



Natural Infrastructure Report

How natural infrastructure can shape a more resilient coast for birds and for people

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NATURAL INFRASTRUCTURE REPORT

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CONTENTS

- 4 California
- 5 Florida
- 6 Louisiana
- 7 Maryland –DC
- 8 North Carolina
- 9 South Carolina
- 10 Texas

The stakes for coastal conservation have never been higher. Burgeoning coastal development and population, along with increasingly frequent and severe storms due to climate change, are putting birds and communities at grave risk. Combined, Hurricanes Harvey, Irma, Maria and Nate caused over 200 deaths, an estimated \$330-630 billion in damages, evacuation of millions of people, and extreme habitat loss. The U.S. has experienced an

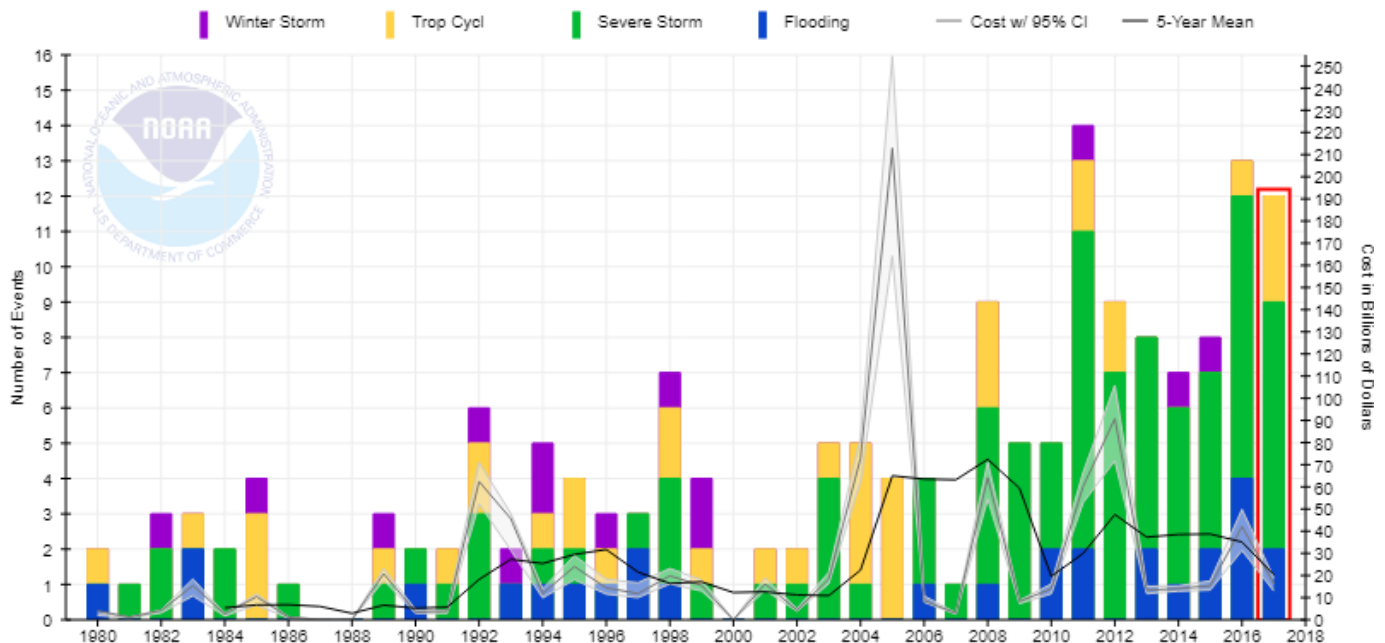
increasing number of billion dollar disaster events—from 1980-2017 there were 5.8 events per year, but from 2013-2017, there were 11.6.

Natural infrastructure can help communities prepare and recover from extreme coastal events, by buffering storm damage, absorbing flood waters, and providing a front line of defense from storms.

Audubon works at over 1,000 sites across all our coasts. At some of these sites, we are pioneering efforts to tackle extreme weather events and sea level rise for birds and people through natural infrastructure projects. Natural infrastructure enhances coastal resiliency, creates necessary habitats for birds and other wildlife, and safeguards the robust coastal economy. Coastal regions provide 40% of US employment, support more than

THE COST AND FREQUENCY OF BILLION DOLLAR DISASTERS HAS INCREASED IN THE U.S.

Billion-Dollar Disaster Event Types by Year (CPI-Adjusted)



Credit: NOAA

69 million jobs, and generate half of the nation's Gross Domestic Product. Coastal restoration creates 30 jobs for each million dollars invested. Additionally, natural infrastructure helps decrease the costs of natural disaster damage.

- Studies show that a 2.5-acre decrease in wetlands corresponds to a \$33,000 increase in storm damages.
- In the Chesapeake Bay, for every dollar spent constructing living shorelines, up to \$1.75 is returned to the economy.
- New Jersey's freshwater wetlands on average save \$3 billion per year in avoided losses from floods, storm surges, and other disturbances.

Federal investment in natural infrastructure will help increase preparedness of coastal communities and economies, while benefitting fish and wildlife, which also often provide a critical foundation for coastal economies.

Audubon works closely with our partners across the federal government on natural infrastructure and restoration projects, including the Department of Agriculture, Natural Resources Conservation Service; Department of Commerce, National Oceanic and Atmospheric Administration; Department of Defense, Army Corps of Engineers; Department of the Interior, Fish and Wildlife Service; and the Environmental Protection Agency. It is critical that these programs receive adequate funding to decrease future risks and increase

preparedness of coastal communities. Natural infrastructure solutions need to be supported as part of the recovery efforts after natural disasters so we build back communities to be stronger and better prepared for future storms. This report highlights some of Audubon's efforts that help tackle both near- and long-term threats confronting wildlife and their habitats while benefiting and sustaining healthy coastal communities.

Aramburu Island shoreline protection and ecological enhancement project



View from the Richardson Bay Audubon Center and Sanctuary.
Photo: John Takekawa, Director of San Francisco Bay Programs, Audubon California

Aramburu Island is located adjacent to Richardson Bay Audubon Center and Sanctuary, along the shoreline in the northwest region of Richardson Bay, south of San Francisco Bay. It was originally created from fill material as part of the Strawberry Spit, but it was converted into a 17-acre island in 1987 as wildlife habitat mitigation for development of the southern portion of the spit. Prior to restoration, the island was degraded by shoreline erosion and non-native plant colonization. The site was designated as an open space area under the Marin County General Plan.

The Aramburu Island Shoreline Protection and Ecological Enhancement Project was funded through recovery efforts from the 2007 Cosco Busan Oil Spill. The project was initiated in 2011 by Audubon California working in partnership with Marin County Department of Parks and Open Space to

enhance the natural resource value of the area. The project goals include:

1) reducing erosion of the eastern shoreline; 2) creating wetland and terrestrial habitats to support a range of target species and natural communities; and 3) providing a platform for enhancing resilience to sea-level rise.

Project Benefits:

San Francisco Bay is a highly urbanized area that is home to more than 7 million people. It also supports diverse natural communities dependent on conserving healthy ecosystems in the baylands between the open water to the upland extent of tidal influence. The bayland ecosystems are comprised of an interconnected mosaic of habitats, including the living shorelines at the edge of the bay that provide support of ecological functions for numerous species. Islands and beaches provide critical ecological functions, including providing food or cover for birds.

Timeline: 2011-2018

Location: Richardson Bay,
Tiburon, California

Partners: Marin County, U. S. Fish and
Wildlife Service

Costs: \$1.1 million

Funding Source: U.S. Fish and
Wildlife Service

The project was constructed in 2011 and provided jobs for construction and technical staff to complete the work. It increased coastal resiliency by stabilizing the eroding shoreline through introduction of cobble materials and enhancement of habitats which resulted in an increased use by populations of waterbirds, including nesting Black Oystercatchers. It provided flood and erosion protection for nearby homes along the shoreline, and it served as one of the only models for shoreline enhancement in San Francisco Bay. Ongoing monitoring includes examining waterbird and invertebrate response and oyster restoration.



Audubon employees and volunteers complete ongoing monitoring projects.
Photo: John Takekawa, Audubon

Erosion control breakwater reef at Richard T. Paul Alafia Bank Bird Sanctuary

The Richard T. Paul Alafia Bank Sanctuary is comprised of two islands in Tampa's Hillsborough Bay, leased from and managed in collaboration with The Mosaic Company and Port Tampa Bay. This Globally Important Bird Area supports more than 13,000 nesting pairs of 18 shorebird, seabird, and wading bird species. Storm-driven waves and increasingly large ship wakes over the years have caused substantial erosion, washing away the sandy shoreline and toppling trees into the water. Audubon works with the Mosaic Company and Port Tampa Bay to add onto the successful existing breakwater oyster reef habitat, which intercepts onshore wave and wake energy from storms and shipping traffic in Tampa Bay, a major port. In addition to ongoing erosion, Hurricane Irma caused damage to the sanctuary where breakwater structures had not been installed. The Alafia Bank continues to experience rapid loss of critical habitat along the northern shoreline not protected by offshore breakwaters. Events like Hurricane Irma exacerbate and accelerate this process and will continue to do so until the breakwater array is completed.

Erosion control at Alafia Bank is beneficial to more than 13,000 nesting pairs, including some of Florida's rarest birds: Little Blue Herons, Tricolored Herons, Reddish Egrets, Roseate Spoonbills and American Ospreys. The sanctuary hosts one of the region's largest White and Glossy Ibis colonies and the state's largest spoonbill colony. It also creates underwater structure for benthic invertebrates and their sportfish predators. Seagrass can recruit in the calm waters behind the

breakwaters. This is an important site for rare Diamondback Terrapins. Recovery of this species on public lands and private preserves like this one will help reduce any potential regulatory burden on private landowners that would result from their listing.

Project Benefits:

In 2016, the Florida Fish and Wildlife Conservation Commission created 13 new and expanded 5 existing Critical Wildlife Areas, essential for the survival of the state's waterbirds. These designations allow for the posting of no-entry, in-water buffers to protect these vulnerable areas from disturbance. Alafia Bank was granted a year-round closure with a buffer, and is among the most important of this network of sites crucial to the survival of these species in Florida.

Erosion control at Alafia Bank provides many jobs and is beneficial to Florida's economy. Each phase has required the subcontracting of private engineering services, wave attenuation device fabrication, barge rental and placement staff. Wildlife

Timeline: 2011-TBD

Location: Hillsborough Bay, Tampa Bay, Florida at the mouth of the Alafia River

Partners: The Mosaic Company, Port Tampa Bay, Living Shoreline Solutions, Reef Innovations

Costs: \$2.1 million

Funding Sources: National Fish and Wildlife Foundation, Environmental Protection Commission of Hillsborough County, Tampa Bay Estuary Program, Living Shorelines Solutions, Reef Innovations, Coastal Resources Group, Tampa Audubon Society, the Mosaic Foundation, and many donors to Audubon

viewing in Florida generates more than \$5 billion per year in economic impact, from domestic visitors alone. Alafia Bank is responsible for fledging a substantial number of the most sought-after species in the region for birdwatchers, including Reddish Egret, Roseate Spoonbill and American Oystercatcher. The breakwater also provides important reef and essential fish habitat and has become a destination for recreational and professional anglers.



Breakwater reef protects Alafia Bank from destructive erosion. Photo: John Landon

Mid-Barataria Sediment Diversion



Brown Pelicans in the Mississippi River Delta are among many species that will lose important habitat. Photo: Ned Haight (CC BY-NC-ND 2.0)

Within the Barataria Basin, wetland loss averaged 5,700 acres per year between 1974 and 1990 due to natural erosional processes and human activities of channelization, levee construction and development. The Mid-Barataria Sediment Diversion is needed to reverse past and mitigate future land loss. This project will replicate natural deltaic and sedimentation processes by directing sediment, fresh water and nutrients from the Mississippi River into adjacent degrading wetlands in Barataria Basin to build and sustain tens of thousands of acres. The 2017 Louisiana Coastal Master Plan shows that the land area built or maintained by the project, based on Delft-3D modeling analysis, is projected to be approximately 8,000 acres in project year 2020, and nearly 30,000 acres over the 50-year lifespan of the project.

The Mid-Barataria Sediment Diversion has been studied by state and federal agencies since 1984. The project was included in the U.S. Army Corps of

Engineers and state of Louisiana civil works study called the Louisiana Coastal Area (LCA) Ecosystem Restoration Study. The study culminated in 2004 with a programmatic level main report and Environmental Impact Statement (EIS). The project has since been included in the state of Louisiana Coastal Master Plans in both 2012 and 2017 as one of its highest priority projects for rebuilding Louisiana's wetlands. In January 2017, the Mid-Barataria Sediment Diversion was designated as a covered project under the Fast-41 Federal Permitting Dashboard, a public platform that tracks agency reviews and permitting for projects of national significance. Audubon and partners are working to expedite permitting for and approval of this project.

Project Benefits:

Since diversions reestablish natural deltaic processes and continuously build land over time, they provide long-term benefits that constructed marsh creation projects alone do not. Sediment diversions provide

Timeline: Permitting underway with construction set to be completed 2020-2021

Location: Myrtle grove area, Plaquemines Parish, along the west side of the Mississippi River, influencing Barataria Bay

Partners: State of Louisiana and Federal permitting agencies (NOAA, DOI, Corps of Engineers)

Costs: \$1.3 billion

Funding Sources: Army Corps of Engineers, National Fish and Wildlife Foundation, National Resource Damage Assessment, the RESTORE Act, and more

a regular supply of sediment and fresh water to wetlands, sustaining traditional marsh creation projects while also building new land. Ensuring wetlands throughout Barataria Basin would safeguard critical habitat for important birds and other wildlife, including several endangered species, resulting in higher biodiversity and productivity. Additionally, these new and sustained wetlands provide a buffer from storm surge for communities and industry.

LAND LOSS AREA CHANGE IN LOUISIANA FROM 1932-2010.



Credit: Economist.com

Blackwater climate adaptation project



Dredged material getting deposited at Blackwater National Wildlife Refuge.
Photo: Middleton Evans/Audubon Board Member

Blackwater National Wildlife Refuge lies at the core of the Southern Dorchester County Important Bird Area, whose marshes not only support a unique salt marsh bird community but also are essential to a local economy based on farming, fisheries, and tourism. However, nearly all of the tidal marsh here is predicted to disappear beneath rising seas by 2100. In the planning phase of the project, Audubon and partners combined the results of habitat management, research, sea level rise models and marshbird surveys to develop a suite of strategies for increasing marsh resilience to sea level rise, and to prioritize locations where their implementation is most feasible.

Implementation projects to date include experimental tree removal to facilitate upslope migration of tidal marsh into salt-stressed forest and the application of 26,000 cubic yards of sediment dredged from the Blackwater River onto 40 acres of submerging marsh to raise the marsh elevation and reinvigorate marsh vegetation. A new project that began in 2017 will halt and reverse erosion in a marsh

recently transitioned from uplands where ponded water in a collapsed basin is causing vegetation loss. By extending the head of a tidal creek into this basin we will relieve flooding, enhance tidal exchange, and revive marsh vegetation.

Project Benefits:

The goal of the Blackwater Climate Adaptation Project is to ensure the persistence of the tidal marsh ecosystem and its unique birds and other wildlife in the face of sea level rise. The benefits of preventing the loss of these marshes are enormous and relate to the local economy, quality of life, ecosystem health, and biodiversity. This area supports hundreds of people in small communities and could convert to open water by 2100. Dorchester County's 84,000 acres of tidal marsh act as a buffer for local communities against sea level rise and support countless nursery areas for hatchling fishes in their creeks. Blackwater refuge receives 200,000 visitors annually, over two-thirds of visitors to the county, who add millions of dollars to the County's economy. The marshes also act as a filter and a sink for nutrient pollution and help

Timeline: January 2011 - December 2018

Location: Dorchester County, Maryland

Partners: The Conservation Fund, U.S. Fish and Wildlife, Sustainable Science LLC, U.S. Geological Survey, Maryland DNR

Costs: \$3.5 million

Funding Sources: Town Creek Foundation, USFWS, Maryland DNR, National Fish and Wildlife Foundation (Hurricane Sandy Coastal resilience award to TCF), Wildlife Conservation Society, France-Merrick Foundation

the Chesapeake Bay attain the nutrient reduction targets set in the 2014 Chesapeake Bay Agreement.

Dorchester County's marshes are home to 30,000 wintering waterfowl and a salt marsh bird community including species entirely dependent on this ecosystem, such as Saltmarsh Sparrow and the eastern Black Rail. Both of these species are in rapid decline and threatened with extinction within decades. If a core of high-quality marsh can be safeguarded there is hope for these species.



A Great Blue Heron in Blackwater National Wildlife Refuge.

Photo: James O'Guinn/Flickr (CC BY 2.0)

Currituck Sound marsh restoration



A Green Heron at a marsh in Currituck Sound. Photo: Christopher Elliot/Audubon Photography Awards

In 2010, the US Army Corps of Engineers completed a multi-year, multi-stakeholder study and found marsh and submerged aquatic vegetation (SAV) is disappearing, especially in mid-Currituck Sound. The study predicts 430 acres of marsh will disappear every 6 years. Marsh and SAV should be recovered to sustain the health of the estuary and provide natural buffers that reduce impacts of storms and flooding. Audubon and partners aim to construct terraces in the mid-Currituck marsh complex to break wave energy, reduce marsh loss, allow new marsh and SAV to become established, and provide a zone where marsh can be restored.

Project Benefits:

The marsh complex is designated as a global Important Bird Area for waterfowl and supports healthy populations of Osprey, marsh birds, herons and egrets. It is designated essential fish habitat by NOAA for species such as Bluefish and Summer Flounder, and supports significant populations of Striped Bass, Mullet, Blue

Crabs, and White Perch. A study by the North Carolina Natural Heritage Program found the presence of several rare plant species in the marsh, and that Endangered Atlantic sturgeon and West Indian manatee frequent the marsh channels.

Essential ecosystem services of marshes and SAV are significantly diminished by the loss of these habitats. Tidal marshes and SAV provide nursery grounds for fisheries, food for wildlife, and export large amounts of detritus that forms the foundation of aquatic food webs. The loss of these habitats threatens fisheries and wildlife that are important to the lives, livelihoods, and economy of the Sound's residents and businesses. Marshes also provide buffering benefits that reduce the damaging impacts of storms and flooding, which are all-too frequent along North Carolina's coast.

To preserve and enhance the societal and ecological benefits the marshes of Currituck Sound provide, Audubon created the Alliance for Currituck Sound, a multi-

Timeline: Initial planning underway; construction phase depends on funding

Location: Mid-Currituck Sound between Duck and Corolla, North Carolina

Partners: Alliance for Currituck Sound partnership: Currituck County, USFWS, NERR, USACE, NCWRC, Chowan University, Sea Grant, TNC, Albemarle-Pamlico NEP, and more

Costs: \$1 million

Funding Sources: Private foundations, and individuals

stakeholder group of agencies, NGO's and users (watermen, hunters, and recreational companies). Bordering the sound, Currituck and Dare counties depend on tourism for income, as tourism generates over \$1 billion annually in this area. The natural wonders of the famed Outer Banks attract tourists, and while the beach is a dominant draw, more sound-side recreation is critical. These activities, combined with the Heritage uses of the sound—fishing, crabbing, and most especially waterfowl hunting—are the economic lifeblood of the community.

Audubon and members of the Alliance have already sought multi-millions of dollars in grants to restore and enhance the sound. These natural infrastructure projects, such as the demonstration living shoreline project at the Donal C. O'Brien Audubon Sanctuary, will protect traditional jobs while creating new ones in coastal engineering and adaptation to sea level rise. These marshes support the culture, economy, and physical structure of the Outer Banks.

Crab Bank Seabird Sanctuary restoration



Crab Bank has diminished to a narrow slice of sand. Photo: Vanessa Kauffmann

Crab Bank is a narrow slice of sand in Charleston harbor that historically has supported up to 5,000 nesting birds in one season. It's one of just five Seabird Sanctuaries protected by the South Carolina Department of Natural Resources and is a designated Globally Important Bird Area by Audubon. But wind and waves have taken a toll on Crab Bank. Today, less than 100 birds can nest on this shrinking crescent of sand. Audubon and partners support the renourishment of Crab Bank using dredged material from Charleston Harbor, which would make the now 0.5 acre island a huge 80 acre island. It will cost the Army Corps of Engineers an estimated \$3.5 million to create habitat from dredged material rather than dumping the sand out in the ocean.

Project Benefits:

Crab Bank is protected during the nesting season from human disturbance. These islands are vital for the success of beach nesting seabirds and shorebirds, which include many species in decline. Data show that Crab Bank also serves as a secondary site for other established colonial sites subject to severe tidal overwash or human disturbance. In 2007, the island supported 15 breeding pairs of American Oystercatchers, 179 Black Skimmer nests, 615 Brown Pelican nests, 50 Gull-billed Tern nests, 1,212 Royal Tern nests, and 35 Sandwich Tern nests. These birds rely on safe places to recover and maintain healthy populations. With an increasing number of people moving to the coast, beach-nesting bird habitat faces more risks than ever. Maintaining and restoring

Timeline: 2017 - 2019

Location: Charleston Harbor, Crab Bank Seabird Sanctuary, at the mouth of Shem Creek in Mt. Pleasant, South Carolina

Partners: Audubon South Carolina, Coastal Conservation League, South Carolina Aquarium, South Carolina Department of Natural Resources, Coastal Expeditions, South Carolina Wildlife Federation

Costs: \$3.5 million

Potential Funders: US Army Corps of Engineers, South Carolina Port Authority, private funding

Seabird Sanctuary islands is critical for coastal birds and communities. More sand on Crab Bank would restore bird habitat and put the dredged sand to use.

The added wave energy from larger container ships navigating Charleston Harbor also poses a potential problem to beach nesting birds. Added sand to Crab Bank would mitigate this problem and provide a base to create living shorelines, which can decrease erosion due to wave energy. Additionally, this project will help restore oyster reefs near the island. Oyster reefs provide microhabitat for small marine organisms and improve water quality for fisheries habitat. This island is a fantastic resource for people living and visiting Charleston and adds enormous aesthetic and economic value to Shem Creek and greater Charleston areas. Birds and other wildlife are what makes South Carolina such a beautiful place to live and visit, and has made South Carolina a successful area to do business.

Erosion control and restoration on Chester Island



Chester Island was impacted by Hurricane Harvey causing severe cliff erosion and gathering of young Brown Pelicans.
Photo: Courtesy of Audubon Texas

In the 1960s, the U.S. Army Corps of Engineers (USACE) created a 200-acre island, called Chester Island (formerly known as Sundown Island) using dredged material from the Matagorda ship channel that Audubon now manages. This island is one of the largest bird sanctuaries on the Texas coast, providing nesting habitat for thousands of colonial waterbirds every year. The system is susceptible to severe erosion from high velocity currents from annual wind and storm events plus ship wakes from vessels coming in and out of Matagorda Ship Channel. From 1960 to 2017, the island lost 117 acres and even more after Hurricane Harvey devastated the island. High winds and storm surge from Hurricane Harvey caused harmful impacts including erosion that shifted the shoreline, the mortality of many birds, land loss of another 7 acres, wetland breaches leaving a strong flow in and out of the island, sediment loss leaving embankments up to 20 feet, substantial

vegetation loss, and large amounts of trash deposited on Chester Island. Loss of nesting vegetation and ground nesting habitat devastated the amount of colonial waterbird species and their composition, which will likely impact future nesting seasons.

Beginning in 2007, Chester Island lost its source of supplemental dredge material due to USACE's decision to realign the Intercoastal Waterway. Since then, the island has lost close to 35 acres. In 2014, the USACE began working with Audubon to re-supplement the island. Helping to offset the continued erosion, restoration is an ongoing effort. In 2017, USCAE added 1 million cubic yards of beneficial use material to the coastline of the island. After Hurricane Harvey devastated the island, more dredge material is needed to mitigate the impacts of erosion and habitat loss. Audubon also plans to hire a contractor to move material within the island to provide more suitable bird habitat.

Project Benefits:

Chester Island is a vital part of Texas' coastal economy as it serves as one of the largest colonial waterbird nurseries on the Texas coast, helping to make Texas one of the leading ecotourism states on the Gulf. The Texas coast attracts birders and nature-lovers from all over the world bringing tourists to restaurants, hotels and recreational activities near the Central Coast and communities like Port O'Connor, Texas. Due to its distance from the mainland, birds have a safe sanctuary where predators are easily controlled and human disturbance is minimal. During

Timeline: October 2016 – ongoing

Location: Matagorda Bay near Port O'Connor, Texas

Partners: US Army Corps of Engineers

Costs: \$5.1 million

Funding Sources: U.S. Army Corps of Engineers

the nesting season, Chester Island usually hosts 17,000-20,000 breeding pairs of 18 different bird species.

Dallas, Houston and Austin were among the country's fastest growing cities in 2009. As Texas' population grows and coastal development increases, nesting oases become rare. Barrier islands are critical to ensure nesting bird species have a safe place to reproduce.

Rookery islands like Chester are an important part of a resilient bay system and serve as a great litmus test of overall bay health. Productive islands mean healthy and productive marine ecosystems and fisheries. Additionally, they are a part of our larger barrier island system. Barrier islands protect coastal communities because they are the first line of defense during threatening storms and absorb much of the wave energy that erodes private and public beachfront properties. Recent observations found that after the passage of hurricanes in 2005 and 2008, restored barrier islands weathered the storms much better than adjacent non-restored areas. While the restored portions maintained their sandy beaches, unrestored portions eroded back to a predominantly marsh shoreline.