COASTAL BEND
ENVIRONMENTAL INDICATORS REPORT

2020

PRODUCED BY:

COASTAL BEND BAYS & ESTUARIES PROGRAM

FUNDED BY:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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ENVIRONMENTAL INDICATOR REPORT

This Environmental Indicators Report presents six questions of interest to the community designed to reveal the state of our bays and estuaries. Answers to these questions are found through reviewing indicator data that addresses underlying conditions and points to trends. CBBEP looked at indicators that are specific, measurable markers that help assess the condition of the environment and how it changes over time. Both sharp changes and general trends in the values of those markers can indicate improved or worsening environmental health.

This report serves as an environmental report card to provide information on the health of the estuary and help improve plans for the future. With a focus on our program's goals and priority issues, we reviewed data to determine the status and trends of these issues. Using environmental indicators, we are able to tell if conditions are stable, improving or declining. Continued evaluation of the data helps further define ecological conditions and changes resulting from individual restoration activities and quantifying changes which occur on an ecosystem level.

In 2010, CBBEP released the "Environmental Indicators Report," which provided citizens of the Coastal Bend with important information about the health of the bays and estuaries and presented data on observed trends. This 2020 indicator report represents an update to this previous version and highlights some of the changes we have seen in the last decade.

The data presented within this report portrays a complex picture of the environmental quality of the Coastal Bend Bays & Estuaries Program area.

HOW TO READ THE INDICATOR BAR

Each indicator has a status and trend bar used to show at a glance whether the indicator data is showing a good (healthy) or poor state.

GOOD/INCREASING

If the dot is to the left of center, the indicator condition is generally **poor**. If it is to the right, it is generally **good**. If the dot is in the center, the data indicates a **moderate** condition. Arrows indicate the direction of any trends the data reveals (**increasing** or **decreasing**). If there is no arrow, this indicates a neutral trend or **stable** state. These graphics are based on CBBEP's interpretation of the data.

2020 ENVIRONMENTAL INDICATOR REPORT HIGHLIGHTS

FOCUS QUESTION 1: Is it safe for people to come into contact with bay water?

INDICATOR 1: Fecal Bacteria Levels

» Although the majority of beaches in the Coastal Bend were under notifications less than 5% of the time, the number of days above acceptable health standards has increased in the past five years.

FOCUS QUESTION 2: Is it safe to eat seafood caught in area bays?

INDICATOR 2: Seafood Consumption Advisories

» Mercury is bioaccumulated in older and larger fish that should be avoided for consumption.

» There are several safe options of fish to eat from the bay, including the Texas favorites, such as red drum, spotted sea trout and southern flounder, species that are less likely to build up mercury.

» Several species of offshore marine fishes were included in the current advisory of TDSHS.

INDICATOR 3: Oyster Harvesting Areas

» The system with the most restricted area for oyster harvesting is between Baffin Bay to Port Mansfield in the Upper Laguna Madre with 100% of the bay area, followed by Corpus Christi Bay with 31% of the bay area closed to harvesting.

» Restricted areas to harvesting have remained constant since 2014 in the Coastal Bend area.

» Waters in Oso Bay and Copano Bay have been impaired for oysters due to high concentrations of bacteria since 1998.

FOCUS QUESTION 3: Is water and sediment quality improving or degrading?

INDICATOR 4: Number of Impaired Segments

» High levels of bacteria in water is the main cause of water body impairment in the Coastal Bend.

» Several large water bodies in the area require the development of TMDL and I-Plans, such as Nueces River, Corpus Christi Inner Harbor, Oso Bay and Copano Bay.

INDICATOR 5: Harmful Algal Blooms

» Harmful algal blooms pose threats to humans and wildlife - red tide produces a toxin that affects people and kills fish and other animals, and brown tide can block sunlight and kill seagrasses.

» The frequency of harmful algal blooms has increased throughout the Coastal Bend.

» The economic cost of a harmful algal bloom fish kills reached $11 million dollars in 2015.

2020 ENVIRONMENTAL INDICATOR REPORT HIGHLIGHTS

FOCUS QUESTION 4: Are fish and wildlife populations increasing or decreasing?

INDICATOR 6: Recreationally Important Species

» Although spotted seatrout catch rates increased considerably since 1984, due to elevated fishing pressures, the bag limit established in 1984 was reduced by half in 2016.

» Red drum abundance has recovered to arguably one of the best in the nation and catch regulations have not changed since late 1980s.

» Southern flounder conditions and continues to decline coastwide since the late 1970s.

INDICATOR 7: Ecologically Important Species

» Atlantic croaker abundance increased between 1985 and 2015 almost 400%.

» Juvenile Atlantic croaker bait industry in Texas has rapidly expanded and fish are sold at great value.

INDICATOR 8: Commercially Important Species

» Brown shrimp abundance in the Coastal Bend region remains within safe margins buts its average kept declining during the past decade.

» Both blue crab scientific surveys of abundance and commercial landings in the Coastal Bend show a steep decline since the 1990s - the abundance of blue crab could impact other wildlife that depend on it as prey.

INDICATOR 9: Colonial Waterbirds

» Colonial waterbirds represent the top of the food chain and reflect the system's overall health.

» The Texas central coast represents more than 25% of coastwide population of 14 species.

» Whereas several bird populations continue to show declines during the past decade, a few showed important nesting pair recovery levels: White-faced Ibis, Sooty Tern, Brown Pelican, Sandwich Tern, and Royal Tern.

FOCUS QUESTION 5: Are habitats for fish and wildlife increasing or decreasing?

INDICATOR 10: Seagrass Area

» Seagrass cover has declined approximately five percent in the past 10 years in the Coastal Bend area, but some bay systems have remained relatively stable.

» In addition to propeller scarring, natural causes such as drought and storms can have important negative impacts in seagrass habitat.

» Adequate regulation and education programs have demonstrated benefits to seagrass habitat.

INDICATOR 11: Saltwater Marsh Area

» During 2001–2016, the Coastal Bend experienced an increase of 1.1% in emergent saltwater marsh, a gain of 885 acres, which represents an average of 55 acres per year.

» Across the entire Texas coast mangrove increased by 74% between 1990 and 2010.

» Relative sea-level rise threatens saltwater marsh by drowning them.

2020 ENVIRONMENTAL INDICATOR REPORT HIGHLIGHTS

FOCUS QUESTION 5: Are habitats for fish and wildlife increasing or decreasing?

INDICATOR 12: Freshwater Marsh Area

» During 2001–2016, the Coastal Bend experienced an increase of 5% in emergent freshwater wetlands, a gain of more than ten thousand acres, which represents an average of 649 acres of freshwater marsh per year.

» Other types of freshwater wetland types have decreased between 5 and 7% during the 2001–2016 time period.

» Future scenarios of the combined impacts of sea-level rise and storm surge show that freshwater marshes could disappear within the Copano and San Antonio bay areas by 2100.

INDICATOR 13: Rookery Islands

» Erosion, combined with other threats, has considerably decreased the number and size of islands available as nesting habitat in all bay systems.

» In San Antonio Bay, only a few small islands remain to provide nesting habitat for a very small number of birds.

» Hurricanes can have severe impacts by destroying or reducing nesting substrate availability for long periods of time.

» Active management and ecological restoration of nesting islands is essential to maintain the health of waterbird populations.

FOCUS QUESTION 6: Are freshwater inflows adequate to maintain a healthy bay?

INDICATOR 14: Quantity and Timing of Inflows

» Statewide drought has persisted in Texas for more than 60% of the time during the past 20 years.

» Freshwater inflows to the Nueces Estuary show an increasing trend during the past decade.

» The implementation of the agreed pass through monthly targets is subject to water availability and thus local environmental needs are subject to complicated regional to global patterns of a changing climate.

» Drought/Wet conditions are natural cycles in the Coastal Bend Bays area and conditions within the bays have adjusted over time to those cycles.

INDICATOR 15: Bay Salinity Levels

» Average salinity trend continues to increase in the Coastal Bend bays.

» More than 37% of the time Nueces Bay salinity has exceeded the stress threshold of 30 ppt since 2000.

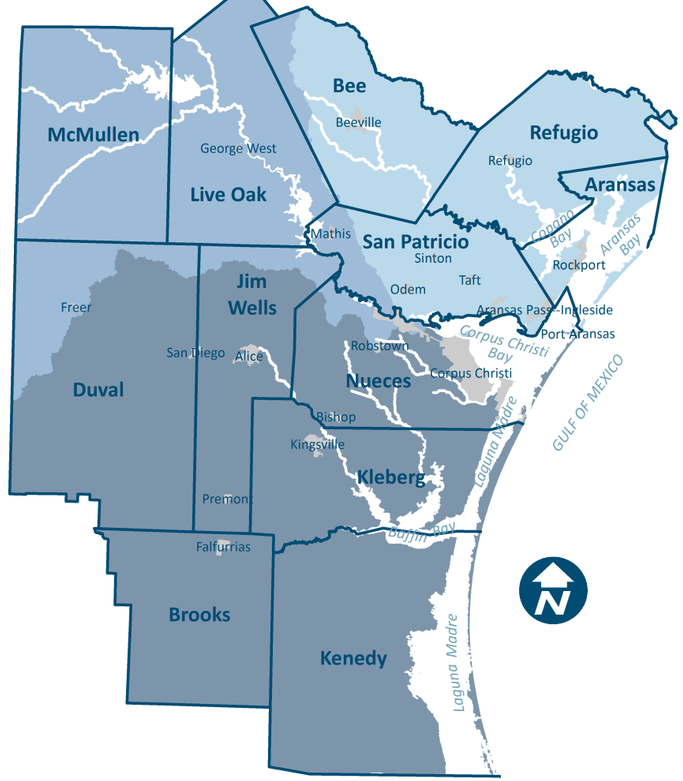
COASTAL BEND BAYS & ESTUARIES PROGRAM

The Coastal Bend Bays & Estuaries Program (CBBEP) is a local non-profit 501(c)(3) organization established in 1999. The CBBEP program area encompasses the 12 counties extending from an area locally referred to as the landcut in the Laguna Madre, through the Corpus Christi Bay system, and north to the Aransas National Wildlife Refuge. The CBBEP was founded following the designation of Corpus Christi Bay and the surrounding area as a National Estuary Program.

The mission of the CBBEP is the implementation of the Coastal Bend Bays Plan, which is designed to protect and restore the health and productivity of the bays and estuaries while supporting continued economic growth and public use of the bays. The plan addresses the major priorities and issues in the region and identifies specific actions that would benefit the bay system and the users of the bays.

The CBBEP is a non-regulatory, voluntary partnership effort working with industry, environmental groups, bay users, local governments, and resource managers to improve the health of the bay system. Public participation by individuals and organizations is encouraged. A mix of local governments, state and federal agencies, foundations, industry and private individuals provide program funding.

TWELVE-COUNTY PROGRAM AREA OF THE COASTAL BEND BAYS & ESTUARIES PROGRAM



For over 20 years, the Coastal Bend Bays & Estuaries Program has been working with partners to create a Texas Coastal Bend with cleaner water and sediment, healthier habitats, greater public access, and a more aware and engaged public. With the help of partners, the Coastal Bend Bays & Estuaries Program has restored thousands of acres of marsh habitat, funded dozens of projects designed to improve water quality, and installed infrastructure to enhance public access opportunities. In addition to implementing projects that address priority issues like water quality, habitat restoration, and nature tourism, the CBBEP has created organizational programs to research and manage coastal birds, conduct environmental education programs, and acquire coastal habitats for the purposes of conservation.

BACKGROUND

Our bays and estuaries provide seafood, recreation and economic benefits. It's important to study and protect them to ensure these benefits continue in the future.

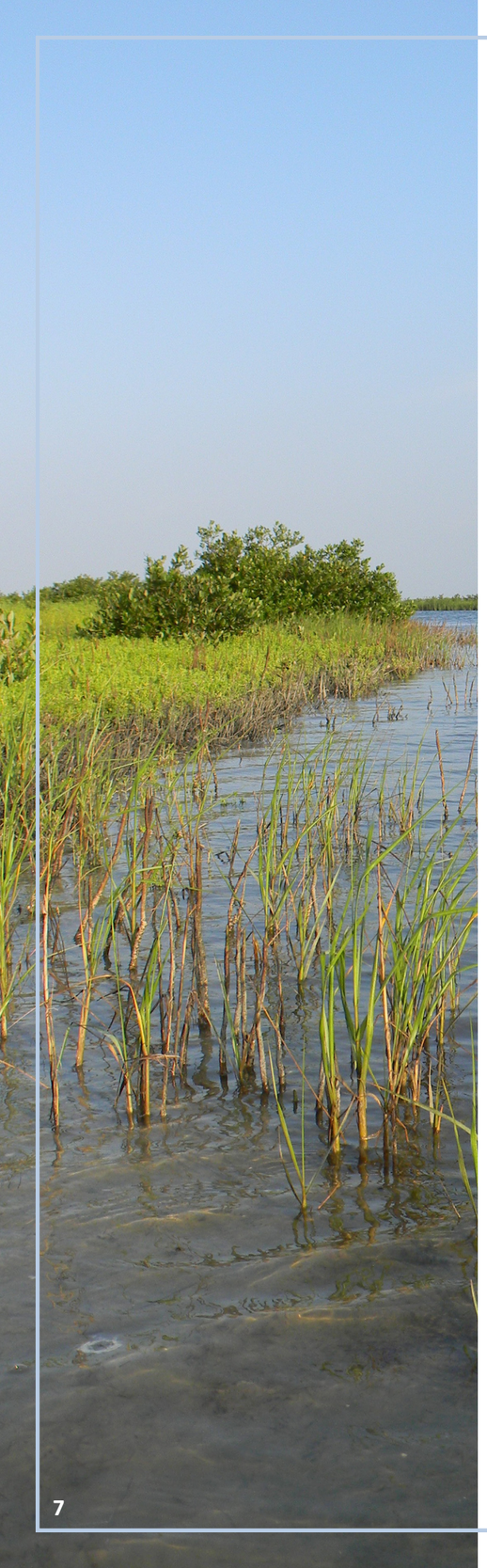
Each question in this Environmental Indicators Report is addressed by selecting indicators, and providing a discussion of the background, concerns, and an explanation regarding the local conditions. The goal of this report is to provide the community with important information about the health of our bays and estuaries. It will also help gauge trends and improve plans for the future.

Before the questions are presented, this introduction gives some background about the area and the issues affecting it, such as population growth, water use, port traffic, air quality, climate change, and tourism. These issues can often become factors in the health of our bays and estuaries.

PHYSICAL LANDSCAPE

Estuaries are waterways, such as bays and bayous, where fresh water drained from the surrounding watershed mixes with salt water from the ocean. This mixing of fresh and saltwater creates biologically productive areas that support many kinds of fish, invertebrates, coastal habitats, and other wildlife. The CBBEP program area includes 75 miles of estuaries and adjacent watersheds along the south-central coastline of Texas. This region, known as the Coastal Bend, encompasses 12 counties, 11,500 square miles of land, and 515 square miles of bays, estuaries, and lagoons.

The Coastal Bend contains three of the seven Texas estuary systems - the Aransas, Nueces, and Upper Laguna Madre estuaries. Hydrographic conditions in the Coastal Bend are influenced primarily by climatic conditions, freshwater inflow, and, to a lesser extent, tidal exchange. The Mission, Aransas, and Nueces rivers contribute the primary freshwater inflow to the Coastal Bend bays and estuaries, but overall, the system receives limited inflow in proportion to its drainage area. Great variability in these inflows is characteristic of the area. The program area includes one major tidal pass to the Gulf of Mexico (the Aransas Pass), as well as two smaller passes (Packery Channel and Cedar Bayou).



KEY HABITATS

The habitats and living resources of the Coastal Bend are unique and diverse. The high-level of species diversity is due to the wide array of land and aquatic habitat types found in the region, including arid chaparral, riparian forests, oak savannas, oxbow lakes and swales, river deltas, coastal marshes and ponds, tidal flats, oyster reefs, seagrass meadows, open bay bottoms, barrier islands, jetties and other hard substrates, and sandy beaches.

SEAGRASS MEADOWS

Seagrasses are submergent, rooted and flowering plants that grow in marine environments. Seagrass meadows are found primarily in shallow water (less than 3 ft) in estuaries, hypersaline lagoons, and brackish coastal areas. They are among the most productive ecosystems in shallow waters. They provide nursery areas for estuarine fish and wildlife, and food sources for various animals including fish, shellfish and waterfowl. Within the CBBEP program area, extensive seagrass meadows are found in the Upper Laguna Madre and Redfish Bay.

SALTWATER MARSH

Saltwater marshes are intertidal areas between upland and estuarine/marine systems, and they are dominated by marsh grasses and herbaceous plants. Saltwater marshes are important nursery and feeding grounds for a variety of fish, invertebrates and birds and they protect the shoreline from erosion. Extensive saltwater marshes occur in the northern part of the CBBEP area where freshwater inflow and precipitation are higher. Saltwater marshes are replaced by extensive wind tidal flats from Mustang Island southward, due to lower precipitation and higher evaporation rates.

FRESHWATER MARSH

Freshwater marshes represent transitional areas between terrestrial and freshwater aquatic environments. They provide numerous benefits to people, including water purification, flood protection, groundwater recharge, and streamflow maintenance. These areas also provide habitat for fish and wildlife, and in Texas, are especially important as a source of food and water for migratory birds that spend the winter on the coast. Freshwater wetlands generally occur along streams in poorly drained depressions and in the shallow water along the boundaries of lakes, ponds, and rivers. However, in the Coastal Bend, freshwater marshes are also unique features of the barrier island system. Extensive freshwater marshes occur along the Copano mainland, within the Mission River valley, along the Aransas and Nueces rivers, and on Live Oak and Blackjack peninsulas.

TIDAL FLATS

The sand and/or mud environments bordering bays and estuaries may seem barren and relatively featureless, but they are actually highly productive and provide essential habitat to millions of migrating shorebirds. Within the CBBEP area, most tidal flats are wind-tidal flats, meaning that wind-associated tides are responsible for the frequent but shallow inundation that maintains this feature. Tidal flats are found on the bay sides of St. Joseph Island, Mustang Island, and Padre Island, and at the edges of Baffin Bay.

OYSTER REEFS

Oysters are naturally abundant in shallow bays and estuaries. As generations of oysters grow on top of each other, they form reefs that provide habitat for many other animals, such as fish, invertebrates and birds. Oysters are capable of filtering as much as 50 gallons of water each in a single day, removing silt and contaminants from the water, and thus improving local water quality and clarity. Oysters are also an important commercial fishery in Texas. Despite their importance, oyster reefs are one of the most threatened marine habitats on earth, with losses resulting from water quality degradation, coastal development, destructive fishing practices, overfishing, and storm impacts.

OPEN BAY

The open bay community is defined as the unvegetated and soft-bottomed portion of the submerged estuarine environment. Extent of the open bay community is determined primarily by factors limiting success of submerged plants and oysters, such as depth, turbidity, exposure to wave action, and salinity. Primary production is dominated by phytoplankton, which are the base of the marine food chain. Most of Corpus Christi Bay, Nueces Bay, Oso Bay, Mission Bay, and Aransas Bay, except for a few scattered areas of oyster reefs and seagrass meadows, can be characterized as open bay.

BARRIER ISLANDS

Barrier islands are elongate geologic landforms that lie parallel to the mainland shoreline and are typically isolated from the mainland by bays and estuaries. Barrier islands extend along the northeastern most boundary of the CBBEP area and include southern Matagorda, St. Joseph, Mustang and northern Padre islands. These islands function as protective barriers to the adjacent mainland and maintain the biologic diversity of the CBBEP area. They are threatened by rising sea waters and tropical storms.

GULF OF MEXICO BEACH

The Gulf of Mexico beach habitat encompasses the sandy shoreline and associated shallow, nearshore waters off the barrier island chain that fringes the Texas coast. This habitat community is often highly biologically diverse, highly productive due to the transport of food by currents, and accounts for the highest energy of the coastal area (for example waves). Matagorda, St. Joseph, Mustang, and Padre islands serve as protective barriers to the three principal estuarine systems within the Coastal Bend. The dynamic Gulf beaches and adjacent waters support ecological connectivity between the Texas estuaries and the rest of the Gulf of Mexico.

PEOPLE

The population of the CBBEP program area has increased by nine percent between the years of 2010 and 2019, with a recorded population of 624,503 residents in 2019. The Corpus Christi metropolitan area, consisting of Aransas, Nueces, and San Patricio Counties, accounted for 75 percent of the Coastal Bend population. According to projections of the Texas Demographic Center (TDC), the Coastal Bend population is projected to increase by 27%, to 792,996 people by 2050. Population growth can be an underlying

cause of ecosystem stress due to the increase of housing, transportation, and other infrastructures needed to accommodate additional residents.

WATER

The Coastal Bend relies primarily on surface water sources for municipal and industrial water supply use. The three major surface water supply sources include: (1) the Choke Canyon Reservoir/Lake Corpus Christi System in the Nueces River Basin, (2) Lake Texana on the Navidad River in Jackson County, and (3) the Mary Rhodes Pipeline to the Colorado River in Matagorda County. Some areas are dependent on groundwater. There are two major aquifers that lie beneath the region, the Carrizo-Wilcox and Gulf Coast aquifers. The Gulf Coast Aquifer underlies all counties within the Coastal Bend and yields moderate to large amounts of freshwater.

With increasing population and growing industry comes increased demand for water resources. Total water use for the 12-county CBBEP program area is projected to increase 104% from 168,782 acre feet in 2010 to 345,746 acre feet in 2070, more than doubling. The different types of water use and associated demands are shown in figure below. The current major water user groups are manufacturing and municipal, which includes homes and businesses. Because irrigation is only used in a few locations, agricultural water usage is relatively minimal in this area.

ECONOMY

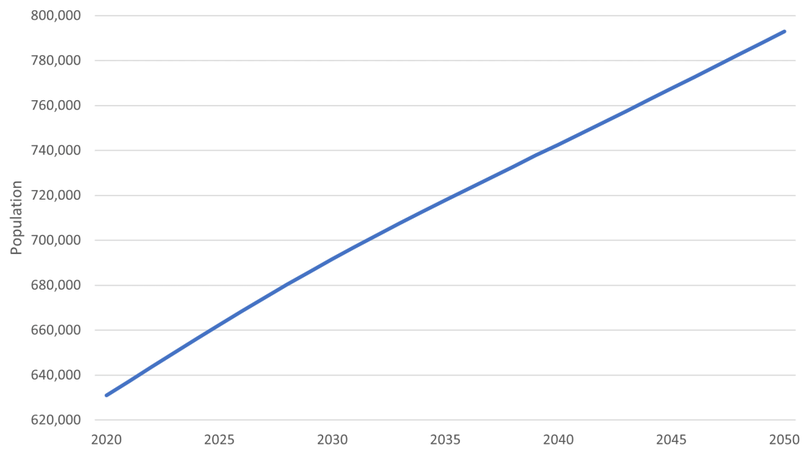
The natural environments of the Texas Coastal Bend contribute resources and invaluable ecosystem services – such as cultural and recreational benefits, seafood, flood prevention and habitat productivity – that bolster business development, improve quality of life, and attract people to Texas. The coast's built environments provide the support services, transportation and infrastructure systems that allow communities, businesses and families to grow and flourish in the Coastal Bend.

The primary economic activities within the Coastal Bend area include oil and gas production and refining, petrochemical manufacturing, military installations, retail and wholesale trade, agriculture, and service industries including education, health services, tourism and recreation industries, and governmental agencies. The services sector continues to have the biggest economic impact in economic contribution. However, ocean related jobs are a major factor in the economy of the Coastal Bend area. In 2015, ocean-related jobs provided 11.8% of the total jobs in Nueces County. This represents a 36% increase in ocean jobs since 2005. The primary ocean-related jobs in these counties are tourism and recreation, offshore mineral extraction, and marine transportation.

In recent years, the Texas Coastal Bend has seen a rapid increase in industrial expansion and activity around the bay system, which is being driven by oil and gas development in Texas and expansion of operations at the Port of Corpus Christi. The Port has been in operation since 1926, and it has since become the 3rd largest port in the United States, based on total revenue tonnage and the 2nd largest exporter of crude oil.

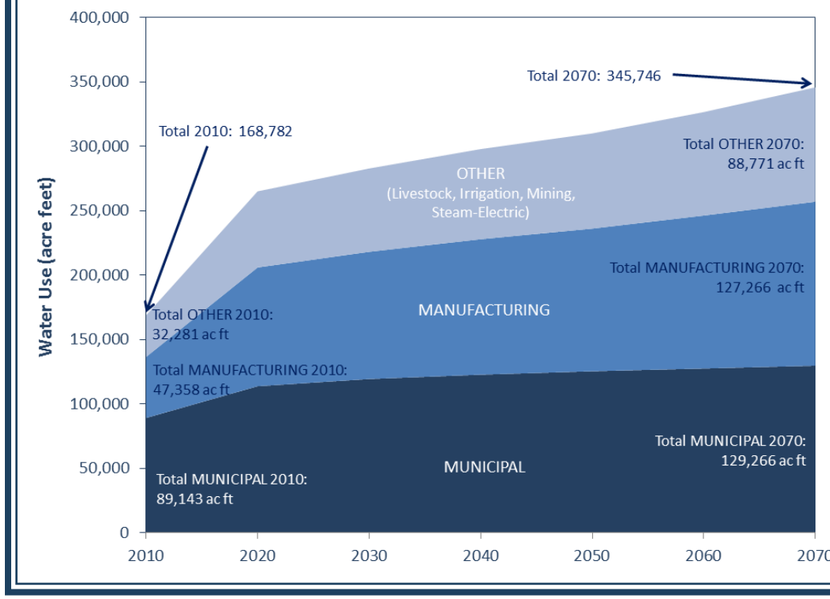
COASTAL BEND POPULATION PROJECTIONS 2020-2050

Source: TDC 2020

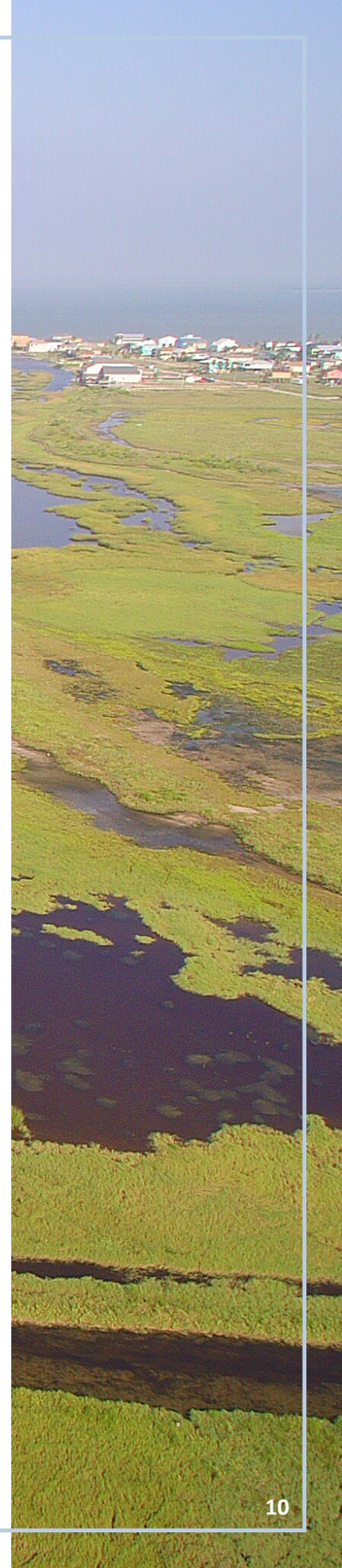


COASTAL BEND WATER USE PROJECTIONS 2020-2070

Source: TWDB 2016



Commercial fishing exerts an effect upon the economies of the local region where these activities occur and upon the entire state. According to a 2015 Texas Parks and Wildlife Department report, landings of finfish and shellfish in the Texas Coastal Bend bays and estuaries totaled 77,470,015 pounds between 1994 and 2012. The ex-vessel value of this catch was just over $114 million. The Aransas Bay System showed the largest landings for shrimp, blue crab, and oysters, while the Upper Laguna Madre System had the largest landings of finfish.



Recreational fishing, tourism, and other recreational activities are also big business in the Texas Coastal Bend. Tourism and recreation account for more than 70% of ocean-related jobs in Nueces County in 2015. Corpus Christi is the sixth most popular tourist destination in Texas. A growing share of tourist activities in Corpus Christi are related to nature and wildlife, particularly beach strolling, birdwatching, and hunting and fishing. The area's 113 miles of beaches and waterfront are above all the most popular destinations in Corpus Christi. Nature tourism now accounts for 47 percent of all visitor trips. Annual destination spending by nature-oriented visitors is estimated at $674 million for 2012-13, which represents over 50 percent of overall visitor spending.

CLIMATE CHANGE

A growing body of knowledge shows that climate change poses major threats to our nation's estuaries. Predictions of climate change suggest that sea level rise, storm intensity and surge, drought, rainfall and hydrology, and acidification will be impacting our coastal zones during this century. The Texas Coastal Bend area is already experiencing the effects of some of the stressors of climate change. In recent years the establishment of biota more characteristic of tropical habits has been observed, with range expansions of red and black mangrove, mangrove snapper, snook, and other species. In addition, more droughts and hypersaline conditions have been observed, indicating that the region is experiencing more intense rainfall events with longer, dry periods in between.

In 2016, the CBBEP completed the Texas Coastal Bend Regional Climate Change Vulnerability Assessment (CCVA). The CCVA identified potential changes caused by a changing climate and environment in the Coastal Bend area and assessed how changes will impact the stability of the environment in the region. The failure in designing and implementing effective avoidance, mitigation, minimization, and adaptation strategies will result in large costs for addressing the climate change problem to the citizens of the Coastal Bend.

PROTECTING OUR BAYS AND ESTUARIES . . .

To address many of the issues that are affecting Texas Coastal Bend bays and estuaries, the Coastal Bend Bays & Estuaries Program has created organizational programs to research and manage coastal birds, conduct environmental education programs, and acquire coastal habitats for the purposes of conservation.

LAND CONSERVATION PROGRAM

CBBEP's Land Conservation Program is working with partners to conserve valuable habitats within the Coastal Bend. To date, CBBEP has conserved close to 14,000 acres, and we manage these lands responsibly and sustainability for the long-term benefit of both wildlife and people.

COASTAL BIRD PROGRAM

CBBEP's Coastal Bird Program works to conserve coastal birds and their habitats, identifying and addressing conservation needs through on-the-ground management actions, research, and education and outreach. We bring innovative management, diversified partnerships, and science-based decision-making to bird conservation in the Coastal Bend.

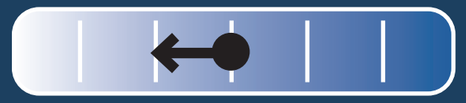
DELTA DISCOVERY PROGRAM

CBBEP created the Delta Discovery Program to provide opportunities for classrooms and families to connect with nature, and to plant the seeds of stewardship in individuals whose decisions affect our estuaries. We provide field trips for thousands of students each year, train teachers on how to connect classrooms to outdoor experiences, and allow families to discover the estuary in their own backyard.

FOCUS QUESTION 1

Is it safe for people to come into contact with bay water?

INDICATOR 1:
Fecal Bacteria Levels



MODERATE/DEGRADING

WHAT WAS MEASURED?
Levels of *Enterococcus* spp., a fecal indicator bacteria in bays and Gulf waters.

WHAT DID WE FIND?
Although the majority of beaches in the Coastal Bend area has stayed at 5% or under of the time subject to notification, such as 'advisories' and 'closings,' some popular beaches in Aransas and Nueces counties stayed more than 10% of the swimming days (May through September) above acceptable health standards.

ANSWER TO FOCUS QUESTION 1
Not all the time. While many of the sites monitored for bacteria show levels safe for recreation, except after a rain, it is recommended to check the advisories provided by the Texas Beach Watch program before swimming at the beach.

INDICATOR 1:
Fecal Bacteria Levels

BACKGROUND

Texas beaches consistently rank among the state's top tourist destinations. In 2014, tourists visiting the Texas coast spent $19.7 billion traveling and over $10.4 million at hotels alone. Beach water quality is affected by multiple natural events and man-made activities, including the quality of water in streams, bays and the Gulf of Mexico. Several programs are in place to address bacteria levels in the waters of the Coastal Bend area.

The Texas Beach Watch Program, a non-regulatory program, implemented by the Texas General Land Office, monitors water for the presence of *Enterococcus* spp. fecal indicator bacteria as a surrogate of harder to detect, disease-causing microorganisms where sewage or storm runoff is present. Water samples are collected weekly during the peak beach season, which runs from May through September, and every two weeks during the rest of the year. When monitoring results show exceedances for bacteria, the program issues a beach advisory that warns people of possible risks of swimming or a beach closing that closes the beach to public swimming.

Water quality notification actions use 'advisories' and 'closings' to inform of bacteria levels above healthy standards and thus of unsafe conditions for recreational swimming. Safe limits have been established nation-wide by the BEACH Program of the Environmental Protection Agency (EPA). To check the status of beaches before your visit them, search the map at the Texas Beach Watch website. Additionally, an updated list of all Texas beaches that are part of the public notification program is available at EPA's searchable database BEACON.

CONCERNS

Gulf of Mexico and bay waters may become polluted when rainwater washes away contaminants (like animal feces, fertilizer, pesticides, and trash) from yards, farms, streets, construction, and industrial sites. It is not unusual to measure higher concentrations of bacteria after a heavy rain following a storm. Pollutants can also come from poor performing sewage treatment plants and septic tanks. Bacteria from human and animal waste may indicate the presence of disease-causing microorganisms that pose a threat to public health. Bacteria in water can accumulate in the tissue of oysters and other shellfish, making them unsafe to eat (see Indicator 3). Besides affecting shellfish, exposure to fecal bacteria can cause unfavorable effects on human health. The most common result of exposure to fecal bacteria is gastroenteritis (includes diarrhea and abdominal pain), but more serious conditions can occur.

LOCAL CONDITIONS

During 2007-2019, the number of monitored beaches In the Coastal Bend area varied by county: Aransas (1), Kenedy (0), Kleberg (4), Nueces (18) and San Patricio (1). The Beach Watch Program data shows that the number of days under notification actions has increased during this period, especially in the past five years. In Nueces County, the Light House beach accounted for 365 days under action in 2018, and actions in Cole Park beach in downtown Corpus Christi have remained between 93 and 190 action days since 2016. EPA's BEACH Program recognizes the complications of identifying the possible causes of pollution, but the large increase in 2018 could be a combination of environmental effects resulting from the heavy floods of Hurricane Harvey in 2017.

During the past decade, all beaches monitored in Aransas and Nueces Counties have had notification actions for at least one day per season, with the exception of Laguna Shores in Nueces County. At least three beaches continuously were under actions for more than 10% of their swimming season in average during the past 10 years, including Cole Park beach during 23% of the time. Mustang Island beaches, including Mustang Island State Park, in Nueces County have recurrently accounted for the fewer actions days with a reported maximum of four days under action in 2016 recorded since 2009, therefore the public beaches with the highest quality in the area. Rockport Beach Park in Aransas County showed a significant reduction after reaching 58 days under action in 2016 to a minimum of 3 days in 2019 since its monitoring started in 2008. Kleberg County beaches have not been subject of any notification actions by the Texas Beach Watch Program since 2009.

An overall look at bacteria levels in the Coastal Bend area suggests that although it is safe to have recreational activities in bay waters as long as it is not immediately after a heavy rain, in a small creek, or next to a drainage system, the days bacteria levels were above acceptable health standards has increased in the past five years.

HOW CAN YOU HELP?

- Take a "Leave No Trace" approach to prevent and minimize harm to the beach - learn more at ACT at the Beach.
- Bag pet waste and place it into your trash can - dog, cat and waste of other pets can pollute our bays & estuaries.
- Volunteer at beach cleanup events organized by the Texas Adopt a Beach Program.
- Learn how to prevent pollution at the City of Corpus Christi Storm Water Pollution Prevention website.

REFERENCES

EPA. 2018. Recreational water quality criteria. Office of Waters 820-F-12-058. Environmental Protection Agency. Washington, D.C., 63 pp.

EPA. 2020. BEACON 2.0: Beach Advisory and Closing On-line Notification dataset. Environmental Protection Agency.

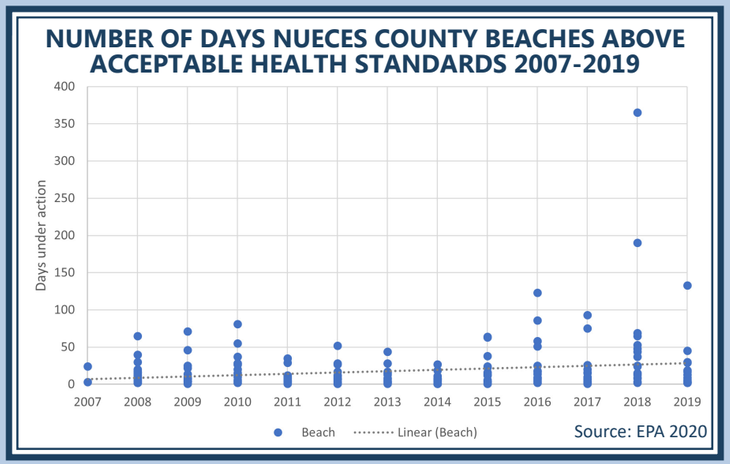
TGLO. 2016. Shoring up the future for the Texas coast. Texas General Land Office (TGLO). Austin, 15 pp

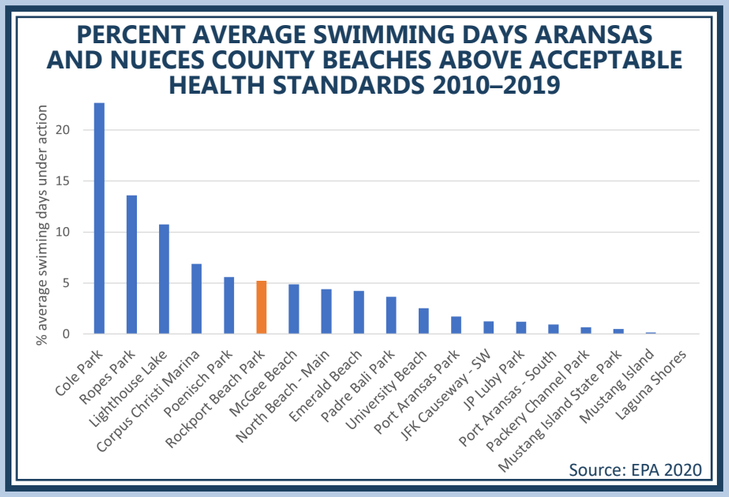
ADDITIONAL INFORMATION

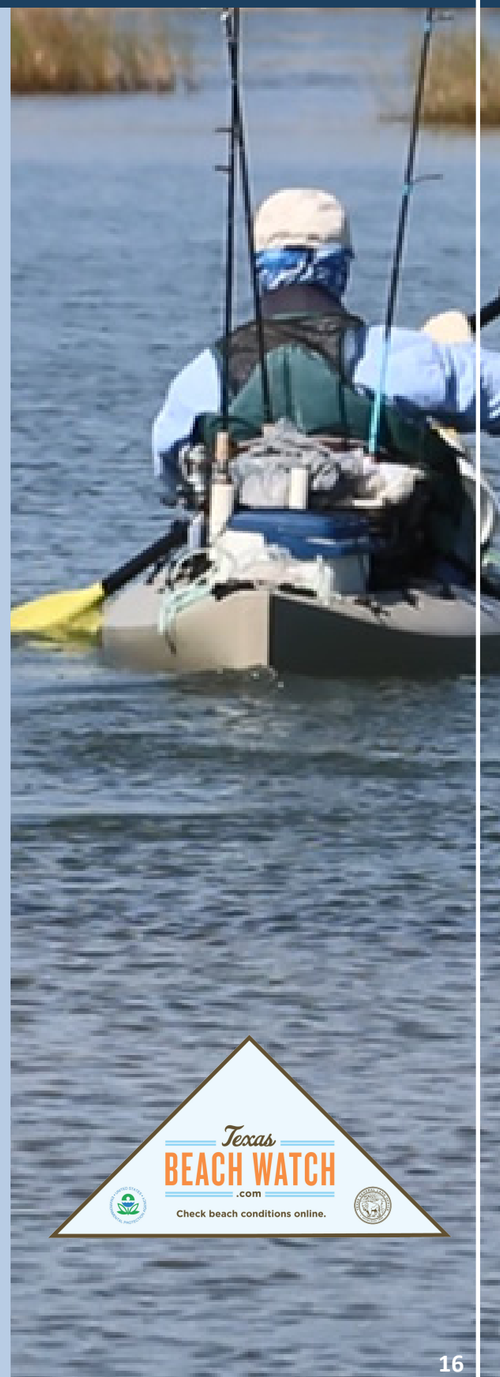
EPA - BEACH Act

TGLO - Coastal Management Programs and Resources

EPA - Technical Resources about Beaches







FOCUS QUESTION 2

Is it safe for people to eat seafood caught in area bays?

INDICATOR 2:
Seafood Consumption Advisories

GOOD/STABLE

INDICATOR 3:
Oyster Harvesting Areas

GOOD/STABLE

WHAT WAS MEASURED?

Health advisories with recommendations for fish consumption and areas restricted to oyster harvest.

WHAT DID WE FIND?

There are several options to eat freshwater and marine fish, including the Texas favorite game fish – red drum, spotted sea trout and southern flounder. However, mercury is bioaccumulated in older and larger fish, and its consumption is suggested to be limited to two meals per month. The system with the most restricted area for oyster harvesting is the area between Baffin Bay to Port Mansfield in the Upper Laguna Madre with 100% of the bay area restricted, followed by Corpus Christi Bay System with 31% of the bay area restricted (Nueces Bay entirely).

ANSWER TO FOCUS QUESTION 2

Generally yes, but not in all areas. While the number of offshore marine fishes with advisories has increased in the last decade, restricted areas to oyster harvesting have remained constant since 2014 in the Coastal Bend area.

INDICATOR 2:
Seafood Consumption Advisories

CONDITION/TREND: GOOD/STABLE

BACKGROUND

A consumption advisory is a recommendation to limit consumption to specified quantities, species, and sizes of fish due to harmful contaminants associated with the seafood in question. The Texas Department of State Health Service (TDSHS) is responsible for monitoring and evaluating contaminated fish and shellfish (see indicators 3 and 6), and for advising the public when contamination of a certain species used as a food source has exceeded safe eating levels. They use this information to determine how much fish is safe to eat per month of fish species caught commercially or recreationally (see indicators 7 and 9). Although you are not required to follow the eating recommendations, the TDSHS may declare a public water body as a prohibited area when a serious or imminent threat to public health has been identified. Therefore, TDSHS issues two levels of advisories, the first being a consumption advisory which is posted when there is a possibility of fish or shellfish contamination. The second level is a consumption ban where possession and consumption of fish and/or shellfish from a particular area is prohibited. When a water body is tested and levels of contamination are below harmful levels, the water body is taken off of the advisory list.

CONCERNS

The human health concerns related to fish consumption range from fish diseases, fish parasites, fish biotoxins (created by fish), chemicals accumulated in their tissue, and seafood handle issues. A continuous concern in the Gulf of Mexico waters and other areas has been fish contamination with heavy metals, including mercury (see Indicator 6). Mercury is present and enters the environment naturally. However, an excess of mercury also builds up from human activities such as mining operations, chemical production, coal or waste burning, battery manufacturing, and waste disposal. Then mercury settles in the bottom of bays, lakes, and rivers where it can remain for many years and is passed from fish food to larger fish via the food chain. Since fish are not able to eliminate most chemicals from their tissue the level of chemicals in fish may exceed the levels in surrounding waters, a process known as bioconcentration. For humans, mercury is a neurotoxin that affects people of all ages.

The status of waters in Texas estuaries and the Gulf of Mexico is subject to change by the TDSHS at any time based on monitoring results. Degraded conditions may be due to high rainfall and runoff, flooding, hurricanes and other extreme weather conditions, spills, red tide, or the failure or inefficient operation of wastewater treatment facilities. Consumption advisories and bans are important in order to keep the public safe from consuming contaminated seafood. The current status of fish species and areas advisories may be obtained from the Seafood and Aquatic Life Group of TDSHS by calling 512-834-6757, or by accessing the current fishing advisories and bans from their website and online map viewer.

LOCAL CONDITIONS

The TDSHS provides recommendations of freshwater and saltwater fish that are less and more likely to build up mercury in their tissue. The Texas favorite game fish – red drum, spotted sea trout and southern flounder are species less likely to build up mercury. On the contrary, popular offshore game fish such as cobia, king mackerel, tuna and sharks are more likely to build up mercury. TDSHS recommends eating more often smaller and younger fish, and those that are less likely to build up mercury.

Although estuarine fish are safe to eat, a number of nearshore species should not be eaten due to high levels of mercury. Several consumption advisories have been issued for marine fishes in the past decade, in addition to the advisory for king mackerel since 1997. The result of bioconcentration of chemicals in the aquatic food web is a process known as biomagnification, where chemicals increase at each level in the aquatic food chain. Therefore, the current advisory for the Gulf of Mexico waters includes to avoid large fish that are at the top of the food chain. The TDSHS recommends taking a S.A.F.E. approach when eating fish. Their suggestion is to eat 'S'maller and younger fish, to 'A'void older fish of any species, to remove fish 'F'at, and to 'E'at fish that has been properly cooked.

HOW CAN YOU HELP?

- Use the Texas Fish Consumption Advisory Viewer top review the current fish consumption advisories issues by TDSHS before you fish.
- Learn about healthy and sustainable fish options at the national FishWatch database.

REFERENCES

TDSHS. 2012a. Characterization of potential adverse health effects associated with consuming fish from the northwestern Gulf of Mexico (nearshore and offshore waters of Texas). Seafood and Aquatic Life. Texas Department of State Health Services (TDSHS). Austin, 46 pp.

TDSHS. 2012b. Northwestern Gulf of Mexico fish consumption advisory: Frequent asked questions. Texas Department of State Health Services (TDSHS). Austin, 4 pp.

TDSHS. 2013. Fish and shellfish consumption advisory ADV-48. Texas Department of State Health Services (TDSHS). Austin.

TDSHS. 2020. Fishing advisories, bans, and FAQs about bodies of water. Seafood and Aquatic Life. Texas Department of State Health Services (TDSHS). Austin. https://www.dshs.texas.gov/seafood/advisories-bans.aspx

ADDITIONAL INFORMATION

FDA - Advice about Eating Fish

TDSHS - Fish Smart. Eat Smart. Be Healthy: A Guide to Healthy Advisories for Eating Fish Caught in Texas Waters

TDSHS - Texas Fish Consumption Advisory Viewer

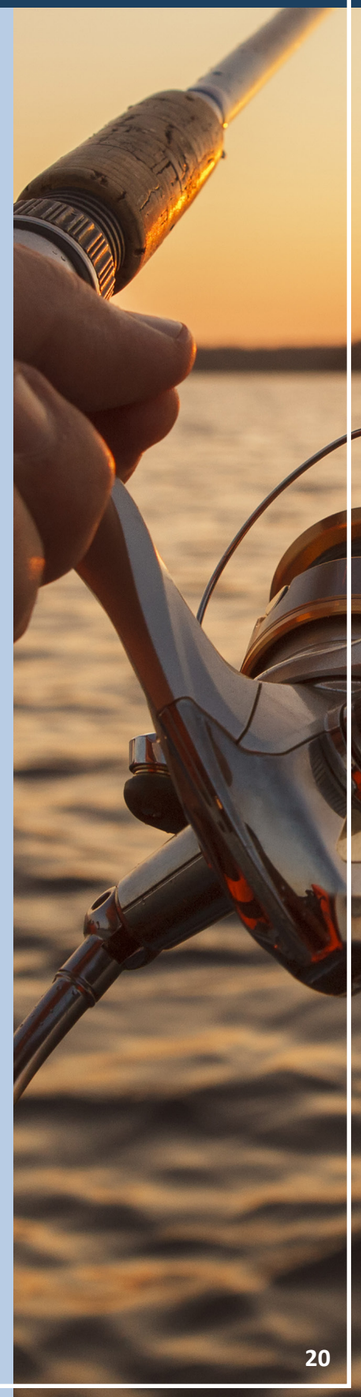
TDSHS - Seafood and Aquatic Life

SEAFOOD CONSUMPTION ADVISORIES FOR MERCURY

SPECIES	AREA	TIER 1	TIER 2	YEAR CURRENT ADVISORY ISSUED	YEAR PREVIOUS ADVISORY ISSUED
Blackfin tuna	Gulf Waters	Do not eat	2 meals/month	2013	
Blue marlin	Gulf Waters	Do not eat	Do not eat	2013	2012
Little tunny "Bonito"	Gulf Waters	Do not eat	2 meals/month	2013	
Crevalle jack	Gulf Waters	Do not eat	2 meals/month	2013	
King mackerel < 35"	Gulf Waters	Do not eat	1 meal/week	2013	
King mackerel > 35"	Gulf Waters	Do not eat	2 meals/month	2013	1997 (>37")
Sharks (all)	Gulf Waters	Do not eat	2 meals/month	2013	
Swordfish	Gulf Waters	Do not eat	2 meals/month	2013	2012
Wahoo	Gulf Waters	Do not eat	2 meals/month	2013	

Source: TDSHS 2013, 2020

Note: Tier 1 applies to women of childbearing age and children under 12; Tier 2 applies to women past childbearing age and adult men.



INDICATOR 3:
Oyster Harvesting Areas

CONDITION/TREND: GOOD/STABLE

BACKGROUND

The Texas Department of State Health Service (TDSHS) is responsible for providing information in maps and written areas where seafood can be safely harvested. Shellfish, typically clams, oysters (mollusks) and crabs, constitute important commercial and recreational fisheries of the Coastal Bend area. However, some bay waters can have restrictions for consumption of shellfish by humans. The TDSHS regularly sample water quality and seafood for contaminants to prevent human health issues by identifying areas that are off limits for harvesting. In waters with consumption bans, possession and consumption of molluscan shellfish is prohibited.

CONCERNS

In Texas, molluscan shellfish are defined by TDSHS as oysters, clams, and mussels and pose health risks that are different from fish and crabs. Because molluscan shellfish are filter feeders and are often eaten raw, a public program has been developed to reduce risk to consumers. Molluscan shellfish harvest areas are classified on harvest maps indicating areas that are approved, conditionally approved, restricted, or prohibited for harvest. Restricted and prohibited areas are classified as such based on levels of fecal pollution, human pathogens, or contaminants. Before commercially or recreationally harvesting molluscan shellfish, individuals should have a current shellfish classification map and determine the location of the approved and conditionally approved harvest area limits. Additionally, Texas Parks and Wildlife Department may also take actions to close shellfish harvest areas due to shellfish resource concerns or enforcement issues. The current status of shellfish harvesting areas may be obtained from your local Texas Parks and Wildlife Department (TPWD) office by calling toll-free 1-800-685-0361, or by downloading the current maps from the TDSHS website, accessing their online map viewer or calling their Seafood and Aquatic Life Group at 512-834-6757.

LOCAL CONDITIONS

Consumption advisories for shellfish are issued by TDSHS every year. However, the status of harvest areas is subject to change at any time. Status changes may be due to high rainfall and runoff, flooding, hurricanes and other extreme weather conditions, spills, harmful algal blooms (see Indicator 5), or the failure or inefficient operation of wastewater treatment facilities. Coastal Bend bays and sub-bays with harvesting areas subject of advisories include: Copano(TX32), Aransas (TX29/30), Mesquite (TX28), Redfish, Corpus Christi (TX33), and Nueces Bays. These areas comprise 935 square miles of aquatic environments. The system with the most restricted area is the area between Baffin Bay to Port Mansfield in the Upper Laguna Madre with 100% of the bay area (487 sq mi), followed by Corpus Christi Bay with 31% of the bay area (63 sq mi). This includes waters in Nueces Bay that are entirely restricted to harvesting. Restricted areas to harvesting have remained constant since 2014 in the Coastal Bend area. Many of these areas remain under this status as a preventive measure due to their proximity to housing developments (for example the presence of septic tanks) or industrial areas. Saint Charles Bay in Aransas County has been closed by TPWD since 2017 to allow the oyster population to recover and reach legal sizes. Additionally, all waters in Oso Bay and some portions of Copano Bay have been classified as restricted for oyster harvesting due to high concentrations of bacteria since 1998 (see Indicator 7).

REFERENCES

TDSHS. 2020a. Shellfish classification of harvesting areas GIS database 2014-2020. Seafood and Aquatic Life Program, Texas Department of State Health Services. Austin.

TDSHS. 2020b. Shellfish classification of harvesting areas maps 2020-2021. Seafood and Aquatic Life Program, Texas Department of State Health Services. Austin.

HOW CAN YOU HELP?

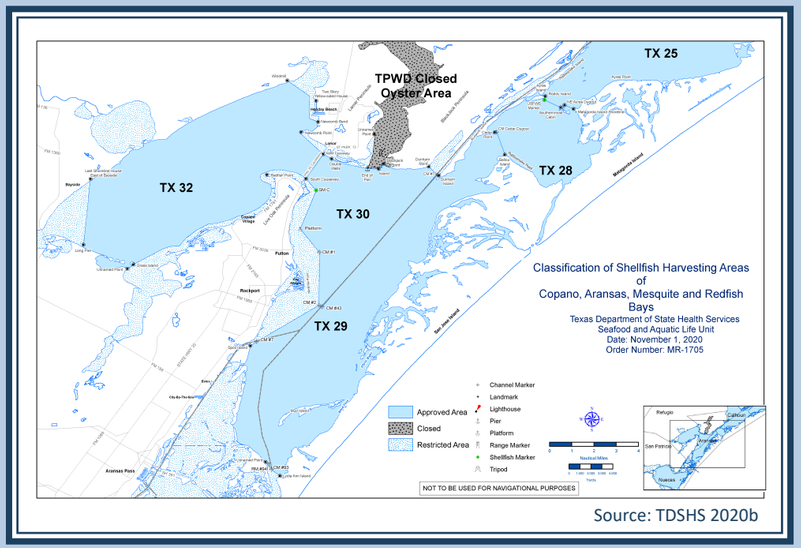
- Learn how to prevent pollution of bays by keeping storm water clean at the City of Corpus Christi Storm Water Pollution Prevention website.
- Join TCEQ's Total Maximum Daily Load Program: Communities Working Together to Improve Water Quality.
- Report water quality issues using TCEQ's Surface Water Quality Web Reporting Tool.

ADDITIONAL INFORMATION

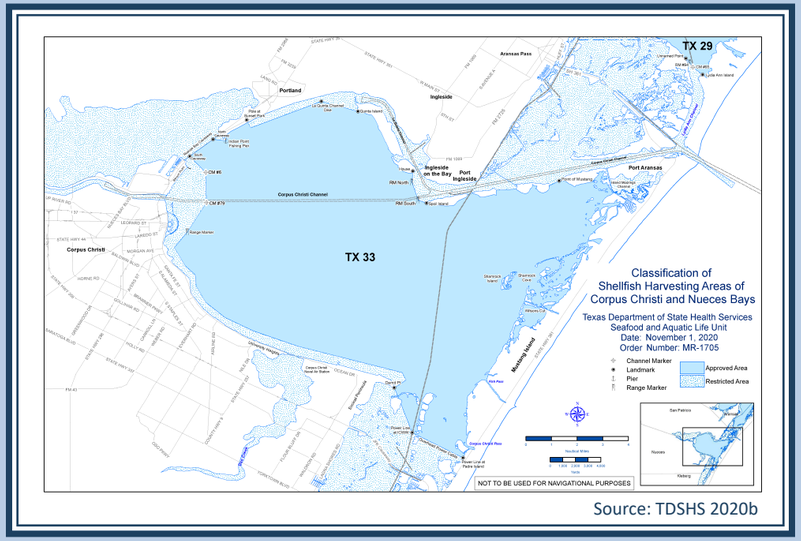
TPWD - Oyster Regulations

TDSHS - Seafood and Aquatic Life

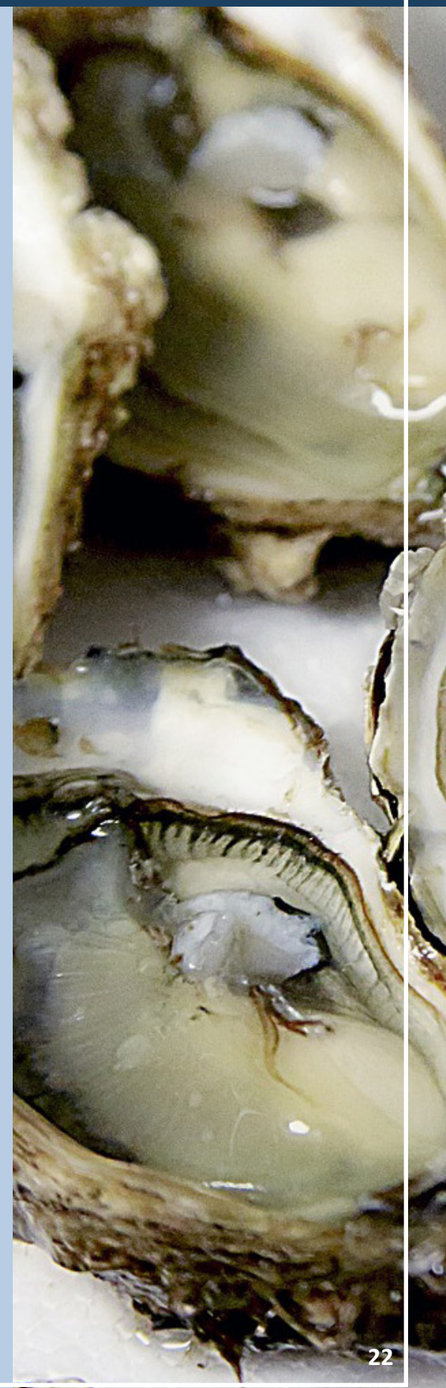
TDSHS - Texas Shellfish Harvest Area Viewer



Source: TDSHS 2020b



Source: TDSHS 2020b



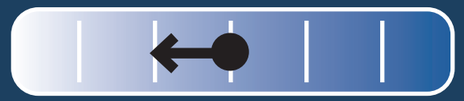
FOCUS QUESTION 3

Are water and sediment quality stable, improving, or degrading?

INDICATOR 4: Number of Impaired Segments (303d List)

MODERATE/STABLE

INDICATOR 5: Harmful Algal Blooms



MODERATE/DEGRADING

WHAT WAS MEASURED?

Number of water body segments impaired by pollution and bacteria, and the frequency and severity of harmful algal blooms in bays and Gulf waters.

WHAT DID WE FIND?

High level of bacteria in water is the main cause of water body impairment in the Coastal Bend. Several segments have been impaired for periods of time extending to several decades. The frequency of harmful algal blooms has increased throughout the Coastal Bend area, and the events can last several months and move throughout the entire Texas coast. The economic cost of these events can reach more than ten million dollars.

ANSWER TO FOCUS QUESTION 3

Although there are some areas within the CBBEP area that do not meet the TCEQ water quality standards, implementation plans with total maximum daily load specifications are helping to restore the health of water bodies. Harmful algae species are naturally present within marine waters, just not in concentrations that have impacts in human and wildlife health.

INDICATOR 4:
Number of Impaired Segments

CONDITION/TREND: MODERATE/STABLE

BACKGROUND

In 1972, the Clean Water Act established acceptable water quality standards for waterways in the United States based on their intended public use. Texas uses four general categories for water use: aquatic life use, contact recreation, public water supply, and fish consumption. Each use type has unique water quality standards that must be met to be considered safe.

Standards associated with the aquatic life use are designed to protect native plant and animal species that live in and around the water. The standards associated with the contact recreation use are designed to ensure that water is safe for swimming or other water sports that involve direct contact with the water. Standards associated with the public water supply use ensure water from a lake or river is suitable for use as a source for a public water supply system. Standards associated with the fish consumption use are designed to protect people from eating fish or shellfish that may be contaminated.

Every two years, the Texas Commission on Environmental Quality (TCEQ) assesses the status of its waters and produces the Texas Integrated Report of Surface Water Quality for the Clean Water Act Section 303(d) List. The report describes the status of Texas waters based on historical data and identifies water bodies that do not meet the standards set for their use and the pollutants and conditions responsible. The latest report was published in 2020 and is available at the TCEQ's Surface Water Quality Monitoring website.

CONCERNS

Water bodies listed on the Section 303(d) list do not meet applicable water quality standards and are considered to be "impaired." Impaired water bodies are not ecologically healthy, thus they do not provide the ecological benefits of which they are capable, and people and nature depend on. The criteria for evaluating water health include dissolved oxygen, temperature, pH, dissolved minerals, toxic substances, and bacteria.

The development of a plan for improvement is required for every water body included in the 303(d) list. Using this list, TCEQ develops a schedule to establish Total Maximum Daily Loads (TMDL) for priority impaired waters in Texas. A TMDL is a scientifically-derived target representing the maximum concentration of a particular pollutant in water to keep it healthy. The goal of a TMDL is to reduce the amount of pollutants in a waterway so it is safe for its intended use. The TMDL provides a measurable way to target the efforts to protect and improve the quality of streams, lakes, and bays. Maintaining the 303(d) list is a critical effort of TCEQ that helps us keep track of the health and recovery of an essential resource for all life in Texas.

LOCAL LEVELS

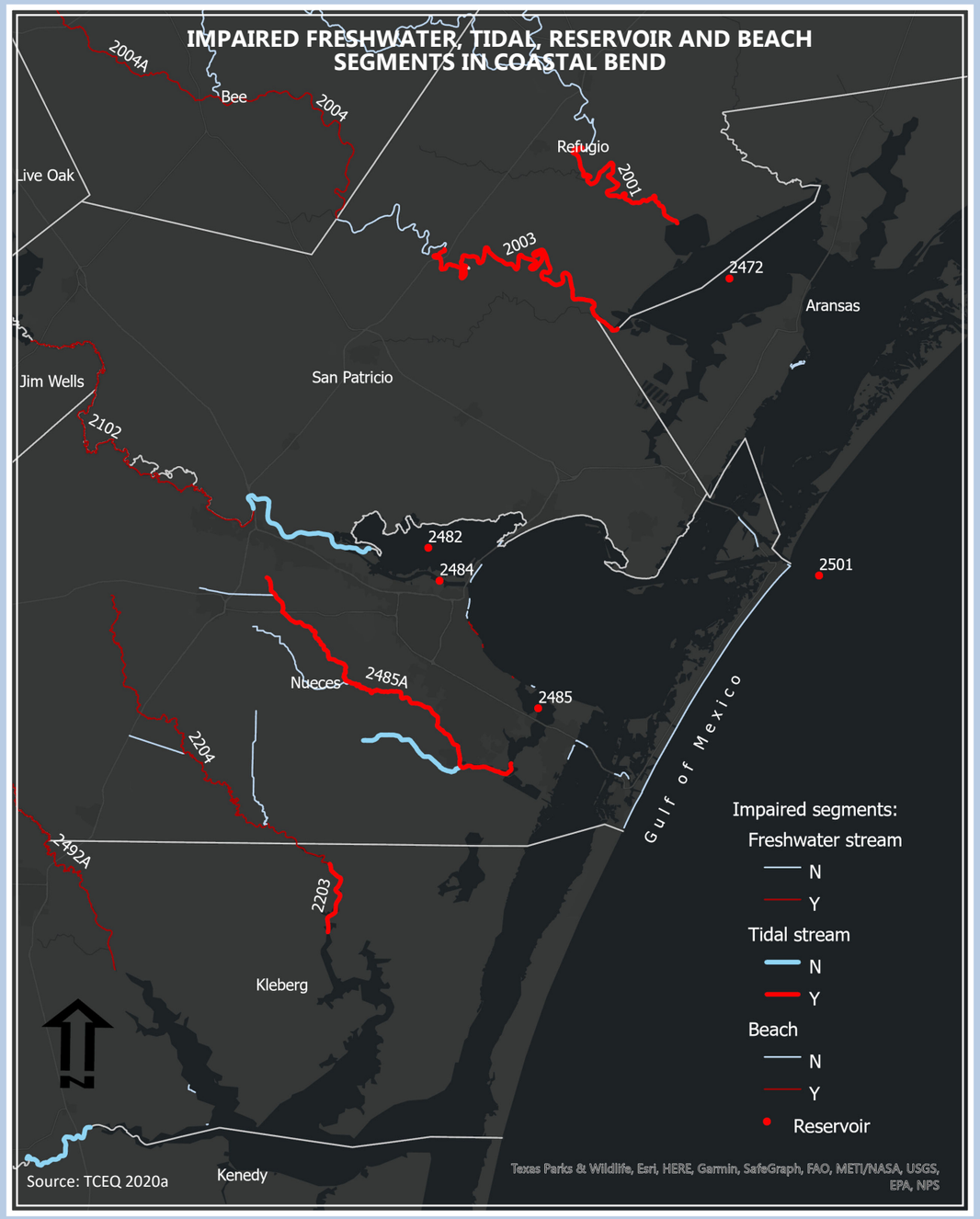
At present, most segments listed are due to high bacteria levels in water. High concentrations of bacteria frequently occur due to sources of pollution that cannot be reasonably controlled by existing regulations or wildlife sources. It limits all categories for water use, including swimming and other recreational potential (see Indicator 1). Other impairments include low oxygen and high dissolved solid levels. Additionally, the waters of the Gulf of Mexico have mercury levels in excess in some fish tissue (see indicators 2 and 6). Oxygen levels reflect the ability of a water body to support a healthy, diverse aquatic population. Low levels of dissolved oxygen are harmful to aquatic species and can occur seasonally or due to sporadic events such as during harmful algal blooms (see Indicator 5). Some locations listed have contaminants that cannot be easily cleaned up and may require allowing nature to restore the system over time through natural process and flushing from heavy rains and storms.

REFERENCES

Nicolau, B.A., and E.M. Hill. 2012. Nueces Bay total maximum daily load project – Year-six implementation effectiveness monitoring data report. Texas Commission on Environmental Quality. Austin.

HOW CAN YOU HELP?

- Join TCEQ's Total Maximum Daily Load Program: Communities Working Together to Improve Water Quality.
- Report water quality issues for rivers and water bodies using TCEQ's Surface Water Quality Web Reporting Tool.
- Take a "Leave No Trace" approach to prevent and minimize harm to the bays.
- Bag pet waste and place it into your trash can - dog, cat and waste of other pets can pollute our bays & estuaries.



COASTAL BEND SEGMENTS OF PRIMARY CONCERN ACCORDING TO 2020 TEXAS COMMISSION ON ENVIRONMENTAL QUALITY 303(d) LIST

TYPE	ID	NAME	YEAR LISTED	IMPAIRMENT	303(D) CATEGORY**	DATE OF TMDL* ADOPTION	I-PLAN/WPP STATUS
Freshwater	2102	Nueces River	2012	Total dissolved solids in water	5c		
	2204	Petronila Creek	2016	Bacteria in water	5b		WPP in development
			2000	Chloride in water	4a	2007	I-Plan revised 2014
			2000	Sulfate in water	4a	2007	I-Plan revised 2014
			2000	Total dissolved solids in water	4a	2007	I-Plan revised 2014
	2492A	San Fernando Creek	2006	Bacteria in water	5c		WPP in development
	2004	Aransas River	2014	Bacteria in water	4a	2016	I-Plan approved 2016
Tidal	2001	Mission River	2004	Bacteria in water	4a	2016	I-Plan approved 2016
	2003	Aransas River	2004	Bacteria in water	4a	2016	I-Plan approved 2016
	2203	Petronila Creek	2010	Bacteria in water	5c		
	2485A	Oso Creek	2002	Bacteria in water	5a	2019	I-Plan in development
Reservoirs	2482	Nueces Bay	2016	Copper in water	5c		
	2482OW	Nueces Bay (Oyster Waters)	1998	Zinc in edible tissue	4qa	2006	I-Plan approved 2007
	2484	Corpus Christi Bay Inner Harbor	2016	Copper in water	5c		
	2485	Oso Bay	1996	Bacteria in water	4a	2007	I-Plan in development
			1996	Depressed dissolved oxygen in water	5b		
	2485OW	Oso Bay (Oyster Waters)	2006	Bacteria in oyster water	5a		
	2481CB	Corpus Christi Bay (Recreational Beaches)	2010	Bacteria in water	5a	2020	I-Plan in development
	2472OW	Copano Bay/Port Bay/Mission Bay (Oyster Waters)	1998	Bacteria in oyster water	5c		
	2501	Gulf of Mexico	1998	Mercury in edible tissue	5c		

Notes: *TMDL = Total Maximum Daily Loads. **5a = TMDL are underway, scheduled, or will be scheduled for one or more parameters; 5b = a review of the standards for one or more parameters will be conducted; 5c = additional data or information will be collected and/or evaluated for one or more parameters; 4a = impairments that are not suitable for a TMDL or for which a TMDL has already been approved.

Source: TCEQ 2020b, 2020c, 2020d, 2020e.

SOS. 2020. Site-specific uses and criteria Rule §307.7. Texas surface water quality standards 2018. Texas Administrative Code. Texas Secretary of State (SOS). Austin.

TCEQ. 2020a. Assessment unit GIS data. Open Data Portal. Texas Commission on Environmental Quality. Austin.

TCEQ. 2020b. Segments with total maximum loads. Texas Commission on Environmental Quality. Austin.

TCEQ. 2020c. Summary table of completed TMDLs and I-Plans. Texas Commission on Environmental Quality. Austin.

TCEQ. 2020d. Texas integrated report index of water quality impairments. Texas Commission on Environmental Quality. Austin, 135 pp.

TCEQ. 2020e. Texas integrated report of surface water quality – Texas 303(d)list (category 5). Texas Commission on Environmental Quality. Austin, 115 pp.

ADDITIONAL INFORMATION

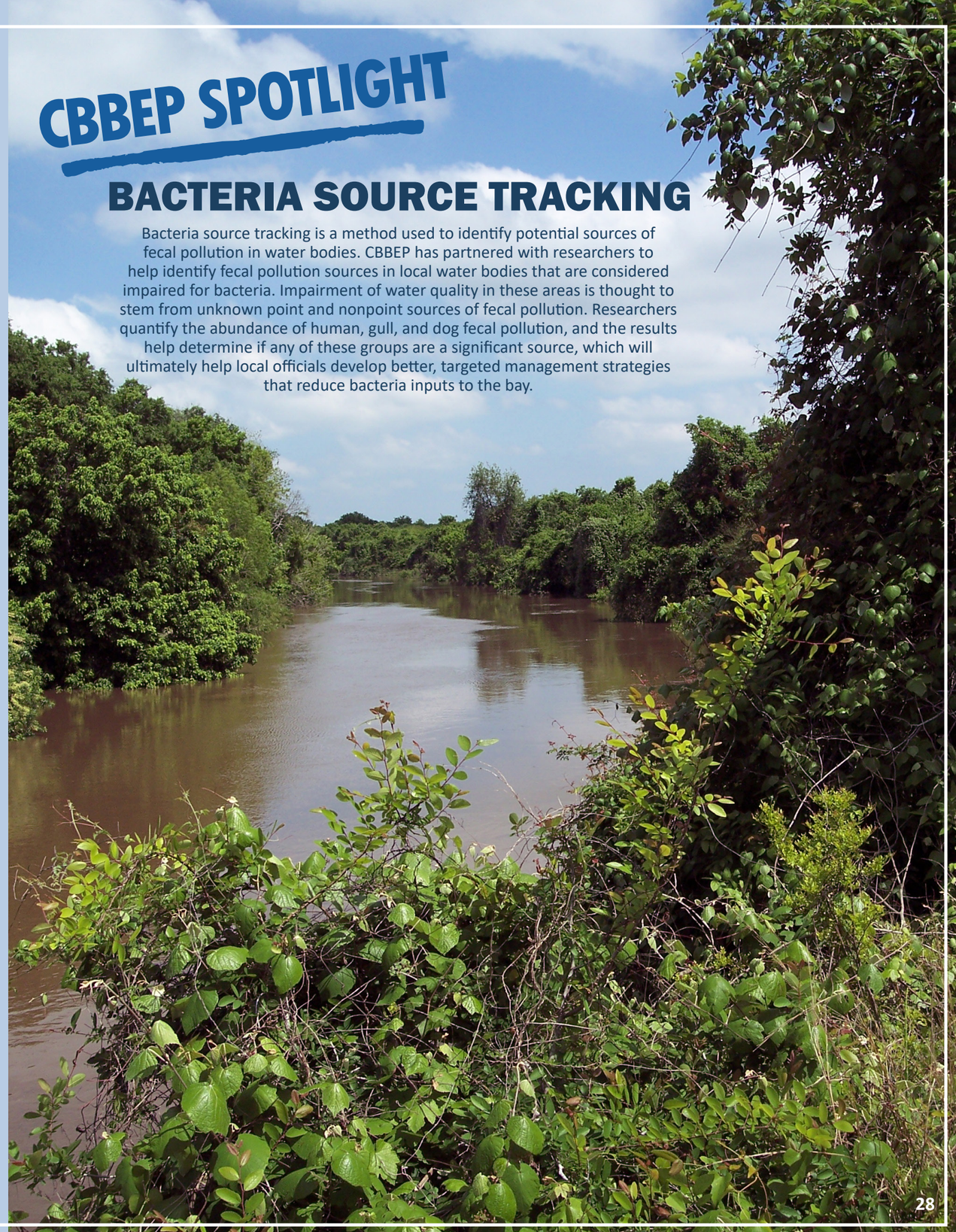
Nueces River Authority

TCEQ - Surface Water Quality (segments) Viewer

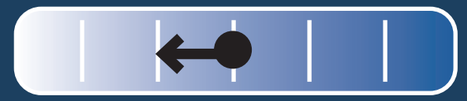
CBBEP SPOTLIGHT

BACTERIA SOURCE TRACKING

Bacteria source tracking is a method used to identify potential sources of fecal pollution in water bodies. CBBEP has partnered with researchers to help identify fecal pollution sources in local water bodies that are considered impaired for bacteria. Impairment of water quality in these areas is thought to stem from unknown point and nonpoint sources of fecal pollution. Researchers quantify the abundance of human, gull, and dog fecal pollution, and the results help determine if any of these groups are a significant source, which will ultimately help local officials develop better, targeted management strategies that reduce bacteria inputs to the bay.



INDICATOR 5:
Harmful Algal Blooms



CONDITION/TREND: MODERATE/DEGRADING

HOW CAN YOU HELP?

» Report suspected harmful algal blooms and fish kills at TPWD's (512-389-4848 or hab@tpwd.texas.gov). Also report sick and dead seas turtles and marine mammals.

» If you suspect a harmful algal bloom, call TPWD (1-800-792-1112) for the latest updates, information, and advisories before fishing. Call TDSHS (1-800-685-0361) for current information about shellfish.

BACKGROUND

Microscopic algae are plants that are usually aquatic, unicellular, and lack true stems, roots, and leaves. Algal blooms can occur in both marine and freshwater environments when a naturally occurring algal species grows faster than other species and reproduces rapidly. A harmful algal bloom (HAB) is a bloom of a species that produces toxins that are detrimental to plants and animals.

Blooms can be caused by several factors. An increase in nutrients in water can cause algae growth and reproduction to increase dramatically resulting in a bloom, just as fertilizing a lawn makes the grass grow faster. In other instances, something may change in the environment so that certain algae can "out compete" the other algae for food, which can result in a bloom of the algae with the advantage. This environmental change can be related to the water quality, temperature, nutrients, sunlight, or other factors. These events are typically called red or brown tides due to discolor or the water that they produce. However not all HAB events are caused by *Karenia brevis*, the algae that causes red tide, and brown tide is caused by the algae *Aureoumbra lagunensis* that is unique to the Gulf of Mexico.

Texas Parks and Wildlife Department (TPWD) has a Kills and Spills Team of biologists that respond to an incident where fish or other animals have been harmed to determine the cause of the dead fish. The team investigates suspected HAB and other environmental factors to monitor during the full span of the 'fish kill' and/or bloom. TPWD provides useful information about the effects and identification of red and brown tide, as well as the status reports of current and past events in their HAB website. If a HAB event is suspected, the public can call TPWD's information service at 1-800-792-1112 for the latest advisories. Additionally, NOAA's Harmful Algal Blooms Observing System (HABSOS) program provides geographical information about past events across the Gulf of Mexico in their online mapper.

CONCERNS

Both red tide and brown tide are common HAB in the Coastal Bend area, red tide being the most concern to people because it can cause irritation. Although these algae are believed to be always present at low concentrations in waters in the Gulf of Mexico, and when in bloom, locations can change daily due to wind conditions. Research indicates that these tides are part of a natural cycle within the Laguna Madre and other Texas bays.

In Texas, high concentrations of *K. brevis*, commonly known as red tide, may discolor the water, causing it to appear red, light or dark green, or brown. Red tide produces a toxin (brevetoxin) which can affect the central nervous system of fish, birds, mammals, other animals, and people. The most visible result of red tide is dead fish on the beach or floating in the water. Their effects in dead fish containing the toxin can remain on beaches for weeks or months following a bloom. Red tides can begin in the summer or early fall and can last for days or months. During brown tide events the water appears brown, taking on the color of the alga. In dense enough concentrations, and over a period of months, brown tide can kill seagrasses by blocking out the sunlight they need to survive. Brown tide does not release any toxins and although there is no evidence that it poses any harm to people, you should never eat fish found sick or dead, whether or not they are caught during an active event. Though brown tide apparently has no effect on juvenile or adult fish, it can be deadly to fish larvae. Brown tides are also moved around by winds, and therefore, an area that is murky in the morning might be clear by the afternoon.

Human health effects associated with the exposure to brevetoxin (red tide) are well documented. They range from respiratory and eye irritation and other uncomfortable symptoms when exposed by breathing air with high concentrations near an affected area, to effects associated with eating contaminated shellfish such as neurotoxic poisoning. People who swim during red tide or inhale brevetoxins dispersed in the air may experience irritation of the eyes, nose, and throat, as well as coughing, wheezing, and shortness of breath. People with existing respiratory illness, such as asthma, may experience these symptoms more severely. Commercial seafood from local restaurants and seafood markets is safe if it is tested for red tide toxins before it is sold. *Dinophysis ovum* is another marine HAB microorganism that produces okadaic acid and causes diarrhetic shellfish poisoning when filtered and concentrated by molluscan shellfish, such as oysters and mussels. There is no evidence of neurotoxicity caused by *D. ovum*, nor fatal cases reported.

HARMFUL ALGAL BLOOMS IN COASTAL BEND BAYS AND GULF OF MEXICO SINCE 2000

YEAR	RED TIDE	BROWN TIDE**	DINOPHYSIS
2000	COR/GULF		
2001	ARA,COP,COR*		
2005	COR,ULM/GULF	BAF	
2006	ARA,COP,COR, ULM/GULF*		
2008			ARA,COP,COR
2009	COR,ULM/GULF*		
2010			ARA,COP,COR
2011	ARA,COP,COR/ GULF*		ARA,COP,COR
2012	ARA,COP,COR/ GULF*		
2013	COR,ULM/GULF	BAF	
2014		BAF	ARA,COP,COR
2015	COR,ULM/GULF*	BAF	
2016	COR/GULF*	BAF	
2018	COR/GULF*	BAF	
2020			***

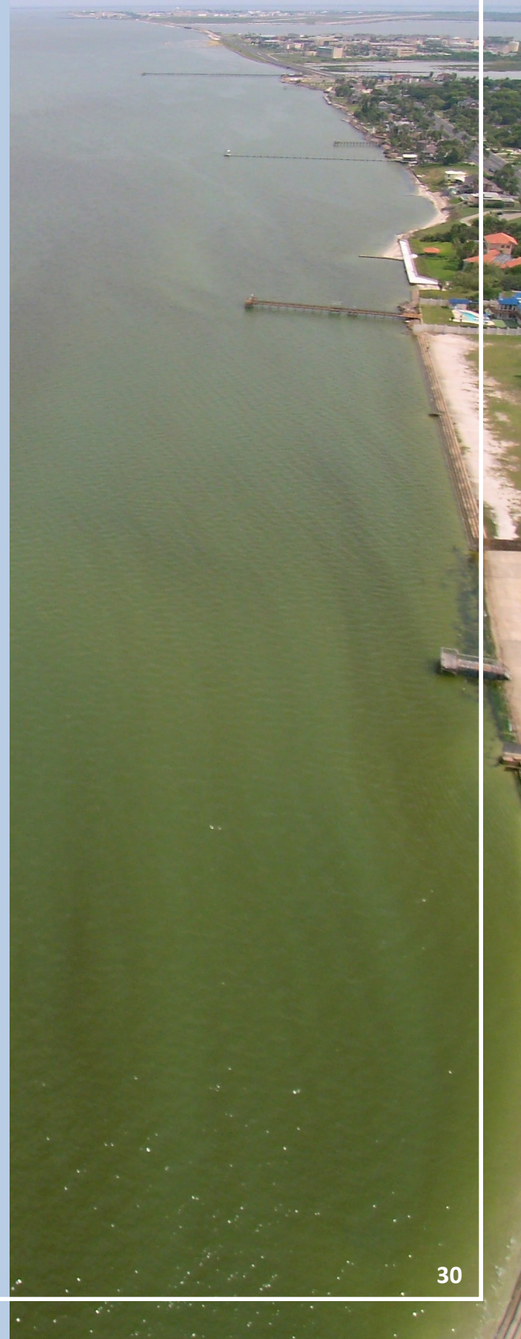
Source: Red tide: Tominack et al. 2020, TPWD 2020; Brown tide: Cira and Wetz 2019, Wetz pers. Comm. 2020; Dinophysis: TDSHS 2014.

Notes: Grey shaded area represents data time series available. Area key: ARA: Aransas, COP: Copano, COR: Corpus Christi, ULM: Upper Laguna Madre, BAF: Baffin, GULF: Gulf of Mexico. * Fish kill associated to event. ** Events with more than 800,000 cells/mL. *** Event report is in progress by TDSHS.

LOCAL LEVELS

The Laguna Madre was home to what is believed to be the longest continual algal bloom in history, from 1989-1997. In late 1989, a brown tide originated in Baffin Bay. At the time, the organism responsible for the bloom was unknown to science. It was given the name *Aureoumbra lagunensis*, meaning "the golden shadow from the lagoon". It is not known what factors led to this long-term bloom.

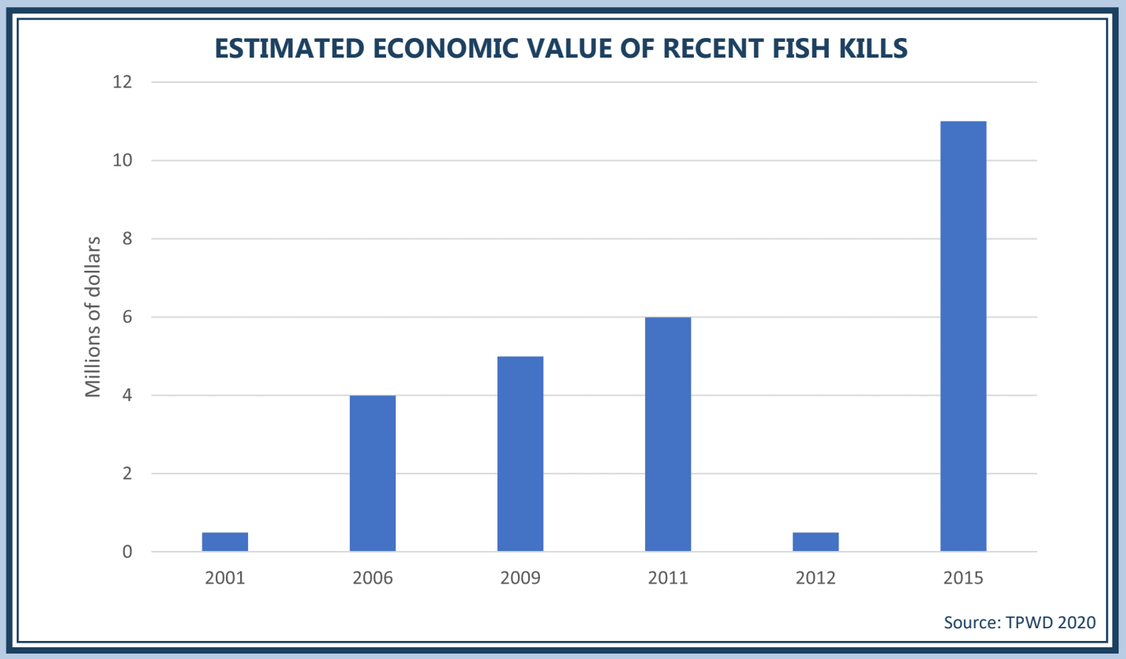
Historically, Texas red tides have had a duration from weeks to months and occurred August through February, with higher concentrations measured around October. They typically begin



offshore in the Gulf of Mexico and are transported by currents and winds toward shore. Blooms come up along beaches in estuaries, bays, and the Gulf. Brown tide events also last from months to years.

Texas has historically recorded red tide events along coastal waters. The most common location for the occurrence of red tide within the Coastal Bend region are the Corpus Christi and Padre Island National Seashore, both bay and Gulf waters. The frequency of documented red tide events has increased since 1986. The 1986 red tide caused more documented impacts to fisheries' resources than previously reported incidents. The 2000 red tide was more extensive in area coverage than previously reported incidents. The areas affected vary from year to year, from a single event in a ship channel in 1990 to the entire coastline in 2000. The 2005 red tide began near South Padre Island and moved north to Port Aransas and the 2006 red tide bloom began at Port Aransas and moved south along Mustang and Padre islands. In 2009, red tide began near South Padre Island and has moved north towards Port Aransas and Corpus Christi Bay. Six red tide events occurred during the past 10-years. The 2011 red tide event was particularly large in geographic extent and intensity, spreading from the lower coast of Texas up to Galveston Bay. Since 2006 there have been several large red tides events with high probabilities to cause respiratory irritations in people for periods of several months. Another important aspect of red tide is the impact that it can have in wildlife. The Kills and Spills Team of TPWD that investigates HAB-associated fish kills also estimates the economic cost of red tides in fish. Results shows that economic cost has increased from 2001 with a value estimated value of approximately $500,000 dollars to 2015 with an estimated value of more than $11 million dollars. *Dinophysis* events are monitored by TDSHS. Although it has been recorded in oysters, most cases that compromise human health have been reported from the consumption of mussels.

Harmful algae are always naturally present within the water column, just not in concentrations that are intolerable. There are some unanswered questions about these algae, for example what cause them and their relationship to other environmental variables such as an increasing salinity (see Indicator 16), and what their entire role is within the ecosystem. Therefore, it is important for scientists to continue to learn about them in order to take measures to reduce frequency of blooms and to protect the resources.



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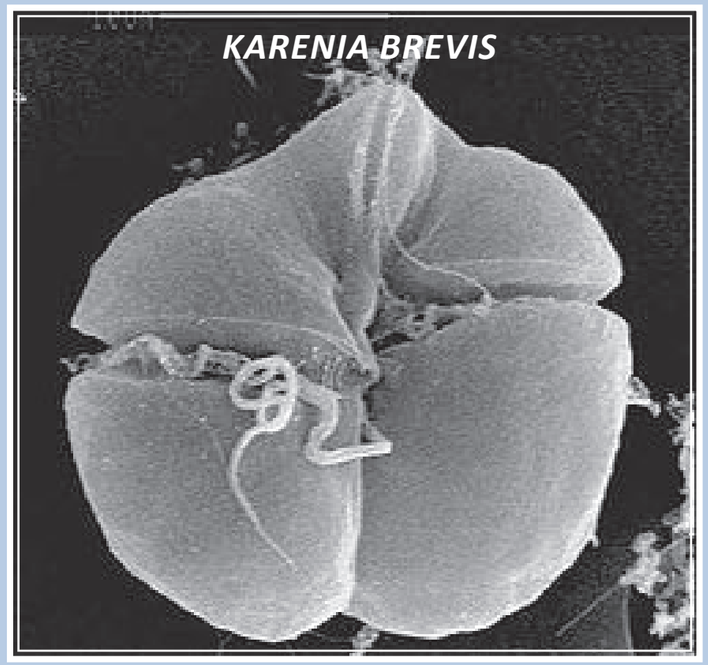
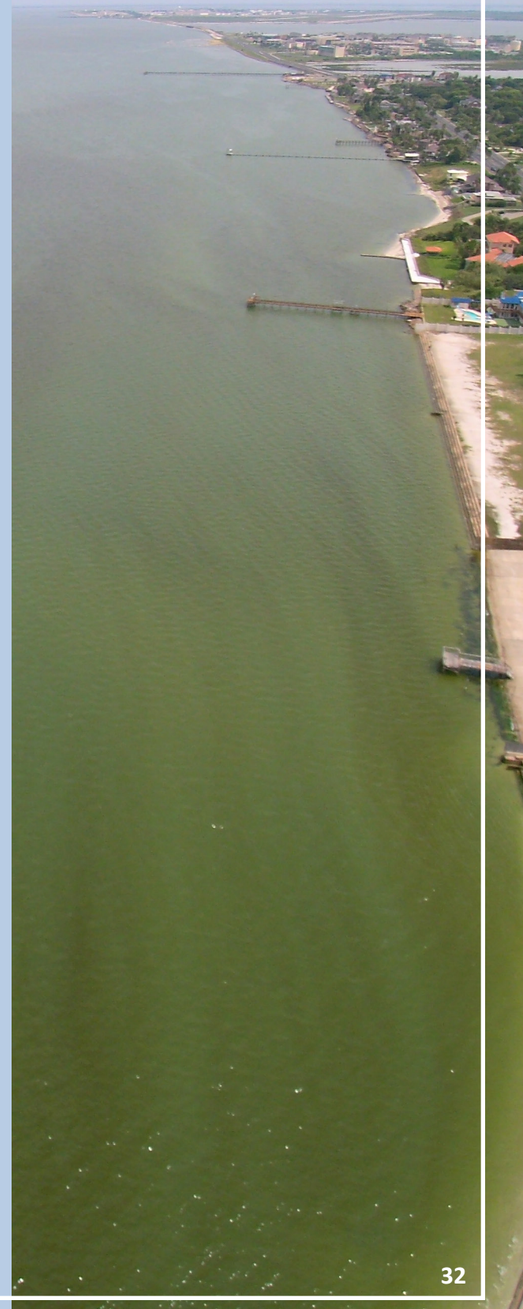
NOAA - Gulf of Mexico HAB-OFS Bulletin Guide

NOAA - Gulf of Mexico Harmful Algal Bloom Forecast

TDSHS - Harmful Algal Blooms

TPWD - Kills and Spills Team (KAST)





FOCUS QUESTION 4

Are fish and wildlife populations stable, increasing, or decreasing?

INDICATOR 6:
Recreationally Important Species

GOOD/INCREASING

INDICATOR 7:
Ecologically Important Species

GOOD/INCREASING

INDICATOR 8:
Commercially Important Species

MODERATE/DECREASING

INDICATOR 9:
Colonial Waterbirds

POOR/STABLE

WHAT WAS MEASURED?

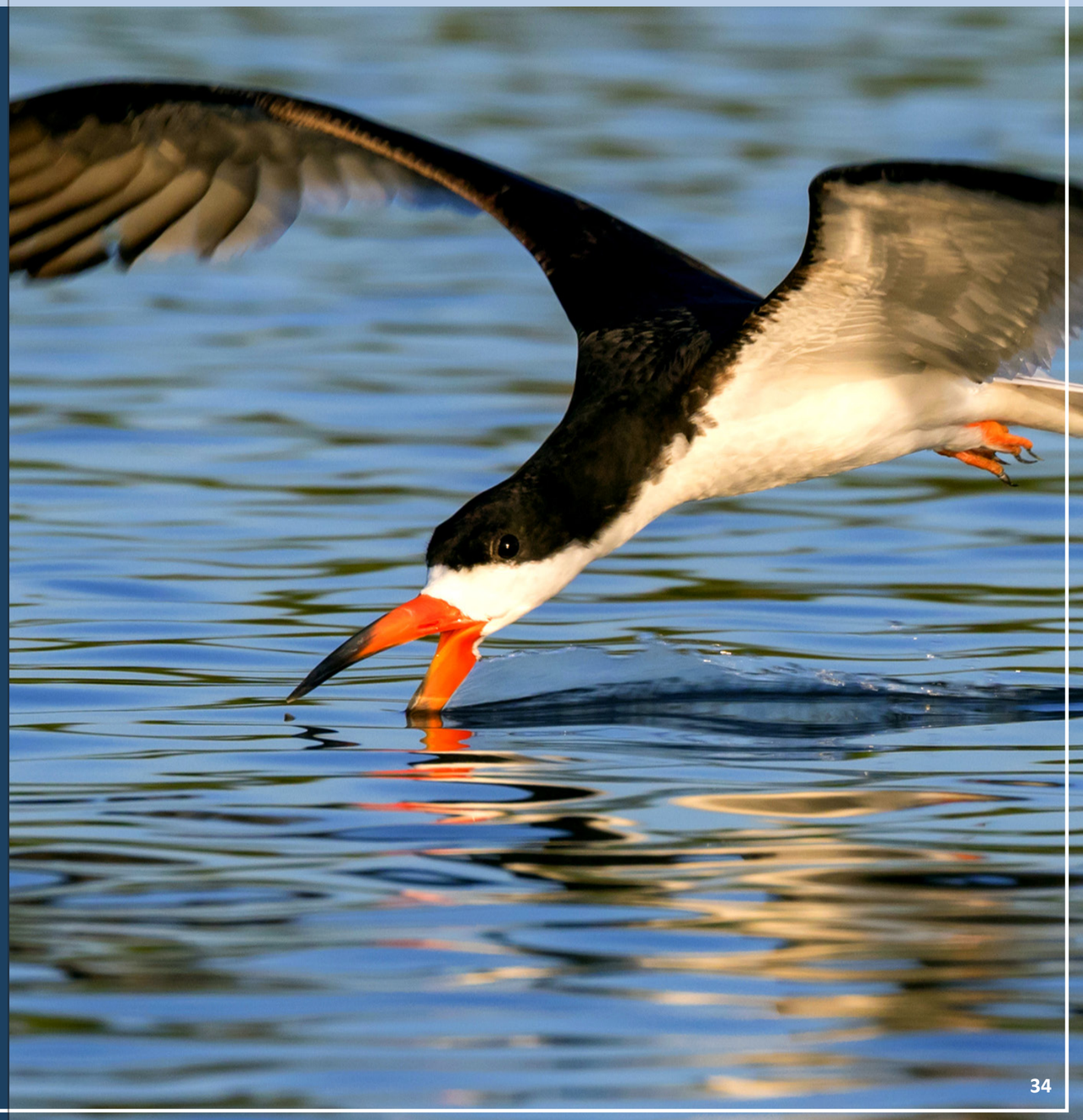
Changes in abundance of recreationally, ecologically and commercially important species of fish and shellfish, and the number of nesting pairs of colonial waterbirds.

WHAT DID WE FIND?

Recreationally important red drum, spotted seatrout, and ecologically important Atlantic croaker and anchovies abundances are stable or increasing in the Coastal Bend. However, despite management actions over the past decade, southern flounder populations continue to decline. Abundance of commercially important brown shrimp and blue crab show declines during the past decade, particularly blue crab. Nesting pairs of four of the five colonial waterbirds assessed were below their average during the past three years: American White Pelican, Black Skimmer, Great Blue Heron, and Reddish Egret.

ANSWER TO FOCUS QUESTION 4

While some fish populations have increased or continue to be stable, the abundance of southern flounder and blue crab continued to decline. Whereas several species of colonial waterbirds continue to show declines during the past decade, a few showed important recovery levels.



INDICATOR 6:
Recreationally Important Species

CONDITION/TREND: GOOD/INCREASING

BACKGROUND

Catching and eating fish is fun and rewarding, but it can also have a negative effect on fish populations. Fortunately, some fish populations have a remarkable ability to replenish themselves, so that, within limits, they can be harvested on a continuing basis without being diminished. Harvest not only affects the number of fish in a population, but also the size and age structure of the population. A lightly harvested population will have a greater number of older fish that can reproduce and replenish the population than one that is heavily harvested.

Recreational fisheries in freshwater streams, bays and nearshore areas are locally managed by the Texas Parks and Wildlife Department (TPWD). TPWD actively manage fish populations using scientific monitoring and angler input on regular basis to ensure the continuity of this favored Texas sport.

RECREATIONAL DAILY BAG AND MINIMUM SIZE LIMITS

SPECIES	2000		2009		2016		2019		2020	
	MIN SIZE	BAG LIMIT	MIN SIZE	BAG LIMIT	MIN SIZE	BAG LIMIT	MIN SIZE	BAG LIMIT	MIN SIZE	BAG LIMIT
Red drum	20"	3							20"	3
Southern flounder	14"	10	14"	5*					15"	5*
Spotted seatrout	15"	10			15"	10/5**	15"	5	15"	5

Source: TPWD 2003 and multiple years of TPWD Outdoor Annual.

Notes: Grey shaded areas represent changes in limits. * Southern flounder daily bag limit during November is 2. ** Spotted seatrout bag limit was 10 fish North of Matagorda Bay and 5 fish South of the bay.

CONCERNS

Many factors can limit fish population abundance. Some environmental aspects are better understood such as pollution and habitat limitations, but we are just beginning to learn about other such as the impacts that climate change can have in fish. Resource managers design and enforce harvest regulations to prevent population collapses. Particularly, we need to guarantee that there are abundant mature male and female fish that can produce enough young to replace the number of fish that are dying – for natural and harvesting causes.

TPWD has guidelines for harvesting fish using size and bag limits. These catch limits were first developed in 1967 for some fish and have continue to evolve since then as more fish have been harvested and uncertainties about environmental limitations grow. Guidelines are available every year in the Outdoor Annual publication of TPWD.

LOCAL LEVELS

SPOTTED SEATROUT

Spotted seatrout provides a good example of the effect of harvest. Spotted seatrout have a maximum lifespan of nine years, females grow larger and faster than males, and reach maturity between one and two years of age, which is about a 12-inch fish. Spotted seatrout catch rates increased considerably between 1984 and 2019. Its average size in Spring catches have remained relatively stable since the early 1980s. Due to elevated fishing pressures the bag limit of 10 fish established in 1984 was reduced to five in 2016. Over six million spotted seatrout fingerlings are now stocked annually into our bays from fish hatcheries in Corpus Christi and Lake Jackson.

RED DRUM

Revered for its power, speed and delectable flavor, red drum have become one of the most popular game fish in Texas marine waters. Many will remember in the late 1970s and early 1980s when red drum all but disappeared from our bays. Management measures were adopted throughout the 1980s. In addition to implementing management measures, a stocking program to enhance the wild population of red drum was established and hatcheries were developed along the coast. Since then, the fishery has recovered to arguably one of the best in the nation and catch regulations have not changed. Its average size in Spring catches have remained relatively stable since the 1990s. More than 14 million red drum fingerlings were stocked along the coast in 2017.

SOUTHERN FLOUNDER

Southern flounder is one of the top three fish targeted by anglers in Texas bays. Flounder has continuously decreased coastwide since the late 1970s measured by the catch per hour and size of flounder collected in TPWD annual gill net surveys. Research results show that his species struggles in maintaining recruitment levels during warm winters, and thus affected as climate change causes the oceans to heat up. In order to try to counter declines in the flounder population, TPWD has implemented a number of management changes since 1988, including the recent increase of the minimum size to 15 inches in 2020. TPWD will continue to assess flounder status and the efficacy of management actions over the next years. Stocking of southern flounder fingerlings has increased considerably since first conducted in 2006.

HOW CAN YOU HELP?

- Obtain a Fishing License and Saltwater Stamp and become familiar with the state fishing rules for salt water if you plan on fishing on the Gulf Coast.
- Join an Angler Education program with the Texas Parks and Wildlife Department.

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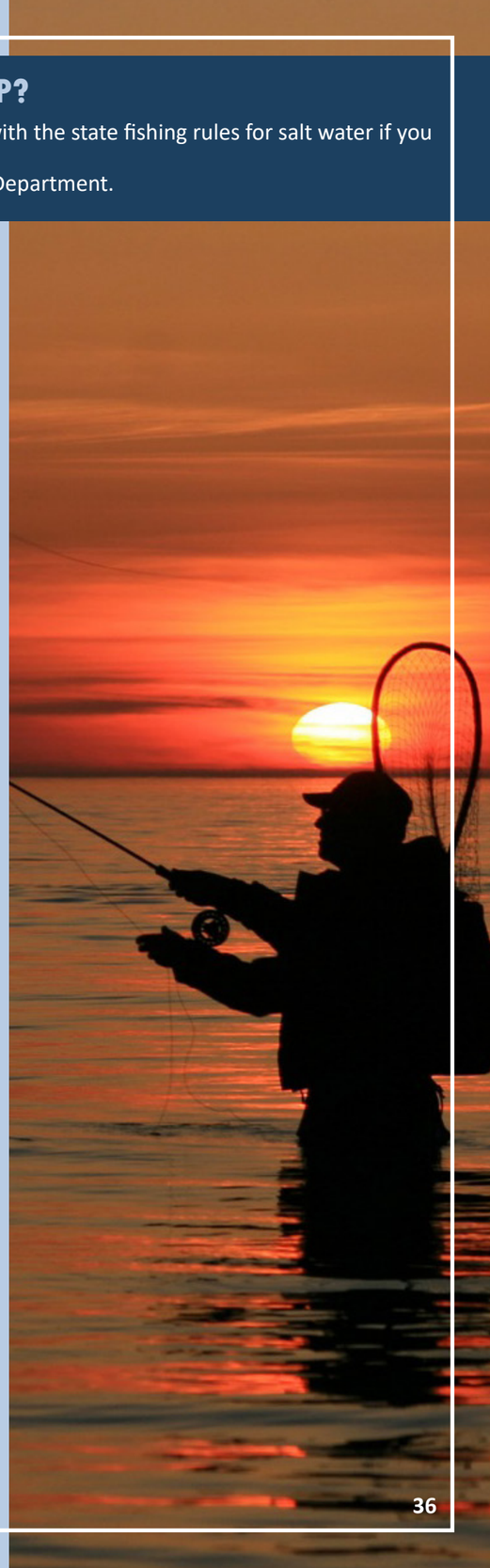
TPWD. 2020b. Outdoor annual. Texas Parks and Wildlife Department (TPWD). Austin.

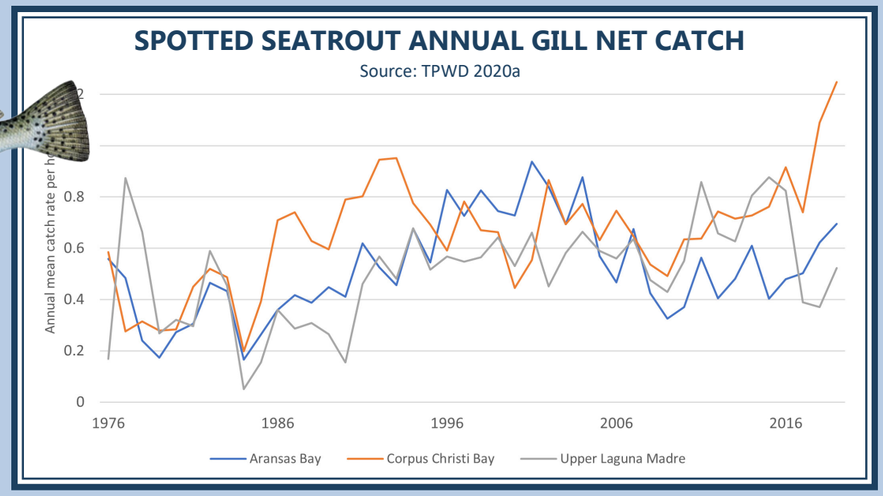
ADDITIONAL INFORMATION

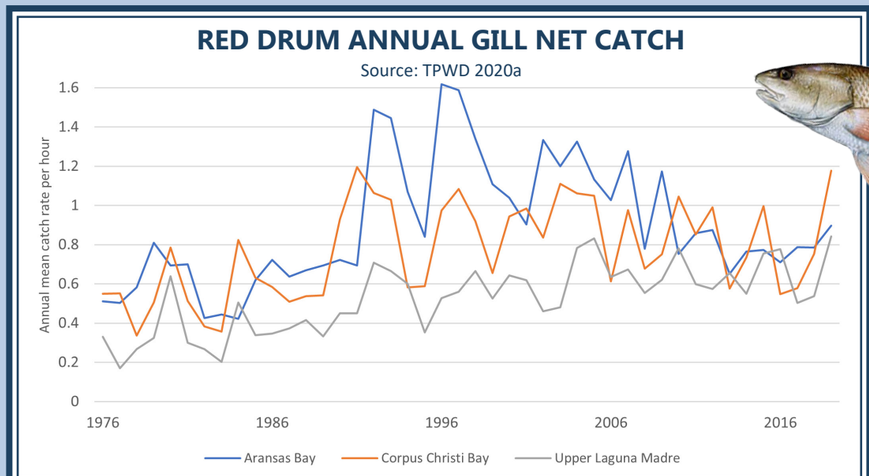
TPWD - Outdoor Annual: Summary of Texas Hunting, Fishing & Boating Regulations

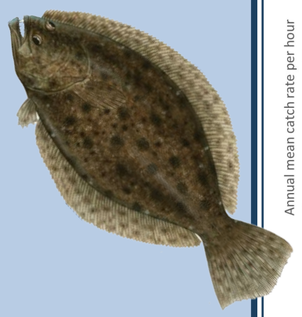
TPWD - Recreational Fishing

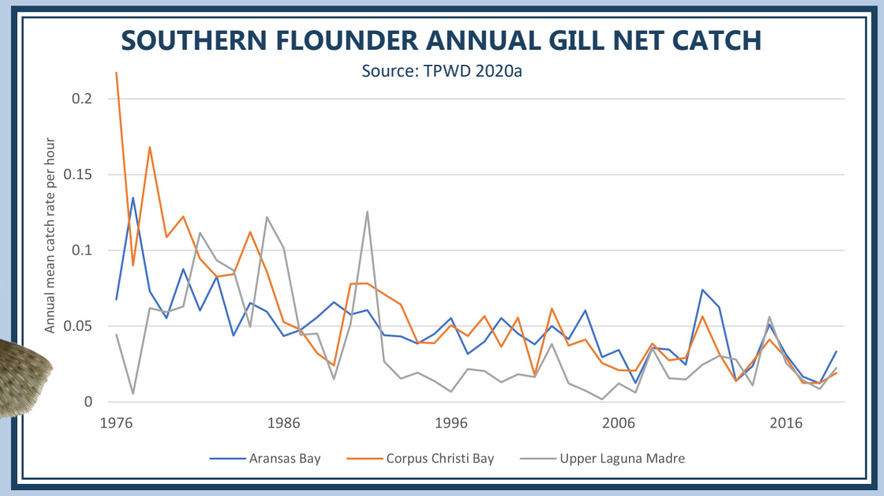
TPWD - Stocking Public Waters











CBBEP SPOTLIGHT

ECOSYSTEM-BASED APPROACH TO ASSESS BAFFIN BAY'S BLACK DRUM

Black drum represent another important commercial and recreational fishery in the state of Texas, but in recent years, alarming trends appeared in the south Texas black drum fishery. Specifically, a large proportion of black drum landed in Baffin Bay by both recreational and commercial anglers exhibited abnormal physical characteristics. These alterations included overall reduced condition, strange tissue morphology (fisherman have named "jellyflesh"), and empty guts. These unusual landings prevented commercial dockside sale and recreational consumption of black drum for a period of time in Baffin Bay. CBBEP funded research to examine habitat use and food sources of black drum in Baffin Bay. Researchers found through isotopic analyses of muscle tissues that black drum use resources from both Baffin Bay and the Laguna Madre under normal estuarine salinity conditions, but the fish are more constrained to Baffin Bay under hypersaline conditions, when prey resources there are limited. This effect could make it possible for fish to become 'trapped' in Baffin Bay, even when food resources in the complex are scarce, leading to emaciation events like those seen recently.

INDICATOR 7:
Ecologically Important Species

CONDITION/TREND: GOOD/INCREASING

BACKGROUND

Anchovy and Atlantic croaker fisheries are not large in Texas coast, but they do play a very important role in the ecosystem in whether the more common game fish, like red drum and spotted seatrout, will be plentiful and healthy in the coming years. These lower food chain 'forage' fish are good indicators of estuary pollution stress and form an important trophic link in the Coastal Bend waters. For example, the small bay anchovy consumes zooplankton and invertebrates and, in turn, is prey base for several larger species of fish including the spotted seatrout. Commercially, juvenile Atlantic croaker is typically used as bait to catch other fish. It is also an important food source for some of the major sports fish. Both spotted seatrout and red drum feed on the croaker at some point in their life cycle and depend on the fish for a source of nutrients to survive.

The Texas Parks and Wildlife Department (TPWD) gathers information and data on these fish species since they are indicators of how healthy the bays and estuaries might be. This annual monitoring program began collecting data for these two species in 1982 and since then it has proven useful in identifying early warnings of negative changes throughout the ecosystem, including their abundance and capacity of maintaining important recreational and commercial fisheries.

CONCERNS

Historically, the unintentional capture (bycatch) of juvenile Atlantic croaker in shrimp nets was a concern. During 1995 and 1996, TPWD instituted "limited entry" and "buy back" programs for commercial shrimping, which relieved this concern. However, overfishing continues to be a potential problem for croaker populations due to the rapid expansion of the bait industry in Texas. Typically, fish are sold individually and in some places their value can reach $12 per dozen. Estimating croaker abundance is complicated due to its highly variable growth rate and 95% of the population naturally dies within their first year. A scientific concern is that heavy fishing pressure can lead to fisheries-induced patterns leading to decreases in size and early maturation. At this time, there are no conclusive population assessments to suggest the species is overfished in Texas. Although the species remains very common in coastal waters the consequences for declines in its abundance on ecosystem health has yet to be fully investigated.

LOCAL LEVELS

Atlantic croaker abundance in Coastal Bend bays increased between 1985 and 2015 almost 400% in the bay trawls. It grew 60% only in the past decade. The data also shows an increase in size until 2009. Other data such as gill net shows a slight increase in the relative abundance (which is also true for the entire Texas coast), and bay bag seine shows a recovery by 2015 to levels of the mid-1980s. Overall, Coastal Bend data for bay anchovies show a strong increase in TPWD bay trawls since 1982. This trend is certainly clear during the past 10 to 20 years.

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TPWD. 2020. Fisheries independent monitoring database 1982 - 2019. Coastal Fisheries Division. Texas Parks and Wildlife Department (TPWD). Austin.

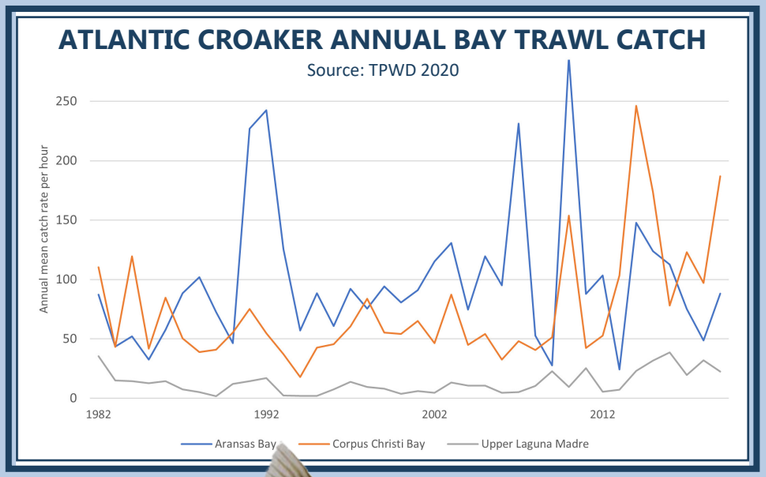
ADDITIONAL INFORMATION

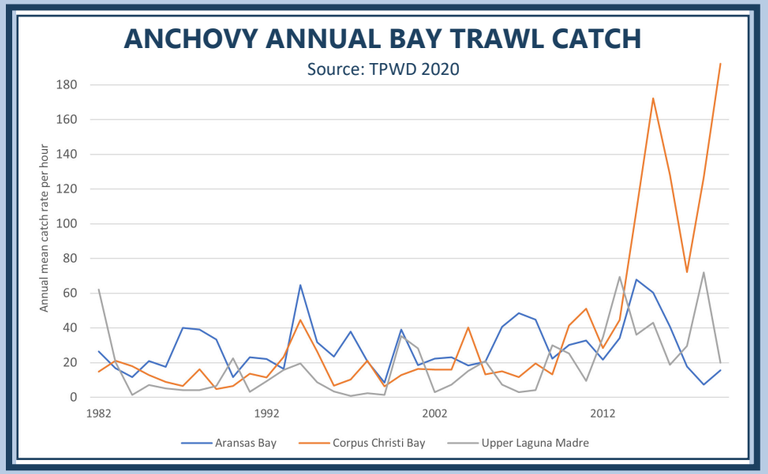
TPWD - Commercial Fishing Information

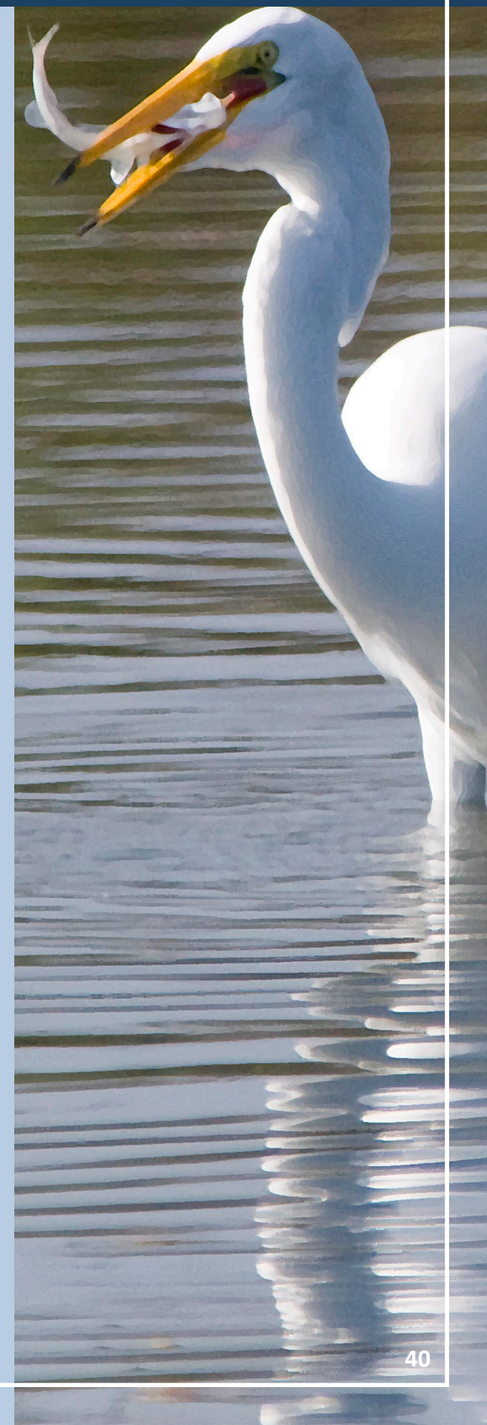
Gulf States Marine Fisheries Commission

HOW CAN YOU HELP?

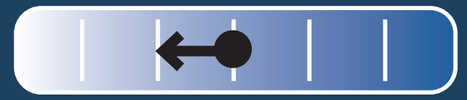
» Join an Angler Education program with the Texas Parks and Wildlife Department.
» Support restoration projects that provide habitat for ecologically important fish species.







INDICATOR 8:
Commercially Important Species



CONDITION/TREND: MODERATE/DECREASING

BACKGROUND

The Texas coast is home to important commercial fisheries that contribute to our nourishment and our wellbeing. The Texas shrimp fishery is one of the largest seafood industries in the country. Different species of shrimp are found in Texas coastal waters, but the two most important commercially are brown shrimp and white shrimp. The blue crab is also a commercially important shellfish in Texas that is fished entirely in estuaries and bay waters.

The Gulf of Mexico is responsible for 94% of the commercially wild-caught brown shrimp in the United States, totaling almost five billion pounds and valued at more than eight billion dollars since 1980. Texas produces 45% of the wild-caught brown shrimp in the Gulf, thus the largest producer of the region in 2018. Texas Coastal Bend residents have relied on the shrimp and blue crab bounty coming from the local estuaries, bays and nearshore.

Adult shrimp migrate offshore to spawn. A female may lay between one half to one million eggs at a single spawning. Upon hatching, the larvae are totally reliant upon favorable currents to transport them back to inshore waters. Once they move into brackish waters, the larvae become part of the bottom community. Young shrimp remain in the estuary until they mature, and the cycle is repeated. Shrimp are fished using a variety of fishing gears, but the most common commercial operations use twin-trawl offshore and single trawl net in the bays.

Blue crab is the most commercially important crab species in Texas. The crabs are sold live to processors, seafood houses, and supermarkets for sale over the counter. Generally, production has been highest in the bays that receive the most fresh water and lowest in those that receive the least. In the blue crab life cycle, the female migrates to the saltier portions of the lower bays and Gulf where it spawns. The male remains in the estuary. Blue crab can also be caught in different ways, but most commercial fishermen use box-like crab traps.

Commercial saltwater fisheries in bays and nearshore areas are actively managed by the Texas Parks and Wildlife Department (TPWD). TPWD records catch landings of crab and shrimp populations and conducts annual surveys of their populations to assess their health. The Texas Parks and Wildlife Commission is charged with specifying opening and closing dates of shrimp and crab seasons, using the information generated by the monitoring program.

CONCERNS

Overfishing and loss of habitat are the biggest challenges for the Coastal Bend shrimp fishery productivity. Bottom trawling and other fishing activities that involve direct contact between fishing gear and the bottom environment in the bays, estuaries, and Gulf of Mexico can alter the structure and ecology of marine habitats. In Texas waters, bottom trawling for shrimp is the dominant commercial fishing activity. Therefore, shrimp trawling could be an important source of negative impacts to shrimp population but also to many other fish and shellfish. There are also concerns on the effects of shrimp trawling on larger species such as fish and sea turtles. Fisheries research during the past three decades has contributed largely to the reduction of incidental catch (bycatch) by designing turtle and fish excluders for nets, which has increased their survival while maintaining shrimp catch efficiency.

The annual recruitment, or number of juvenile crabs, is often dependent upon rainfall, both the quantity and the timing. Concerns about habitat loss are also key with this fishery. Marshes, seagrass meadows and muddy/soft bottoms are critical habitat for juvenile blue crabs and are necessary for them to reach maturity. The lack of these critical habitats for small crabs increases their mortality from predation. Overfishing is another concern, especially when an increasing variable environment seems to make their populations more vulnerable. Blue crab is also an important food source for the endangered whooping crane that winters in the Texas coast. The lack of rainfall in 2009 and 2010-2014 drought reduced the freshwater inflows into the coastal marshes and bays, raising the salinity levels and threatening wildlife including the whooping crane population.

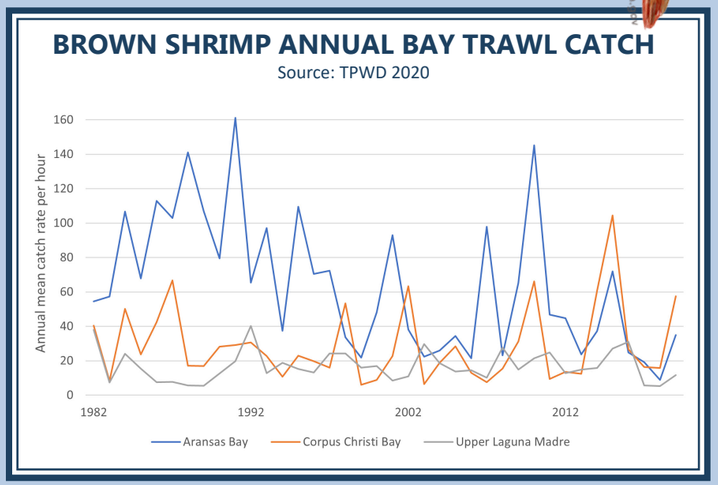
HOW CAN YOU HELP?

- Learn about sustainable fisheries management and seafood options by searching the FishWatch database.
- Fisherman can join the Marine Resource Education Program to gain a better understanding of how, when, and where to engage effectively in fisheries science and management.

LOCAL LEVELS

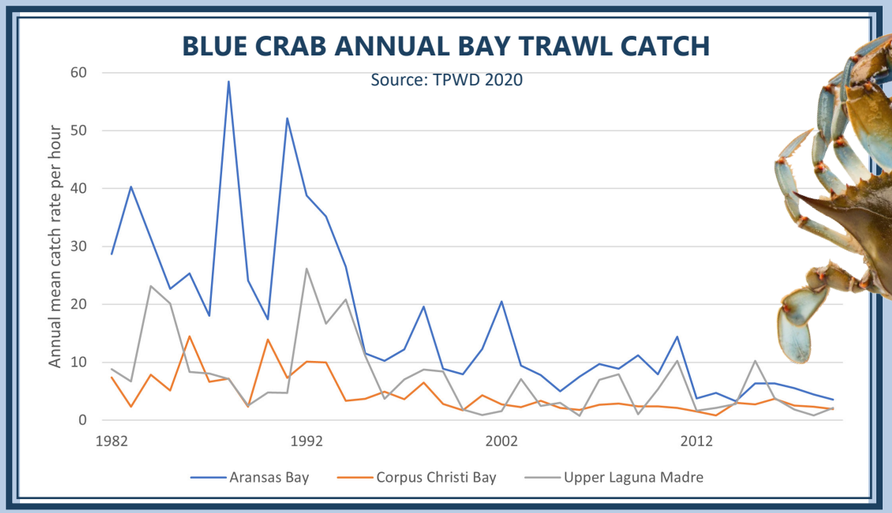
BROWN SHRIMP

As technology improved and fishing pressure on shrimp increased over the last 75 years, TPWD has enacted more stringent regulations. Commercial shrimping is now restricted from certain “nursery” bays. There are regulations on the mesh and size of trawls, the time of day, and the allowable daily catch. The Texas brown shrimp commercial landings have declined 27% during the past 18 years – from 64 billion pounds in 2000 to 47 billion pounds in 2018. This variability in catch is the response to environmental, but also socio-economic factors. Annual scientific surveys by TPWD using bay trawls also show a variable pattern across the Texas coast, but apparent stable abundance for Corpus Christi Bay and the Upper Laguna Madre. Overall, its abundance in the Coastal Bend region seem to be within safe margins buts its average kept declining during the past decade.



BLUE CRAB

Commercial landings of blue crabs in Texas are the lowest since 1969. With Limited Entry for crabbing established in 1998 (first license buyback in 2000), the number of crabbers has decreased 40% from 381 (1997) to 224 (2004). Since that time the number of pounds landed per crabber appears to have stabilized. The TPWD Coastal Bend region bay trawl catch rates trend for blue crabs, which has mirrored the commercial landings, show a steep decline. Although the decline pattern indicated some level of stabilization in their abundance by 1998, new declining levels are shown since the early 2010s in the region. Only near 3 million pounds were landed in 2012, an amount well below the historic average of 6.3 million and nowhere near the 11.9 million pounds landed in 1987. These landings generate around $12 million annually for coastal economies: when landings decline not only do the crabbers suffer, but so do their communities. In 2002, Texas implemented an abandoned crab trap removal program that is benefiting the habitats of blue crab and many other species.



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ADDITIONAL INFORMATION

TPWD - Commercial Fishing Information

NOAA - FishWatch

Gulf States Marine Fisheries Commission

CBBEP SPOTLIGHT

REDUCTION OF GHOST FISHING FROM DERELICT BLUE CRAB TRAPS

Abandoned crab traps continue to catch estuarine wildlife - a concept known as “ghost fishing.” They are known to be a significant source of mortality for a variety of organisms, many of which are recreationally or commercially important. To help address the problems associated with abandoned crab traps, the State of Texas closes every bay system in the State to crabbing for a 10-day period each February to allow for derelict traps to be removed. In 2020, CBBEP received funding from the National Oceanic and Atmospheric Administration, Marine Debris Program to begin working with partners on an expanded and more strategic effort to locate and remove derelict traps along the mid-Texas coast. The project will also gather standardized data that can be used to better asses ecological/economic impacts and to identify and address the root causes of trap abandonment to ultimately lessen ghost fishing.

INDICATOR 9:
Colonial Waterbirds

CONDITION/TREND: POOR/STABLE

BACKGROUND

Colonial waterbirds are those that gather in large groups during nesting season. Many of them nest in habitats along the Texas coast. Populations of these birds are key indicators of environmental health and productivity. They represent the top of the food chain and reflect the coastal system's overall health.

The Coastal Bend area provides a relatively productive and diverse range of aquatic habitats favored by waterbird species. These include riparian fringes, riverine deltas and high marshes, cordgrass marshes, seagrass beds, wind-tidal flats, calm shallow waters and open bay waters. More than 20 species of migratory colonial waterbirds currently nest on islands between the mainland and barrier islands of the Texas Coastal Bend, and in various nearshore freshwater environments.

The diversity and abundance of these birds have supported communities along the Texas coast enjoy economic benefit from the increasing popularity of birding ecotourism.

SPECIES FOR WHICH TEXAS CENTRAL COAST REPRESENTS GREATER THAN 25% COASTWIDE POPULATION IN 2010

American White Pelican	Laughing Gull
Black-crowned Night Heron	Reddish Egret
Black Skimmer	Roseate Spoonbill
Brown Pelican	Royal Tern
Caspian Tern	Sandwich Tern
Great Blue Heron	Snowy Egret
Great Egret	Tricolored Heron

Source: TCWS 2011

CONCERNS

Waterbird populations were decimated prior to the early 1900s, mainly for the plume trade. Some species suffered nearly to the point of extinction. Since then, populations have been struggling to rebound. The constant and even increased pace of coastal development and other human impacts have limited their ability to recover to pre-settlement abundance.

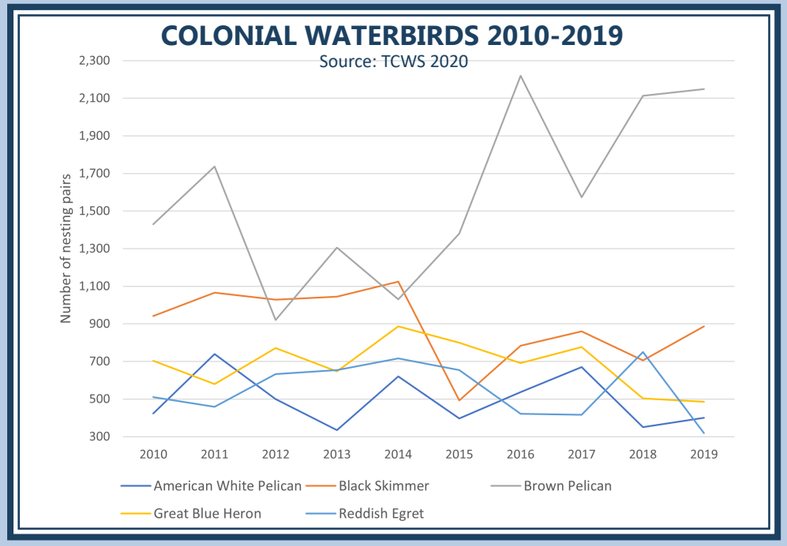
The Texas Colonial Waterbird Society (TCWS) has documented changes in their populations over the past 40 years, mostly with negative impacts. Current challenges to waterbird recovery continue to be habitat loss – both of nesting and feeding areas -- proliferation of human-subsidized predatory mammals such as raccoons and coyotes, spread of the imported red fire ant, invasion of non-native trees and shrubs, increased human disturbance of colonies, pollution, scarcity of adequate nesting substrate, including rookery island erosion and subsidence (see Indicator 14). Climate hazards such as those posed by hurricanes, have proven in recent years to have devastating effects on colonial waterbird populations, including the direct kill of those that are not able to evade the storm.

LOCAL LEVELS

Number of nesting bird pairs has been used since 1973 by the TCWS to assess the success of the population in reproducing, and therefore, in persisting over time. Surveys are conducted annually at nesting habitat throughout the Coastal Bend by several institutions. This long-term database is helpful to resource managers and other decision-makers in determining their status at multiple levels, such as state level trends, and the effects of specific management actions at the individual island level. This program calculated that there were 14 species of the 25 that nest in Texas for which the central coast represents more than 25% of their population, in 2010.

In 2019, TCWS monitoring results showed that nesting pair counts of four species were considerably below average of the previous 9-years in the Coastal Bend area when their number of pairs during the last three years are compared to the previous six: Great Blue Heron, White Ibis, Laughing Gull, and Forster's Tern. Pairs of four of the five key species included in the 2010 version of this report, were below their average during the past three years: American White Pelican, Black Skimmer, Great Blue Heron, and Reddish Egret. Brown Pelican was the only among these five species that showed an increase of 36% during the past 3 years. These species were selected as examples of nesting type, habitat and foraging diversity of birds nesting in the Coastal Bend area. From the TCWS data it is also clear that nesting pair counts fluctuate over time and some trends can reverse over periods of time. For example, Laughing Gull pairs continuously declined in the past 10-years, after increasing during the previous decades. Additional species that show good sign of recovery levels during the past three years are: White-faced Ibis (600%), Sooty Tern (100%), Sandwich Tern (6%), and Royal Tern (4%).

Attempting to assess the status of bird populations without acknowledging that of its habitats, food availability and extraordinary events such as storms, is a complicated task. In 2017, Hurricane Harvey struck the central Texas coast as a category 4 storm, fundamentally reshaping or destroying many of the islands these birds utilize as nesting sites during the spring and summer months. Reddish Egret already had a limited distribution and nesting pair numbers shown a considerably decline during the past decade. Its decline was accelerated after H. Harvey by losing approximately 14% of the nesting pairs during the four years after the storm. Many birds likely perished but the scale of these losses may never be known.



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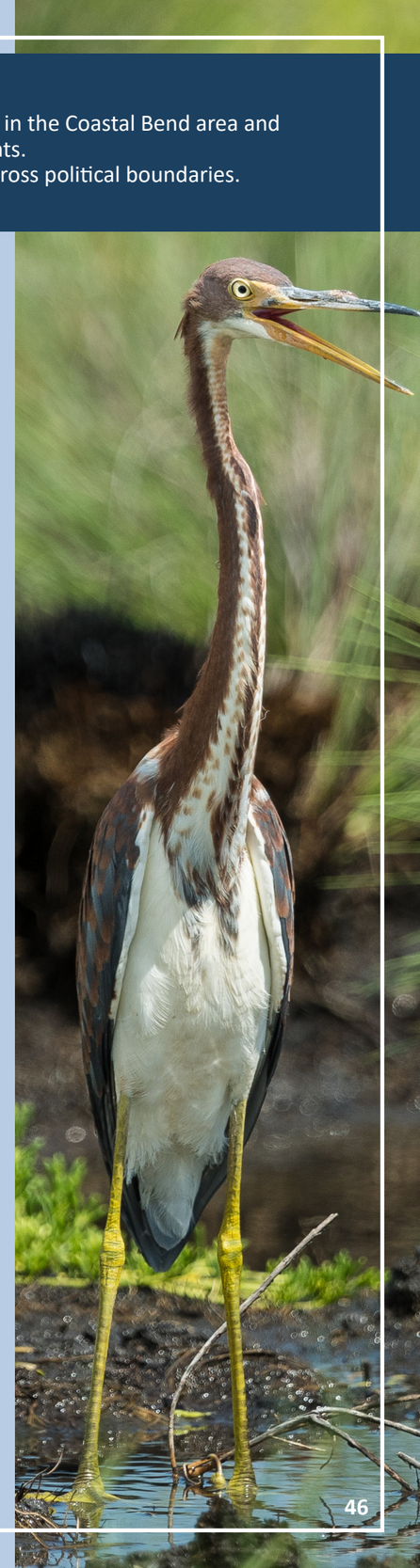
ADDITIONAL INFORMATION

Texas Waterbird Society

HOW CAN YOU HELP?

- Become a citizen scientist by getting familiar with the local species that nest in the Coastal Bend area and contributing observations and other knowledge about their status and threats.
- Support bird conservation projects, including those of migratory birds that cross political boundaries.
- Support legislation that promotes a sustainable use of the environment.



FOCUS QUESTION 5

Are habitats for fish, birds, and other wildlife stable, increasing, or decreasing?

INDICATOR 10:
Seagrass Area

GOOD/STABLE

INDICATOR 11:
Saltwater Marsh Area

GOOD/STABLE

INDICATOR 12:
Freshwater Marsh Area

GOOD/DECREASING

INDICATOR 13:
Rookery Islands

POOR/DECREASING

WHAT WAS MEASURED?

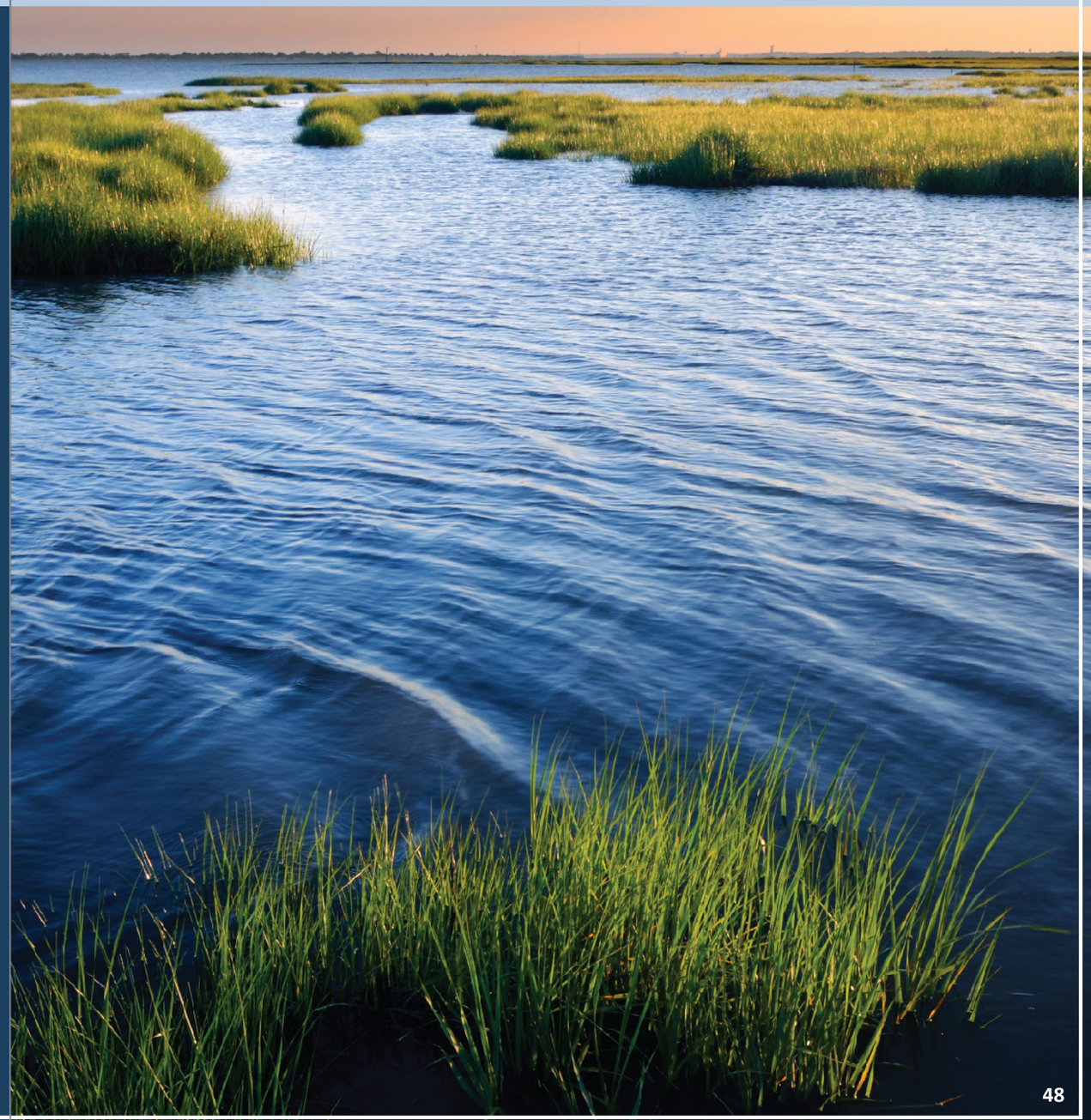
Changes in area of seagrass, saltwater marsh, freshwater marsh, and rookery island habitats.

WHAT DID WE FIND?

Although seagrass area cover has declined approximately five percent in the past 10 years in the Coastal Bend, it continues to grow in some bay systems such as Redfish Bay and the northern end of the Upper Laguna Madre. During 2001–2016 the Coastal Bend area experienced increases of 1.1% in emergent saltwater marsh, and 5% of emergent freshwater marsh. Other freshwater wetlands experienced loss during the same period. Erosion, combined with other threats, has considerably decreased the number and size of islands available as nesting habitat in all bays.

ANSWER TO FOCUS QUESTION 5

Whereas coastal habitats have remained relatively stable across the area, even showing some increases in the past decade, there are still significant threats that impact their functionality and therefore their benefits to nature and people. Coastal development continues to threaten freshwater wetlands in the barrier island system, and relative sea-level rise threatens marshes by drowning them or promoting the replacement of saltwater marsh by black mangroves along shorelines. Rookery islands have been highly impacted by sea-level rise in the past decade.



INDICATOR 10:
Seagrass Area

CONDITION/TREND: GOOD/STABLE

HOW CAN YOU HELP?

- Boat responsibly (lift, drift, pole and troll) and learn about good boating practices to reduce damage to seagrass.
- Avoid areas that are too shallow for boats to navigate without damaging the seagrass - use the Seagrass Viewer, a mobile-compatible app created by TPWD to identify areas with seagrass.
- Do your part to help maintain good water quality in the bays so seagrasses can thrive.

BACKGROUND

Submerged seagrass are flowering plants that dominate the sea bottom of Texas bays and estuaries, referred to as meadows or beds. These marine plants require sunlight to grow and therefore are restricted to shallow areas of the bays. These highly specialized plants play critical roles in the coastal environment, including nursery habitat that provides both substrate and shelter for recreationally and commercially important fisheries (including game fish like spotted seatrout and red drum), a major source of food for wildlife, effective structure for stabilizing coastal sediments and preventing erosion, major biological agents in nutrient cycling processes, carbon sequestration and improving water quality.

Five seagrass species occur in Texas bays: turtle, shoal, manatee, star, and widgeon grass. Although not true grasses, they grow rooted and submersed in the higher salinity waters of most Texas bays and estuaries. Like leaves on a tree, seagrass leaves fall off during the winter and regrow the following spring. The majority of seagrasses in Texas are found in the waters of the Laguna Madre, but they are present in all bay systems.

The biodiversity and productivity of seagrasses are directly linked to coastal economies. They provide an estimated value of $9,000 to $28,000 per acre for commercial, recreational, and storm protection benefits in Texas. Frequently, seagrass habitat is used as a measure of coastal health, since they can maintain or improve water quality. Seagrass beds rank with coral reefs and rain forests as some of the most productive habitats on the planet.

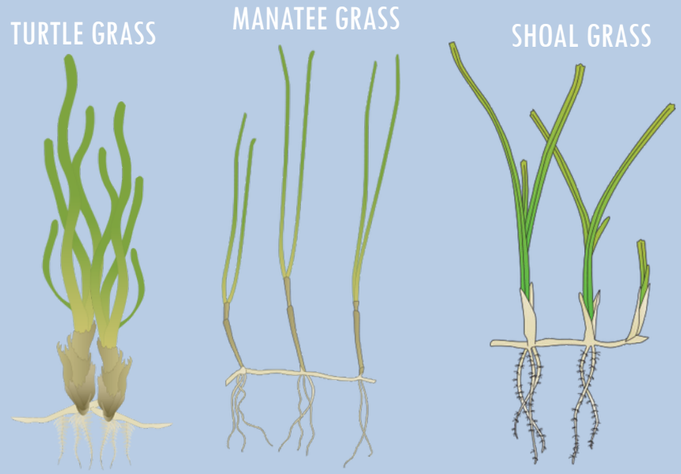
The three state agencies with coastal resource management responsibility for seagrasses are the Texas Environmental Quality, Texas General Land Office, and Texas Parks and Wildlife Department (TPWD). These three agencies collect substantial amounts of coastal data and monitor status and trends of seagrasses along the Texas coast. The TPWD manages a number of programs focused on seagrass regulations, management and education, including the leadership for the implementation of the Seagrass Conservation Action Plan. Additionally, in 2011, the University of Texas Marine Science Institute started the Texas Statewide Seagrass Monitoring Program (TSSMP) that collects biophysical data of seagrass habitat from hundreds of sampling points every year in the Coastal Bend area.

CONCERNS

Many factors affect the health of seagrass beds, including natural and human induced disturbances. Natural disturbances can be hurricanes, algal blooms, or high runoff from rivers during floods. Naturally, seagrasses are affected when severe wind or wave action result in increased turbidity and erosion of seagrasses. Human-originated impacts may result in seagrass habitat loss both directly and indirectly. Seagrasses, like all green plants, must have sunlight to grow, and therefore effects of activities that limit water transparency can have large impacts. These activities include dredging and filling, nutrient loading, and pollution, such as that conditions created by spills. Dredging can remove the grasses directly, cover them up by depositing spoil on top of them, and limit light penetration from resulting turbidity. Excessive nutrient loading leads to algal blooms which limit sunlight. Pollution can prevent seagrass recover for long periods of time, until seabed is cleaned or are naturally flushed.

Propeller scarring is another important threat to seagrass beds that occurs when grass is uprooted by the propeller of a boat. Propeller scars, also known as 'prop' scars, when occurring on an individual basis may seem minimal compared to other threats, but when multiplied by the thousands become a serious impact. Some prop scars can recover within one year and other may never recover. Their recovery may depend on several factors, including the species of the seagrass, sediment type, water clarity and the direction of the scar in relation to the prevailing water currents. A combined negative effect happens when extensive scarring reduces the ability of seagrass beds to withstand large-scale storm events.

Predicting changes in the seagrass habitat requires a broad understanding of seagrass ecology and changes in the bays, whether they are man-made or occur naturally. As Texas population continues to grow, the impacts in the coastal environments caused by shoreline development, recreational activities, transportation and other infrastructure and water quality issues increase. Historic evidence shows that large events of freshwater inflows, storms, and harmful algal blooms, together with erosion created by wave action and sustained dredging activities, and prop scarring have affected the distribution of seagrasses in the Coastal Bend.



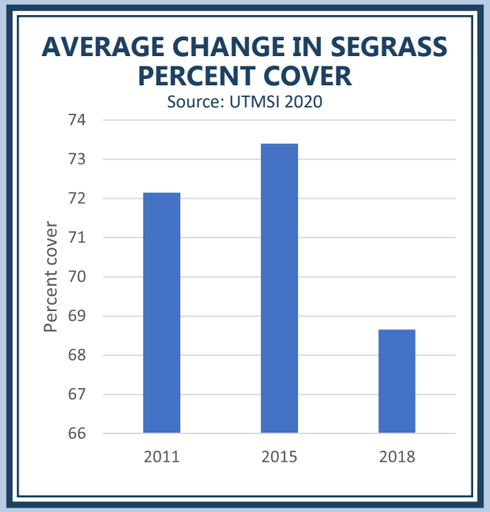
LOCAL LEVELS

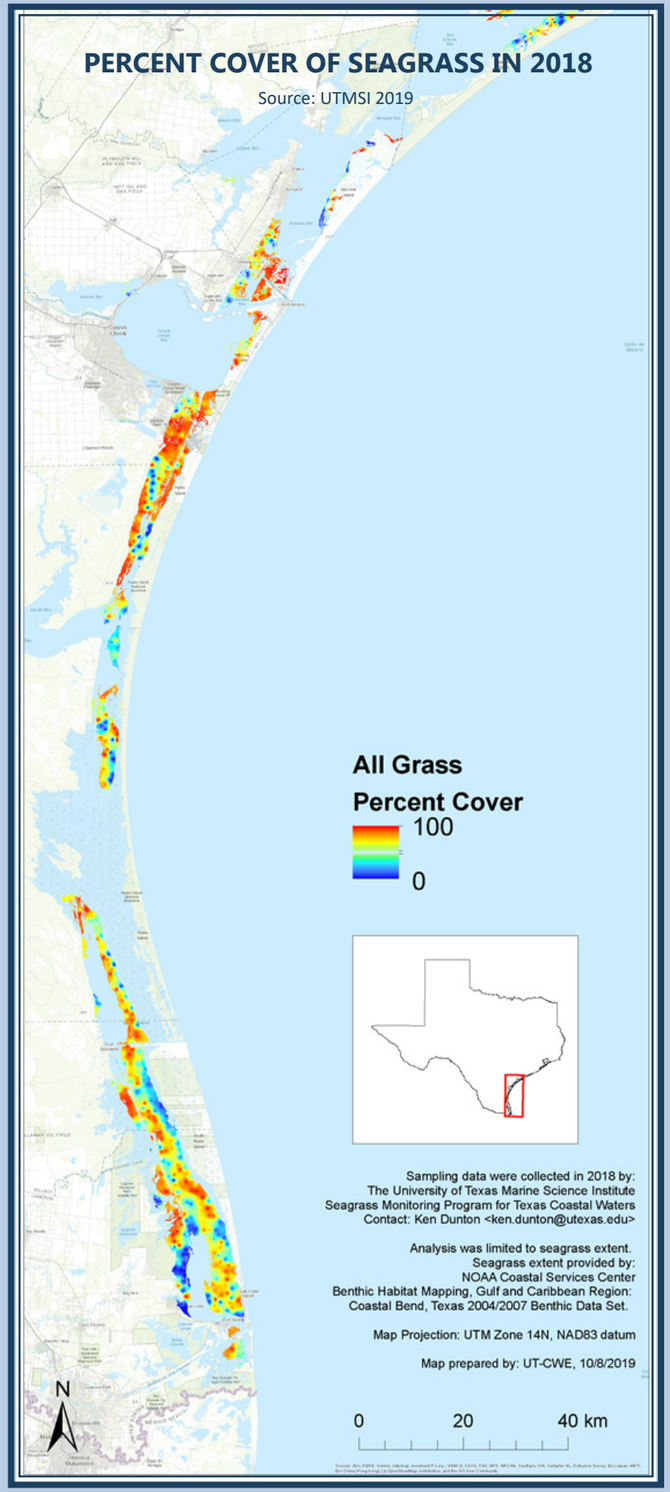
By the 1990s, Redfish Bay had suffered extensive damage due to scarring from boat propellers, leading TPWD to create the Seagrass Conservation Plan of Texas and establish the Redfish Bay State Scientific Area (RBSSA) in 2000, which includes 14,000 acres of submerged seagrass beds. TPWD continued to monitor the RBSSA to evaluate the effects of new regulations on seagrass and found that a significant reduction in propeller scarring occurred after mandatory regulations were passed. Due to these promising results, a law that prohibits the uprooting of seagrass with an outboard motor propeller was adopted in Texas in 2013. Since that time, to support its implementation, TPWD has launched a massive education and outreach campaign that includes the "lift, drift, pole and troll" mantra and educational materials that ranged from online materials to field signs to billboards.

According to the Bureau of Economic Geology study of 2008, seagrasses increased in total area from the 1950s through 2004. Approximately 87% of this gain occurred from 1979 through 2004. In the 2000s a study of the National Oceanic and Atmospheric Administration (NOAA) systematically used satellite images to estimate that there were 11,668 acres of seagrass beds in the Coast Bend area. Additional complete surveys of the area extent of seagrass has not been conducted since the NOAA study, but it shows that that seagrasses are more abundant in the Upper Laguna Madre,

followed by Redfish Bay, Aransas Bay, Baffin Bay, Corpus Christi Bay, Copano Bay and Nueces Bay. Recent results in 2018 from the Texas Statewide Seagrass Monitoring Program that measures the species composition and percent cover in a defined sampling area, showed that overall seagrasses cover has reduced by five percent in the Coastal Bend area since 2011, remaining relatively stable. However, the species composition continues to change due to multiple factors. This reduction in cover could be the result of man-made activities and of natural events such as drought and storms.

Overall, seagrass cover decreased between 2011 and 2018. However, specific results show that approximately 73% of the bay floor is covered in seagrass in Corpus Christi Bay which increased from 65% in 2017. The increase in seagrass cover is relevant given the impact of Hurricane Harvey in 2017 in the region. In 2017, Hurricane Harvey's intense winds resulted in decreases in seagrass cover, and greater loss of turtle grass, a climax species relative to shoal grass, a prolific pioneer species. In the Upper Laguna Madre area, data from the TSSMP long term database shows that seagrasses covered approximately 66% of the bay floor in the ULM, matching the coverage of 66% in 2017. It is possible that lower salinities levels are promoting the re-establishment of some species of seagrass in the northern and central portions of the Upper Laguna Madre since the massive die off due to the severe drought in 2014. In 2020, TPWD continues to monitor the amount of prop scarring and the prolonged seagrass recovery in Redfish Bay using digital aerial photographs in disturbed seagrass meadows.





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ADDITIONAL INFORMATION

TPWD - Propeller Scarring

TPWD - Seagrass Protection Regulation

TPWD - Seagrass Viewer

INDICATOR 11:
Saltwater Marsh Area

CONDITION/TREND: GOOD/STABLE

HOW CAN YOU HELP?

- Avoid driving in low and wet areas along the shoreline.
- Contact a local environmental organization to see how you can volunteer to help protect our salt marshes.
- If you own property on the water, consider protecting it with a "living shoreline," such as marsh grass or an oyster reef instead of a bulkhead or riprap.

BACKGROUND

Saltwater marshes are transitional wetland habitat between the land and the ocean, also known as tidal marshes or estuarine marshes. These marsh salt-tolerant plants take root on mud flats around the edges of bays and are considered as part of the wetland community. They are important habitats of the Texas Coastal Bend; functioning as spawning grounds, nursery and foraging areas for wildlife, filtering pollutants, stabilizing sediments, protecting shorelines, reducing floods and supporting cultural activities such as bird watching. Saltwater marshes are also imperiled habitats due to increasing human development along the Texas Coast. Tidal marshes are formed and maintained by a number of factors including the unique balance between freshwater inflow and the tidal flushing of saline water. Over time, saltwater marshes accumulate organic material, storing its carbon in roots stems and leaves that otherwise could have negative impacts in our atmosphere.

Wetland protection is a national priority since the 1970s, as established in the Clean Water Act. Numerous agencies now are involved in the wetlands protection issue in some way. The Army Corps of Engineers is responsible for protecting the integrity of the nation's waterways through a program established to regulate the discharge of dredged and fill material. In Texas, saltwater marshes and other wetland types are protected from degradation by the Texas Surface Water Quality Standards overseen by the Texas Commission on Environmental Quality. The Texas General Land Office also regulates and permits projects associated with saltwater marsh habitat. Before a permit can be granted, the applicant must show that the project has considered all viable alternatives to avoid or minimize impacts as much as possible. Any wetland loss must be compensated for by constructing new wetlands, or by restoring or enhancing existing wetlands.

CONCERNS

Wetlands represent less than five percent of the total land area in Texas, but they are critical to the state's environmental quality and well-being. Historically, saltwater marsh areas were not recognized as being a necessary part of the interconnected ecological system and were aggressively converted to agricultural and range lands or filled in to create dry land. Today, conservation efforts have increased and there are regulations protection certain wetlands and multiple programs that provide incentives for those not protected. The Texas Parks and Wildlife Department developed a Texas Wetlands Conservation Plan in 1997 that has no net loss goals. However, concerns that persist related to human activities are: filling marsh for commercial development and public infrastructure, dams, conversion of marsh for farming, and pollution from runoff. Sea level rise and subsidence are the most relevant natural threats being globally discussed that can change saltwater marshes for long periods of time – including causing marshes to drown and be converted to open water. Current future scenarios call for the sea level to rise another 1-2 feet in the next 80 years. The position of saltwater marshes on the coastal landscape and their productivity makes them important not only as a part of the natural environment but also to economic activities.

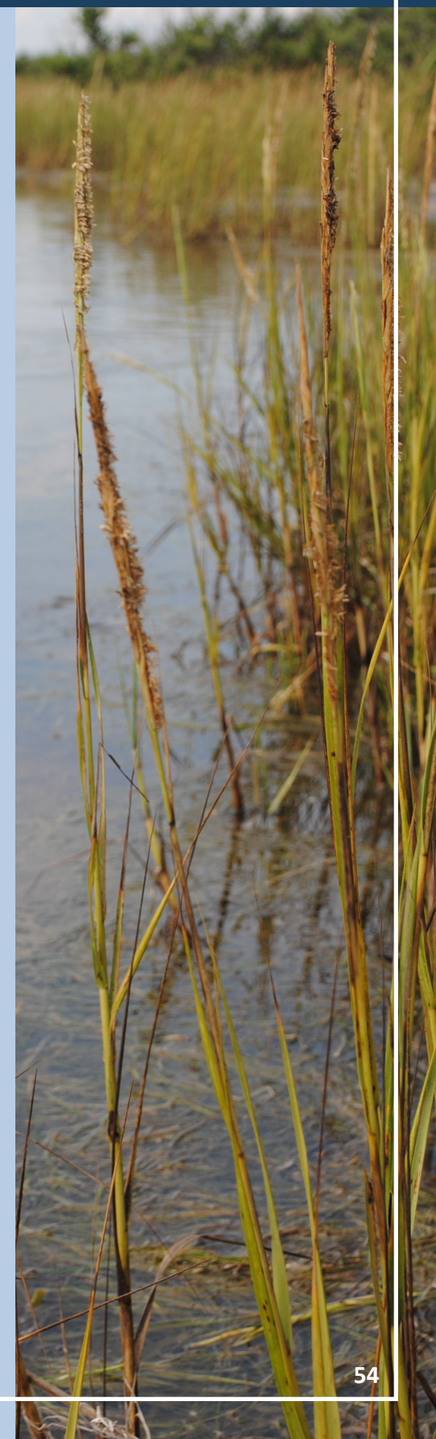
LOCAL LEVELS

Estuarine marshes increased in total area during each period (1950s–1979 and 1979 to 2002–04), with a total net gain of 5,550 acres from the 1950s through 2002–04. According to the 2006 Bureau of Economic Geology (BEG) study, Texas Coastal Bend barrier island estuarine marshes are increasing due to the expansion of marsh into low flats and into former uplands. The study also found black mangrove (*Avicennia germinans*) habitat also experienced an increase of more than 25% between 1979 and 2004.

Recent multi-year landcover classifications provided by the Coastal Change Analysis Program (C-CAP) program of the National Oceanic and Atmospheric Administration also show an increase of 1.1% in emergent saltwater marsh during the period 2001 – 2016 in the Coastal Bend area. The change represents a gain of 885 acres, which represents an average of 55 acres of saltwater marsh created every year. The increase contrasts with the losses experienced by other estuarine wetland types, such as the loss of 92% of forested wetland (four acres per year) and 45% loss of scrub/shrub wetland (2 acres per year), during the same period of time. In 2014, Cedar Bayou, which divides Matagorda and San Jose Islands, was re-opened after being closed for more than two decades by siltation. The goal was to increase water exchange between the Gulf of Mexico and Mesquite Bay, however the impacts of this restoration project on saltwater marsh habitat is not clear yet.

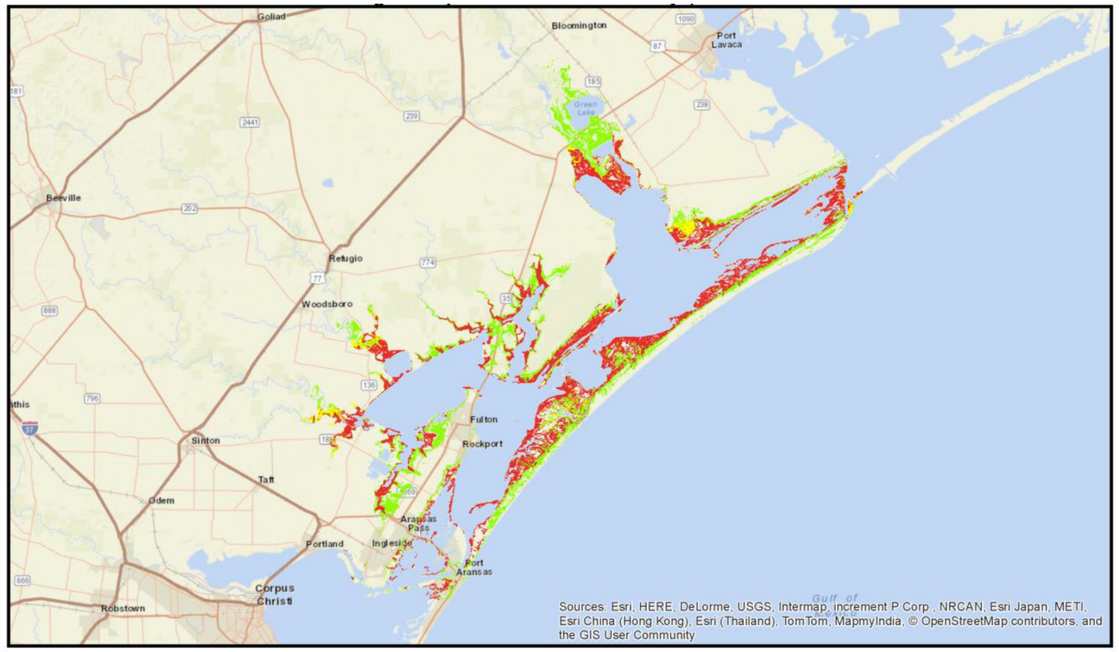
Black mangrove continued to expand during the past 10-years to rates that have not recorded previously along the Texas coast. A study of the BEG in Espiritu Santo Bay shows that the Bayucos Island area experienced the highest expansion of the area of approximately 1000 acres in 12 years (2001-2013), which represents a nearly 700% gain at a rate of 72 acres per year. Across the entire Texas coast, between 1990 and 2010 mangrove has increased in 74% and salt marsh area decreased by 24% net loss. Although only six percent of that loss was attributable to mangrove expansion, its impacts in the saltwater marsh vegetation replacement need to be further investigated in the Coastal Bend area.

Relative sea-level rise acts at a slow but continuous pace that degrades marshes by drowning them, due to an increase in wave impacts and eroding the sediments. Over the period from 2008 through 2100 assuming three feet of relative sea-level rise, future scenarios show that 47% of saltwater marshes could disappear withing the Copano and San Antonio Bays area.



MARSH CHANGE IN 2100 WITH 1 METER SEA LEVEL RISE

Source: Brenner *et al.* 2016



Marsh Change with 1m SLR in 2100

- Marsh Gain due to 1m SLR in 2100
- Marsh Persistence due to 1m SLR in 2100
- Marsh Loss due to 1m SLR in 2100

N

0 5 10 20 Miles

The Nature Conservancy
North America

The funding for this project was provided by a grant through Texas General Lands Office.

Note: 1 meter is equivalent to 3.2 feet.

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ADDITIONAL INFORMATION

Association of State Wetland Managers – Texas Chapter

BEG - Texas Wetland Map

USFWS - Wetlands Mapper, National Wetlands Inventory

CBBEP SPOTLIGHT

NUECES BAY MARSH RESTORATION

The Nueces Bay Marsh Restoration Project took over 10 years to fully complete, cost approximately $5.3 million dollars, and resulted in the restoration of 160 acres of extremely valuable marsh habitat along the Nueces Bay Causeway. Marsh restoration began in 2009 and occurred in three major phases. In 2016, the finishing touches were placed on the project with multiple volunteer plantings, as well as construction of an observation deck and installation of educational signs which provide public access and information about the restoration project and the benefits of restoring marsh habitat. Over 300 volunteers contributed to planting the newly created terraces.

INDICATOR 12:
Freshwater Marsh Area

CONDITION/TREND: GOOD/DECREASING

HOW CAN YOU HELP?

- » Reduce waste, trash and conserve water.
- » Using phosphate-free detergents and responsibly disposing of chemical products helps reduce water pollution.
- » Maintain a buffer strip of native plants along streams and wetlands.
- » Become a citizen science by volunteering to monitor the health of wetlands near your community.

BACKGROUND

Freshwater marshes are non-tidal wetlands dominated by grasses and other emergent plants. They are created by water that accumulates from streams, rainfall, and areas where groundwater is exposed in a surface depression.

Fresh to brackish water marshes found on the Texas coast are unique features of the barrier island system. These wetlands were formed as the barrier island grew seaward, and the series of swales that were left behind from the building of sand ridges form the marsh habitat. Water in these marshes is derived from a combination of runoff from the adjacent dunes and from groundwater. Water percolates through the sandy dunes very easily, and generally comes to the surface in the swales between the dunes. Many of these swales rarely have ponded water on the surface, but because groundwater is found just under the surface for extended periods of time, only wetland vegetation can thrive.

Although ephemeral in nature, these habitats play an important role in the coastal area, and especially in the barrier island ecosystem where freshwater is scarce. These palustrine (fresh water) marshes are home to many birds and animals that use them as a source of food and water. Birds from all over North America use Texas coastal habitats during migration and many species spend the winter on the coast using the freshwater wetlands. These wetlands provide additional benefits to nature and humans, such as refugia, pollutant filtration, flood reduction, carbon storage, bird watching and other cultural activities.

Freshwater marsh is also protected and managed by the same regulations that apply to saltwater marsh wetlands. Since 1997 the Texas Wetlands Conservation Plan and the federal and state agencies implementing conservation measures have a no net loss goal.

CONCERNS

The major threat to freshwater barrier island marsh habitat is draining and filling for development of beach houses, condominiums, hotels, marinas, boat docks, and their supporting infrastructure. The destruction of dune-stabilizing vegetation by human activities can cause dunes to migrate, consequently filling those wetlands. The biggest current source of loss for freshwater coastal wetlands is urban sprawl. Additionally, these wetlands are impacted by pollution originated by runoff.

Some of the important factors of these wetlands are that in times of ample rainfall, these depressions provide scarce freshwater and wetland habitats for island fauna. When these depressions are dry, biological diversity on the barriers is depleted. The depressional wetlands play a role in regulating the fresh groundwater levels; many acting as recharge areas when the groundwater level declines. On the contrary, marsh habitats in the barrier island area are vulnerable to inundation by saltwater during storms. Storm surge during large events can push saline water into freshwater marshes leading to the death of much of the standing biomass.

LOCAL LEVELS

In a report completed in 2006 by the Bureau of Economic Geology (BEG) titled “Status and Trends of Wetland and Aquatic Habitats on Texas Barrier Islands: Coastal Bend,” BEG looked at the Coastal Bend Barrier Island complex and found that from 2002 to 2004 a total of 1,895 acres of palustrine marsh existed. Palustrine habitats had their largest distribution in 1979, at 2,199 acres, and lowest in the 1950s at 1,643 acres. During 2004, North Padre Island had the largest number of palustrine wetlands totaling 879 acres, followed by San Jose Island with 726 acres. Mustang Island had 230 acres and Harbor Island had the least at 59 acres, probably due to the small size of the island. Results of the study show that Coastal Bend barrier island palustrine marshes are decreasing from the 1979 coverage due to island development, agricultural practices on the island, and drier conditions.

In a report completed in 2008 by the BEG titled “Status and Trends of Inland Wetland and Aquatic Habitats in the Corpus Christi Area,” the BEG found a total of 13,906 acres of palustrine marsh within the estuarine systems of Corpus Christi and Aransas Bay in 2004. Palustrine marsh had its largest distribution in the 1950s, at 20,968 acres, and lowest in 2004 at 13,906 acres. The average rate of palustrine marsh loss for both time periods was about 147 acres per year.

The Copano mainland, Lamar Peninsula, Live Oak Peninsula, coastal prairies, and Port Bay all experienced fluctuations in palustrine marsh area and contain transitional areas dominated by *Spartina spartinae*. Drier climatic conditions caused by drought during the previous years had a diminishing effect on the areal extent of palustrine marsh by 2004. At the local level, community development in places like Key Allegro and Aransas Pass contributed to gross losses of wetlands. The overall trend was characterized primarily by reduction (84%) of palustrine marsh through conversion to uplands. On the Mission and Aransas Rivers, palustrine marsh experienced significant loss over the long term. Most palustrine marsh loss was located in areas that had become estuarine marsh because of landward movement of the salt/freshwater boundary within the river system.

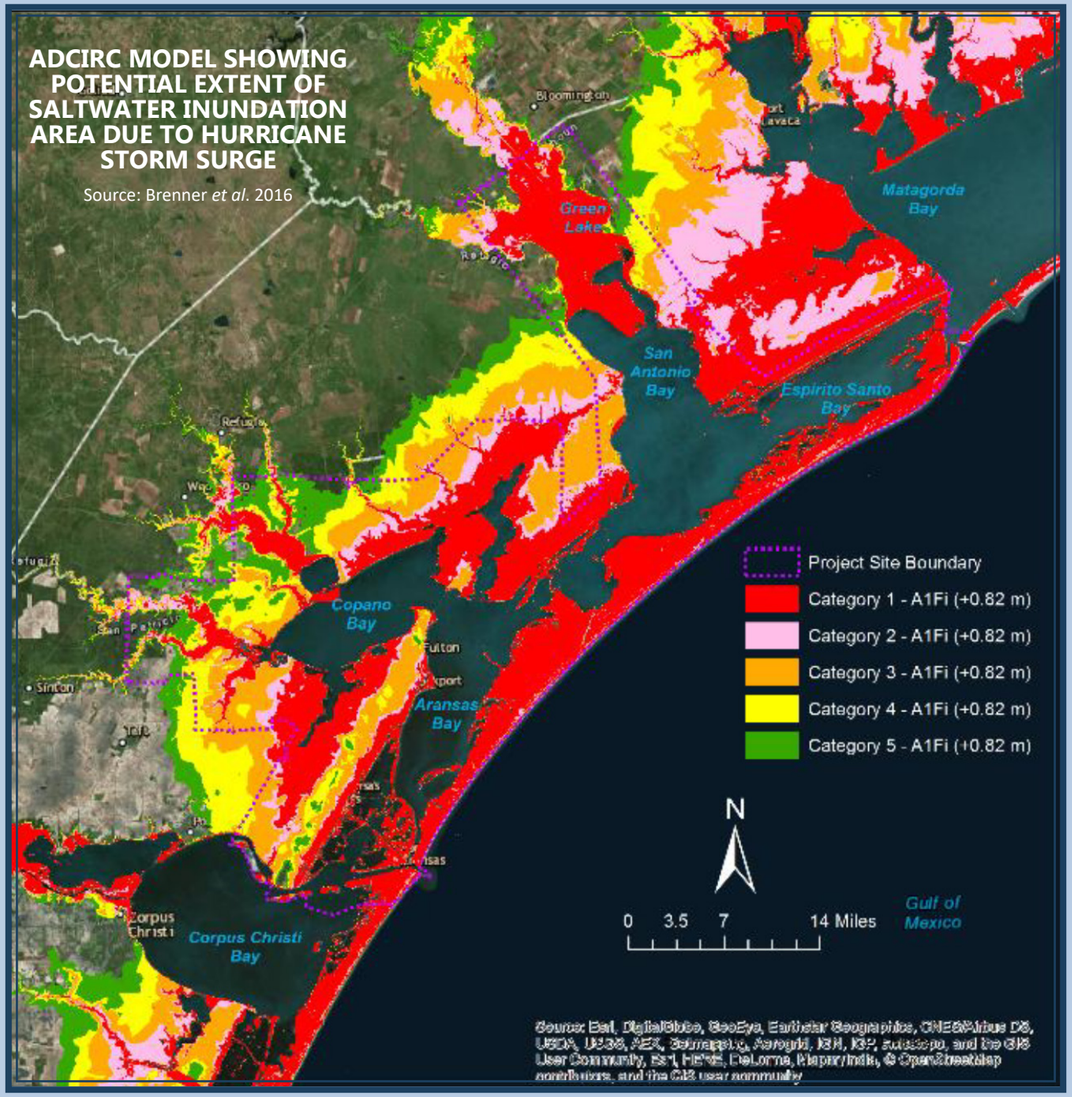
Recent multi-year landcover classifications provided by the Coastal Change Analysis Program (C-CAP) program of the National Oceanic and Atmospheric Administration (NOAA) show an increase of five percent in emergent freshwater marsh during the period 2001-2016 in the Coastal Bend area. The change represents a gain of 10,378 acres, which represents an average of 649 acres of freshwater marsh created every year. The increase contrasts with the losses experienced by other palustrine wetland types, such as the loss of seven percent of forested wetland (215 acres per year) and five percent loss of scrub/shrub wetland (406 acres per year), during the same period of time.

CHANGE IN PALUSTRINE WETLANDS IN THE COASTAL BEND 2001–2016

WETLAND TYPE	PCT CHANGE	2001 (ACRE)	2016 (ACRE)	CHANGE RATE (ACRE/YR)	GAIN
Palustrine Forested	-7	52,670	49,230	-215	-3,440
Palustrine Scrub/ Shrub	-5	136,039	129,549	-406	-6,489
Palustrine Emergent	5	192,710	203,088	649	10,378

Source: NOAA 2020

Future scenarios over the time period from 2008 through 2100 assuming three feet of relative sea-level rise, show that between 41 and 85 percent of freshwater marshes could disappear within the Copano and San Antonio Bays area. Additionally, future sea-level rise is predicted to intensify the impacts of storm surge by allowing higher inundation areas and barrier island over wash.



Notes: Map shows storm surge exposure areas for Saffir-Simpson category 3 hurricane event by 2100 (ADCIRC 0.82 m). Storm categories key: Category 1 (red), category 2 (pink), category 3 (orange), category 4 (yellow), and category 5 (green).

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ADDITIONAL INFORMATION

Association of State Wetland Managers – Texas Chapter

BEG - Texas Wetland Map

Texas A&M-AgriLife Extension & Sea Grant - Texas Wetlands

TPWD - Wetlands

USFWS - Wetlands Mapper, National Wetlands Inventory

INDICATOR 13:
Rookery Islands

CONDITION/TREND: POOR/DECREASING

BACKGROUND

Colonial waterbirds depend on a healthy ecosystem to thrive, but during nesting season they are highly dependent on the natural and man-made islands in the Coastal Bend during the nesting season (see Indicator 10). Key advantages of nesting on an island are the lack of predators and human disturbance, and relative proximity to feeding areas. Suitable nesting substrates in the islands range from shrubs for wading birds to bare ground for terns. These nesting aggregations of birds are called rookeries. In the Costal Bend area rookeries are located in islands in the bays, which in contrast to barrier islands, are typically smaller but the colonial nature of the nesting birds makes them extraordinarily valuable for this entire guild of species.

Rookery islands in the Coastal Bend bay systems range in size from mere spits of shell hash which are sometimes submerged at the highest tides, to the 300+ acre Pelican Island in Corpus Christi Bay. Vegetative structure ranges from unvegetated bare ground to well-developed hackberry (*Celtis laevigata*) and mesquite (*Prosopis glandulosa*) mottes. Approximately 185 islands existed in the decade of 2000 within the Coastal Bend region that have at some time in the last 30 years been used by nesting waterbirds.

CONCERNS

Human presence and development on the coast have significantly altered the historical ecology of colonial waterbirds, both positively and negatively. Many islands, and a greater total acreage of islands, were created in the mid- to late-20th century associated with dredging activities for navigation and oil and gas development. Large islands are typically unsuitable for nesting by waterbirds because they can support permanent populations of predators, such as raccoons and coyotes. Most rookery activity takes place on smaller islands or ones which have been actively managed to address threats and enhance habitat.

Erosion has led to the complete loss of several islands and continues to be the highest threat to nesting island availability into the future. Deepening of adjacent waters for navigation channels, increased ship traffic, loss of oyster reef structure due to commercial harvesting, and relative sea-level rise have resulted in increased wave energy battering island shorelines, and a net loss of rookery island area.

Natural nesting substrate and constructed platforms play an important role in the success of colony establishment in the remaining islands. Active vegetation management has become increasingly important as natural vegetated habitat matures (thickens), and invasive species colonize new islands.

An increasing number of bay users, primarily boaters and recreational fishermen, create an additional stress to nesting colonies. When they are unaware of, or unconcerned with, the effects of their disturbance on birds during the nesting season (typically from late February through August), their presence causes nesting birds to flush, which can lead to egg and chick death or even complete colony abandonment.

LOCAL LEVELS

Colonial waterbird populations have experienced a variety of negative impacts during the past four decades, where Black Skimmers have declined by approximately 70% during that time. During the past decade alone, the erosion of low elevation islands has been exacerbated by the acceleration of relative sea-level rise in Texas coastal waters. Some bay systems have experienced the near complete disappearance of all nesting islands over that time. Tropical storms, such as Hurricane Harvey in 2017, have contributed to major losses in the quantity and quality of island nesting sites, including the complete destruction of the vegetation used as nesting substrate on some islands. These and other events have reshaped the utilization patterns of nesting islands across the Coastal Bend area by colonial waterbirds. Consequently, these changes have increased the need for active ecological restoration actions needed to maintain suitable nesting habitat.

Several habitat restoration projects were completed by concerned stakeholders primarily in two bay systems during the past decade: Corpus Christi and Nueces, including the restoration of five islands in 2020 by CBBEP. Active management actions were regularly conducted across the region by the Coastal Bird Program of the CBBEP during this period. Especially after Hurricane Harvey important actions of sign installation, vegetation management, predator removal, and nesting platform construction were completed. Island creation projects are expensive, requiring extensive engineering, permitting, dredging, equipment mobilization and construction costs. However, they are considered essential to address the declines in waterbird populations.

HOW CAN YOU HELP?

- When boating in the bays, maintain a safe distance from nesting islands and reduce other forms of disturbance (e.g., sound pollution), especially during the months of February through August.
- Become a citizen scientist by getting familiar with the local species that nest in the Coastal Bend area and contributing observations and other knowledge about their status and threats.

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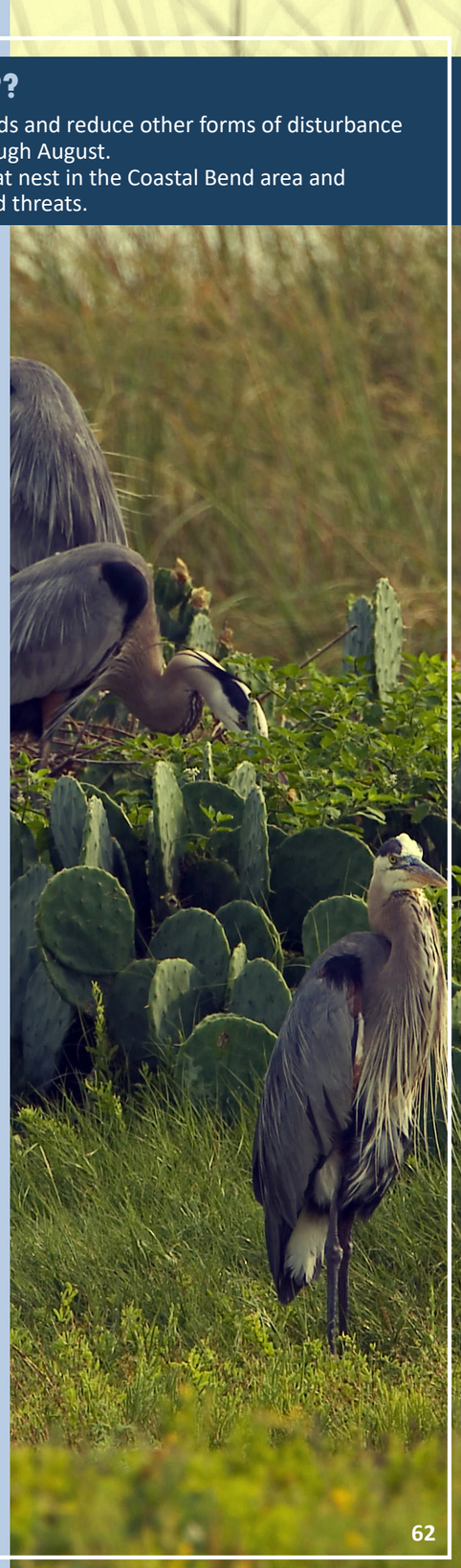
TCWS. 1982. An atlas and census of Texas waterbird colonies 1973-1980. Texas Colonial Waterbird Society, Caesar Kleberg Wildlife Research Institute. Kingsville, 357 pp.

ADDITIONAL INFORMATION

Texas Colonial Waterbird Society

Gulf of Mexico Sea-level Rise Portal



COLONIAL WATERBIRD NESTING ISLAND STATUS AND TRENDS

SYSTEM	HISTORIC CONDITION*	2010 STATUS	2020 STATUS	DESCRIPTION OF CHANGE	10-YEAR PROJECTION OF CHANGE**
San Antonio Bay	Seadrift Islands and the Turnstake spoils provided nesting habitat for hundreds of pairs	Poor	Extreme	Historic nesting islands have eroded away, and only one supports any vegetation. Others remaining are ephemeral shell ridges occasionally used by ground-nesting birds	Regional partners are working to build an island of several acres in area with suitable elevation and erosion protection on one of the Seadrift Islands. Once completed and actively managed, it will drastically improve status of resources in bay
Aransas & Copano Bays	Second Chain of Islands, and Deadman/Long Reef supported the majority of nesting	Moderate	Poor	System was severely impacted by Hurricane Harvey in 2017, removing most of the woody vegetation islands. The two islands in Little Bay have increased in importance	A feasibility study has been completed for a potential island restoration/creation project in the future
Redfish Bay	Many "young" spoil islands supported thousands of pairs before large islands became heavily vegetated	Poor	Poor	Small number of remaining productive islands continue to experience moderate erosion and considerable human disturbance	No proposed island creation projects are planned, but management effort should continue to focus on disturbance reduction to increase nesting success
Corpus Christi Bay	Most nesting was on Pelican Island along the Corpus Christi Ship Channel and Shamrock Island	Good	Moderate	Pelican Island has become very large and heavily vegetated making it attractive to predator populations. Shamrock Island has become the most important island in the system	Shamrock Island has been the focus of extensive shoreline protection projects but continues to be heavily impacted by high tides and storm-induced erosion which is fragmenting the island
Nueces Bay	Many islands spread throughout East and West Nueces Bay supported thousands of nesting pairs	Moderate	Good	All islands had eroded away except for New Island (created in 2001), and Causeway Island (which regularly received supplemental dredge material). A project completed in 2020 restored five important islands in the west part of the bay	Restored islands should support large numbers of nesting pairs again, once they have become vegetated
Upper Laguna Madre/Oso Bay	Well over 100 islands of varying size supported thousands of nesting pairs	Moderate	Poor	Dense vegetation on large spoil islands have allowed predators to expand, while many smaller islands have eroded away rapidly in past decade	Restoration projects in the northern part will protect remaining nesting habitat/ Proposed projects further south are critically important

Source: D. Newstead pers. comm. 2020, TCWS. 1982. An atlas and census of Texas waterbird colonies 1973-1980. Texas Colonial Waterbird Society (TCWS), Caesar Kleberg Wildlife Research Institute. Kingsville, 357 pp

Notes: * Based in TCWS (1982) 1973 - 1980 data. ** Projections do not consider restoration efforts not yet completed.

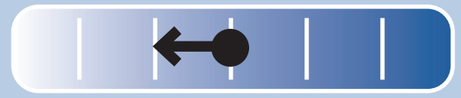
CBBEP SPOTLIGHT

NUECES BAY ROOKERY ISLANDS

Lack of nesting area and suitable vegetation have been major factors preventing the recovery of colonial waterbirds in Nueces Bay. In 2020, CBBEP restored five rookery islands in Nueces Bay - these islands had been eroding for many years. Each island was protected by placing limestone rock around the perimeter and restored by filling the area with new sediment. Now that restoration of the islands is complete, CBBEP's Coastal Bird Program will focus on managing these islands to ensure the best conditions for nesting success.

FOCUS QUESTION 6

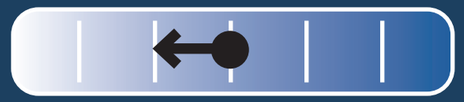
Are freshwater inflows adequate to maintain a healthy bay system?



INDICATOR 14: Quantity and Timing of Inflows

MODERATE/STABLE

INDICATOR 15: Bay Salinity Levels



MODERATE/DEGRADING

WHAT WAS MEASURED?

The quantity and timing of bay freshwater inflows and changes in salinity levels in Corpus Christi Bay.

WHAT DID WE FIND?

Although the implementation of agreed passthrough targets is subject to reservoir water availability and thus subject to complicated regional to global patterns of a changing climate, freshwater inflows to the Nueces Estuary showed an increasing trend during the past decade continuing to support a healthy environment in Nueces Bay. However, the average salinity continued to increase in the Coastal Bend bays in the past ten years.

ANSWER TO FOCUS QUESTION 6

Salinity levels exceeded the ecological stress threshold of 30 parts per thousand during 37% of the time in Nueces Bay during the past 20 years (equivalent to more than seven years). Moreover, statewide drought has persisted in Texas for more than 60% of the time during the same period of time (12 years). Keeping salinities around natural seasonal levels remains an essential goal and current levels of freshwater inflows promote a diverse and productive estuarine ecosystem.

INDICATOR 14:
Quantity & Timing of Inflows

CONDITION/TREND: MODERATE/STABLE

BACKGROUND

The flow of freshwater into a bay system from its watershed (drainage areas) helps to ensure that necessary salinity, nutrient, and sediment are adequate to maintain an ecological balance and productivity of economically and ecologically important species. Sources of freshwater inflows entering the bays and estuaries consist of rain, groundwater, and the largest contributor, surface water from rivers and streams. The characteristic natural community living in and around the Texas Coastal Bend bay system is largely defined by the volume, timing, location, and quality of freshwater inflows.

The Nueces River is one of the largest contributors of freshwater into our local bays and estuaries. Because of the alteration of natural freshwater inflows into Nueces Bay due to the Choke Canyon and Lake Corpus Christi Reservoirs, agreed “pass through” inflows allow a certain amount of freshwater flow into the Nueces Bay each month. Inflows from other rivers and streams in the area are not regulated in the same way and are naturally controlled by a combination of environmental conditions such as a drought and human use of water rights.

The City of Corpus Christi is responsible for distributing water to all necessary users, as well as ensuring all target pass through requirements to the Nueces Estuary are met, when water is available in the reservoirs. The Nueces River Authority (NRA), a governmental organization created in 1935, works closely with the City of Corpus Christi to protect, conserve and develop surface water resources including flood control, irrigation, navigation, water supply, wastewater treatment, and water quality control within the Nueces River Basin. The NRA maintains a website with daily current and historic reservoir and pass through status reports.

CONCERNS

Natural fluctuations of freshwater inflows into the bay can have an immense impact on organisms within the bay system. For example, if a long drought persists and creates a situation of very little freshwater inflow into the bay, it may cause hypersaline (high salt content) conditions that in turn affect bay shrimp catches which need a certain salinity range in order to mature in healthy numbers. On the other extreme, there may be an abundance of freshwater inflow after an extended heavy rain event that causes eutrophication (high nutrient conditions), triggers large algal blooms that deplete oxygen and light within the water column, and negatively effects fish and plants.

Long-term data from the Palmer Drought Severity Index shows that statewide drought has persistent in Texas for more than 60% of the time during the past 20 years, limiting the amount and time of rain and consequently of freshwater inflows in our bays.

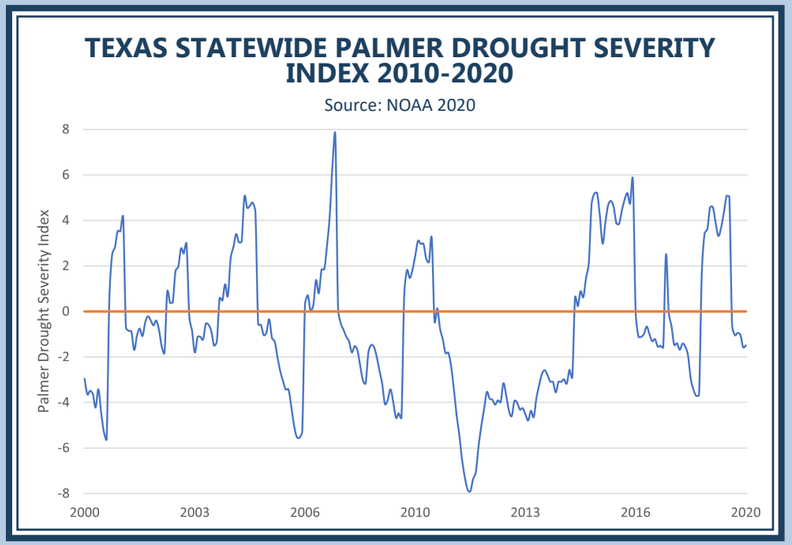
Healthy bays support wildlife and many human uses, including recreation, tourism, commercial fishing, transportation, and water supply. With the population of Texas projected to increase 26% in the next 30 years, the demand for water is anticipated to exceed current supply, requiring increased use of both surface water and groundwater. Without adequate provisions to protect freshwater flows, while also balancing other needs, additional demands for water could impact flows potentially leading to degraded aquatic and coastal ecosystems.

LOCAL LEVELS

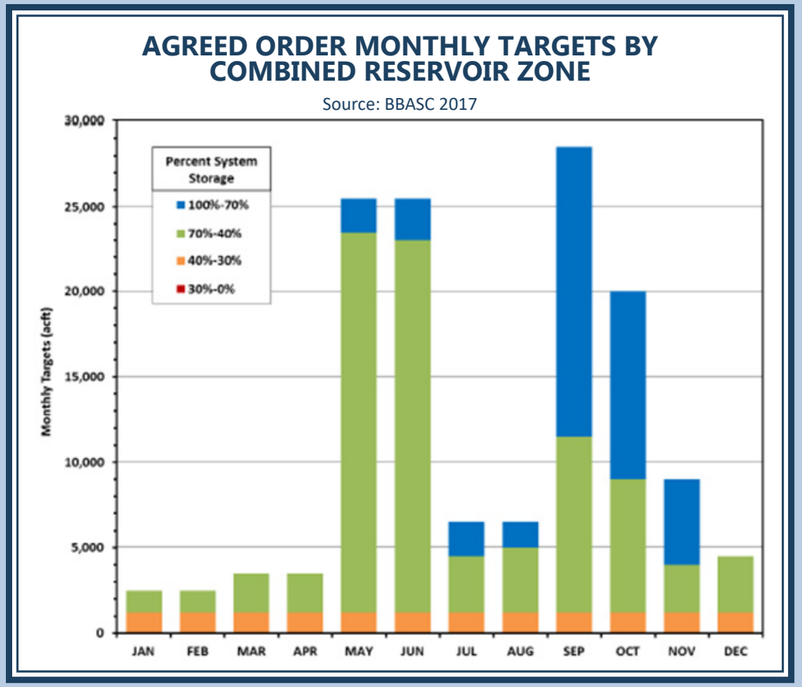
Although the implementation of the agreed pass through inflows continue to support a healthy environment in the Nueces Bay and beyond, the impacts of increased salinity (see Indicator 16) in the long-term health and productivity of bays in the Coastal Bend is unclear due to recurrent drought conditions of more than 60% per decade. Certainly, the original motivation of the pass through monthly targets attempt was to mimic the natural freshwater inflow cycle into the Corpus Christi Bay system under typical conditions, but in practice their implementation is subject to water availability and thus local environmental needs are subject to complicated regional to global patterns of a changing climate. Flooding conditions due to storm events in the watershed which might have benefited the bays have been minimized to protect property and human well-being.

HOW CAN YOU HELP?

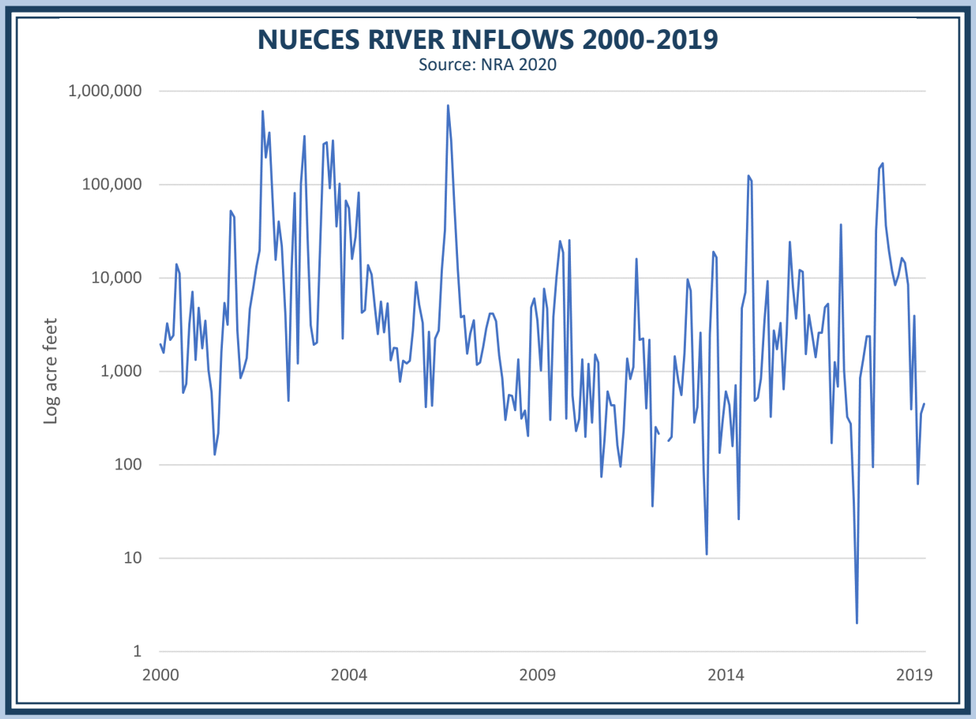
- Help conserve your watershed health by implementing sustainable practices of water use, waste disposal, and land development
- Join TCEQ’s Total Maximum Daily Load Program: Communities Working Together to improve water quality.
- Keep yourself informed of reservoir and river conditions to balance your water use using real-time data



Note: Values represent departure from mean relative to month data using the baseline period 1901–2000.



The chart below created with monthly inflow data from the NRA shows the amount of freshwater that flowed into the Nueces Estuary in acre feet (logarithmic scale) between 2000 and 2019. Although inflows seem to fluctuate considerably during the past 20 years, they show an increase during the past decade. This positive trend varied from an annual average of 638 acre feet in 2011 to a maximum of 32,617 acre feet in 2018. Based in the complexity of managing multiple water needs, especially during drought periods, freshwater inflows continue to support a healthy bay system. Scientific work continues to develop insights of ways habitats and wildlife live in high salinity conditions during prolonged periods of time. At present, there are good examples of populations that thrive in our bays such as red drum (see indicators 7-9).



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NRA. 2020. Monthly statistics dataset 2000-2019. Nueces River Authority. Corpus Christi.

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TWDB. 2017. 2017 State water plan: Water for Texas. Texas Water Development Board. Austin, 133 pp.

ADDITIONAL INFORMATION

TWDB - Environmental Flows

Nueces River Authority

TPWD - Texas River/Stream Flow

USGS - Texas Water Dashboard

CBBEP SPOTLIGHT

NUECES DELTA SALINITY MONITORING

Since 2009, CBBEP has contracted with the Conrad Blucher Institute to monitor salinity at stations within the Nueces Delta and Nueces Bay - data from these stations is used to monitor releases of freshwater from reservoirs into the Nueces Delta system.

INDICATOR 15:
Bay Salinity Levels

CONDITION/TREND: MODERATE/DEGRADING

BACKGROUND

Salinity is a measure of how much salt is contained in a unit of water. Ninety percent of dissolved ions in seawater are chloride and sodium salts. The salinity of Gulf of Mexico coastal seawater is relatively constant at about 35 parts salt per thousand parts water by weight (ppt). Salinity of freshwater is near zero. Therefore, most of the salinity variations in the estuary are responses to river freshwater inflow, local precipitation, runoff, evaporation and mixing by winds and ocean tides.

The ability of resource agencies to manage freshwater supplies to Coastal Bend bays and other estuaries to protect coastal habitats and promote fish and wildlife productivity requires an integrated knowledge of the relations between the organisms and their aquatic environment. The salinity of the water, and particularly its seasonality and decadal patterns, affect which aquatic species can survive. In short, salinity is a fundamental property of the estuary that determines its biological characteristics and productivity.

The Texas Water Development Board's Surface Water Resources Division and the Conrad Blucher Institute's Division of Nearshore Research at Texas A&M University-Corpus Christi have been monitoring salinity levels since 1987 for the various bays around the Coastal Bend. The Conrad Blucher Institute publish real-time salinity monitoring data from stations along the Nueces River and Estuary, including daily salinity relief check information.

CONCERNS

Management of the freshwater supply is complicated in part because Lake Corpus Christi's freshwater supply serves two major purposes: human consumption and salinity control. Ironically, when freshwater runoff from the Nueces Watershed is scarce, as in dry years, a greater supply of water is needed to lower the salinity of the bays and maintain their productivity. This increase of freshwater demand is what happened during the severe drought in 2010–2014.

In order to relieve some salinity stress in the estuary, freshwater pass through targets were developed, based on historical salinity levels and the combined reservoir system volume, in attempts to mimic natural freshwater inflow to the bay system (see Indicator 15). In simple terms, freshwater is released from reservoirs to lower salinity levels. If salinity is already low, the City gets the salinity relief credit shown in table, which is a percent reduction of the monthly target.

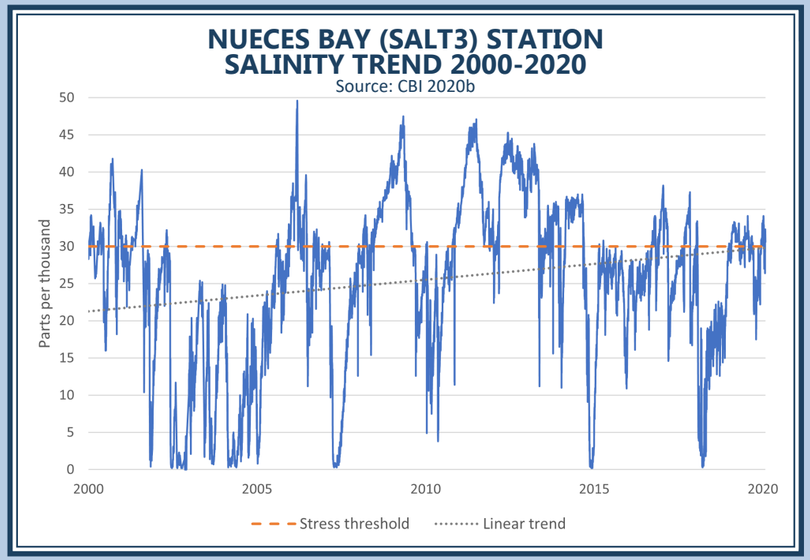
LOCAL LEVELS

A natural north to south salinity gradient is present along the Texas coast, with lower average salinities in northern bays and increasing salinities to the south. For example, salinities in San Antonio Bay may be as low as zero ppt, while values as high as 70 ppt may occur in Baffin Bay and the Upper Laguna Madre.

Although historical data shows that the Corpus Christi Bay system, which receives runoff from urban areas in addition to Nueces River inflow, experienced lower average salinities than the southern region of the Coastal Bend area, continuous data from SALT3 reference station and other automatic stations show that average annual salinity in the Nueces River estuary has steadily increased during the past two decades. Higher average salinity levels in Nueces Bay were observed in 2009 (highest level of 39 ppt) and it did not lower considerably until 2015, which coincides with the severe drought period. In these past three years, average salinity has come down by approximately 25% since its level in 2014. However, the lowest average annual level of 9 ppt recorded in 2004 has not been observed again. Optimum salinity ranges vary for the Corpus Christi Bay system depending on proximity to the river and season, but in general, salinities can be between 1 to 30 ppt. This increasing salinity trend is unlikely due to natural climate variability, but instead a response to other factors such as growing human water demand in the watersheds. By keeping salinities within this target range and not exceeding the 'stress threshold' of 30 ppt, fish, wildlife, and plants will be less stressed and more productive.

HOW CAN YOU HELP?

- Conserve water by reducing and reusing water when possible - install water-saving appliances, collect rainwater to water your landscaping, and plant native plants that need less water
- Buy and use less products that consume a lot of water in their construction process
- Keep yourself informed of reservoir and river conditions to balance your water use using real-time data



MONTHS	REDUCTION FOR AVERAGE SALINITY		
	5 PPT BELOW SUB	10 PPT BELOW SUB	15 PPT BELOW SUB
Jan, Feb, Mar, Apr, Jul, Aug, Nov, Dec	25%	50%	75%
May, Jun, Sept, Oct	0%	25%	75%

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CBI. 2020b. Daily salinity time series 2000–2020. Conrad Blucher Institute, Texas A&M University - Corpus Christi.

TWDB. 2017. 2017 state water plan: Water for Texas. Texas Water Development Board. Austin, 133 pp.

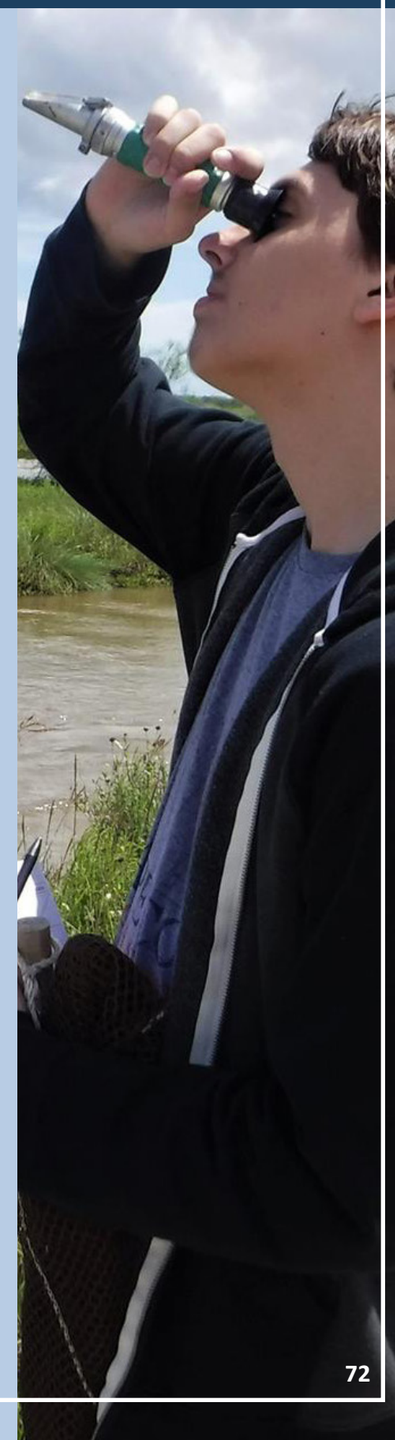
ADDITIONAL RESOURCES

Nueces Estuary Salinity Relief Check

Nueces River Authority

Texas River/Stream Flow

Water Data for Texas



COASTAL BEND BAYS & ESTUARIES PROGRAM

615 North Upper Broadway, Suite 1200
Corpus Christi, TX 78401
361.336.0304
cbbep.org