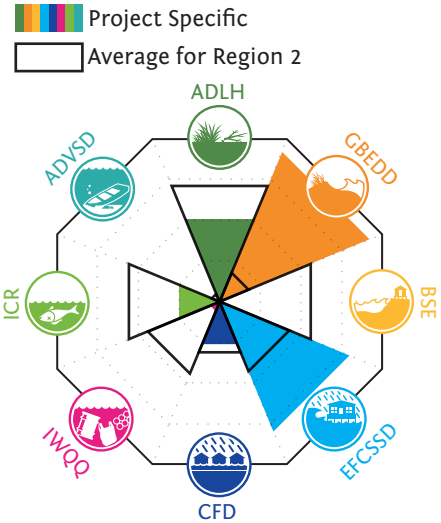
Resiliency Strategy:

Ecological Resiliency (Beach Nourishment and Dune Restoration)

Jobs Created:

Creates approximately 575 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The project would nourish and restore approximately 8 miles of beach shoreline and dunes on Sargent Beach. This solution could include constructing groins or detached breakwaters. The nourishment efforts would primarily rely on sand sources that developed nearshore along the Brazos and San Bernard River deltas, with the additional possibility of a source offshore in the Colorado River Delta.

Project Need

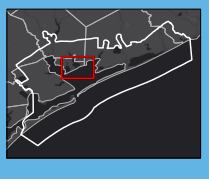
The Sargent Beach shoreline is heavily eroding. A restoration recommendation of phased 2-mile stretches of shoreline, focused on critical needs, is proposed to account for sediment and budget limitations as opposed to addressing the full project length in a single phase of work.

Project Benefit

This project would help protect the shoreline of Sargent Beach from erosion and habitat loss. The construction of groins or detached breakwaters would retain sediment on the beach to slow the natural processes of offshore transport.

Estimated Total Project Cost: $66,300,000

Redfish Lake Living Shoreline *(Project ID R2-5)*



Region: 2

Location:

South of Port Alto and east of Keller Bay

County:

Calhoun

Status:

Conceptual

Stakeholders:

- Texas A&M University

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

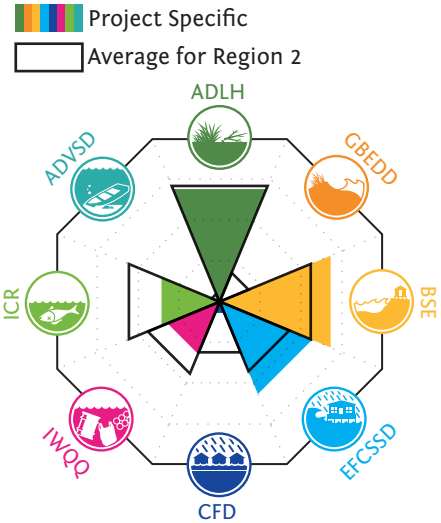
Resiliency Strategy:

Ecological Resiliency (Oyster Reef Planning, Restoration and Monitoring; Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 58 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The peninsula typically separating Redfish Lake from Matagorda Bay is breached. This project would allow for the rebuilding and reconnection of the breached bayside hook back to the peninsula with approximately 3 miles of living shoreline. In addition, the project could restore oyster reefs in the area as a part of the living shoreline.

Project Need

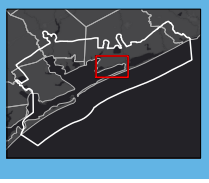
The breach of the peninsula separating Redfish Lake and Matagorda Bay is causing saltwater intrusion into Redfish Lake, which is degrading wetlands, seagrasses, oyster reefs and other marine habitats in the area.

Project Benefit

The reconnection of the breached bayside hook would restore the hydrology of Redfish Lake and help improve the health of local wetlands, seagrasses, and marine habitats. Restoration of oyster reefs in the area would allow for a natural line of defense for Matagorda Bay. Healthy oyster reefs could create natural wave breaks due to the added elevation and structure of the reef. The restored oyster reefs also could be incorporated into the living shoreline design for additional benefits.

Estimated Total Project Cost: $4,700,000

Mad Island Shoreline Protection and Ecosystem Restoration *(Project ID R2-6)*



Region: 2

Location:

Five miles west of Matagorda and south of Mad Island Lake

County:

Matagorda

Status:

Engineering & Design

Stakeholders:

- The Nature Conservancy
- Texas Parks & Wildlife Department
- Texas Sea Grant

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration, and Monitoring)

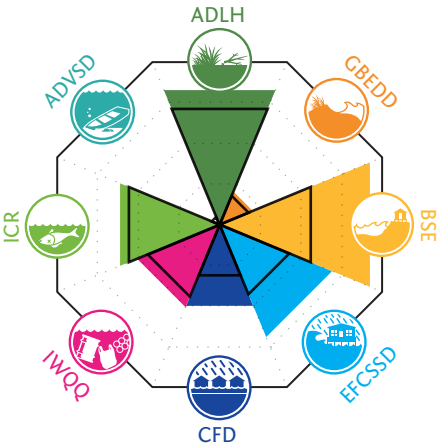
Jobs Created:

Creates approximately 117 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 2



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.

Project Need

The Mad Island Marsh Preserve has been impacted by shoreline erosion at a rate of 5 feet to 10 feet per year 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.

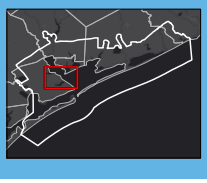
Project Benefit

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 maintain a healthy salinity gradient of this estuarine system.

Estimated Total Project Cost: $7,400,000*

**Partial funding identified*

Ocean Drive Living Shoreline *(Project ID R2-7)*



Region: 2

Location:

Ocean Drive near Indianola

County:

Calhoun

Status:

Conceptual

Stakeholders:

- Calhoun County

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Community Infrastructure

Action:

Wetland Protection and/or Shoreline Stabilization

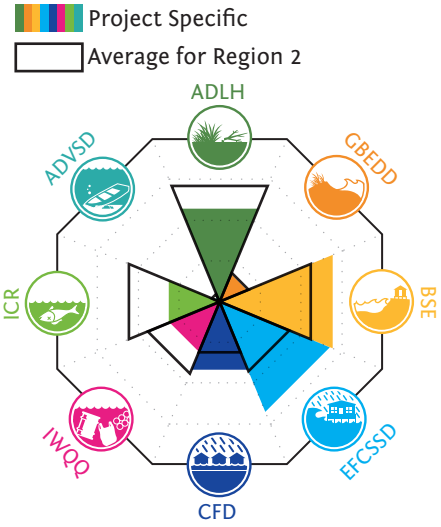
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration, and Monitoring); **Societal Resiliency** (Land-Based Transit Enhancement)

Jobs Created:

Creates approximately 65 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

Ocean Drive is a coastal roadway that connects several coastal communities on the western side of Matagorda Bay. This project would add a living shoreline-type stabilization using breakwaters along Ocean Drive near Indianola, heading north, to control shoreline erosion while potentially building back eroded nearshore habitat.

Project Need

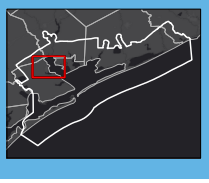
The shoreline in this area has seen an increase in bay shoreline erosion and Ocean Drive is experiencing more frequent flooding, which is expected to continue to worsen under future sea level rise predictions. Magnolia Beach, off the northern end of Ocean Drive, is a popular RV and camping area that is experiencing significant beach erosion.

Project Benefit

This project would serve as a long-term solution to preserve the various restoration projects that have been attempted in the past, such as beach nourishments and wetland restorations. Protecting the shoreline also would help reduce the risk of Ocean Drive from being inundated during high tides or large rainfall events. This is critical since Ocean Drive is an evacuation route for the nearby community.

Estimated Total Project Cost: $4,500,000

Port Lavaca Living Shoreline *(Project ID R2-8)*



Region: 2

Location:

Port Lavaca bay shoreline southwest of the Causeway

County:

Calhoun

Status:

Conceptual

Stakeholders:

- City of Port Lavaca

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

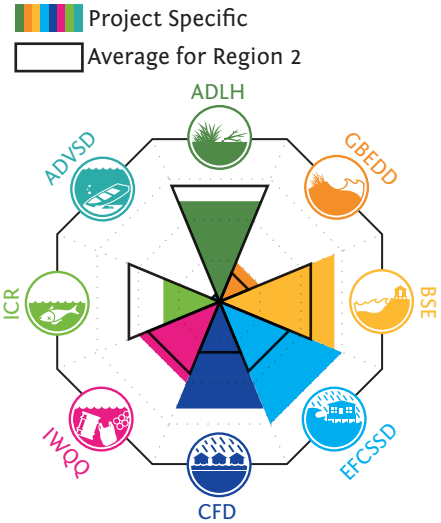
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration, and Monitoring); **Societal Resiliency** (Community Infrastructure Planning and Development)

Jobs Created:

Creates approximately 34 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project proposes to add a living shoreline at Port Lavaca along the bay shoreline southwest of the Lavaca Bay Causeway to enhance wetlands and improve the quality of runoff into Lavaca Bay.

Project Need

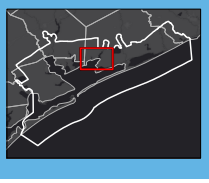
The wetlands in this area have experienced erosion and degradation due to wind driven waves and boat wakes. The purpose of this project would be to attenuate wave action generated by southeasterly winds.

Project Benefit

The living shoreline would trap sediment that could be used to restore wetlands along the shoreline and to filter stormwater runoff in the wetlands prior to the water entering Lavaca Bay. A living shoreline in this area would be very visible to the public and could be an aesthetic alternative used to help educate the public on the benefits of wetlands to stormwater treatment.

Estimated Total Project Cost: $2,400,000

Palacios Shoreline Revitalization Project
(Project ID R2-9)



Region: 2

Location:

Palacios shoreline on Matagorda Bay

County:

Matagorda

Status:

Conceptual

Stakeholders:

- City of Palacios

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Community Infrastructure

Action:

Wetland Protection and/or Shoreline Stabilization

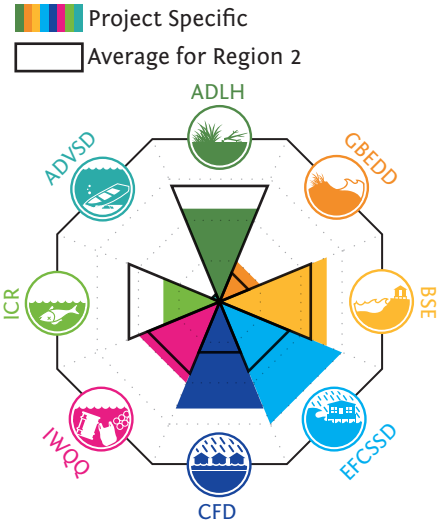
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration, and Monitoring; Oyster Reef Planning, Restoration, and Monitoring); **Societal Resiliency** (Storm Surge Suppression)

Jobs Created:

Creates approximately 63 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The Palacios Seawall is the only line of protection for this area from erosion and infrastructure damage caused by wave energy from winds and storm surge. The seawall is approximately 3 miles long and fringes Palacios' southern and eastern shores. A lighted walkway, boat ramps and lighted fishing piers are maintained along the approximately 1.5-mile southern section of seawall. These areas enhance angling, birdwatching and sightseeing opportunities, creating popular destinations for locals and tourists. The Palacios living shoreline project proposal is for engineering, design and construction of a rock sill located approximately 50 feet to 100 feet offshore and parallel to selected segments of the seawall.

Project Need

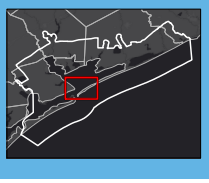
Storm surge from Hurricane Harvey resulted in significant scour and undercutting along sections of the seawall. Hurricane Harvey also destroyed much of the recreational fishing and nature tourism infrastructure – lighted piers, walkways, etc. The tidal segment of the Tres Palacios River/Bay is listed as an impaired water by the Environmental Protection Agency's Clean Water Act.

Project Benefit

The purpose of the project would be to attenuate wave action generated by prevailing southeasterly winds, enhance protection of the seawall and infrastructure by reducing scour and erosion, reduce annual maintenance costs, stabilize shorelines, and protect and enhance fringe oyster reef habitats, wetland habitats, and the fish and wildlife resources that utilize them. Specific sections of the living shoreline would be located at storm water drains/culverts and designed to trap sediment, encourage wetland development and help alleviate water quality issues. Benefits would include increased shoreline stabilization, reduced scour and undercutting at the seawall base, improved water quality, enhanced birdwatching and fishing opportunities, and enhanced habitat availability in the Tres Palacios nursery area.

Estimated Total Project Cost: $4,400,000

Chester Island Restoration *(Project ID R2-10)*



Region: 2

Location:

Island in southwest Matagorda Bay, east of Port O'Connor

County:

Matagorda

Status:

Shovel-ready

Stakeholders:

- Audubon Texas
- U.S. Army Corps of Engineers
- Texas General Land Office
- San Antonio Bay Partnership

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Rookery Island Enhancement

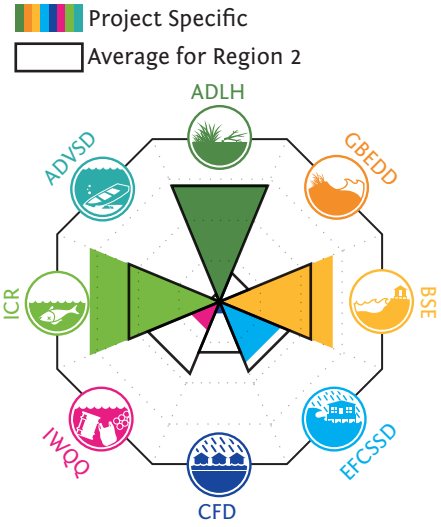
Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation)

Jobs Created:

Creates approximately 65 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The project would slow the erosion of Chester Island by adding 30 acres of land using nearshore breakwaters to retain and build back soils. This project is shovel-ready and potential sites for beneficial use of dredged material (BUDM) have been identified to rebuild the eroded land. Funding for this project would pay for additional time and resources to place the BUDM material in a manner beneficial to the island's avian inhabitants.

Project Need

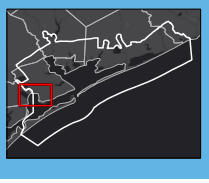
Chester Island is a U.S. Army Corps of Engineers dredged placement site that is eroding at a faster rate than material is being placed. The primary causes of erosion are high currents near the Matagorda Ship Channel jetties, wakes from the ship channel and Gulf Intracoastal Waterway, high tides, and strong wind-driven wave forces.

Project Benefit

Enhancing this critical bird habitat for the millions of migrating birds that fly through and nest on this rookery island will continue to allow the colonial waterbirds to flourish.

Estimated Total Project Cost: $4,500,000

San Antonio Bay Rookery Island Restoration
(Project ID R2-11)



Region: 2

Location:

Island south of the City of Seadrift in San Antonio Bay

County:

Calhoun

Status:

Permitted

Stakeholders:

- San Antonio Bay Rookery Island Restoration
- U.S. Fish and Wildlife Service
- San Antonio Bay Foundation
- San Antonio Bay Partnership
- Texas Department of Transportation

Project Type:

Habitat Creation & Restoration

Action:

Rookery Island Enhancement

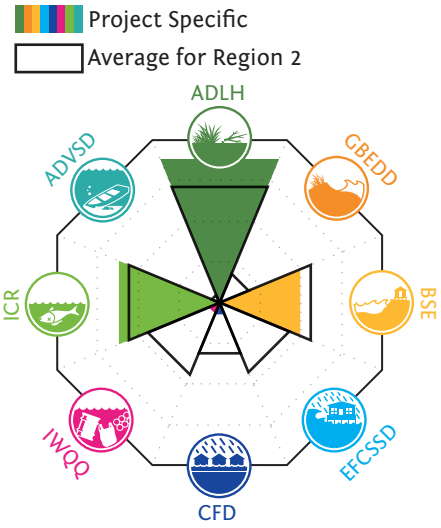
Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation)

Jobs Created:

Creates approximately 138 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The loss of nesting habitat in San Antonio Bay has led to a decline in herons, egrets, black skimmers and brown pelicans. An initial site assessment of San Antonio Bay identified five locations of previously functioning rookery islands that are suitable for reconstruction. This project would allow for the restoration of a historical rookery island utilizing one or more of the five identified locations. This project is currently permitted.

Project Need

The decline in bird populations at San Antonio Bay negatively impacts the entire Texas Gulf Coast rookery island chain and the local economy.

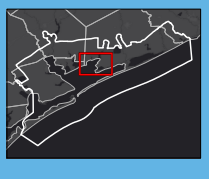
Project Benefit

Restoring a rookery island in San Antonio Bay would provide a vital nesting habitat for various bird species and encourage an increase in local bird populations. Additionally, beneficial use of dredged material would be used from the adjacent channels, when possible, for reconstruction.

Estimated Total Project Cost: $9,600,000*

**Partial funding identified*

Coon Island Restoration *(Project ID R2-12)*



Region: 2

Location:

Island in Tres Palacios Bay near Oliver Point

County:

Matagorda

Status:

Conceptual

Stakeholders:

- Texas Sea Grant
- Matagorda Bay Foundation
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration

Action:

Rookery Island Enhancement

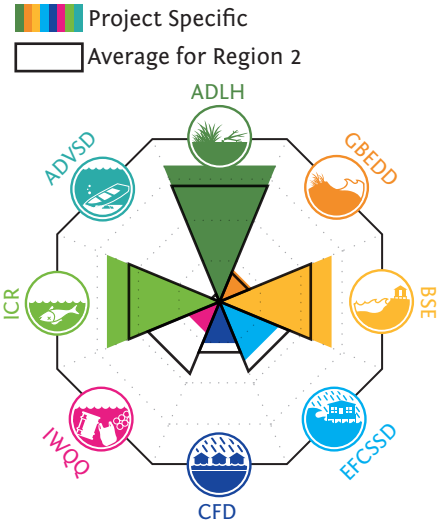
Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement; Rookery Island Protection, Restoration, and Creation)

Jobs Created:

Creates approximately 128 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

Coon Island has been impacted by erosion and relative sea level rise and has lost its original connectivity. This project would add fill material to Coon Island to restore the elevation and original connectivity of the island. The project would be enhanced by concurrently implementing the Oliver Point Oyster Reef Restoration project, which would provide additional wave protection to Coon Island and prevent future erosion of the restored island.

Project Need

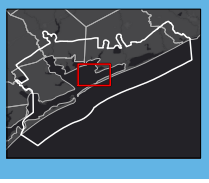
Coon Island in Matagorda Bay has subsided and lost its linear connectivity. The island also continues to lose land through erosion.

Project Benefit

Adding material to increase the elevation of the island would protect Coon Island Bay and improve the shallow water bay habitat providing increased area sheltered from the larger Matagorda Bay and Tres Palacios Bay. This change would support nursery areas for recreational and commercially-important species, which, in addition to restoring the island, would improve bird habitat.

Estimated Total Project Cost: $5,500,000

Half Moon Oyster Reef Restoration – Phase 3
(Project ID R2-13)



Region: 2

Location:

Oyster reef in the heart of Matagorda Bay

County:

Matagorda

Status:

Shovel-ready

Stakeholders:

- The Nature Conservancy

Project Type:

Habitat Creation & Restoration

Action:

Oyster Reef Enhancement

Resiliency Strategy:

Ecological Resiliency (Oyster Reef Planning, Restoration, and Monitoring)

Jobs Created:

Creates approximately 32 jobs during construction.

Project Description

Under this project, 30 acres of oyster reef habitat would be restored at Half Moon Oyster Reef in Matagorda Bay. The project is shovel-ready (designed, permitted and leased).

Project Need

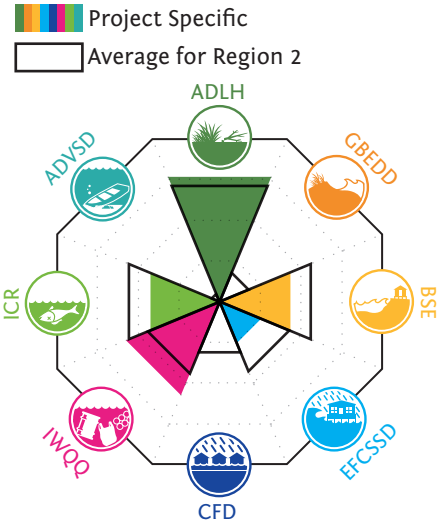
The Nature Conservancy's 2016 study of 54 previously restored acres at Half Moon Reef showed that the oyster reef restoration caused recreational fishing activity to surge. This resulted in an increase of $691,000 of the state's gross domestic product per year and over $1.2 million in annual economic activity.

Project Benefit

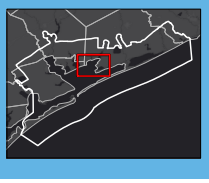
The restoration of Half Moon Oyster Reef would enhance the oyster and fisheries habitat, and expand a popular recreational fishing area.

Estimated Total Project Cost: $2,300,000

Project Benefits Per Issues of Concern



Oliver Point Oyster Reef Restoration *(Project ID R2-14)*



Region: 2

Location:

Oyster reef in Matagorda Bay near Oliver Point

County:

Matagorda

Status:

Engineering & Design

Stakeholders:

- Texas Sea Grant
- The Matagorda Bay Foundation
- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration

Action:

Oyster Reef Enhancement

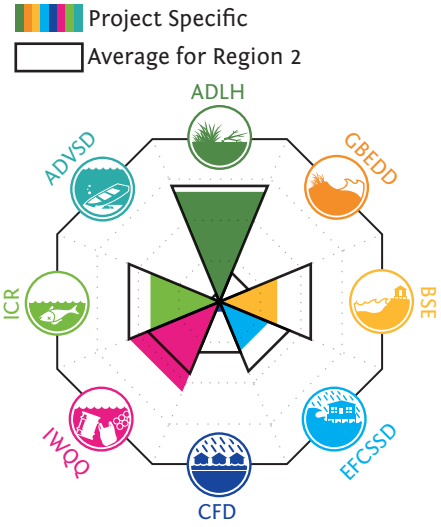
Resiliency Strategy:

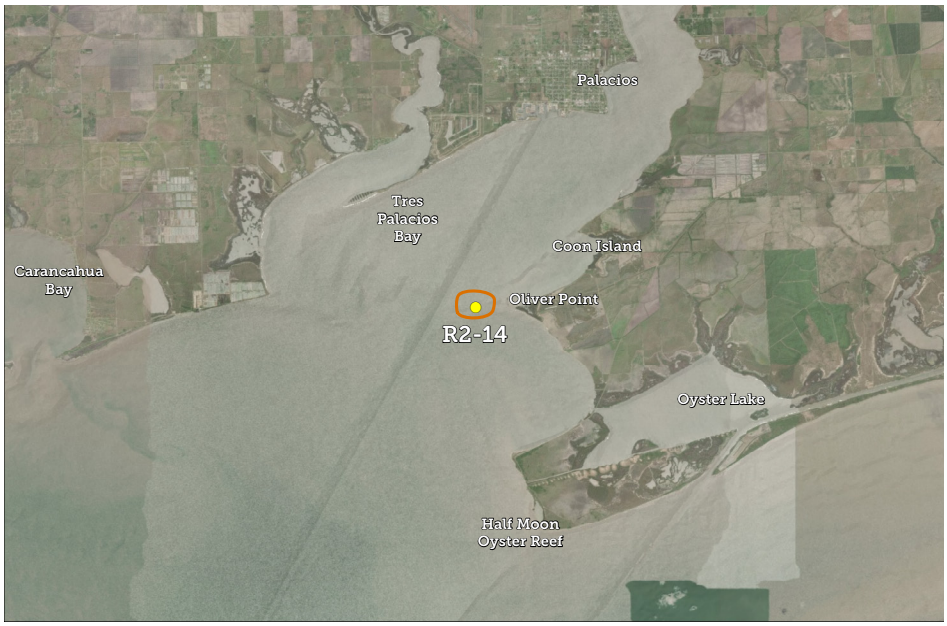
Ecological Resiliency (Oyster Reef Planning, Restoration, and Monitoring)

Jobs Created:

Creates approximately 19 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

The project would restore approximately 10 acres of the legacy Oliver Point Oyster Reef in Matagorda Bay.

Project Need

The Oliver Point oyster reef has lost valuable oyster habitat due to pressures such as coastal storm impacts. In addition, the nearby Oliver Point and Coon Island are experiencing rapid erosion, in part due to a lack of protection provided by the oyster reef structure.

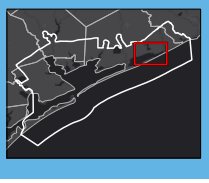
Project Benefit

Restoring the reef would afford wave protection to Oliver Point and Coon Island, and would 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.

Estimated Total Project Cost: $1,400,000*

**Partial funding identified*

Chinquapin Oyster Reef Restoration *(Project ID R2-15)*



Region: 2

Location:

Oyster reef in East Matagorda Bay

County:

Matagorda

Status:

Conceptual

Stakeholders:

- Texas Parks & Wildlife Department

Project Type:

Habitat Creation & Restoration

Action:

Oyster Reef Enhancement

Resiliency Strategy:

Ecological Resiliency (Oyster Reef Planning, Restoration, and Monitoring)

Jobs Created:

Creates approximately 19 jobs during construction.

Project Description

The project would provide approximately 10 acres of oyster reef restoration on the legacy Chinquapin Reef in East Matagorda Bay. The proximity of the reef to the Gulf Intracoastal Waterway would be considered during restoration planning. The project would include coordination to determine if the oyster habitats would be commercially harvestable.

Project Need

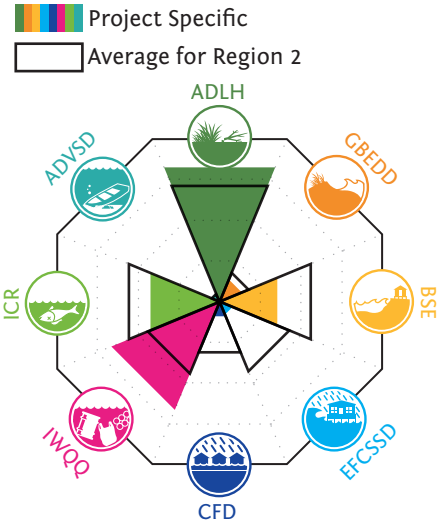
The East Matagorda Bay oyster reefs are harvestable and a public resource. These oyster reefs also are a popular fishing location.

Project Benefit

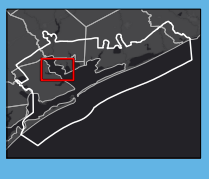
Improved water quality, increased recreational fishing opportunities, enhanced marine biodiversity and other ecosystem benefits would occur with this completed project.

Estimated Total Project Cost: $1,400,000

Project Benefits Per Issues of Concern



Lavaca Bay Oyster Reef Restoration *(Project ID R2-16)*



Region: 2

Location:

Location to be determined in Lavaca Bay

County:

Calhoun

Status:

Conceptual

Stakeholders:

- Port Lavaca
- Calhoun Port Authority
- Texas Parks & Wildlife Department

Project Type:

Habitat Creation & Restoration

Action:

Oyster Reef Enhancement

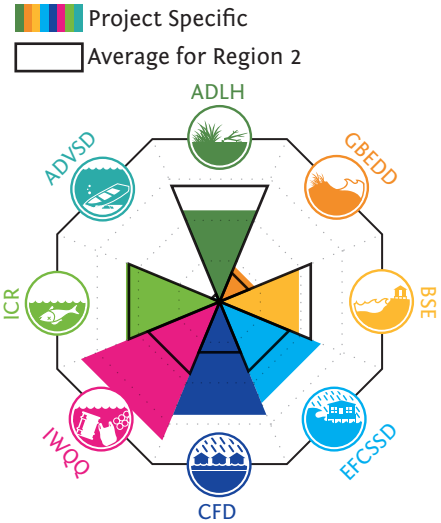
Resiliency Strategy:

Ecological Resiliency (Oyster Reef Planning, Restoration, and Monitoring)

Jobs Created:

Creates approximately 18 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project proposes oyster reef habitat restoration in Lavaca Bay. This project would restore additional reefs in Lavaca Bay, which is known to have a water climate suitable for oyster survival and growth. The project would include coordination to determine if the oyster habitats would be commercially harvestable.

Project Need

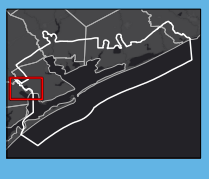
Oyster reefs occupy approximately 33,000 acres of the Matagorda Bay system, with many of these reefs existing in Lavaca Bay.

Project Benefit

Restoring oyster reefs would provide additional nursery habitat for fish, would improve water quality, and could increase the overall biodiversity within the bay. Oyster reef restoration would help protect the shoreline by providing wave attenuation near shorelines. In addition, the project could enhance the local economy through recreational fishing opportunities.

Estimated Total Project Cost: $1,300,000

San Antonio Bay Hydrologic Regional Watershed Plan
(Project ID R2-17)



Region: 2

Location:

Watersheds outfalling to San Antonio Bay

County:

Calhoun

Status:

Conceptual

Stakeholders:

- San Antonio River Authority
- Guadalupe-Blanco River Authority
- City of San Antonio
- Texas Water Development Board
- San Antonio Bay Partnership

Project Type:

Study, Policy, Plan or Program; Hydrologic Connectivity

Action:

Delta Management; Watershed Planning

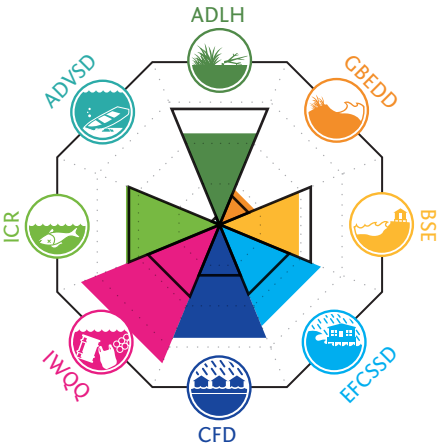
Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement); **Societal Resiliency** (Community Infrastructure Planning and Development); **Administrative Resiliency** (Plan)

Project Benefits Per Issues of Concern

Project Specific

Average for Region 2



Project Description

This regional watershed plan would investigate the viability of alternative options for water quality and stormwater volumes. This regional watershed plan would investigate options such as relocating sediment buildup behind dams, collaborating with industry to create strategies for natural infrastructure to improve treatment and mitigate pollution, outreach or incentives for farming communities to use vegetative buffers between agricultural lands and the bays, and installing piping to redirect and retain floodwaters upstream. The plan also would identify locations for permanent monitoring stations to allow for monitoring and adaptive management throughout the watershed.

Project Need

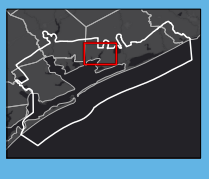
Based on the extreme flooding the region experienced during Hurricane Harvey, regional watershed planning is needed for large-scale storm events.

Project Benefit

This project would help better manage and monitor water quality and stormwater runoff for San Antonio Bay, especially during extreme flooding events. Developing and implementing the plan would improve the water quality that inflows to the Bay from the surrounding watershed and control the volume of stormwater that drains to the Bay. Permanent monitoring stations in the area would allow these efforts to be continuously observed and improved over time.

Estimated Total Project Cost: $250,000

Matagorda Bay Regional Inflow Study
(Project ID R2-18)



Region: 2

Location:

Watersheds outfalling to Matagorda Bay

County:

Matagorda, Calhoun, Jackson

Status:

Study

Stakeholders:

- Lower Colorado River Authority
- University of Texas at Arlington
- U.S. Army Corps of Engineers
- Environmental Flows Initiative
- Texas Water Development Board

Project Type:

Study, Policy, Plan or Program; Hydrologic Connectivity

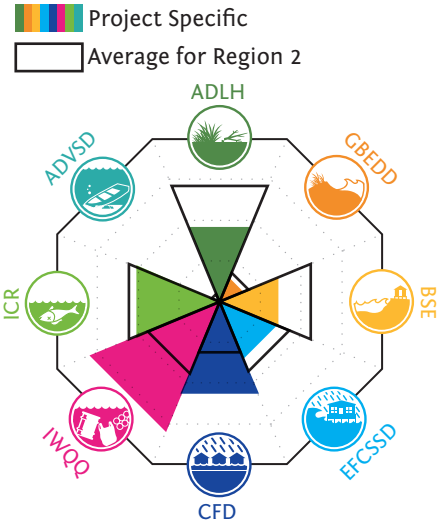
Action:

Watershed Planning

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange); **Administrative Resiliency** (Plan)

Project Benefits Per Issues of Concern



Project Description

Under this project, a regional drainage study would be conducted to describe current conditions and propose management solutions to address freshwater inflow concerns. Recent work has been conducted on Matagorda Bay freshwater inflows via adaptive management plans of the Senate Bill 3 (80th Texas Legislature, 2007) Environmental Flows Process that seek to meet environmental flow recommendations for the system.

Project Need

A primary concern is the depletion of nutrients needed by downstream ecosystems to maintain their functionalities. Particular areas include freshwater flows to Lake Austin, Boggy Bayou, 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.

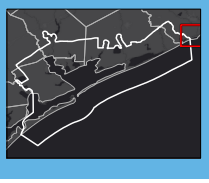
Project Benefit

The outcome of the study would improve rainfall-runoff modeling for coastal watersheds, with a focus on coastal watersheds draining into the San Bernard Estuary and Matagorda Bay.

Estimated Total Project Cost: $250,000*

**Partial funding identified*

Brazos River and San Bernard River Restoration Strategy and Management Plan *(Project ID R2-19)*



Region: 2

Location:

Brazos River and San Bernard River outlets

County: Brazoria

Status: Conceptual

Stakeholders:

- U.S. Army Corps of Engineers
- Texas Water Development Board
- Brazos River Authority
- City of Freeport
- U.S. Fish and Wildlife Service - San Bernard National Wildlife Refuge
- University of Houston-Clear Lake
- University of Texas-Arlington

Project Type:

Study, Policy, Plan or Program; Hydrologic Connectivity

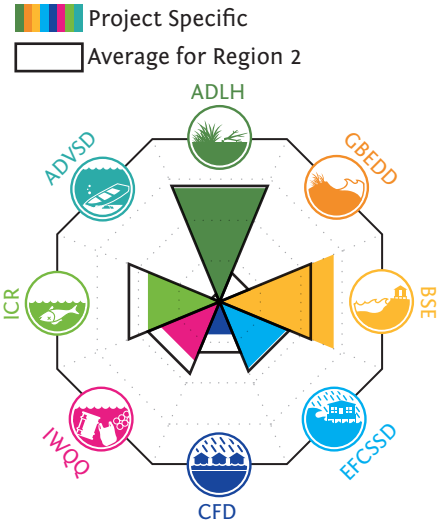
Action:

Watershed Planning

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement); **Societal Resiliency** (Water-Based Transit Enhancement); **Administrative Resiliency** (Plan)

Project Benefits Per Issues of Concern



Project Description

This project proposes a management plan and restoration strategy for the Brazos River and the San Bernard River that would include beneficial use of dredged material. The restoration strategy would have three components. First, the project would include a study to evaluate the influence of flow regime, including floods, and adopted Texas Commission on Environmental Quality freshwater inflow standards on salinity, suspended solids, nutrients, nekton, offshore sediment plume size and direction, and the geomorphology of the Brazos River Delta. Second, the U.S. Army Corps of Engineers would assess the impact of removing locks on the Brazos River and develop a restoration plan that would include structural and non-structural solutions to address the shoaling issues under a separate funding source. Third, there would be a study to assess rainfall-runoff modeling for coastal watersheds draining into the San Bernard Estuary and Matagorda Bay.

Project Need

The hydrology of the Brazos River, San Bernard River and Caney Creek has been disrupted by the Gulf Intracoastal Waterway and by the redirection of the Brazos River using floodgates. This resulted in modifications to openings to the Gulf of Mexico and sedimentary processes. 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, and increased deltaic processes in East Matagorda Bay at Mitchell's Cut.

Project Benefit

While the hydrology changes in the area have both positive and negative impacts on natural resources and the human environment, the region's hydrologic interactions are not well understood. This plan would evaluate the network as a whole, and develop long-term solutions to restore and improve the hydrology of the Brazos River and San Bernard River.

Estimated Total Project Cost: $325,000*

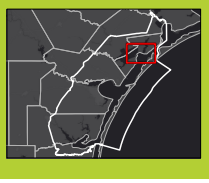
**Partial funding identified*

REGION 3

TIER 1 PROJECTS

27 Projects *$92M+*

Goose Island State Park Habitat Restoration and Protection *(Project ID R3-1)*



Region: 3

Location:

Goose Island State Park, at the Convergence of Aransas Bay and Saint Charles Bay

County:

Aransas

Status:

Permitted

Stakeholders:

- Texas Parks & Wildlife Department
- Texas A&M-Corpus Christi

Project Type:

Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

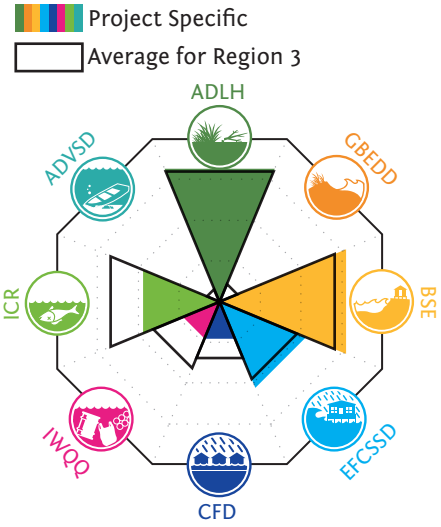
Resiliency Strategy:

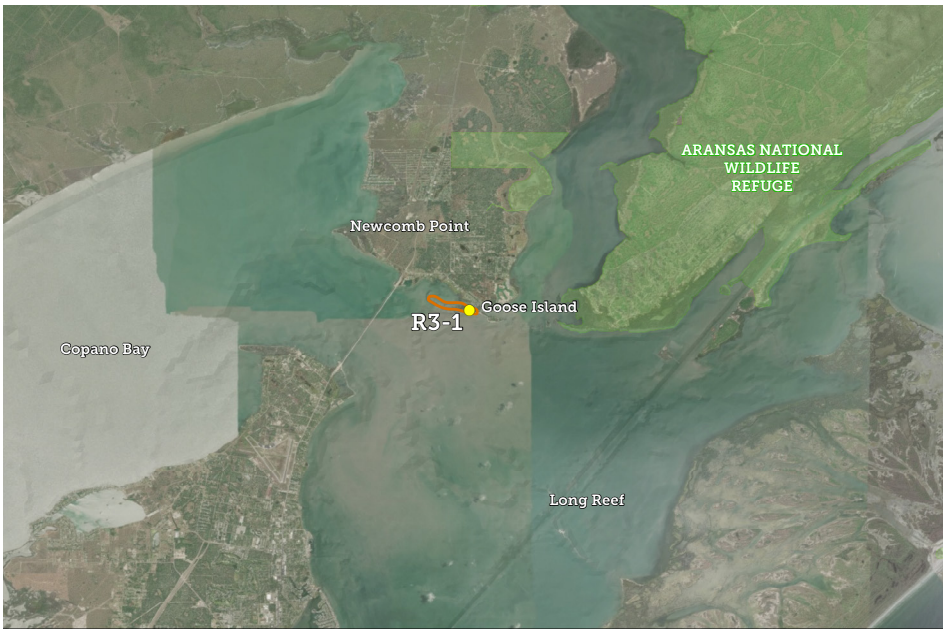
Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 16 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

This project would build upon recent construction of a living reef made of oyster shell just offshore of the project site at Goose Island State Park. Specifically, the project would provide shoreline and habitat protection for the critical estuarine wetland habitat that makes up 25 acres of Goose Island State Park through the construction of 2,000 feet of living shoreline along the rapidly eroding shoreline on the western side of St. Charles Bay. The project would include close to a quarter of an acre of restoration activities, such as transplanting marsh grasses, for the wetland habitat.

Project Need

The shoreline at Goose Island State Park is eroding at a rate of approximately 1.7 feet per year since 1951 due to wave action generated by southeast winds. As a result, this area is in need of protection and restoration.

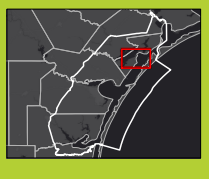
Project Benefit

The primary benefits of this project would be wave attenuation and prevention of shoreline erosion. Secondary benefits would include increased habitat for reef dwelling organisms, water quality improvements from filter feeding oysters, and hard substrate for oysters to settle and grow. This area is visited by thousands of people each year to enjoy the park, see whooping cranes, fish, boat, bird, hunt and enjoy the outdoors. Texas is ranked 4th in the nation for the highest wildlife-associated expenditures.[a] Conserving land at Goose Island State Park contributes to the economic and recreational well-being of the region and the state.

Estimated Total Project Cost: $1,400,000

[a] *U.S. Fish & Wildlife Service. 2011. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Available at: https://www.census.gov/prod/2012pubs/fhw11-nat.pdf (accessed Feb 21, 2019)*

Fulton Beach Road Protection *(Project ID R3-2)*



Region: 3

Location:

Roadway along the northwest shoreline of Aransas Bay, east of TX-35

County: Aransas

Status: Permitted

Stakeholders:

- Aransas County
- Aransas County Navigation District
- City of Rockport
- Town of Fulton

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Community Infrastructure

Action:

Wetland Protection and/or Shoreline Stabilization

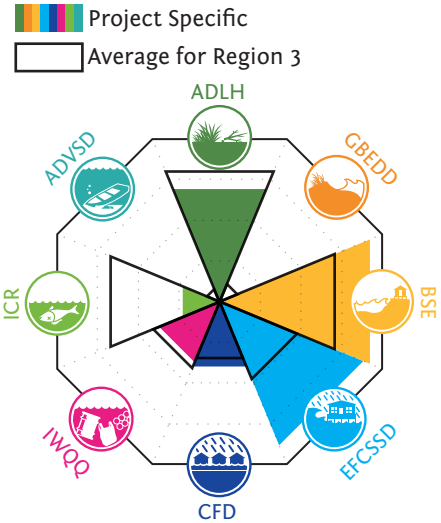
Resiliency Strategy:

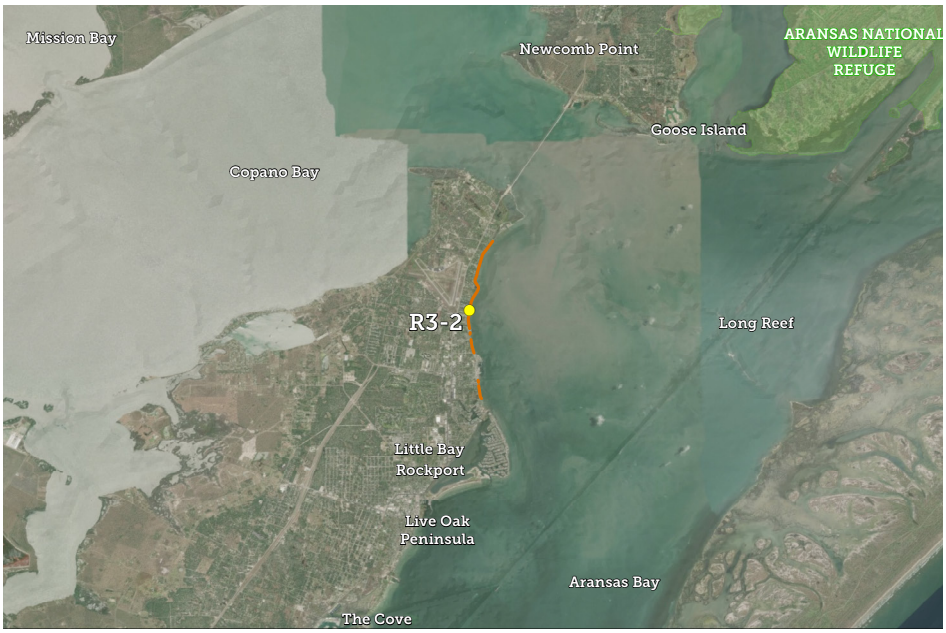
Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Land-Based Transit Enhancement)

Jobs Created:

Creates approximately 80 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

The project would construct up to 4 miles of breakwaters along Fulton Beach in Aransas County. The project would include regrading and filling along the shoreline with vegetative plantings to establish a living shoreline system. The project has been designed and is permitted. The project would build upon previous shoreline stabilization and ecosystem restoration components.

Project Need

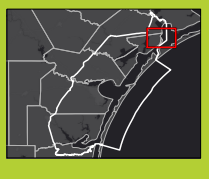
This roadway is critical to the local communities as an evacuation route. The roadway could be undermined or damaged if the erosion in this area is not controlled.

Project Benefit

This project would protect Fulton Beach Road, as well as 70 acres of waterfront property at risk of erosion, which have a cumulative value of $14 million. Healthy wetlands provide a potential economic value of $21,600 per acre based on storm protection.

Estimated Total Project Cost: $3,200,000

Aransas National Wildlife Refuge Dagger Point Shoreline Preservation *(Project ID R3-3)*



Region: 3

Location:

Northeast shoreline of Aransas National Wildlife Refuge along San Antonio Bay

County:

Aransas

Status:

Engineering & Design

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- U.S. Fish and Wildlife Service
- Aransas National Wildlife Refuge
- U.S. Department of the Interior

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

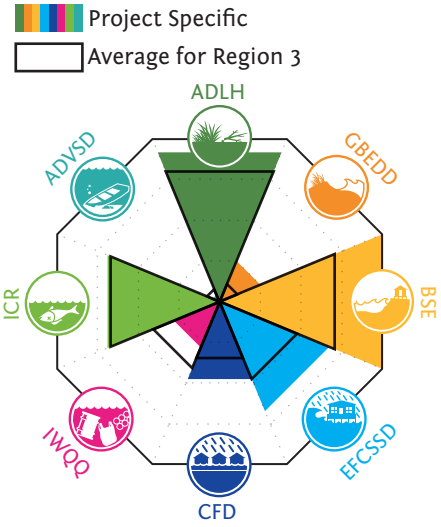
Resiliency Strategy:

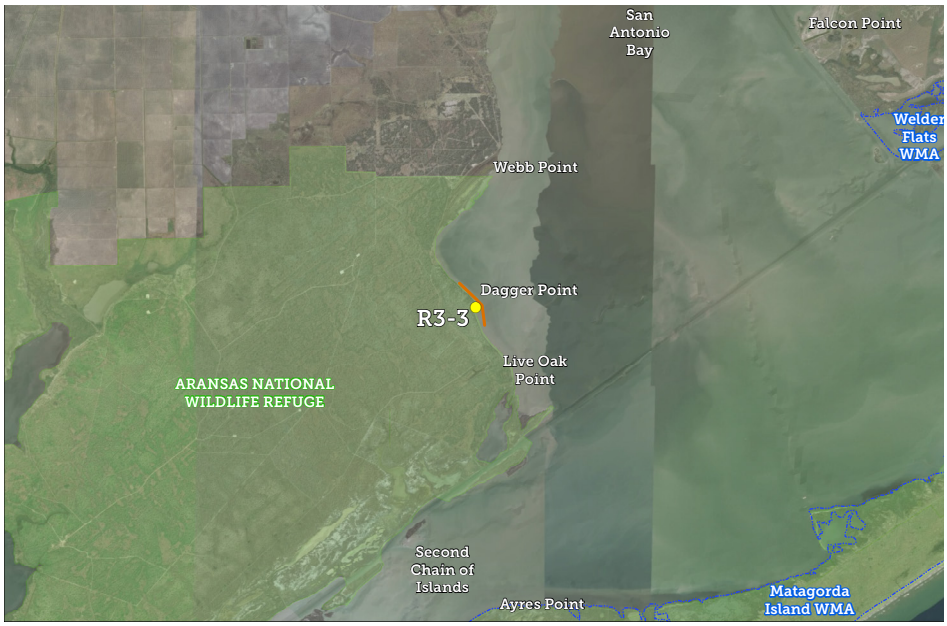
Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 31 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

The project is located along the San Antonio Bay shoreline side of the Aransas National Wildlife Refuge (ANWR) in an area known as Dagger Point. This project would install a living shoreline using rock breakwaters to preserve this area. The Coastal Bend Bays and Estuary Program is working with U.S. Fish and Wildlife Service to conduct an alternatives analysis and complete the preliminary engineering, alternatives analysis, final design and permitting for protection of 1.5 miles of shoreline at Dagger Point. Stakeholders are seeking funding for construction of the shoreline restoration and protection.

Project Need

A 1.5-mile stretch of shoreline along San Antonio Bay is suffering from extremely high rates of erosion, resulting in the loss of valuable coastal habitats every year. Shoreline erosion rates are estimated to range from 5 feet to 30 feet per year, dependent on the specific location and climatic conditions. Years of erosion along the shoreline have resulted in the loss of both emergent marsh habitat and upland habitat that were previously protected by the fringing marsh. Significant erosion in this area has created a bluff that is now 15 feet to 30 feet in elevation. The eroding bluff currently supports a mature stand of Texas Live Oak-Redbay Forest, a plant community that is listed as imperiled. Erosion along this shoreline also threatens nearby public infrastructure at the ANWR and increases the vulnerability of this infrastructure to extreme weather, climate hazards and sea level rise. This infrastructure plays an important role in the local nature tourism economy, necessitating protection from these potential threats.

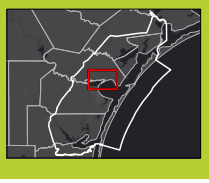
Project Benefit

This project would help preserve the shoreline along Dagger Point and protect nearby critical habitat and public infrastructure.

Estimated Total Project Cost: $2,600,000*

**Partial funding identified*

Portland Living Shoreline *(Project ID R3-4)*



Region: 3

Location:

Shoreline along Nueces Bay northeast of the Nueces Bay Causeway, near Portland

County:

San Patricio, Nueces

Status:

Conceptual

Stakeholders:

- City of Portland
- Nueces County
- San Patricio County

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

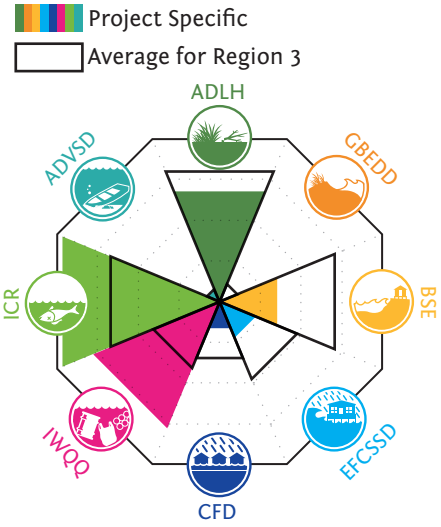
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 36 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The project would create a living shoreline near southwest Portland to prevent shoreline erosion and enhance wetland habitats. The living shoreline would include a shoreline stabilization structure, such as a rock breakwater, in addition to nature-based components, such as wetland plants, to mitigate the effects of erosion.

Project Need

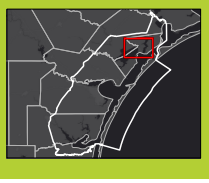
This area of shoreline has degraded due to population growth and land use conversion, in addition to wind-driven erosion. Over the next 50 years, 5 acres of shoreline are projected to erode based on historic shoreline retreat rates if this project does not occur.

Project Benefit

This project would protect the 5 acres of shoreline that are projected to erode. The living shoreline would safeguard the roads, property, and infrastructure behind the shoreline, which would otherwise require relocation or abandonment based on current erosion trends. The project would serve as an example of living shoreline techniques to increase coastal resiliency in a highly visible location for the public.

Estimated Total Project Cost: $3,000,000

Shell Point Ranch Wetlands Protection
(Project ID R3-5)



Region: 3

Location:

Tract on the eastern shoreline of Copano Bay, near Holiday Beach

County:

Aransas

Status:

Acquisition Pending

Stakeholders:

- Texas Parks & Wildlife Department

Project Type:

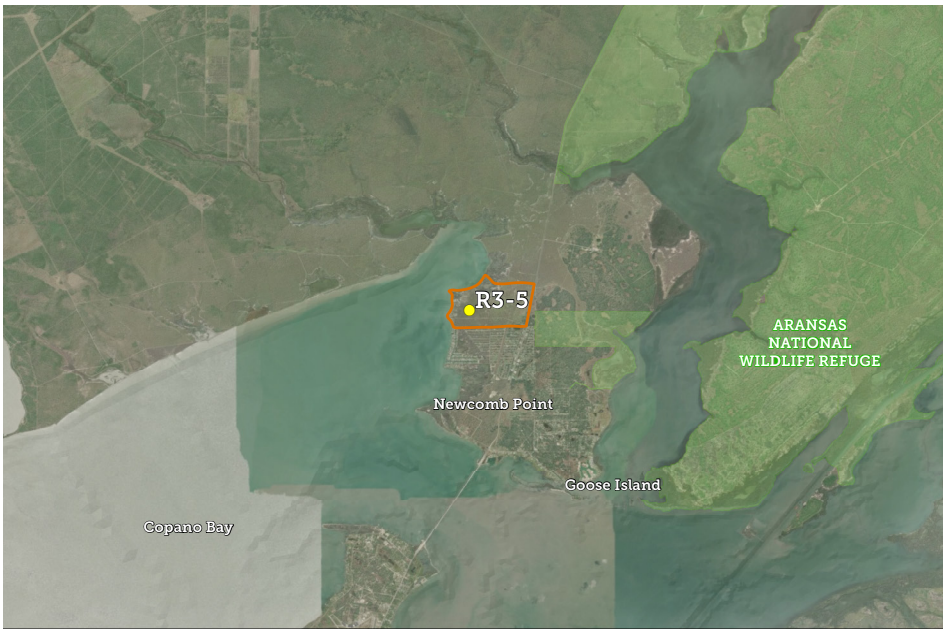
Land Acquisition

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Upland Planning, Conservation and Monitoring)



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, it would be optimal 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.

Project Need

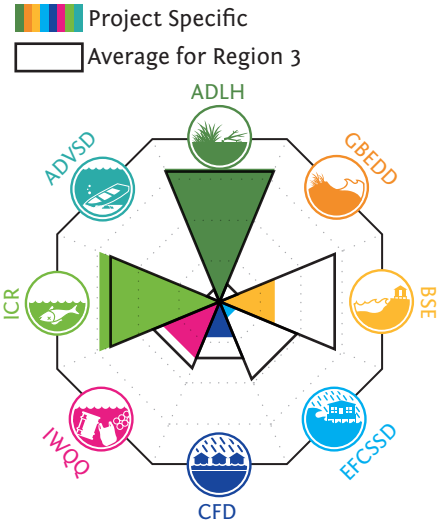
Nearby development threatens upland prairie and wetlands, which are necessary for wildlife diversity. Open space, an essential component of productive wildlife habitat, would contribute to nature tourism and other recreational activities.

Project Benefit

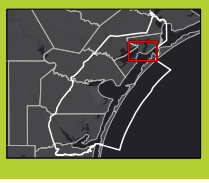
The mosaic of habitats proposed for acquisition would benefit mottled duck and whooping cranes, in addition to other neighboring wildlife. The acquisition also would mitigate flooding and storm surge damage to the area. Undeveloped coastal lands can provide benefits to water quality by filtering stormwater 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.

Estimated Total Project Cost: $5,000,000

Project Benefits Per Issues of Concern



Lamar Beach Road Protection *(Project ID R3-6)*



Region: 3

Location:

Along the southwest shoreline of Saint Charles Bay

County:

Aransas

Status:

Conceptual

Stakeholders:

- Aransas County
- Aransas County Navigation District

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Public Access & Improvements; Community Infrastructure

Action:

Wetland Protection and/or Shoreline Stabilization

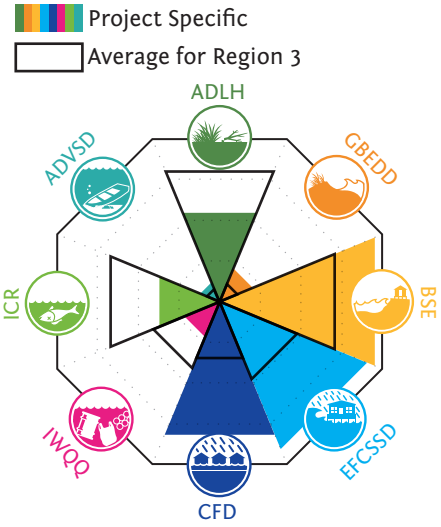
Resiliency Strategy:

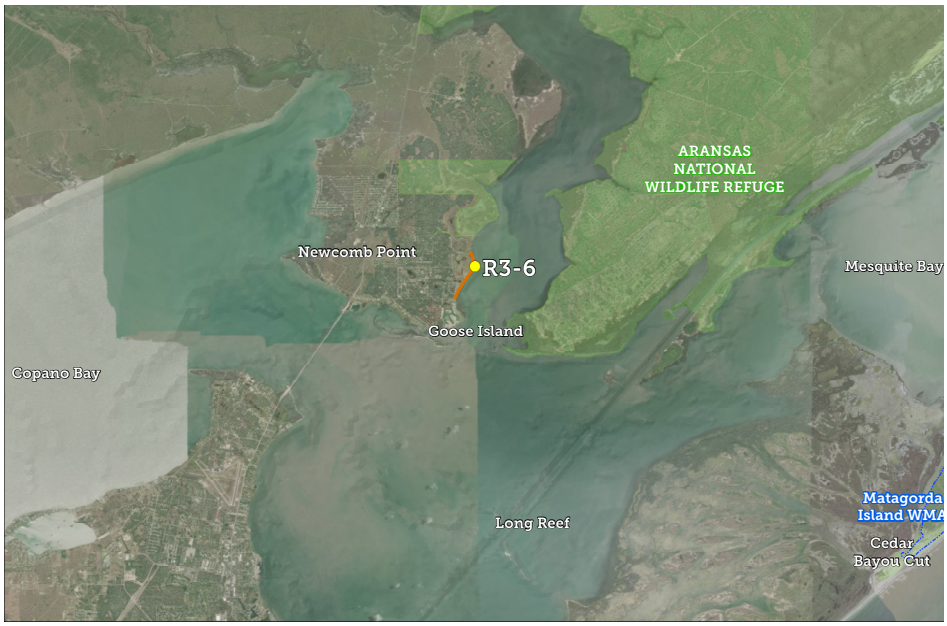
Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Land-Based Transit Enhancement)

Jobs Created:

Creates approximately 45 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

Under this project, approximately 1 mile of breakwaters would be installed along Lamar Beach Road, from Main Street to 12th Street in Aransas County. The project also would include regrading and filling along the shoreline, and marsh planting to establish a living shoreline system.

Project Need

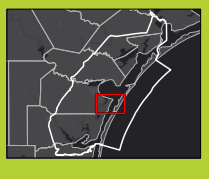
Lamar Beach Road was damaged in 2015 and 2016 with high winds and above-average tides. The roadway is now particularly vulnerable to relative sea level rise and extreme weather events. The current shoreline hardening is non-engineered rubble and concrete rip-rap, which is deteriorating and threatens the road infrastructure and access for public and private users. Lamar Beach Road provides water access for St. Charles Bay and popular kayak launching for the public.

Project Benefit

This new living shoreline would build additional habitat between the road and the water that was lost due to erosion and land subsidence. These measures would protect the roadway from frequent inundation and overtopping by attenuating wave energy before it reaches the shoreline.

Estimated Total Project Cost: $3,500,000

Flour Bluff Living Shoreline *(Project ID R3-7)*



Region: 3

Location:

Laguna Madre between SH 358 and the Barney M. Davis Energy Center

County: Nueces

Status: Engineering & Design

Stakeholders:

- Corpus Christi Metropolitan Planning Organization
- Texas A&M University-Corpus Christi
- Coastal Bend Bays and Estuaries Program
- City of Corpus Christi

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Community Infrastructure

Action:

Wetland Protection and/or Shoreline Stabilization

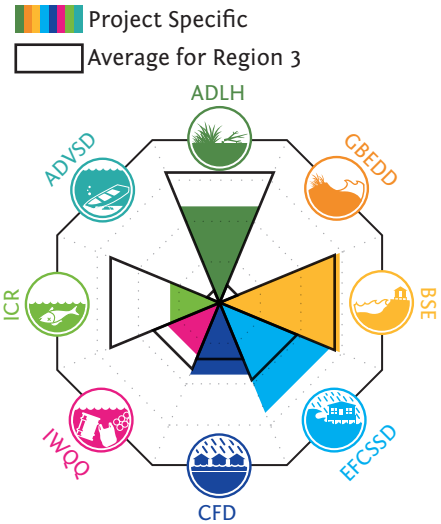
Resiliency Strategy:

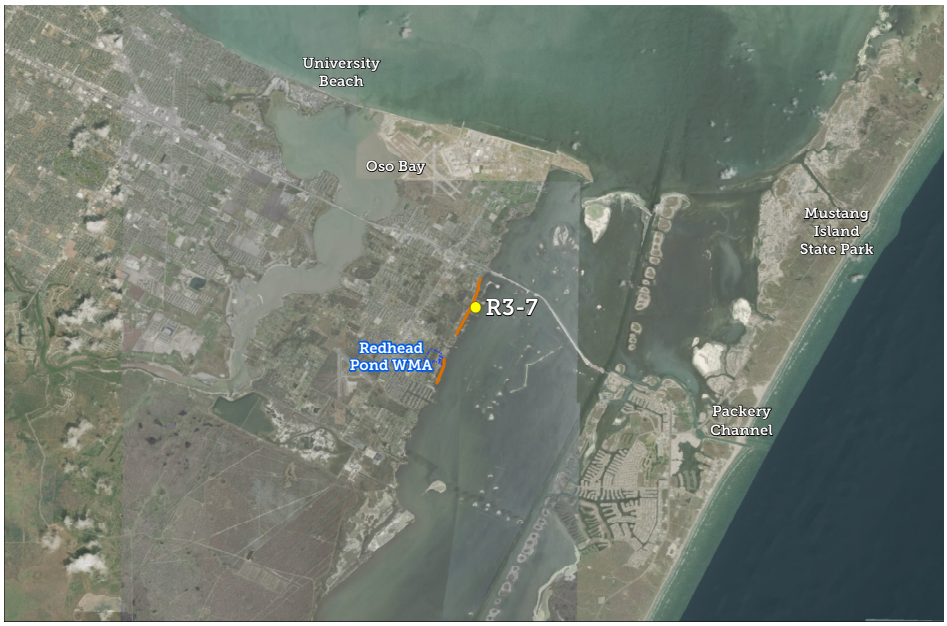
Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Land-Based Transit Enhancement)

Jobs Created:

Creates approximately 41 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

This project would create approximately 1.5 miles of living shoreline to act as a buffer between Laguna Shores Road and the highly erosional shoreline of Laguna Madre, along the eastern shoreline of Flour Bluff.

Project Need

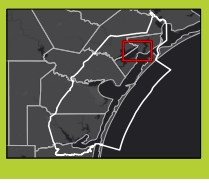
Laguna Shores Road is vulnerable to erosion, flooding and washout from Laguna Madre. The roadway provides access to several residential areas.

Project Benefit

Creating a living shoreline would help to attenuate wave energy and its erosive effects on Laguna Shores Road, thereby protecting roadways, houses and infrastructure in Corpus Christi. The project would be a collaborative opportunity for the City of Corpus Christi to pilot the inclusion of coastal resiliency considerations in the planning of transportation infrastructure projects.

Estimated Total Project Cost: $3,400,000

Newcomb's Point Shoreline Stabilization
(Project ID R3-8)



Region: 3

Location:

Point on Copano Bay, south of Holiday Beach

County:

Aransas

Status:

Conceptual

Stakeholders:

- Texas Parks & Wildlife Department

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

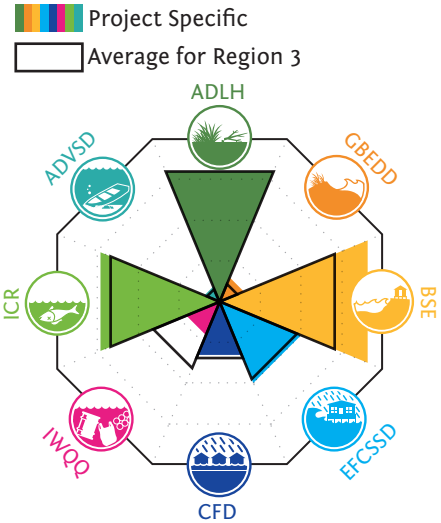
Resiliency Strategy:

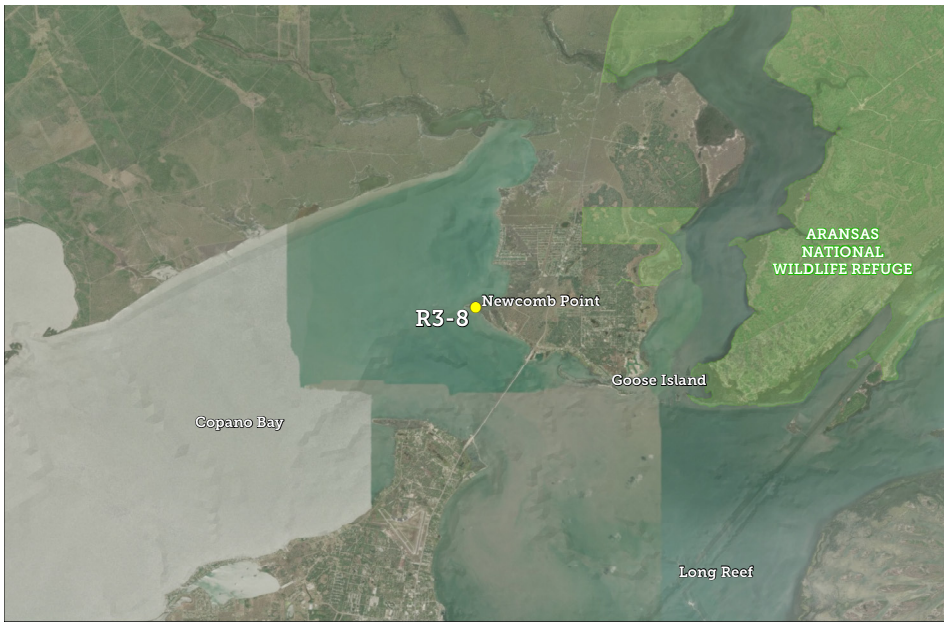
Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 33 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

Newcomb's Point is located northeast of Copano Bay. This project would place shoreline stabilization at Newcomb's 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.

Project Need

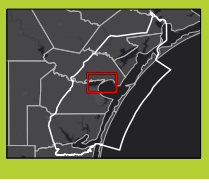
The erosion of this shoreline is endangering the survival of the wetland habitat at Newcomb's Point, which supports a diverse ecosystem and is directly adjacent to the shoreline. This area is currently unprotected and is valuable habitat for whopping cranes.

Project Benefit

Shoreline stabilization at Newcomb's Point would help prevent the continual erosion of this shoreline and would protect wetland habitats in the area. Healthy wetlands also would provide valuable habitat for endangered whooping cranes.

Estimated Total Project Cost: $2,700,000

Indian Point Marsh Area Living Shoreline
(Project ID R3-9)



Region: 3

Location:

Directly south of the Nueces Bay Causeway

County:

San Patricio

Status:

Conceptual

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- Port of Corpus Christi Authority

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

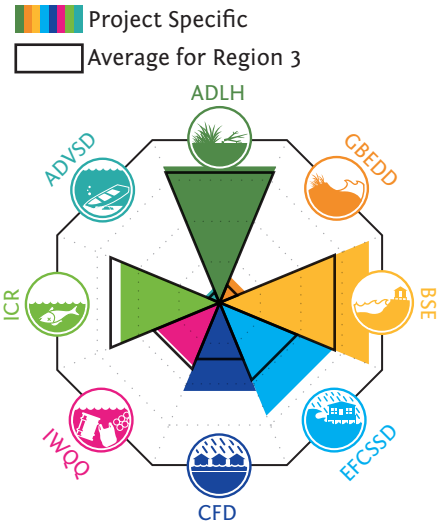
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Land-Based Transit Enhancement)

Jobs Created:

Creates approximately 35 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The Indian Point Marsh Area (IPMA) is located on the 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.

Project Need

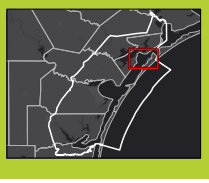
IPMA is one of the last natural marsh areas on the inland shorelines of east Corpus Christi Bay. IPMA also functions as a buffer zone, protecting the Nueces Bay Causeway (US 181/SH 35) from storm impacts. In the last 20 years, IPMA has lost more than 40 percent of its area due to shoreline erosion, subsidence and storm surge.

Project Benefit

According to the Coastal Bend Bays and 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 trapping, water quality improvement, food chain support/nutrient export, fisheries and wildlife habitat, and recreation and education opportunities.

Estimated Total Project Cost: $2,800,000

Long Reef and Deadman Island Shoreline Stabilization and Habitat Protection *(Project ID R3-10)*



Region: 3

Location:

Aransas Bay, north of Big Island

County:

Aransas

Status:

Conceptual

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- The Nature Conservancy
- Audubon Texas
- U.S. Fish and Wildlife Service
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Rookery Island Enhancement

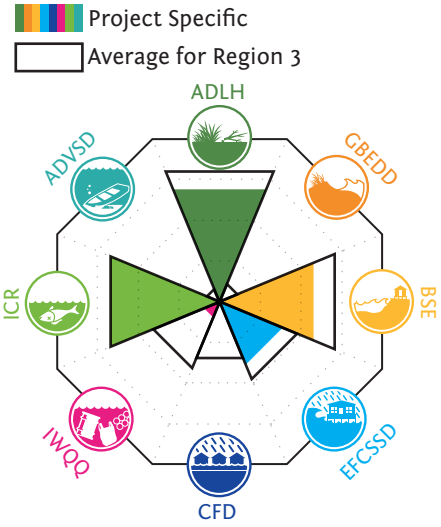
Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation)

Jobs Created:

Creates approximately 33 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

Long Reef and Deadman Island present good options for rookery island restoration in the Aransas Bay System. This project would fund feasibility, preliminary engineering, alternatives analysis, final design and permitting work. An additional phase of the project could fund the construction of the enhancements to Long Reef and Deadman Island.

Project Need

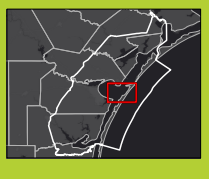
Colonial waterbirds that breed within the coastal zone require islands that provide a healthy nesting structure, are free from predators and disturbance sources, and are relatively close to feeding areas. Within the Coastal Bend, a major migratory route for birds, suitable nesting habitat is thought to be the most limiting factor for most of the colonial waterbird species, leading to the decline of many species. Due to community development and increased vessel traffic and associated shoreline erosion, Aransas Bay has a diminished number of viable rookery islands. Because the Aransas Bay system has a very limited number of active rookery islands, the need to create additional nesting areas for colonial waterbirds within this bay system has been identified as a high priority by local coastal resource managers. This urgency was elevated even further after Hurricane Harvey struck the Coastal Bend. This Category 4 hurricane resulted in major erosion of every rookery island in the Aransas Bay system, including Long Reef and Deadman Island.

Project Benefit

Addressing the loss of rookery islands through the restoration/enhancement of existing rookery islands would expand the area available for bird habitat. This would help save the birds that currently nest on these islands and create an environment for additional species.

Estimated Total Project Cost: $3,400,000

Shamrock Island Restoration – Phase 2
(Project ID R3-11)



Region: 3

Location:

Island in Corpus Christi Bay northwest of Mustang Island

County:

Nueces

Status:

Engineering & Design

Stakeholders:

- The Nature Conservancy
- Texas General Land Office
- Coastal Bend Bays and Estuaries Program
- Shell Oil
- Private Donors

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Rookery Island Enhancement

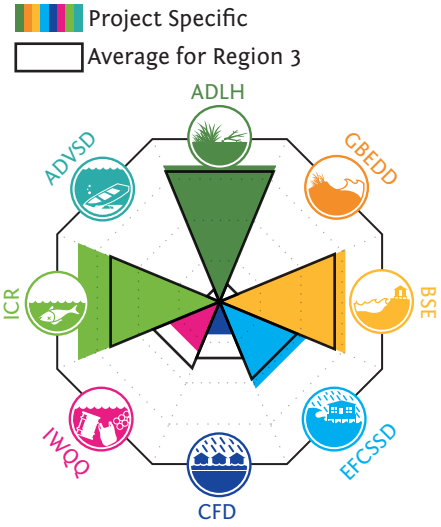
Resiliency Strategy:

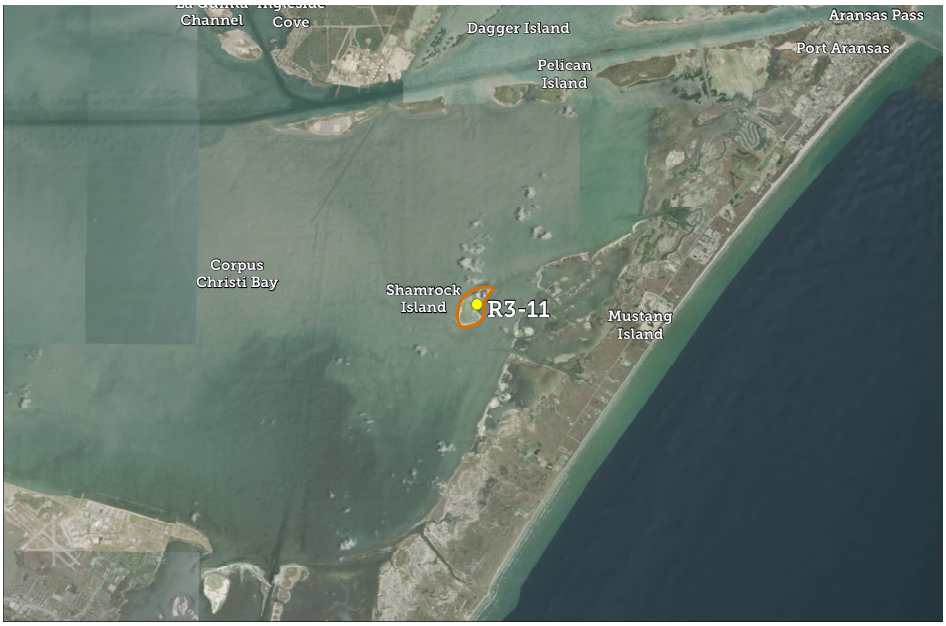
Ecological Resiliency (Rookery Island Protection, Restoration and Creation)

Jobs Created:

Creates approximately 89 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

This 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 breach fill 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.

Project Need

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. The work was partially completed before Hurricane Harvey. During the storm, part of the project was damaged and needs repair.

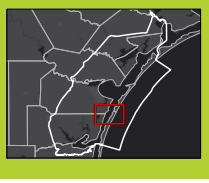
Project Benefit

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.

Estimated Total Project Cost: $3,000,000*

**Partial funding identified*

Tern Island and Triangle Tree Island Rookery Habitat Protection *(Project ID R3-12)*



Region: 3

Location:

Two islands on the bayside of North Padre Island, about 7 miles southwest of the JFK Memorial Causeway

County:

Kleberg

Status:

Conceptual

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- The Nature Conservancy
- Audubon Texas
- U.S. Fish and Wildlife Service
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Rookery Island Enhancement

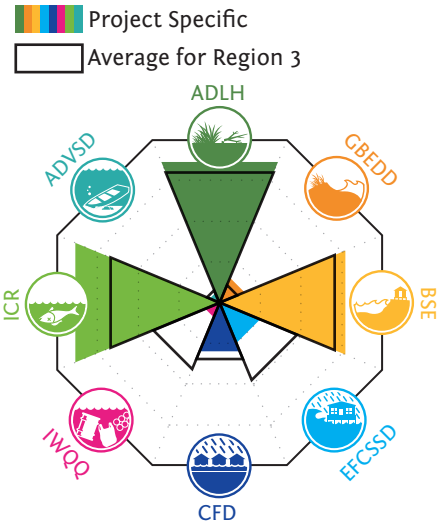
Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation)

Jobs Created:

Creates approximately 43 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

This project would protect two rookery islands, Tern Island and Triangle Tree Island, in the Upper Laguna Madre from erosion by constructing protective structures, such as shoreline armoring for each island. This project would be considered Phase 1 and would include feasibility, preliminary engineering, alternatives analysis, final design and permitting. Phase 2 would cover the construction phase. Opportunities to include beneficial use of dredged material during the construction would be pursued.

Project Need

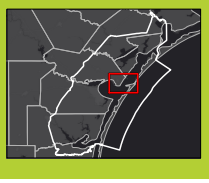
Tern Island and Triangle Tree Island provide nesting habitat for herons, egrets, gulls, terns and skimmers. Erosion of these islands reduces habitat for various bird species, which can lead to insufficient food sources, overcrowding and other pressures that could cause the bird populations to shrink.

Project Benefit

The protective structure, possibly a breakwater, would be designed to protect the islands from wind and wave energy. The protective structure also would trap and secure sediment from possible future dredge placement events.

Estimated Total Project Cost: $3,600,000

Dagger Island Shoreline Protection *(Project ID R3-13)*



Region: 3

Location:

Island in Redfish Bay, north of the Corpus Christi Ship Channel

County:

Nueces

Status:

Permitted

Stakeholders:

- Texas Parks & Wildlife Department

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Rookery Island Enhancement

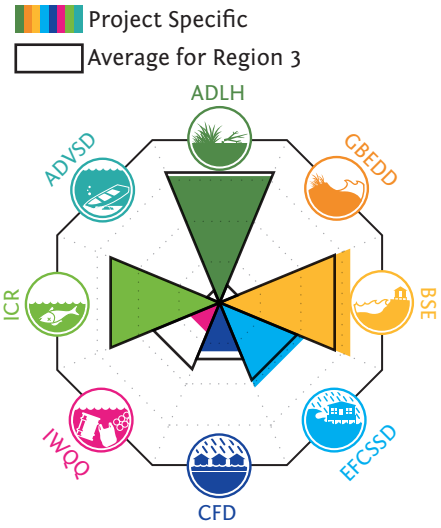
Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation; Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 23 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

Dagger Island, located within the Redfish Bay State Scientific Area (RBSSA), is immediately north of the Corpus Christi Ship Channel (CCSC) and east of the Ingleside peninsula. The RBSSA contains prime habitat for fisheries, submerged seagrass beds, oyster reefs, mangroves, and wetlands that are valuable habitat for fish and avian species. This project is currently permitted.

Project Need

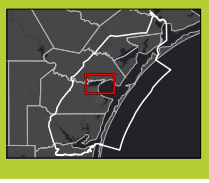
Since 1956, Dagger Island has lost over 124 acres due to erosion. The current rate of erosion averages between 1.3 feet and 5.6 feet per year. The shoreline is eroding due to both natural causes (e.g. wind driven waves, storm events, relative sea level rise) and human causes (e.g. high energy ship wakes from vessel travel on the CCSC, extensive dredging from past oil and gas operations). Over the next 50 years, 27 acres are expected to erode based on historic rates if the project does not occur. Due to the key ecological areas located within the RBSSA, there are growing concerns that the erosion of Dagger Island would have harmful impacts on the surrounding ecosystems. Some initial breached areas are already showing adverse impacts on valuable habitats.

Project Benefit

This project would eliminate or drastically reduce the rate of shoreline erosion and island migration by protecting the shoreline of Dagger Island using nearshore breakwaters. The project would restore up to 35 acres of the island by coordinating with the U.S. Army Corps of Engineers and the Port of Corpus Christi to beneficially use dredged material.

Estimated Total Project Cost: $2,000,000

Causeway Island Rookery Habitat Protection
(Project ID R3-14)



Region: 3

Location:

Island east of the Corpus Christi mainland and north of the Nueces Bay Causeway, off of Rincon Point

County:

Nueces

Status:

Shovel-ready

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- Port of Corpus Christi

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Rookery Island Enhancement

Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation)

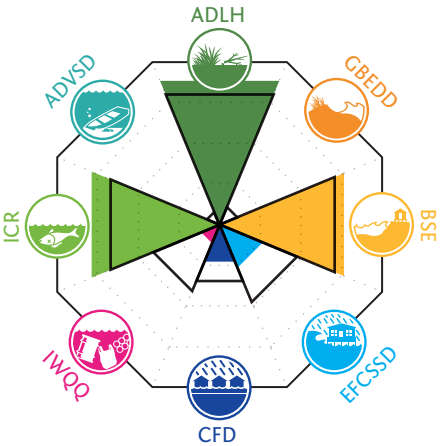
Jobs Created:

Creates approximately 40 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 3



Project Description

The proposed design for protection of Causeway Island would include constructing a segmented rock breakwater around the perimeter of the Island. The Coastal Bend Bays and Estuary Program has an ongoing partnership with the Port of Corpus Christi to beneficially place dredged material on the island. The design for this project is already funded to create and restore the habitat periodically to mitigate relative sea level rise. The U.S. Army Corps of Engineers permit for this project was received in March 2018. The project is considered shovel-ready.

Project Need

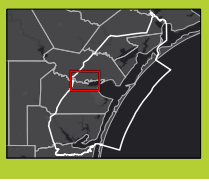
Causeway Island is 7 acres and serves as roosting and nesting habitat for many avian species, including threatened and priority species such as the Reddish Egret, Little Blue Heron, Great Egret, Roseate Spoonbill, Black Skimmer, Caspian Tern and Gull-billed Tern.

Project Benefit

The breakwaters would provide containment and protection for expansion of the island to approximately 17.8 acres over time, both naturally and through future beneficial use of dredged material from Rincon Canal. This would protect the island from wind and wave erosion.

Estimated Total Project Cost: $2,700,000

Nueces River Delta Shoreline Stabilization
(Project ID R3-15)



Region: 3

Location:

The outfall of the Nueces River to Nueces Bay

County:

San Patricio, Nueces

Status:

Shovel-ready

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Delta Management

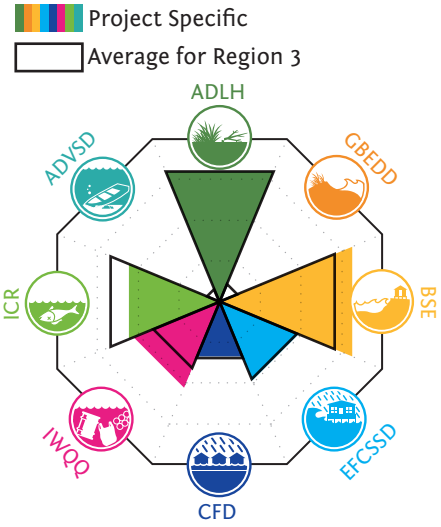
Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 44 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The project would include the construction of breakwaters along approximately 3,900 linear feet of shoreline at the Nueces River Delta to dissipate wave energy that is causing estuarine wetland loss. This project was permitted by the U.S. Army Corps of Engineers in October 2016 and the project is considered shovel-ready. Coordination is ongoing with the Port of Corpus Christi regarding the possibility of beneficially using dredged material in this area.

Project Need

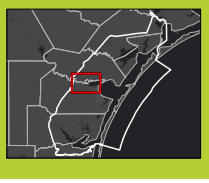
The westernmost shoreline of Nueces Bay at the Nueces River delta is rapidly eroding, with a documented erosion rate of 8.2 feet per year. The Texas General Land Office and the Coastal Bend Bays and Estuaries Program sponsored an alternatives analysis in 2014 for the feasibility, assessment and permitting of the shoreline protection structures. According to the Coastal Bend Bays and Estuaries Program, the no-action scenario could lead to the complete collapse of Corpus Christi commercial and sport fisheries as the decline of nursery habitat irreparably damages the food web.

Project Benefit

This project would provide a great opportunity to protect and restore a large, contiguous area of wetland habitat that has both ecological and resiliency benefits.

Estimated Total Project Cost: $3,500,000

Nueces County Hydrologic Restoration Study
(Project ID R3-16)



Region: 3

Location:

Watersheds in Nueces County

County:

Nueces, San Patricio, Aransas

Status:

Study

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- Texas Commission on Environmental Quality
- Texas A&M University-Corpus Christi
- Nueces River Authority
- City of Corpus Christi
- Port of Corpus Christi Authority

Project Type:

Study, Policy, Plan or Program; Hydrologic Connectivity

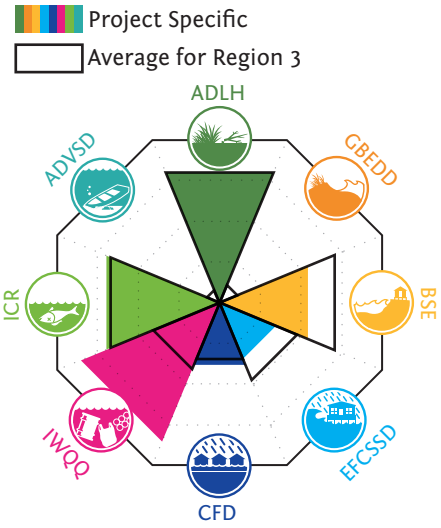
Action:

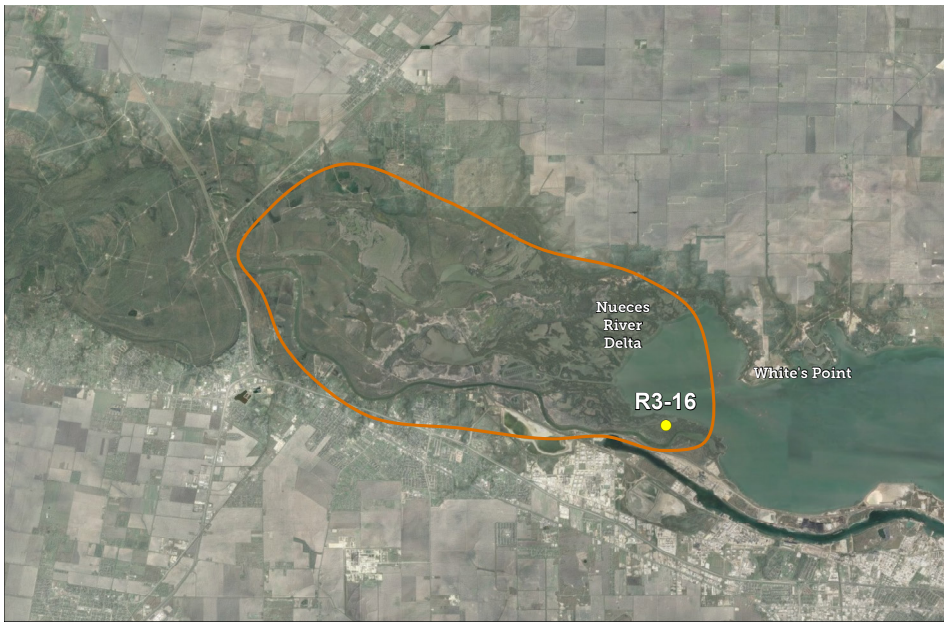
Delta Management

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement); **Administrative Resiliency** (Study)

Project Benefits Per Issues of Concern





Project Description

An adaptive management hydrologic restoration study would look at the interactions of the physical systems that affect the hydrology in Nueces County, 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).*

Project Need

The coastal systems throughout Nueces County 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.

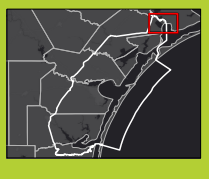
Project Benefit

The study would identify how to best restore coastal ecosystems within the delta system in a manner that is more resilient to freshwater inflow fluctuations. This hydrologic restoration study would build upon these efforts, and would be invaluable for long-term decision making for the mutual benefits of all of the county's residents and industries.

Estimated Total Project Cost: $200,000*

**Partial funding identified*

Guadalupe Delta Estuary Restoration *(Project ID R3-17)*



Region: 3

Location:

Guadalupe River delta, north of San Antonio Bay and east of Mission Lake

County:

Refugio, Calhoun

Status:

Conceptual

Stakeholders:

- San Antonio Bay Foundation
- Guadalupe-Blanco River Authority

Project Type:

Shoreline Stabilization; Hydrologic Connectivity

Action:

Delta Management

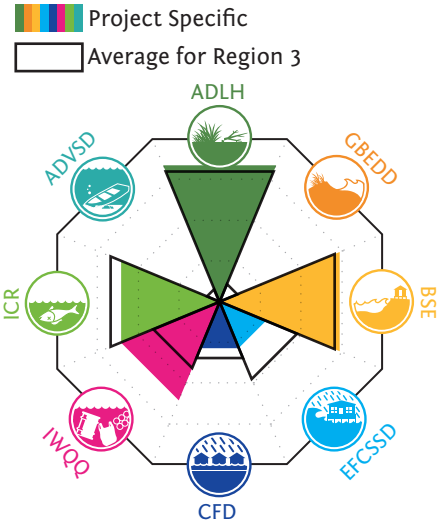
Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement; Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 48 jobs during construction.

Project Benefits Per Issues of Concern



Project Description

The project would restore river flows to the terminal end of the Guadalupe River delta and create a living shoreline to protect the delta from sediment depletion and erosion. The project would involve partial damming of Traylor's Cut to redirect most of the river flow and sediment into the original course of the river. It also would entail constructing a living shoreline by placing oyster shell-filled mesh bags on the terminal end of the delta to slow the rate of delta shoreline erosion, while also allowing sediment transport during high river flows.

Project Need

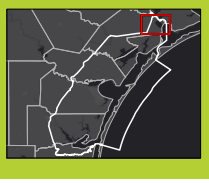
The Guadalupe River delta is slowly losing its wetland habitats and is eroding at an alarming rate due to a man-made diversion. The geomorphic form and function of deltas requires continual sediment replenishment to be productive. The 1930s man-made diversion, Traylor's Cut, redirects 90 percent of the Guadalupe River flow and sediment into Mission Lake, thus not allowing renourishment and sedimentation needed to maintain the estuary in the delta. Over the next 50 years, nearly 80 acres of the delta are projected to erode based on historic rates if this project does not occur.

Project Benefit

There are multiple benefits to the environment by restoring the natural form and function of the delta, including improved nursery habitat for several marine species, such as Rangia clams, fish, oysters, crab, shrimp, diamond back terrapin, waterfowl and shorebirds. Connecting the river to its original course would restore the once naturally functioning ecosystem, which is vital to the area's overall capability to combat invasive vegetation, continuous saltwater intrusion, algal blooms and harmful bacteria. A healthy ecosystem also would allow for increased commercial and recreational harvest of fish, shrimp, oysters and crab.

Estimated Total Project Cost: $3,900,000

Guadalupe River and Delta Wildlife Management Area Acquisition *(Project ID R3-18)*



Region: 3

Location:

Strategic tracts located near the Guadalupe River Delta, around San Antonio Bay

County:

Aransas, Refugio, Nueces

Status:

Conceptual

Stakeholders:

- Texas Parks & Wildlife Department

Project Type:

Study, Policy, Plan or Program; Land Acquisition

Action:

Delta Management

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement; Upland Planning, Conservation and Monitoring)

Project Description

This project would acquire additional land within the Guadalupe River and Delta Wildlife Management Area corridor to connect tidal marsh from the upper reaches of Hynes Bay to the Wildlife Management Area in Refugio County.

Project Need

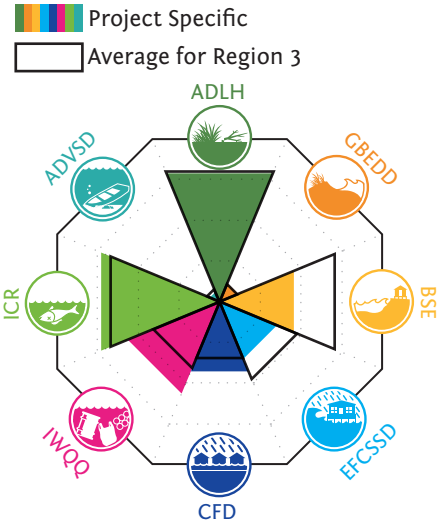
The Guadalupe Delta Wildlife Management Area is a Texas Gulf Ecological Management Site, which indicates its status as a marine area with ecological significance to fish, wildlife and other natural resources.

Project Benefit

Additional acquisitions of land around the Guadalupe River Delta and San Antonio Bay would benefit wildlife species, including the brown pelican, peregrine falcon, whooping crane and Texas diamondback terrapin. Acquisition of this property also would improve the water quality of surface runoff that outfalls into the bay, as natural landscapes and wetlands filter pollutants from point and nonpoint sources, and promote nutrient cycling in the delta.

Estimated Total Project Cost: $3,000,000

Project Benefits Per Issues of Concern



Coastal Bend Gulf Barrier Island Conservation
(Project ID R3-19)

Region: 3

Location:

North Padre Island, approximately 4 miles southwest of the JFK Memorial Causeway

County:

Kleberg

Status:

Conceptual

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- The Nature Conservancy
- Texas Parks & Wildlife Department
- U.S. Fish and Wildlife Service
- U.S. National Park Service
- Texas General Land Office
- Private Landowners

Project Type:

Habitat Creation & Restoration

Action:

Responsible Development

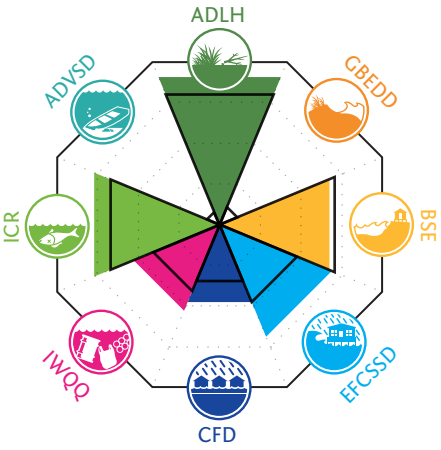
Resiliency Strategy:

Ecological Resiliency (Upland Planning, Conservation and Monitoring)

Project Benefits Per Issues of Concern

Project Specific

Average for Region 3



Project Description

In 2015, Nueces County acquired property on North Padre Island approximately 4 miles southwest of the causeway. There are several ongoing restoration efforts at the site, including eradicating approximately 12 acres of invasive Brazilian Pepper Trees, implementing a prescribed burn management plan, and re-purposing an old impacted well pad site to establish burrowing owl habitat. Nueces County completed a Habitat Land Use Management Plan for the property to guide future conservation efforts that included input received during public meetings from regulatory agencies, non-governmental organizations and the general public.

The acquired property has three immediate needs:

1. Repairing a large blow out in the dune system. During and after the dune restoration process, data will be collected to inform future repairs.
2. Restoring damaged wetlands from human use activities, such as driving through jurisdictional wetlands.
3. Invasive species control and post-control monitoring and removal. This include Brazilian Pepper Trees and Chinese Tallow Trees.

Project Need

North Padre Island is home to critical habitat areas that are at risk of deteriorating, including tidal flats, beaches and dunes. These habitats are deteriorating due to human use and environmental pressures. Ecologically, the acquired property on North Padre Island is a valuable section of land along the Texas barrier island system. The property also has many listed (threatened and endangered) species that call it home, and is an established Aplomado Falcon nesting property.

Project Benefit

In addition to dune and wetland restoration and invasive species removal, the wetlands could be enhanced to support Red Head Duck populations, which are losing habitat, and would create low-impact public access for wildlife viewing.

Estimated Total Project Cost: $500,000

**Partial funding identified*

Packery Channel Nature Park Habitat Restoration – Phase 2 *(Project ID R3-20)*

Region: 3

Location:

Public park located directly north of Packery Channel

County:

Nueces

Status:

Engineering & Design

Stakeholders:

- Nueces County

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Study, Policy, Plan or Program; Public Access & Improvements

Action:

Responsible Development

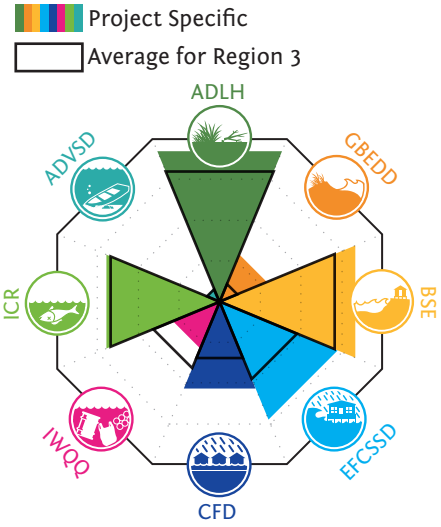
Resiliency Strategy:

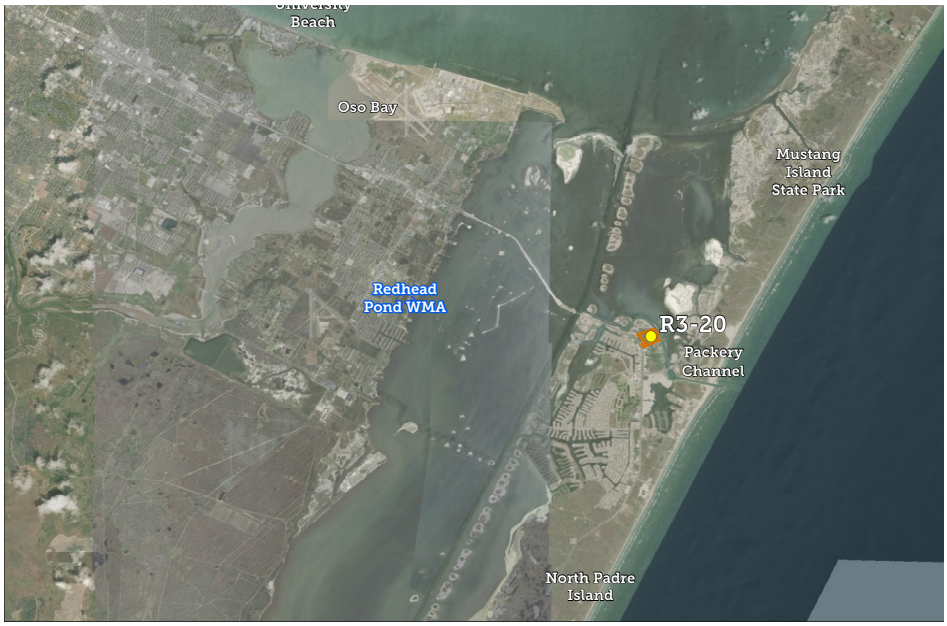
Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Administrative Resiliency** (Study)

Jobs Created:

Creates approximately 30 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

This project would include constructing a living shoreline using a revetment matting design along the natural slope of the shoreline at the Packery Channel Nature Park, extending the 'No Wake Zone' to protect ecologically sensitive habitats and building an elevated boardwalk for public access. A key element of the project would be to collect monitoring data on how bird populations are responding to the restored habitat. Nueces County would continue to work closely with federal and state biologists to enhance the broader Coastal Bend's natural resources, and respond to the needs of the migratory bird populations that use the site.

Project Need

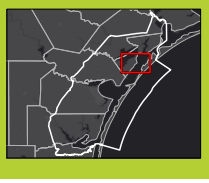
Packery Channel Nature Park has experienced steady shoreline erosion due to the wakes caused by boater traffic and the hardened shoreline immediately to the east. Shoreline erosion and land loss puts roads, community infrastructure and ecologically sensitive habitats at risk of being affected by severe storms, relative sea level rise, and the decrease of property values. In addition, Padre Island is primarily devoid of woodland areas except for an isolated 45 acres located at the northern end of Padre Island, which includes the project site. These woodlands are vital habitat to numerous species of migratory birds, but are under significant threat from municipal, commercial and residential development.

Project Benefit

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. Monitoring associated with the proposed project would be used to develop scientifically-based guidance for other restoration projects regarding plant survival, site structure and migratory bird use to better design future habitat restoration projects and enhance public access, use, enjoyment and education.

Estimated Total Project Cost: $2,500,000

Little Bay Restoration Initiative *(Project ID R3-21)*



Region: 3

Location:

North of Aransas Bay between Rockport and Fulton

County:

Aransas

Status:

Conceptual

Stakeholders:

- Aransas County
- Aransas County Navigation District
- City of Rockport

Project Type:

Habitat Creation & Restoration; Hydrologic Connectivity; Shoreline Stabilization

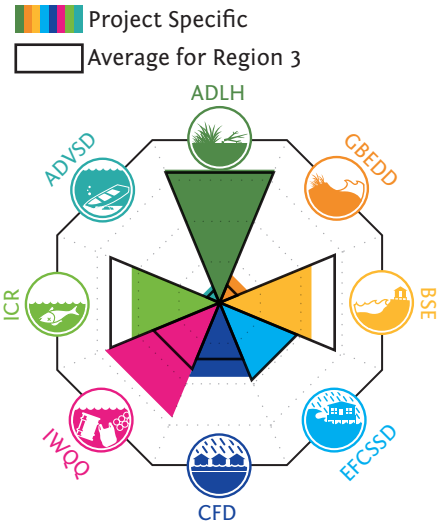
Action:

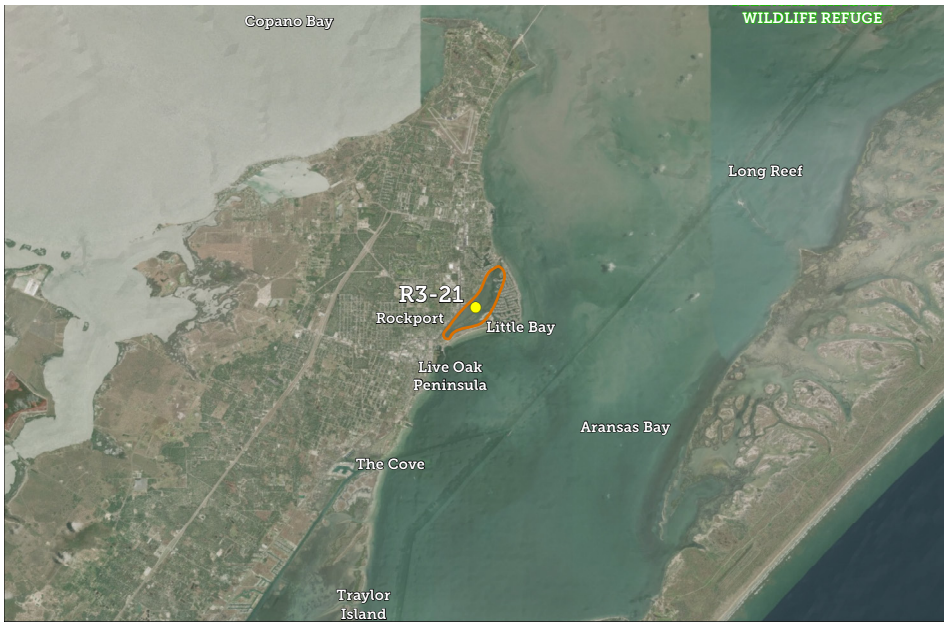
Responsible Development

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring; Rookery Island Protection, Restoration and Creation); **Societal Resiliency** (Water-Based Transit Enhancement)

Project Benefits Per Issues of Concern





Project Description

This project would restore Little Bay, a shallow, enclosed bay with approximately 420 acres of surface area, to a natural, vegetated state. The project would include four tasks to address these issues:

1. Dredge Little Bay to a depth of 9 feet to restore to historical conditions;
2. Beneficially use dredged material to restore two rookery islands and create vegetative habitat for black skimmers, reddish egrets, least terns and other birds that forage, loaf, and nest near Little Bay;
3. Plant 4 acres of new vegetative marsh habitat; and
4. Widen, realign and extend Blevins Channel – one of the two outlets connecting Little Bay with Aransas Bay.

Project Need

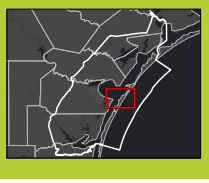
Scientists have identified polluted stormwater runoff, inadequate water circulation and diminished water exchange with Aransas Bay as principal causes of the declining water quality and loss of wildlife habitat in Little Bay.

Project Benefit

This would make Little Bay better able to sustain and enrich an ecosystem that provides habitat for submerged seagrasses, as well as local water fowl, migratory birds, fish, crustaceans and other aquatic fauna.

Estimated Total Project Cost: $14,400,000

Restore Barrier Island Bayside Wetlands on Mustang Island *(Project ID R3-22)*



Region: 3

Location:

Bayside of Mustang Island

County:

Nueces

Status:

Conceptual

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- Texas Parks & Wildlife Department
- Port of Corpus Christi Authority
- Nueces County

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Hydrologic Connectivity

Action:

Responsible Development

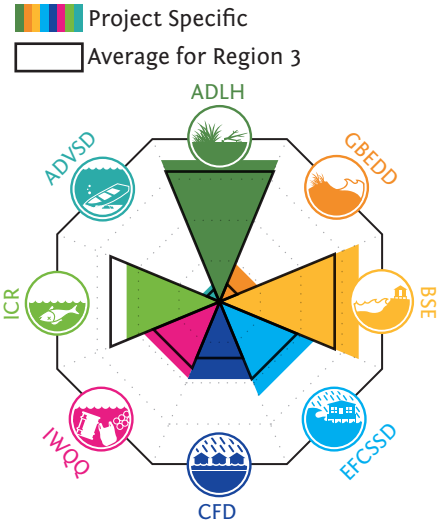
Resiliency Strategy:

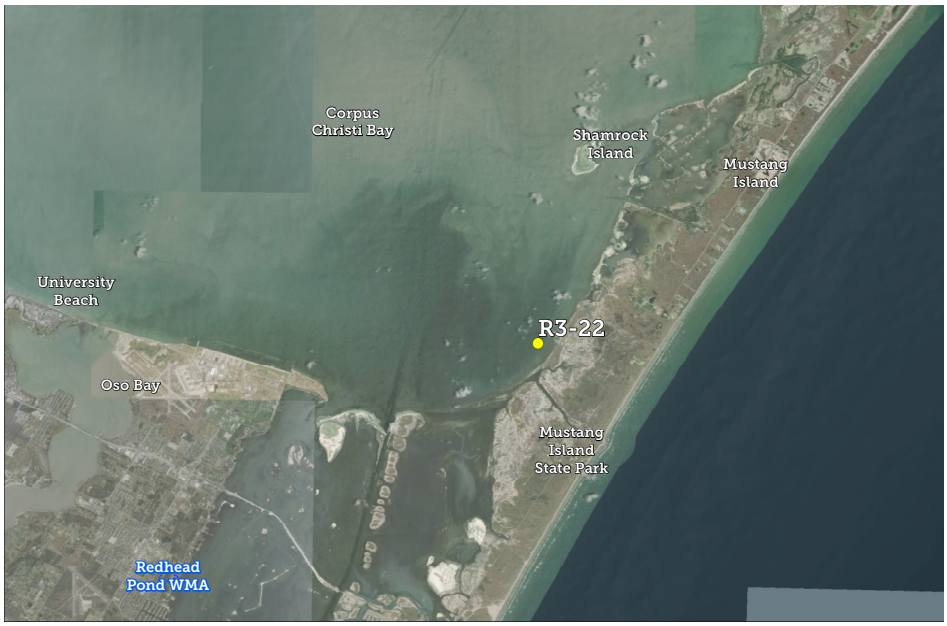
Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 115 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

This project would restore the estuarine wetlands on the bayside of Mustang Island. This would be accomplished by depositing beneficial use of dredged material, incorporating planting, and possibly constructing rock breakwaters as needed to protect habitats from wave forces.

Project Need

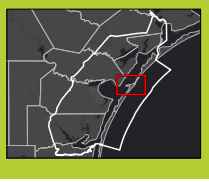
The estuarine wetlands on the bayside of Mustang Island have experienced significant erosion and degradation.

Project Benefit

Restoring these wetlands would provide a buffer on the back side of the island that would filter stormwater runoff from coastal communities. This restoration also could protect these communities from storm surge, particularly surge that forms on the bayside of the island during coastal storms. Restored wetlands would improve the biodiversity of the surrounding bay habitat and support viable bird, fish, and other wildlife populations. All of these acitivities support nature tourism in this area.

Estimated Total Project Cost: $8,400,000

Port Aransas Nature Preserve Stabilization and Restoration *(Project ID R3-23)*



Region: 3

Location:

Port Aransas Nature Preserve, south of the Corpus Christi Ship Channel

County:

Nueces

Status:

Engineering & Design

Stakeholders:

- City of Port Aransas
- Port of Corpus Christi
- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Regional Infrastructure Improvements

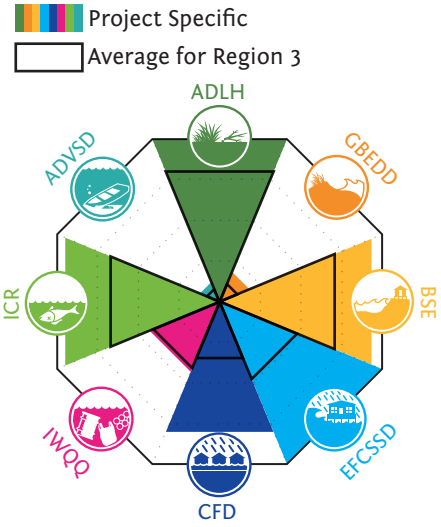
Resiliency Strategy:

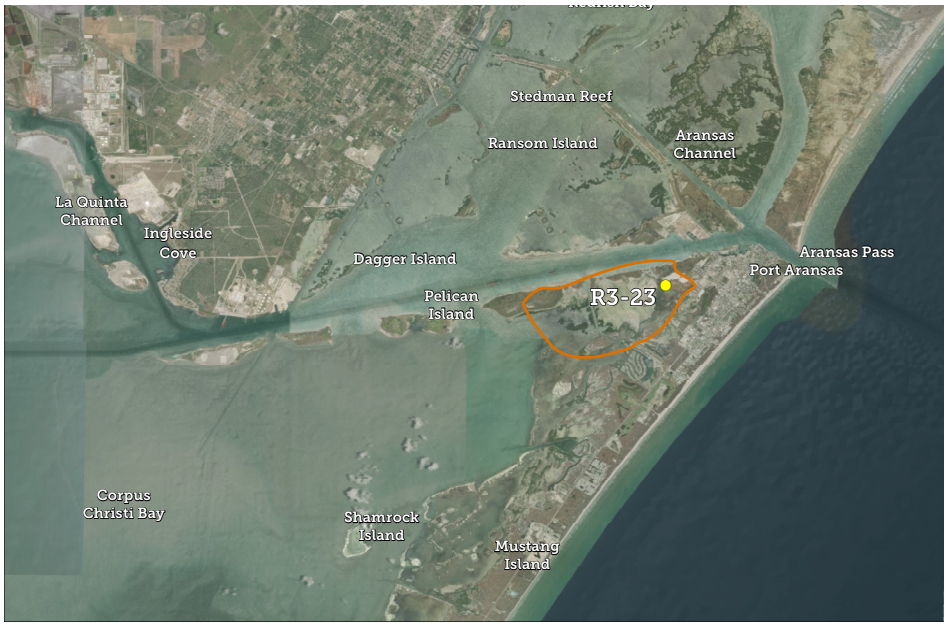
Ecological Resiliency (Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Water-Based Transit Enhancement)

Jobs Created:

Creates approximately 53 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

The recommended improvements under this project include:

- Repairing breaches in the ship channel revetment on northern Mustang Island;
- Constructing living shorelines coming off the ship channel near existing rock revetments to protect mangrove habitat;
- Rebuilding marsh and wetland habitat;
- Repairing the Charlie's Pasture bulkhead that was damaged during Hurricane Harvey;
- Repairing public access; and
- Permitting this site for beneficial use of dredged material to elevate the land.

There is a potential to leverage Federal Emergency Management Agency-Public Assistance funding for this project. The engineering work has been initiated.

Project Need

Wave action from ships and boats in the ship channel has caused saltwater intrusion into these areas, which is degrading this critical habitat for the foraging species. Additionally, portions of this shoreline were impaired from the impacts of Hurricane Harvey. For example, several cuts were created in the bulkhead that had stabilized the ship channel shoreline, and upland areas were blown out. Hurricane Harvey also damaged public access, Port Street and the bulkhead along Port Street, and destroyed the 3 miles of trail boardwalk.

Project Benefit

The 1200-acre Port Aransas Nature Preserve and adjacent lands along the Corpus Christi Ship Channel are important habitats for piping plovers, whooping cranes, snowy plovers and least terns. This project would repair damages from Hurricane Harvey and protect and rebuild wetland habitat. While restoring this area, the design also would account for the future deepening and widening of the Corpus Christi Ship Channel, which is planned to allow larger vessel traffic through the area.

Estimated Total Project Cost: $4,400,000*

**Partial funding identified*

Corpus Christi Bay Wastewater, Stormwater Quality and Pollution Management Improvements
(Project ID R3-24)

Region: 3

Location:

City of Corpus Christi Metro Area

County:

Nueces

Status:

Conceptual

Stakeholders:

- City of Corpus Christi

Project Type:

Structure/Debris Removal; Study, Policy, Plan or Program; Community Infrastructure

Action:

Regional Infrastructure Improvements

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement); **Societal Resiliency** (Community Infrastructure Planning and Development); **Administrative Resiliency** (Program)

Project Description

This project would involve the 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. There also are opportunities to increase the capacity at the wastewater treatment plant in the City of Corpus Christi. This project would both identify necessary improvement(s) and provide opportunities for implementation.

Project Need

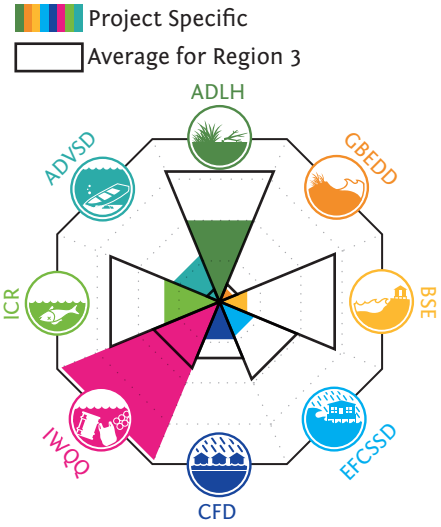
Corpus Christi Bay suffers from polluted stormwater runoff. Trash, debris and pollutants carried by stormwater runoff are negatively impacting the water quality of the bay as well as human use of the bay, and fish and wildlife populations.

Project Benefit

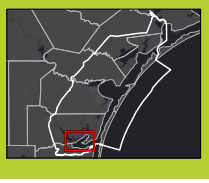
This project would improve the water quality and fish and wildlife health of Corpus Christi Bay by implementing various techniques with the goal of reducing the inflow of polluted stormwater runoff, trash and debris. Additionally, increasing the capacity at the wastewater treatment plant would improve the ability of the City of Corpus Christi to treat stormwater that outfalls to the bay.

Estimated Total Project Cost: $1,000,000

Project Benefits Per Issues of Concern



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



Region: 3

Location:

Baffin Bay and surrounding watersheds

County:

Kleberg

Status:

Conceptual

Stakeholders:

- Coastal Bend Bays and Estuaries Program
- Texas A&M University-Corpus Christi
- Texas Water Resources Institute
- Baffin Bay Stakeholder Group

Project Type:

Study, Policy, Plan or Program; Hydrologic Connectivity; Community Infrastructure

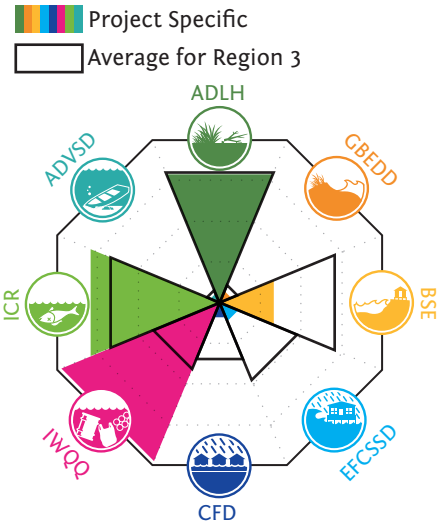
Action:

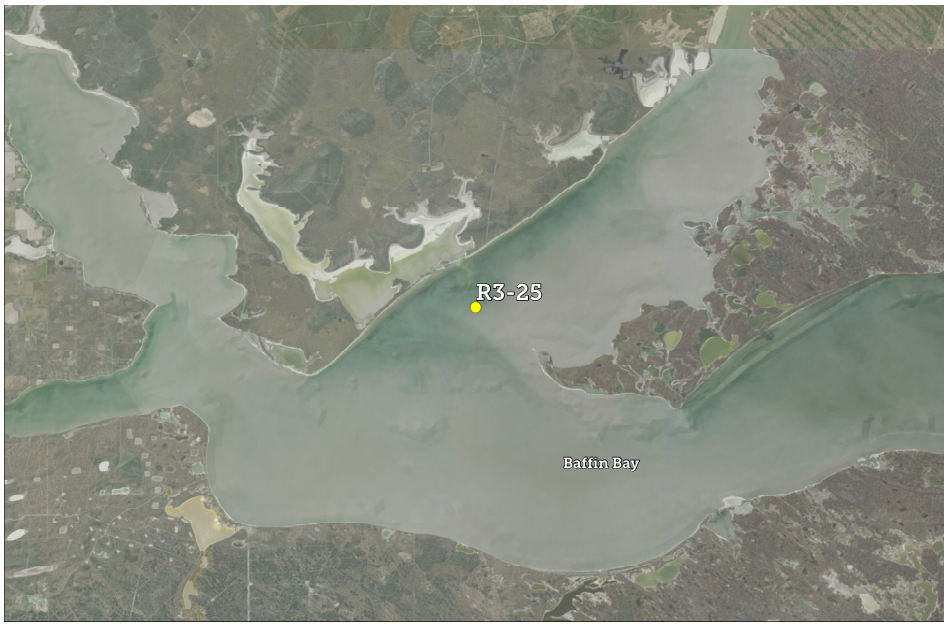
Watershed Planning

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement); **Societal Resiliency** (Community Infrastructure, Planning and Development); **Administrative Resiliency** (Plan)

Project Benefits Per Issues of Concern





Project Description

The Baffin Bay Watershed Monitoring and Management Plan would guide restoration efforts aimed at reducing pollutants to the watershed streams and bay. This project would support all phases of plan development, including additional bay and watershed data collection, land use and load modeling, outreach to engage landowners and businesses in the stakeholder process, and improvement of stewardship practices. And finally, assembly of the watershed plan itself. The same stakeholder group also is working to secure funding for "early phase" targeted restoration activities.

Project Need

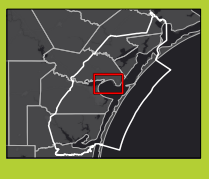
Baffin Bay and its watershed streams exceed Texas Commission on Environmental Quality's screening levels for chlorophyll, and the streams are considered impaired for several water quality variables. Because of concerns about the negative impacts of these water quality issues on the health of Baffin Bay and its fishery, a stakeholder group was formed with a goal of developing a watershed protection plan.

Project Benefit

Establishing a watershed protection plan and subsequent pollution reduction actions would improve the health of Baffin Bay. The Baffin Bay system is considered the "jewel" of the Texas coast because of its tremendous fishing and recreation potential, as well as its positive economic impact on the surrounding communities.

Estimated Total Project Cost: $2,500,000

Corpus Christi & Nueces Bays Oyster Reef Restoration
(Project ID R3-26)



Region: 3

Location:

Locations to be identified in the Mission-Aransas Estuary

County:

Nueces, San Patricio

Status:

Conceptual

Stakeholders:

- Texas Parks & Wildlife Department
- Coastal Bend Bays and Estuaries Program

Project Type:

Habitat Creation & Restoration

Action:

Oyster Reef Enhancement

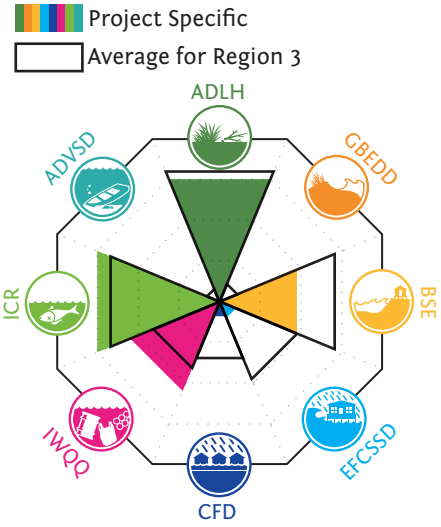
Resiliency Strategy:

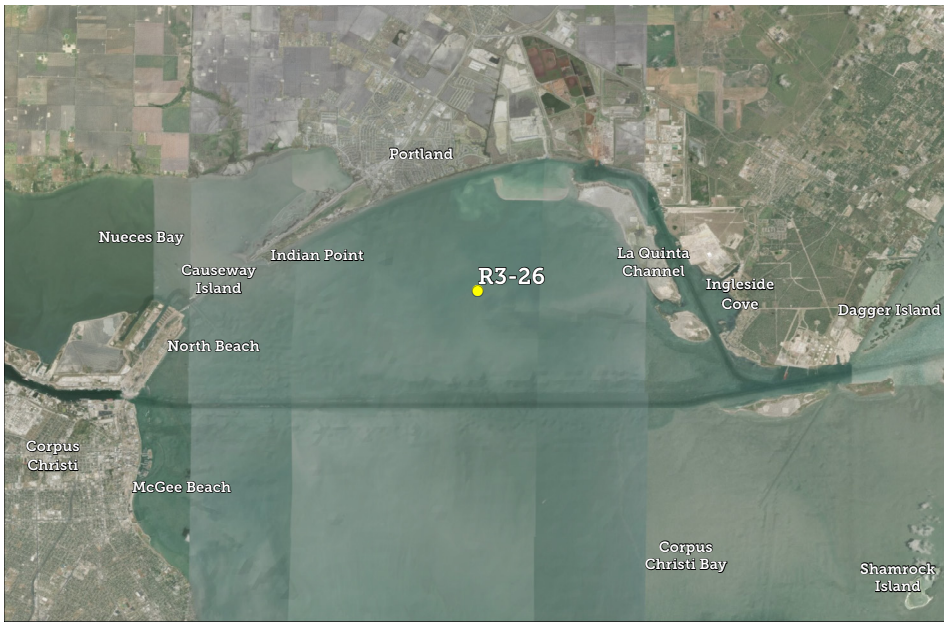
Ecological Resiliency (Oyster Reef Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 7 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

Under this project, locations in the Coastal Bend area that have been identified through existing habitat suitability index models would be selected to restore degraded oyster reefs. The project would include data collection and monitoring activities to assess the viability of future oyster reef restoration efforts in the Coastal Bend bays.

Project Need

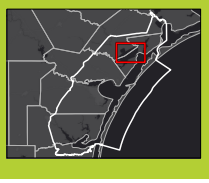
Texas bay systems are experiencing ongoing degradation of oyster reefs due to coastal storms, over-harvesting, water quality impacts and commercial dredging. The Nueces Estuary, in particular, has historically supported oyster reefs. However, due to changes in freshwater inflow, the system does not currently produce robust oyster populations and may continue to provide impaired environments for oyster reef development in the future. As a result, it is essential to restore oyster reefs in suitable locations in the Coastal Bend using proven methodologies to promote population persistence of this invaluable ecological and economic resource.

Project Benefit

Restored oyster reefs provide water quality benefits by filtering and reducing suspended sediments in bays, as well as erosion control benefits by attenuating wave energy. In addition, commercial oyster fisheries and recreational fishing near healthy oyster reefs are strong economic generators for the state. This project would ensure that funds for oyster reef restoration would be spent in locations with supportive environmental conditions and on projects using demonstrated successful methods to promote the long-term sustainability of oysters in this region.

Estimated Total Project Cost: $700,000

Copano Bay Oyster Reef Restoration *(Project ID R3-27)*



Region: 3

Location:

Copano Bay

County:

Aransas

Status:

Under Construction

Stakeholders:

- The Nature Conservancy
- Texas Parks & Wildlife Department
- Texas General Land Office
- Texas Commission on Environmental Quality

Project Type:

Habitat Creation & Restoration

Action:

Oyster Reef Enhancement

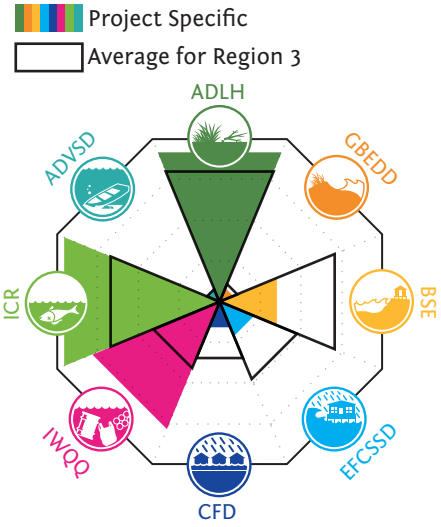
Resiliency Strategy:

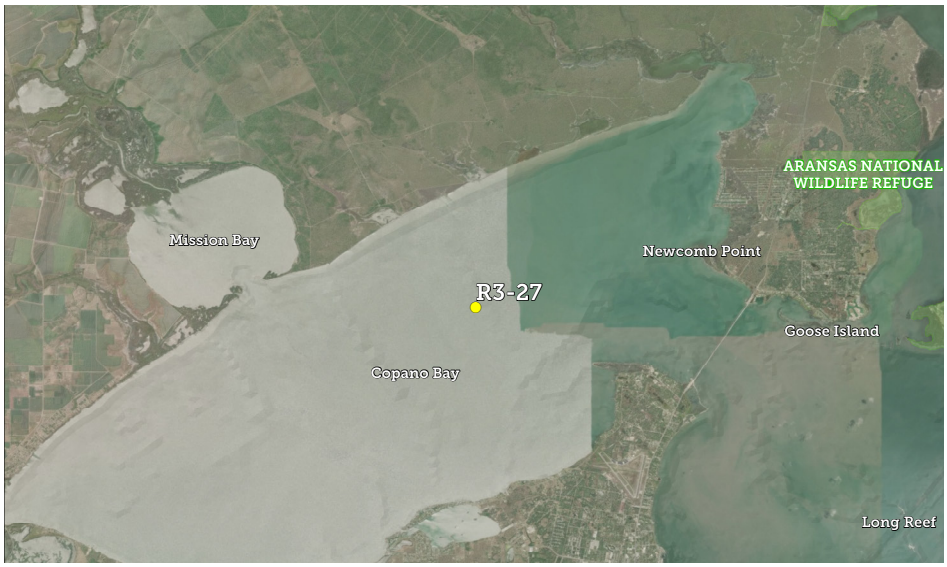
Ecological Resiliency (Oyster Reef Planning, Restoration and Monitoring)

Jobs Created:

Creates approximately 26 jobs during construction.

Project Benefits Per Issues of Concern





Project Description

Using the success of Half Moon Reef as a blueprint, The Nature Conservancy is spearheading a new large-scale (45-acre) oyster reef restoration project in Copano Bay, north of Rockport. Half of the new oyster reef will be designated as a marine sanctuary, and the other half will be open for commercial harvesting. This project is currently funded with National Resource Damage Assessment resources and is under construction; however, more funding would be beneficial to build out the engineered footprint that has been designed. The project would include 3 years of post-construction monitoring.

Project Need

The Texas oyster population is currently at a historic low due to the harmful effects of overharvesting and destruction from hurricanes. This population decrease threatens the Texas economy and water quality along the coast. Data from the Texas Parks and Wildlife Department indicates that the oyster harvesting industry in Texas has provided an average $19 million in from 2007 to 2016.[a] However, oysters take about two years to reach full size and there has been minimal replacement from the quantity harvested over the past several decades. Additionally, oysters act as a natural filter that helps maintain and improve the water quality of the bay. When oyster populations decrease the water quality of the bay decreases, as well.

Project Benefit

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, resulting in an increase in annual economic activity. The dedication of half of the reef as a marine sanctuary would allow for the oysters to grow to full size. Notable benefits of oyster habitat creation are oyster harvests, water filtration, aquatic habitat diversity and shoreline protection by wave energy attenuation.

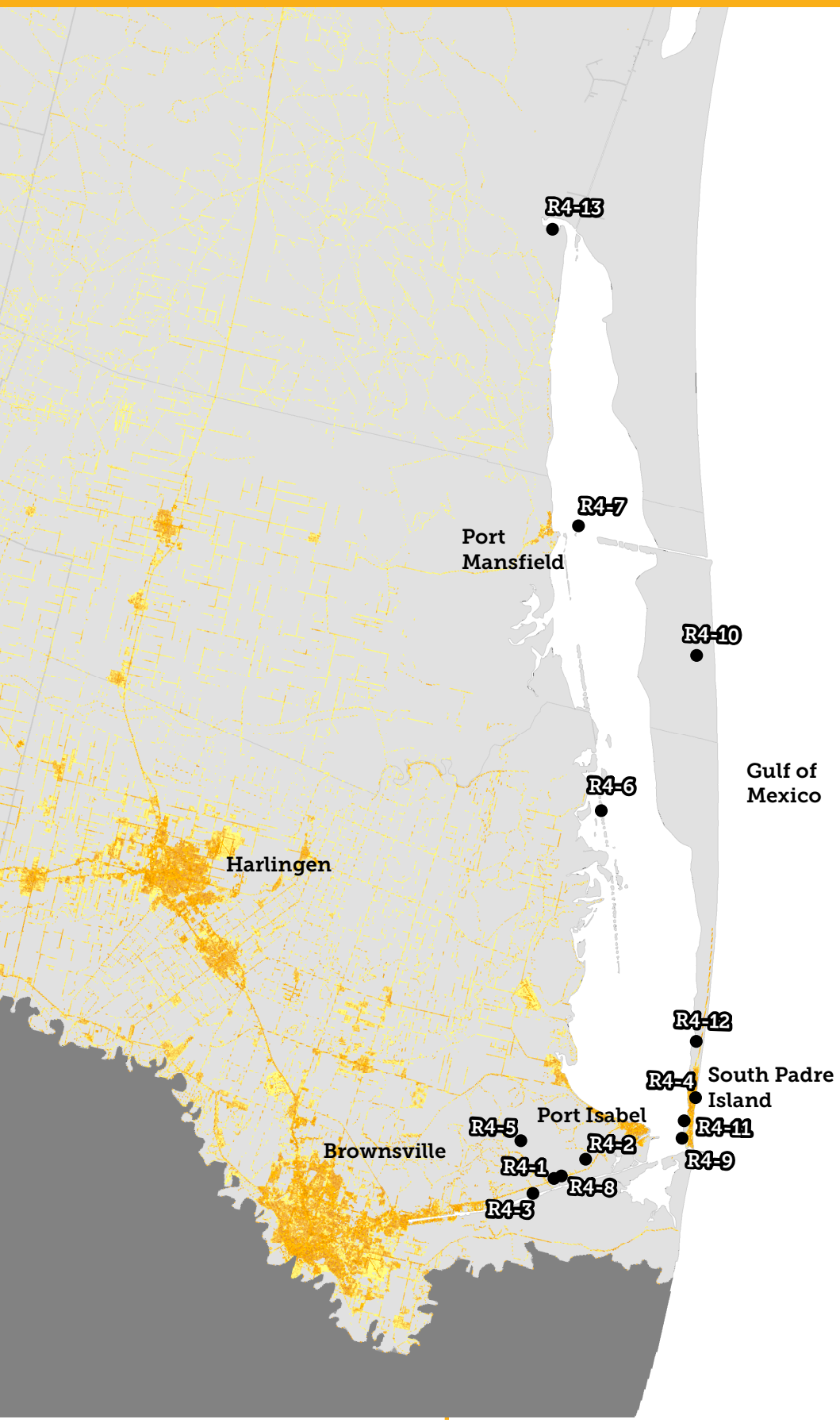
Estimated Total Project Cost: $5,300,000

[a] *Ropicki, A., Dudensing, R. and D. Hanselkahttp. 2018. Economic Contributions of the Texas Oyster Fishery. Texas A&M AgriLife Extension and Texas Sea Grant. Available at: http://texasseagrant.org/assets/uploads/resources/18-502_Economic_Contributions_of_the_Texas_Oyster_Fishery.pdf (accessed Feb 2, 2019)*

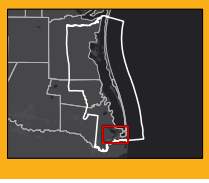
REGION 4

TIER 1 PROJECTS

13 Projects *$145M+*



Bahia Grande Hydrologic Restoration *(Project ID R4-1)*



Region: 4

Location:

Southeastern Bahia Grande, along the Brownsville Ship Channel

County: Cameron

Status: Shovel-ready

Stakeholders:

- Texas Parks & Wildlife Department
- Texas Commission on Environmental Quality
- U.S. Fish and Wildlife Service
- National Oceanic and Atmospheric Administration
- U.S. Department of Agriculture
- Environmental Protection Agency
- Texas General Land Office
- Brownsville Navigation District

Project Type: Habitat Creation & Restoration; Hydrologic Connectivity

Action: Watershed Planning

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement; Wetland Planning, Restoration and Monitoring); **Societal Resiliency** (Water-Based Transit Enhancement)

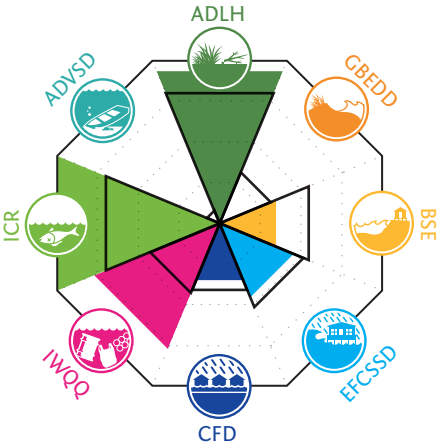
Jobs Created:

Creates approximately 71 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



Project Description

In 2005, a pilot channel was constructed that connected the Brownsville Ship Channel to the Bahia Grande. This restored the original circulation by refilling the main basin. In 2007, to improve natural tidal flow and exchange throughout the whole system, two interior channels were cut to reconnect the larger basin to two smaller interior basins – the Laguna Larga and the Little Laguna Madre. To ensure tidal flow into the basins and to fully restore the natural biological functions of the wetlands, it is recommended to widen and deepen the original pilot channel. This project is expected to go to construction in the second half of 2019, pending receipt of final funding and completion of the bid selection process. A monitoring component, such as installing flow gages on both sides of the inlet, is also recommended to demonstrate project success and would be included in the final funding request.

Project Need

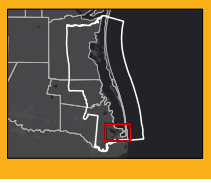
The tidal flow between the Bahia Grande and the Laguna Madre was cut off in the mid-1900s, decreasing the circulation between the two waterbodies. This resulted in large numbers of fish kills and widespread habitat loss.

Project Benefit

The pilot project in 2005 showed benefits to fish populations and wetland habitats in the area. Similarly, the work completed in 2007 continued to improve fish counts, benefited the ecological quality and biodiversity of the Bahia Grande, and reduced wind-blown dust to nearby communities. The proposed continuation of this project would further increase the ecological benefits and the tidal exchange through the complex. It also would reduce more of the dust blown in the area, and it would enhance recreational fishing opportunities.

Estimated Total Project Cost: $5,300,000

Paso Corvinas Wetlands & Hydrologic Restorations
(Project ID R4-2)



Region: 4

Location:

North of SH 48, between the Bahia Grande and Laguna Madre

County:

Cameron

Status:

Conceptual

Stakeholders:

- U.S. Fish and Wildlife Service
- National Wildlife Federation

Project Type:

Habitat Creation & Restoration; Study, Policy, Plan or Program; Hydrologic Connectivity

Action:

Watershed Planning

Resiliency Strategy:

Ecological Resiliency (Freshwater Inflow and Tidal Exchange Enhancement; Wetland Planning, Restoration and Monitoring); **Administrative Resiliency** (Study)

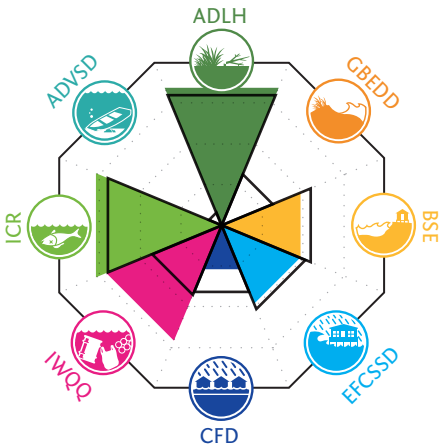
Jobs Created:

Creates approximately 36 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



Project Description

A feasibility study was funded to determine the most effective methods to restore connectivity between Paso Corvinas and the Bahia Grande. A recommended project from this feasibility study would restore and enhance 670 acres of wetlands near Paso Corvinas and return Paso Corvinas to its previous tidally-influenced condition by removing the southwestern sand bar and restoring connectivity between Paso Corvinas and the Bahia Grande. To implement this project, design and construction of the hydrologic restoration alternative need to be performed. The design phase will consider incorporating an improved low water crossing on the northeastern side of Paso Corvinas as a secondary measure to improve overall circulation.

Project Need

The circulation between Paso Corvinas and the Bahia Grande has been altered due to upstream development. This has decreased flows through the waterbodies and allowed a sandbar to build at their pass, restricting tidal exchange.

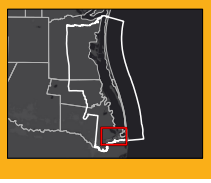
Project Benefit

This project would improve the health of wetlands near Paso Corvinas and restore connectivity between Paso Corvinas and the Bahia Grande. Improving the tidal circulation between the two waterbodies would likewise improve the wetland functionality and benefit the overall health of the ecosystem.

Estimated Total Project Cost: $2,700,000*

**Partial funding identified*

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



Region: 4

Location:

Watershed draining to the Brownsville Ship Channel and Lower Laguna Madre

County:

Cameron

Status:

Ongoing

Stakeholders:

- Arroyo Colorado Watershed Partnership
- University of Texas Rio Grande Valley
- Texas Commission on Environmental Quality
- Texas A&M University-Kingsville
- Lower Rio Grande Valley Stormwater Task Force
- Cameron County

Project Type:

Habitat Creation & Restoration; Study, Policy, Plan or Program; Hydrologic Connectivity; Community Infrastructure

Action:

Watershed Planning

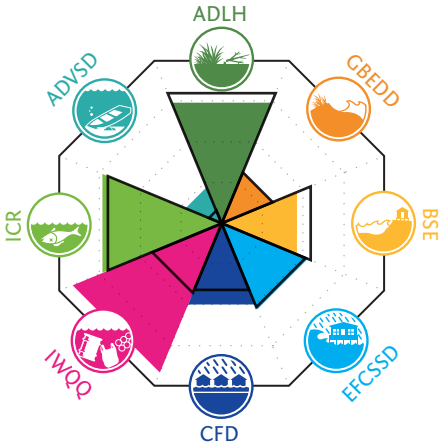
Resiliency Strategy:

Administrative Resiliency (Plan)

Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



Project Description

This project would implement the Lower Laguna Madre and Brownsville Ship Channel Watershed Protection Plan (WPP) to improve and protect water quality. Under this project, hydrologic and water quality monitoring and modeling would be used to assess existing and potential water quality threats from ongoing nonpoint source water pollution within the Laguna Madre and Brownsville Ship Channel Watershed. Public education would be included to seek local participation in developing the WPP and implementing watershed management practices. The WPP encompasses the coastal zone and its habitats, urban and agricultural areas, infrastructure, and streams. The Arroyo Colorado Watershed Partnership, collaborating with stakeholders, would conserve healthy components of the watershed to avoid water quality impairments in the future.

Project Need

Low levels of dissolved oxygen and high levels of fecal bacteria are detected in the Lower Laguna Madre watershed, which drains to the Brownsville Ship Channel and the Lower Laguna Madre. This causes significant negative impacts on the local ecosystem, which is experiencing the proliferation of invasive aquatic plants. Additionally, public use of this channel has been adversely impacted as several portions of the ship channel and the surrounding waterbodies are closed to limit human contact with impaired waters.

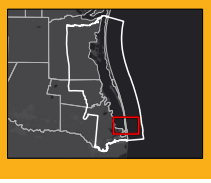
Project Benefit

The benefits of this project would include improved water quality, reduced risk of invasive species colonization, and intact floodplains that allow the watershed to better adapt to more extreme weather patterns and increased precipitation during storms. The project also would reduce public health risks for visitors who partake in beach activities, recreational fishing and nature tourism in the Lower Laguna Madre and upstream resacas, lakes and streams.

Estimated Total Project Cost: $600,000*

**Partial funding identified*

South Padre Island Beach and Dune Management and Restoration *(Project ID R4-4)*



Region: 4

Location:

Gulf shoreline of South Padre Island in Cameron County, north of the Brazos-Santiago Ship Channel

County:

Cameron

Status:

Ongoing

Stakeholders:

- Cameron County
- City of South Padre Island
- U.S. Army Corps of Engineers
- Texas General Land Office

Project Type:

Beach Nourishment;
Dune Restoration

Action:

Beach and Dune Sustainability

Resiliency Strategy:

Ecological Resiliency (Beach Nourishment and Dune Restoration); **Societal Resiliency** (Water-Based Transit Enhancement)

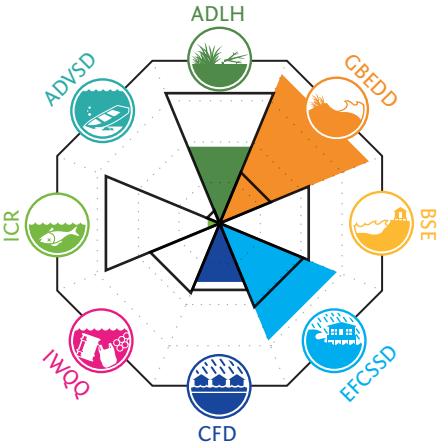
Jobs Created:

Creates approximately 1019 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



Project Description

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 from the Brownsville Ship Channel since 1988. This project would fund annual beach renourishment along this eroding shoreline. This project also would continue to support analysis for regional sediment or dune management planning to work towards the most sustainable practices for maintaining the island's Gulf beach and dune system.

Project Need

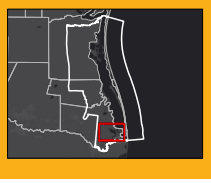
Gulf shoreline erosion occurs across the island at a regional scale, impacting both Cameron County beaches and City of South Padre Island beaches, leading to potential damage to the environment, private property, public infrastructure and hindering economic development. The Gulf shoreline erosion rate throughout much of South Padre Island averages between 10 feet and 15 feet per year, with the average erosion rate increasing as you move north along the island from its southern end. The beaches and dunes are the primary defense against storm surge created from tropical storms and hurricanes, providing risk reduction to development on the island and bay-front communities on the mainland.

Project Benefit

This project would strengthen the beaches and dunes that are the region's first line of defense against coastal storm surge. The City's primary economic driver is tourism, and the project would create a stable, accessible beach for residents and tourists alike. Likewise, renourishment of the beaches and dunes in unincorporated areas of Cameron County will help create healthy, stable and accessible beaches for anticipated future economic development and public enjoyment. In addition, critical habitat for endangered piping plovers and Kemp's ridley sea turtles would be maintained.

Estimated Total Project Cost: $74,100,000 (for 10 miles)

Bird and Heron Islands Restoration *(Project ID R4-5)*



Region: 4

Location:

Islands located centrally within the Bahia Grande

County:

Cameron

Status:

Engineering & Design

Stakeholders:

- U.S. Fish and Wildlife Service
- National Fish and Wildlife Foundation

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Rookery Island Enhancement

Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation)

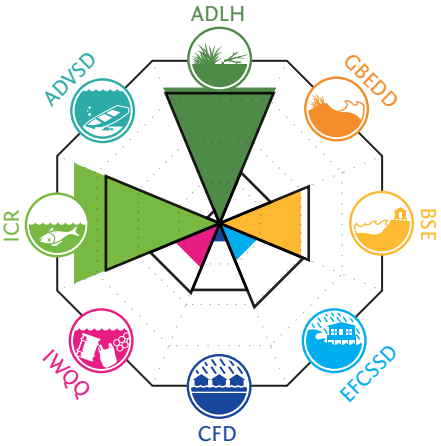
Jobs Created:

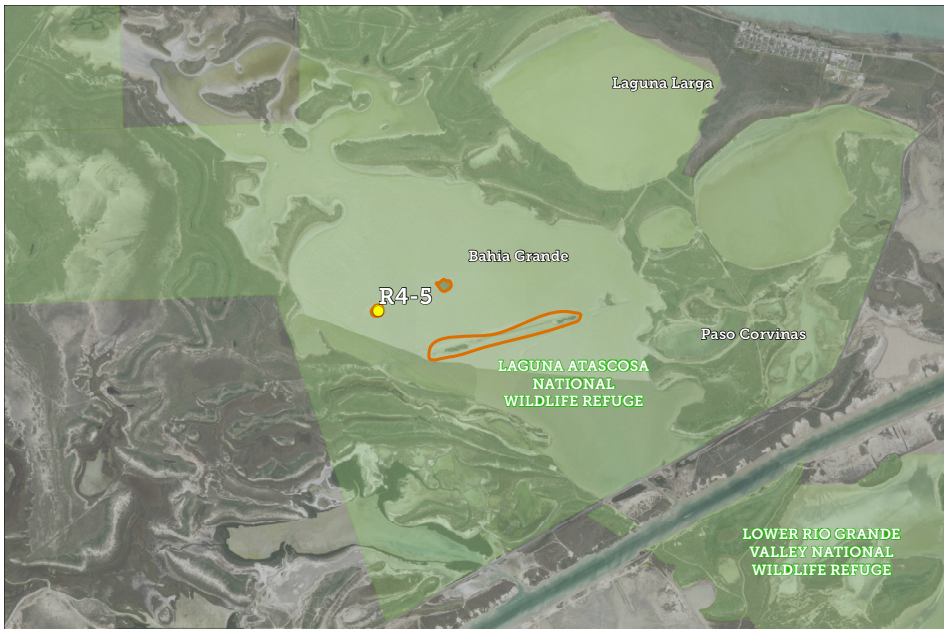
Creates approximately 96 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 4





Project Description

This project would restore up to 36 acres of bird nesting islands in the Bahia Grande – including Bird Island, Heron Island, and two islands along the railroad crossing remains. Shoreline protection for these islands would total approximately 1 mile of rock breakwaters. The project's preliminary engineering design is currently funded and is expected to be complete in 2019. With additional funding, this project would build upon these efforts by financing the final design, construction and monitoring phases of the project.

Project Need

Islands in the Bahia Grande, which support Gull-billed terns and other bird colonies, are experiencing heavy and rapid erosion.

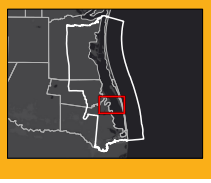
Project Benefit

This project would help control the erosion of bird nesting islands in the Bahia Grande by stabilizing the island shorelines, which would prevent additional erosion of the islands and would reduce the loss of critical bird habitat.

Estimated Total Project Cost: $7,100,000*

**Partial funding identified*

Restore Laguna Madre Rookery Islands
(Project ID R4-6)



Region: 4

Location:

Rookery islands in the bay areas between North Padre Island, South Padre Island and the mainland

County:

Kenedy, Willacy

Status:

Conceptual

Stakeholders:

- Texas Parks & Wildlife Department
- Texas General Land Office

Project Type:

Habitat Creation & Restoration

Action:

Rookery Island Enhancement

Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation)

Jobs Created:

Creates approximately 150 jobs during construction.

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. Most of these 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 re-establishing native habitat. The Texas General Land Office's Texas Coastal Management Program funded a 2016 study of Predicted Waterbird Habitat Loss on Eroding Texas Rookery Islands, which would be used to identify the islands with the most strategic restoration needs.

Project Need

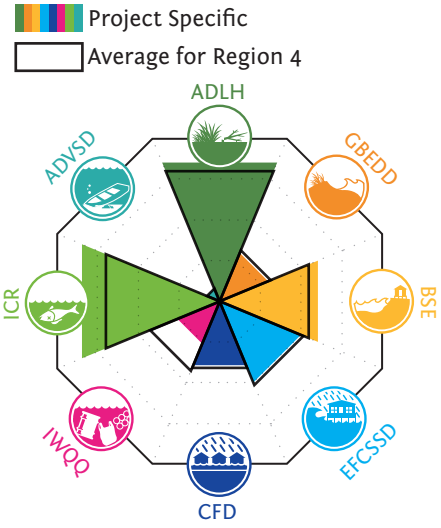
The selected islands for restoration range from "medium" to "extremely high" risk of erosion within the next 10 years based on the Audubon Texas Predicted Waterbird Habitat Loss on Eroding Texas Rookery Islands report.

Project Benefit

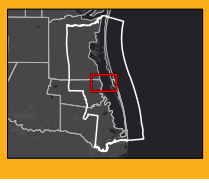
Rebuilding and maintaining Texas rookery islands is critical to ensure migratory bird and shorebird populations remain stable across the state, which supports nature tourism in the surrounding areas.

Estimated Total Project Cost: $12,100,000

Project Benefits Per Issues of Concern



Mansfield Rookery Island Shoreline Protection
(Project ID R4-7)



Region: 4

Location:

Rookery island in the Laguna Madre east of Port Mansfield and north of Mansfield Channel

County:

Willacy

Status:

Conceptual

Stakeholders:

- U.S. Army Corps of Engineers
- Port of Port Mansfield

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Rookery Island Enhancement

Resiliency Strategy:

Ecological Resiliency (Rookery Island Protection, Restoration and Creation)

Jobs Created:

Creates approximately 46 jobs during construction.

Project Description

Mansfield Rookery Island is just north of the Port Mansfield Channel, which connects the Port of Port Mansfield to the Gulf of Mexico. This project would redesign the shoreline protection for the island by adding an additional breakwater or other shoreline stabilization to safeguard the southern and eastern sides of the island. The U.S. Army Corps of Engineers has plans to complete this work in the summer of 2019 as part of a $17 million project to dredge Mansfield Cut and Mansfield Channel.

Project Need

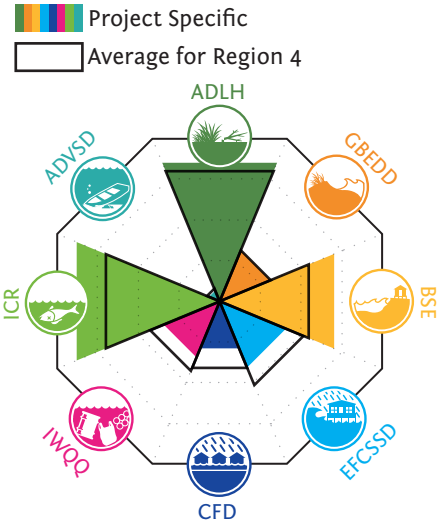
This island has experienced heavy erosion resulting from boat wakes from ships transiting the channel. Partial protection was added in the early 2000's in the form of a breakwater to protect the northern side of the island, while leaving the southern portion of the island exposed, though open to receiving additional beneficial use of dredged material.

Project Benefit

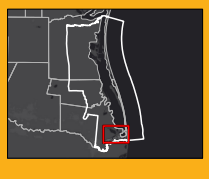
This project would enhance the habitat of the Mansfield Rookery Island and would reduce siltation in the Mansfield channel. Additionally, the project would benefit migratory birds as the island is an important stopover island for the birds traversing the Laguna Madre.

Estimated Total Project Cost: $3,800,000

Project Benefits Per Issues of Concern



Bahia Grande Living Shoreline *(Project ID R4-8)*



Region: 4

Location:

North of SH 48, along the Bahia Grande's eastern shoreline

County:

Cameron

Status:

Conceptual

Stakeholders:

- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization; Public Access & Improvement

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring);
Societal Resiliency (Land-Based Transit Enhancement; Community Infrastructure Planning and Development

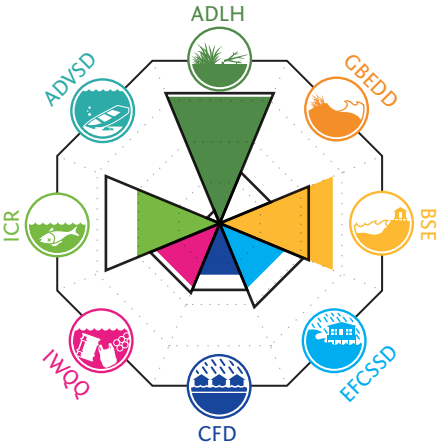
Jobs Created:

Creates approximately 73 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



Project Description

This project would improve State Highway 48 (SH 48) by replacing existing foreign-sourced rip-rap material with naturally-based, native materials to create a living shoreline on the north side of SH 48. Further east along SH 48, erosion issues are not as prevalent, but culverts would be installed to allow flow during large rain events to drain under SH 48 and prevent overtopping and flooding of the roadway.

Project Need

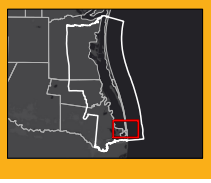
The areas near the roadway shoulders of SH 48 are eroding drastically and the sediment is washing away into the Bahia Grande wetland system. Rip-rap is currently placed along the north side of SH 48, but is not effective in preventing erosion. The rip-rap also is a public health and safety risk, since pieces of concrete used to prevent vehicular travel along the road shoulder have exposed metal rebar jutting out and have been stepped on by anglers.

Project Benefit

This project would prevent the future continual erosion of SH 48 by replacing the ineffective rip-rap with a living shoreline. The removal of the rip-rap would also benefit public health by making the area safer for recreational anglers.

Estimated Total Project Cost: $5,400,000

Restore Barrier Island Bayside Wetlands on South Padre Island *(Project ID R4-9)*



Region: 4

Location:

Bayside on the southern portions of South Padre Island

County:

Cameron

Status:

Conceptual

Stakeholders:

- Texas General Land Office

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Wetland Protection and/or Shoreline Stabilization

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring)

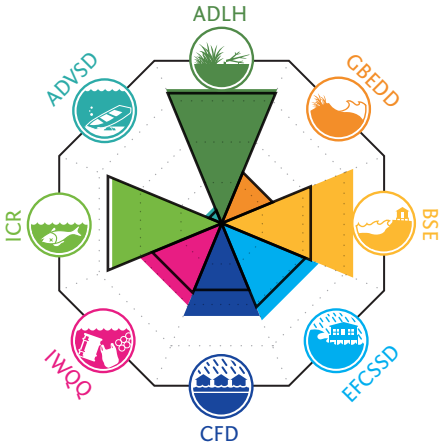
Jobs Created:

Creates approximately 75 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



Project Description

This project would restore the wetlands on the bayside of South Padre Island by depositing beneficial use of dredged material of non-beach quality materials to help rebuild degraded wetlands. Placing additional sediment in these wetlands, while minimizing disturbance to the existing plants themselves, would help the area to stay at pace with relative sea level rise and prevent losing these wetlands in the future.

Project Need

Wetlands are one of the fastest declining habitats in the United States, with over half of America's wetlands experiencing degradation or entirely lost since 1780.[a] Wetlands have similarly declined along the bayside of South Padre Island due to a variety of anthropogenic and environmental factors. As a result, residents of South Padre Island are losing one of their most effective natural protections against coastal flooding, which is the wave and water level attenuation provided by mangroves and other wetland habitats.

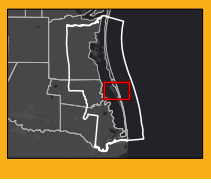
Project Benefit

Restoring wetlands on the bayside of South Padre Island would provide a buffer for stormwater runoff as well as storm surge during large storm events. Intact wetland areas enable healthy watersheds to better adapt to more extreme weather patterns and changes in precipitation.

Estimated Total Project Cost: $5,500,000

[a] *U.S. Fish & Wildlife Service. 2019. National Wetlands Inventory. Available at: https://www.fws.gov/wetlands/ (accessed Feb 27, 2019)*

South Padre Island Coastal Beach Protection
(Project ID R4-10)



Region: 4

Location:

Northern portions of South Padre Island

County:

Cameron

Status:

Conceptual

Stakeholders:

- U.S. Fish and Wildlife Service

Project Type:

Habitat Creation & Restoration; Land Acquisition

Action:

Responsible Development

Resiliency Strategy:

Ecological Resiliency (Upland Planning, Conservation and Monitoring)

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. migration) by precluding development on environmentally sensitive areas.

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.

Project Benefit

This project would protect the natural habitats and ecosystems from human encroachment that could cause native species to diminish. Natural landscapes and floodplains filter pollutants from point and nonpoint sources, promote nutrient cycling, and help retain sediment. The area is also a world-renowned migratory route for many species of birds. Preserving undeveloped properties would safeguard important foraging and nesting habitat.

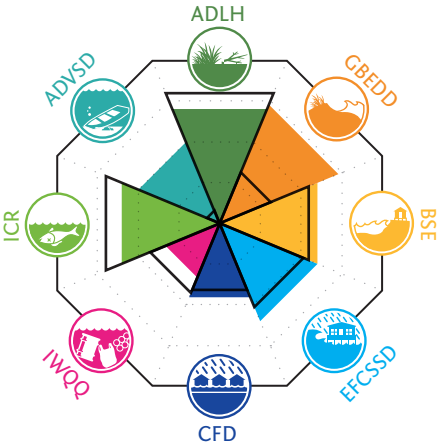
Estimated Total Project Cost: Up to $25,000,000*

**Partial funding identified*

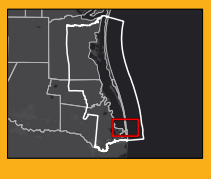
Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



City of South Padre Island Living Shoreline
(Project ID R4-11)



Region: 4

Location:

Bayside of South Padre Island, just north of the Queen Isabella Causeway

County:

Cameron

Status:

Conceptual

Stakeholders:

- City of South Padre Island

Project Type:

Habitat Creation & Restoration; Shoreline Stabilization

Action:

Responsible Development

Resiliency Strategy:

Ecological Resiliency (Wetland Planning, Restoration and Monitoring);
Societal Resiliency (Community Infrastructure Planning and Development)

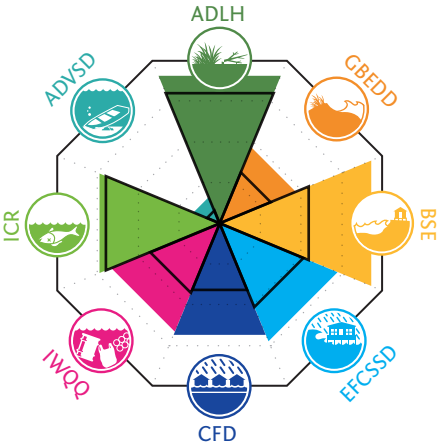
Jobs Created:

Creates approximately 34 jobs during construction.

Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



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 placed between the deeper Tompkins Channel and the upland properties. The living shoreline areas would restore the black mangroves, seagrasses and oyster habitats that are declining in the region. Maintaining access routes to the Laguna Madre would be an important consideration during the project design phase.

Project Need

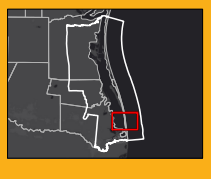
Over the years, the black mangroves, oysters, wetlands, seagrasses and salt flats of the City of South Padre Island have declined in the Laguna Madre due to a variety of natural and human-induced causes (e.g. changes in freshwater inflows and salinity, inadequate protection from ship wakes). This leaves the majority of the city's bayside exposed directly to wave action against existing rubble rip-rap and concrete bulkheads.

Project Benefit

This project would serve as environmental restoration for the area and provide massive amounts of environmental uplift for the bayside of the island. Individuals who live on the bayside would see an increase in the buffer zone between their properties and the Laguna Madre, which acts as protection from nuisance flooding. 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.

Estimated Total Project Cost: $2,600,000

South Padre Island Park Development
(Project ID R4-12)



Region: 4

Location:

Area north of 'The Shores' on the bayside of South Padre Island

County:

Cameron

Status:

Engineering & Design

Stakeholders:

- City of South Padre Island

Project Type:

Habitat Creation & Restoration; Public Access & Improvements; Land Acquisition

Action:

Responsible Development

Resiliency Strategy:

Societal Resiliency (Community Infrastructure Planning and Development)

Project Description

This project would acquire an area on the laguna side of South Padre Island and create a bay access point for wind and water sporting enthusiasts as well as a parking area with additional bay access. The City of South Padre Island has entered into discussions with a willing seller regarding their intent to acquire approximately 137 acres of property north of The Shores community. The City of South Padre Island has begun the process of conceptual planning, engineering and permitting for the proposed site. This venue would provide access to the Laguna Madre for all non-motorized water sports, from kayaks to kiteboards. The city is involving the public throughout this process, beginning by holding a key stakeholder meeting of kiteboard and windsurfing aficionados in 2018 to discuss the ideal design for the facility.

Project Need

South Padre Island is consistently listed among the top wind sporting destinations in the world. However, there is not an access point along the bay for these enthusiasts. Without a planned parking site and access point, the area's fragile salt flats and wetlands are being trampled, driven on, and disturbed as hundreds to thousands of kite-boarders, surfers, wind-surfers, paddle-boarders and kayakers flock to the Laguna Madre each year.

Project Benefit

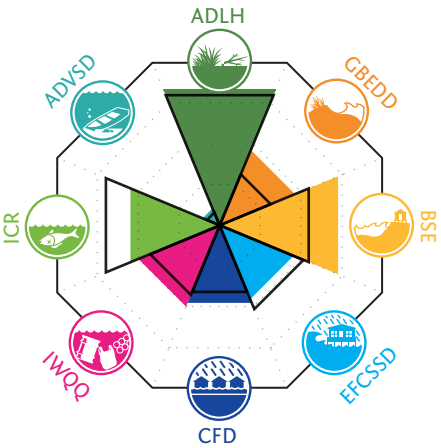
While the construction of this project would require mitigation due to impacts, eliminating the "free-for-all" waterfront access approach that is currently occurring could offset this impact. Maintaining and preserving access to the Laguna Madre is vital to South Padre Island for many reasons. As South Padre Island grows north, making appropriate access available to this area would become even more of a priority for the city. This amenity would positively serve this coastal environment, the local community and tourists.

Estimated Total Project Cost: $1,100,000

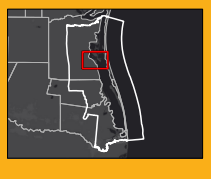
Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



Laguna Madre Relative Sea Level Rise Monitoring and Adaptive Management *(Project ID R4-13)*



Region: 4

Location:

The Laguna Madre

County:

Kenedy, Kleberg, Willacy, Cameron

Status:

Conceptual

Stakeholders:

- Texas General Land Office

Project Type:

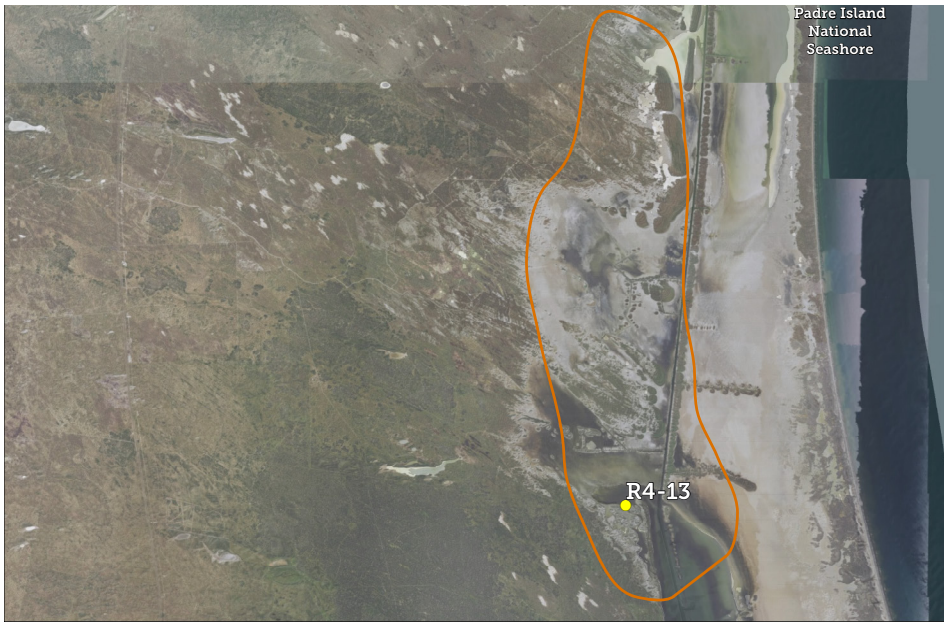
Habitat Creation & Restoration; Study, Policy, Plan or Program

Action:

Data Collection and Monitoring

Resiliency Strategy:

Administrative Resiliency (Plan)



Project Description

This project would create a program to monitor long-term subsidence and sea level rise in the Laguna Madre. While the causes of subsidence are understood in general, they have not been identified for individual coastal communities. This project would include assessing combinations of repeated benchmark measurements, installing Continuously Operating Reference Stations (CORS), studying tide gauge data, and analyzing Interferometric Synthetic Aperture Radar (InSAR) data. The project would make data publicly accessible to all coastal communities.

Project Need

The Texas coast is facing environmental pressures of increased subsidence and sea level rise that will have economic (e.g. loss of infrastructure), social (e.g. relocation and public perception), and environmental (e.g. habitat changes, land use changes) implications for Texas coastal communities. The Laguna Madre area is undeveloped and presents a unique opportunity to study the dynamic coastal response to relative sea level rise with relatively minimal anthropogenic interference. The results would be used to guide future planning on the Texas coast related to response to sea level rise and other environmental changes. A consistent monitoring plan with high accuracy georeferencing spanning many years would be necessary to determine how to respond to future changes along the coast.

Project Benefit

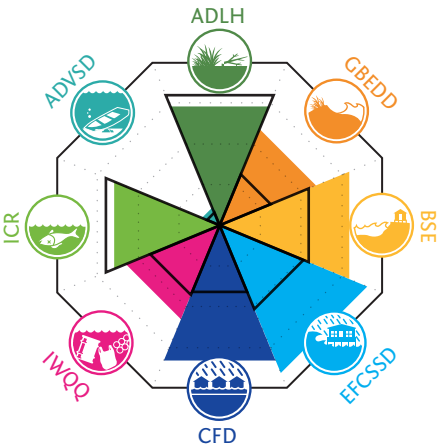
The anticipated benefits of this project would include increased resilience in the face of extreme weather changes by giving coastal experts the ability to predict environmental responses. This could help improve management of the Laguna Madre itself, while providing critical data to benefit the coast at large. The Laguna Madre is a unique attraction of the state, valued for recreational purposes, transporting resources on the Gulf Intracoastal Waterway, and as an important habitat for migratory bird species that support local nature tourism.

Estimated Total Project Cost: $500,000 to design and initiate observations

Project Benefits Per Issues of Concern

Project Specific

Average for Region 4



References

1. U.S. Bureau of the Census. 2017. Total Population, 2013-2017 American Community Survey 5-Year Estimates. Available at: https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t (accessed Feb 14, 2019)

2. Texas Demographer. 2018. Texas Population Projections Program, Sex and Race/Ethnicity Total Population for 2010-2050 in 1 year increments. Available at: https://demographics.texas.gov/data/TPEPP/Projections/Index (accessed Feb 14, 2019)

3. U.S. Energy Information Administration. 2018. Texas State Energy Profile. Available at: https://www.eia.gov/state/print.php?sid=TX (accessed Feb 14, 2019)

4. Port Authority Advisory Committee. 2019. Texas Ports Mission Plan: Investment Strategy - 86th Legislature. Texas Department of Transportation Maritime Division. Available at: http://ftp.dot.state.tx.us/pub/txdot-info/tpp/giww/mission-plan-86.pdf (accessed Feb 14, 2019)

5. U.S. Army Corps of Engineers. 2018. Waterborne Commerce Statistics Center Public Domain Data 2017: Commodity, Origin Region, Destination Region, Short Tons. Available at: https://usace.contentdm.oclc.org/digital/collection/p16021coll2/id/2972 (accessed Feb 15, 2019)

6. Texas Ports Association. 2019. Available at: https://www.texasports.org/ (accessed Jan 10, 2019)

7. Bureau of Labor Statistics. 2017. Quarterly Census of Employment and Wages. U.S. Department of Labor. Available at: https://data.bls.gov/cew/apps/table_maker/v4/table_maker.htm#type=1&year=2017&qtr=A&own=5&ind=10&supp=0 (accessed Feb 14, 2019)

8. Federal Emergency Management Agency. 2017. Texas Hurricane Harvey (DR-4332). Available at: https://www.fema.gov/disaster/4332 (accessed Feb 20, 2019)

9. Texas Division of Emergency Management. 2008. DR-1791-TX Hurricane Ike. Texas Department of Public Safety. Available at: https://www.dps.texas.gov/dem/documents/hurricanes/dr1791.htm (accessed Feb 20, 2019)

10. Texas Division of Emergency Management. 2008. DR-1780-TX Hurricane Dolly. Texas Department of Public Safety. Available at: https://www.dps.texas.gov/dem/documents/hurricanes/dr1780.htm (accessed Feb 20, 2019)

11. Federal Emergency Management Agency. 2005. Texas Hurricane Rita (DR-1606). Available at: https://www.fema.gov/disaster/1606 (accessed Feb 20, 2019)

12. Texas Department of Transportation. 2016. Gulf Intracoastal Waterway Legislative Report - 85th Legislature. Available at: https://ftp.dot.state.tx.us/pub/txdot-info/tpp/giww/legislative-report-85.pdf (accessed Feb 27, 2019)

13. Texas Department of Transportation. 2018. Gulf Intracoastal Waterway Legislative Report - 86th Legislature. Available at: http://ftp.dot.state.tx.us/pub/txdot-info/tpp/giww/legislative-report-86.pdf (accessed Feb 27, 2019)

14. U.S. Energy Information Administration. 2018. Texas State Energy Profile. Available at: https://www.eia.gov/state/print.php?sid=TX (accessed Feb 14, 2019)

15. Texas Comptroller of Public Accounts. 2017. Economy: Texas Military Snapshot. Available at: https://comptroller.texas.gov/economy/economic-data/military/snapshot.php (accessed Feb 14, 2019)

16. U.S. Department of Commerce. 2017. Fisheries Economics of the United States 2015, NOAA Technical Memorandum NMFS-F/SPO-170. National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Available at: https://www.st.nmfs.noaa.gov/Assets/economics/publications/FEUS/FEUS-2015/Report-Chapters/FEUS%202015%20All%20Chapters_Final4_508.pdf (accessed Feb 14, 2019)

17. National Marine Fisheries Service. 2015. Fisheries Economics of the U.S. Interactive Data Tool. Available at: https://www.st.nmfs.noaa.gov/data-and-tools/FEUS/explore-the-data (accessed Feb 27, 2019)

18. Galveston Island Convention & Visitors Bureau. 2017. The Economic Impact of Tourism on Galveston Island, Texas. Available at: https://www.galvestonparkboard.org/ArchiveCenter/ViewFile/Item/181 (accessed Feb 14, 2019)

19. South Padre Island Economic Development Corporation. 2017. South Padre Island Resort Market Analysis, South Padre Island, Texas. Available at: https://www.southpadreislandedc.com/sites/default/files/files/Resources%20%26%20Studies/Visitations%20data%20report%20%20(2)%202017.pdf (accessed Feb 14, 2019)

20. NOAA Center for Operational Oceanographic Products and Services. 2018. Sea Level Trends. Available at: https://tidesandcurrents.noaa.gov/sltrends/ (accessed Dec 10, 2018)

21. NOAA. 2017. Global and Regional Sea Level Rise Scenarios for the United States, NOAA Technical Report NOS CO OPS 083. Available at: https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf (accessed Oct 24, 2017)

22. Winslow, A.G. and W.W. Doyel. 1954. Land-surface subsidence and its relation to the withdrawal of ground water in the Houston-Galveston region, Texas. Economic Geology 49, 413–422. Available at: https://doi.org/10.2113/gsecongeo.49.4.413 (accessed Oct 24, 2017)

23. Morton, R.A., Purcell, N.A., and R. Peterson. 2001. Field evidence of subsidence and faulting induced by hydrocarbon production in coastal southeast Texas. Gulf Coast Association of Geological Societies Transactions Volume LI, 239–248.

24. NOAA Office for Coastal Management. 2018. Fast Facts: Hurricane Costs. Available at: https://coast.noaa.gov/states/fast-facts/hurricane-costs.html (accessed Feb 14, 2019)

25. NOAA National Hurricane Center. 2018. Costliest U.S. tropical cyclones tables updated. Available at: https://www.nhc.noaa.gov/news/UpdatedCostliest.pdf (accessed Feb 15, 2019)

26. NOAA National Centers for Environmental Information. 2018. 2017 U.S. billion-dollar weather and climate disasters: a historic year in context. Available at: https://www.climate.gov/news-features/blogs/beyond-data/2017-us-billion-dollar-weather-and-climate-disasters-historic-year (accessed Feb 14, 2019)

27. Texas A&M Universty AgriLife Extension Service. 2017. Texas agricultural losses from Hurricane Harvey estimated at more than $200 million. Available at: https://today.agrilife.org/2017/10/27/texas-agricultural-losses-hurricane-harvey-estimated-200-million/ (accessed Nov 28, 2018)

28. Texas Parks & Wildlife Department. 2018. Hurricane Harvey Fisheries Damage Assessment - Preliminary Results. Available at: https://www.fisheries.noaa.gov/resource/document/hurricane-harvey-fisheries-damage-assessment-preliminary-results-texas (accessed Feb 15, 2019)

29. Port of Corpus Christi. 2018. Port of Corpus Christi Reflects on One-Year Anniversary of Hurricane Harvey. Available at: http://portofcc.com/port-of-corpus-christi-reflects-on-one-year-anniversary-of-hurricane-harvey/ (accessed Feb 15, 2019)

30. Bain, K. 2019. Port of Beaumont OKs $30M in bonds for Harvey repairs. Beaumont Enterprise. Available at: https://www.beaumontenterprise.com/news/article/Port-of-Beaumont-OKs-30M-in-bonds-for-Harvey-13608338.php (accessed Feb 15, 2019)

31. U.S. Army Corps of Engineers, Galveston District. 2017. District works to overcome Harvey's impacts to Texas' shipping industry. Available at: https://www.swg.usace.army.mil/Media/News-Stories/Article/1310292/district-works-to-overcome-harveys-impacts-to-texas-shipping-industry/ (accessed Feb 15, 2019)

32. Sider, A. 2017. Gasoline Prices Jump in Harvey's Wake. Wall Street Journal. Available at: https://www.wsj.com/articles/gasoline-prices-surge-as-harveys-impact-is-felt-1504202779 (accessed Feb 15, 2019)

33. National Weather Service. 2017. Major Hurricane Harvey - August 25-29, 2017. Available at: https://www.weather.gov/crp/hurricane_harvey (accessed Feb 14, 2019)

34. City of Houston Disaster Recovery Information (Houston Recovers). 2017. Harvey By the Numbers. Available at: https://houstonrecovers.org/numbers/ (accessed Dec 10, 2018)

35. The Governor's Commission to Rebuild Texas. 2018. Eye of the Storm Report. Available at: https://www.rebuildtexas.today/wp-content/uploads/sites/52/2018/12/12-11-18-EYE-OF-THE-STORM-digital.pdf (accessed Feb 14, 2019)

36. Texas Department of Public Safety. 2018. State of Texas Hazard Mitigation Plan. Available at: http://www.dps.texas.gov/dem/Mitigation/txHazMitPlan.pdf (accessed Feb 14, 2019)

37. Texas Department of Public Safety. 2013. State Hazard Mitigation Plan. Available at: https://www.dps.texas.gov/dem/documents/txhazmitplan.pdf (accessed Feb 15, 2019)

38. Harris County Flood Control District. 2018. Harris County's Flooding History. Available at: https://www.hcfcd.org/flooding-floodplains/harris-countys-flooding-history/ (accessed Feb 15, 2019)

39. Texas General Land Office. n.d. Community Development & Revitalization: Hurricanes Ike and Dolly. Available at: http://www.glo.texas.gov/recovery/files/hurricane-ike-disaster-overview.pdf (accessed Dec 10, 2018)

40. Texas Comptroller of Public Accounts. 2018. A Storm to Remember: Hurricane Harvey and the Texas Economy, Fiscal Notes. Available at: https://comptroller.texas.gov/economy/fiscal-notes/2018/special-edition/ (accessed Feb 14, 2019)

41. FEMA Region VI Assessment Branch. 2018. Hurricane Harvey: Coastal Erosion Hot Spot Analysis. Report prepared by Compass PTS JV, led by AECOM.

42. U.S. Army Corps of Engineers, Galveston District. 2018. Coastal Texas Protection and Restoration Feasibility Study: Draft Integrated Feasibility Report and Environmental Impact Statement. Available at: https://www.swg.usace.army.mil/Business-With-Us/Planning-Environmental-Branch/Documents-for-Public-Review/ (accessed Feb 27, 2019)

43. U.S. Army Corps of Engineers, Galveston District. 2017. Sabine Pass to Galveston Bay, Texas Coastal Storm Risk Management and Ecosystem Restoration Final Integrated Feasibility Report – Environmental Impact Statement. Available at: https://www.swg.usace.army.mil/Business-With-Us/Planning-Environmental-Branch/Documents-for-Public-Review/ (accessed Feb 27, 2019)

44. U.S. Fish & Wildlife Service. 1997. Final Proposed Austin's Woods Conservation Plan Land Protection Compliance Document and Conceptual Management Plan, Austin's Woods Units of the Brazoria National Wildlife Refuge Complex. Albuquerque, NM: Fish and Wildlife Service, U.S. Department of the Interior.

45. Texas Water Development Board. 2017. Gulf Coast Aquifer. Available at: http://www.twdb.texas.gov/groundwater/aquifer/majors/gulf-coast.asp (accessed Feb 15, 2019)

46. Bureau of Economic Geology. 2014. Shoreline Change Rates 1930's-2012. Data available at: http://www.arcgis.com/home/item.html?id=7bd9c5bf9823451bb783ce22f18cecc9 (accessed Jan 30, 2017) and described in Paine, J. G., Caudle, T. and J. Andrews. 2014. Shoreline Movement along the Texas Gulf Coast, 1930's to 2012, Final Report to the Texas General Land Office. Bureau of Economic Geology, The University of Texas at Austin.

47. U.S. Army Corps of Engineers, Galveston District. 2018. Galveston District Annual Dredging Meeting. Available at: https://www.swg.usace.army.mil/Portals/26/docs/Navigation/Dredging-Conference/2018/003_FY19_USACE_and_USCG_Commander_Vision.pdf (accessed Feb 27, 2019)

48. Federal Emergency Management Agency. Date varies. FEMA Flood Map Service Center. Available at: https://msc.fema.gov/portal/home (accessed Feb 27, 2019)

49. Texas General Land Office. 2016. Texas Coastal Resiliency Study. Available at: http://www.glo.texas.gov/coastal-grants/_documents/grant-project/texas-coastal-resiliency-study.pdf (accessed Feb 27, 2019)

50. U.S. Geological Survey. 2013. 100-Meter Resolution Impervious Surface of the United States. Available at: https://nationalmap.gov/small_scale/mld/impe100.html (accessed Feb 27, 2019)

51. U.S. Army Corps of Engineers. 2017. U.S. Waterway Data: National Waterway Network. Available at: https://usace.contentdm.oclc.org/digital/collection/p16021coll2/id/1472 (accessed Feb 22, 2017)

52. Texas Comptroller of Public Accounts. 2017. Statewide Economic Data. Available at: https://comptroller.texas.gov/economy/economic-data/ (accessed Jan 10, 2017)

53. Texas State Demographer. 2019. Projections of the Population of Texas and Counties in Texas by Age, Sex and Race/Ethnicity for 2010-2050. Texas State Data Center. Available at: https://demographics.texas.gov/Data/TPEPP/Projections/ (accessed Jan 10, 2019)

54. National Wetlands Inventory. 2017. U.S. Fish & Wildlife Service. Available at: https://www.fws.gov/wetlands/data/data-download.html (accessed Feb 22, 2017)

55. Bureau of Economic Geology. n.d. Shoreline Data Downloads. Bay Shoreline Change Rates. Available at: http://www.beg.utexas.edu/coastal/download.php (accessed Feb 27, 2019)

56. Texas Water Development Board. 2005. Coastal Erosion Rates (Ft. per Yr.), Texas, 1931-2000, Geospatial data compiled for the Texas Hazard Mitigation Package from Bureau of Economic Geology, The University of Texas at Austin, 2000-2003. Texas Coastal Hazards Atlas, Vol. 1-3. http://www.beg.utexas.edu/coastal/hazardsIndex.htm (accessed Feb 22, 2017)

57. Key Allegro Board of Directors. 2017. Letter to Key Allegro Residents – Twelve Weeks After. Available at: http://keyallegroisland.com/letter-to-key-allegro-residents-twelve-weeks-after/ (accessed Feb 26, 2019)

58. World Business Council for Sustainable Development. 2017. Incentives for Natural Infrastructure: Review of existing policies, incentives, and barriers related to permitting, finance, and insurance of natural infrastructure. Available at: https://docs.wbcsd.org/2017/05/Incentives_for_Natural_Infrastructure.pdf (accessed Feb 15, 2019)

59. Allen, C.R., J.J. Fontaine, K.L. Pope, and A.S. Garmestani. 2011. Adaptive management for a turbulent future. Nebraska Cooperative Fish & Wildlife Research Unit - Staff Publications. Available at: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1079&context=ncfwrustaff (accessed Feb 15, 2019)

60. National Academy of Sciences. 2004. Adaptive Management for Water Resources Project Planning. National Academies Press. Available at: https://www.nap.edu/catalog/10972/adaptive-management-for-water-resources-project-planning (accessed Aug 22, 2017)

61. U.S. Army Corps of Engineers, New Orleans District. 2009. Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report, Volume IV Adaptive Management Appendix. Mississippi Valley Division. Available at: https://www.mvn.usace.army.mil/Portals/56/docs/environmental/LaCPR/AdaptiveManagement.pdf (accessed Aug 22, 2017)

62. Walters, C.J. 1986. Adaptive Management of Renewable Resources. Macmillan Publishing Company, New York. Available at: http://pure.iiasa.ac.at/id/eprint/2775/1/ER-86-012.pdf (accessed Aug 22, 2017)

63. The Water Institute of the Gulf. 2013. Adaptive Management Framework for Coastal Louisiana. Coastal Protection and Restoration Authority. Available at: https://thewaterinstitute.org/assets/docs/reports/1_09_2014_Adaptive-Management-Framework-for-Coastal-Louisiana.pdf (accessed Aug 22, 2017)

64. Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC. Available at: https://www2.usgs.gov/sdc/doc/DOI-%20Adaptive%20ManagementTechGuide.pdf (accessed Feb 15, 2019)

Vegetated dune system. (Photo Credit: Texas General Land Office)

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