TEXAS COAST
EXPANDED REPORT CARD
2019

This document is a companion to the 2019 Texas Coast Ecosystem Health Report Card. Both documents can be accessed online at:

www.harteresearchinstitute.org

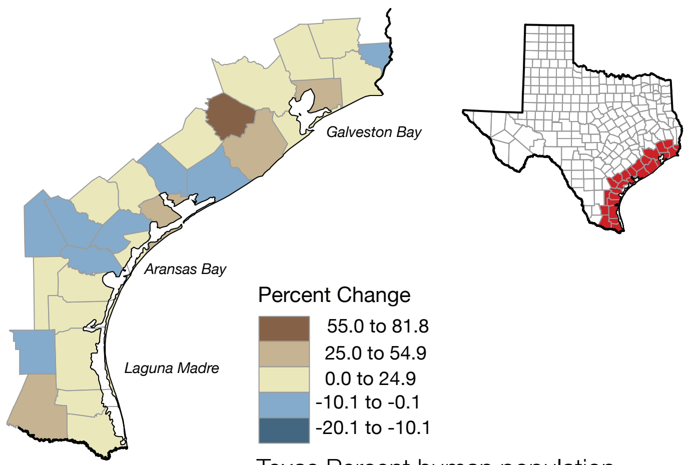
This document discusses in greater detail the different indicators we used to assess the condition of the Texas coast of the Gulf of Mexico. It also shows how we measured the health of each of these indicators in the report card.

Texas Coast Bird Results

Texas coastal habitats support many bird species. During the breeding season, large colonies of spoonbills, herons, egrets, gulls, terns, and skimmers raise their young on bay islands. In winter, millions of waterfowl and shorebirds find a safe haven where food is plentiful and the climate is mild. During migration, the Texas coast is an important hemispheric stopover where birds rest and refuel.

Why do we care?

Texas is the number one bird-watching destination in North America. With 400 species found along the coast, two-thirds of the state's bird diversity resides near the Gulf. Iconic species like Piping Plover and Whooping Crane attract nature tourists. Nature tourism pumps hundreds of millions of dollars into the state's economy and creates thousands of jobs, especially in coastal communities. Beyond economics, birds support ecosystems as predators, scavengers, and prey. Because birds fly, they link ecosystem processes and fluxes in space and time.



Texas Percent human population change (2000-2010): 20.6%

Many factors are driving conditions

Birds face many challenges, or stressors. These can be natural or man-made and may affect survival or reproductive success, and if severe or continual, may cause population sizes to decrease. Stressors for birds include food shortages, disturbance, habitat loss or alteration, development, and climate change. How birds respond to stressors varies in each stage of their annual cycle. The cumulative effects of stressors birds encounter during migration, wintering, and breeding seasons in Texas have resulted in population declines in many species. One of the critical stressors for birds that are migrating and wintering in Texas is habitat quality. For birds that are breeding, disturbance and predation may have the greatest effect. Ensuring that stressors are eliminated or minimized for birds in Texas coastal habitats is key to maintaining healthy bird populations.

Historical trends

Since birds migrate across large distances, the status of any population is affected by the health of ecosystems throughout its range. Populations of many coastal bird species have decreased during the last few decades. Recognition of population decreases is the first step in addressing the causes of decline and working toward species recovery. International Union for the Conservation of Nature (IUCN) data show that in the Western Hemisphere, populations of Mottled Duck, Lesser Scaup, and Least Sandpiper are decreasing while Great Egret and Forster's Tern are increasing. Piping Plover, although currently increasing in North America, remains vulnerable to extinction because its geographic range is limited and its total population is only ~8000 individuals. Piping Plover populations have grown by about 50% since 1985 due to aggressive management of habitat on both wintering and breeding grounds, and reduction of stressors, such as disturbance, during the breeding season. However, these gains could be reversed easily if habitat loss were to again accelerate, or other stressors increase in severity.

In Texas, the status of indicator species populations varies by region. On the upper coast, Great Egret, Mottled Duck, and Piping Plover have decreased over the last 20–40 years whereas populations are stable or increasing on the middle and lower coastal areas. These trends reflect the differences in habitat availability (e.g., losses/degradation due to coastal development, subsidence, etc.), and disturbance pressures that exist along the coast. Loss of habitat is the primary stressor implicated in declines on the upper Texas Coast and will likely continue to be the driving factor in the status of coastal bird populations now and for the foreseeable future. Coastal development makes it difficult for coastal ecosystems to adjust to sea-level rise by essentially blocking landward or seaward movement across the landscape. This is particularly true on the upper Texas coast even if sea level increases by only 0.5 m; landward migration of wetlands is already restricted by existing urban land uses and levees.

Stability

While increasing populations are clearly indicative of "doing something right" and decreasing populations are clearly indicative of the opposite, stable populations may be the best that can be achieved given the limitations of habitat and other resources. Stability should be recognized as a good or even great outcome for areas where habitat loss is significant and/or ongoing. Maintaining suitable habitat that provides critical resources for migrating, wintering, and breeding birds means that stable populations are an achievement.

Methodology

Six bird species were chosen to represent two seasonal guilds—winter/migration and breeding—and several habitat/behavior guilds. Migrating/wintering species indicators are Piping Plover (sight-foraging shorebird), Least Sandpiper (tactile foraging shorebird), and Lesser Scaup (waterfowl). Breeding species indicators are Forster's Tern (ground nester), Great Egret (shrub nester), and Mottled Duck (wetland nester). With the exception of Piping Plover ("Near Threatened"), all species are considered "Least Concern" by the International Union for the Conservation of Nature (IUCN). Data from Audubon's Christmas Bird Count and the USGS Breeding Bird survey were used to assess trends on the Texas Coast. Data were compiled by decade. Then, statistically significant decadal differences in the abundances of species were used to identify a baseline decade. The median abundance of the baseline decade was used as an index value, and the counts of statistically non-random increases or decreases in abundances in subsequent years signified increasing or decreasing population trends.

Texas Coast Seagrass Results

2018 was the first systematic seagrass monitoring program initiated for the entire Texas coast, and the results have yet to be released. For Aransas Bay south, results are available for 2011–2017, during which percent seagrass cover of permanent stations bare and seagrass density at vegetated stations were stable on the midcoast (Aransas and Corpus Christi Bays, Figure 1 top). Percent seagrass cover of bare stations may be increasing in Upper Laguna Madre (Figure 1 middle) while decreasing in Lower Laguna Madre (Figure 1 bottom), although the record is too short to be conclusive.

Why do we care?

World-wide, seagrasses provide nursery habitat for commercially and recreationally important fish and invertebrates; coastal protection from erosion; water purification (e.g., reducing eutrophication and phytoplankton blooms, and removing toxic organic compounds from water column and sediments); and sediment stabilization. They are a sink for atmospheric carbon dioxide, among other valued services. Specific to Texas, seagrasses provide wintering habitat for over half the world's population of Redhead Ducks and essential nursery habitat for Red Drum and shrimp.

Many factors are driving conditions

Seagrasses are very unevenly distributed along the Texas coast, with 82% occurring in Laguna Madre, 18% in mid-coast bays, and only 0.1% in the Galveston Bay system. This reflects the strong gradient in salinity, with Laguna Madre seldom fresher than seawater, the mid-coast bays fresher than seawater 15–70% of the time, and Galveston Bay fresher than seawater >85% of the time. Stressors such as sediment and nutrient inputs, "brown tide" algal blooms, and climatic variability can all lead to sharp changes in seagrass communities at the local to regional scale.

Historical trends

Seagrass mapping and monitoring have been so infrequent and variable in scope along most of the Texas coast that little can be said about trends. Based on approximately decadal mapping of Laguna Madre seagrasses from the 1960s to 1998 and annual sampling of permanent stations within seagrass meadows from 2011 to 2017, the total area of seagrass coverage has changed little. However, seagrass community composition is in flux (Figure 2). Until ~2000, larger, more "climax" species like manatee grass gradually displaced the "pioneer" shoal grass. This process was interrupted in Upper Laguna Madre by multi-month episodes of hypersalinity (>50 ppt) in fall 2012 and summer 2013 that reduced the area dominated by manatee grass by two-thirds (Figure 2 top). In Lower Laguna Madre, Hurricane Alex in June 2010 caused large stormwater discharges into the lagoon that decreased salinity to near freshwater away from the Gulf outlet and eliminated manatee grass almost entirely from the whole system (Figure 2 bottom). Elsewhere along the coast, the two areas of immediate concern are Aransas Bay, where Hurricane Harvey made landfall August 25 2017, and Galveston Bay, into whose watershed Harvey dumped unprecedented amounts of water. The first all-coast sampling in 2018 will reveal how adversely the remnant and recently re-established seagrasses of the Galveston Bay system have been impacted, along with effects on the long established and more extensive seagrass beds of Aransas Bay.

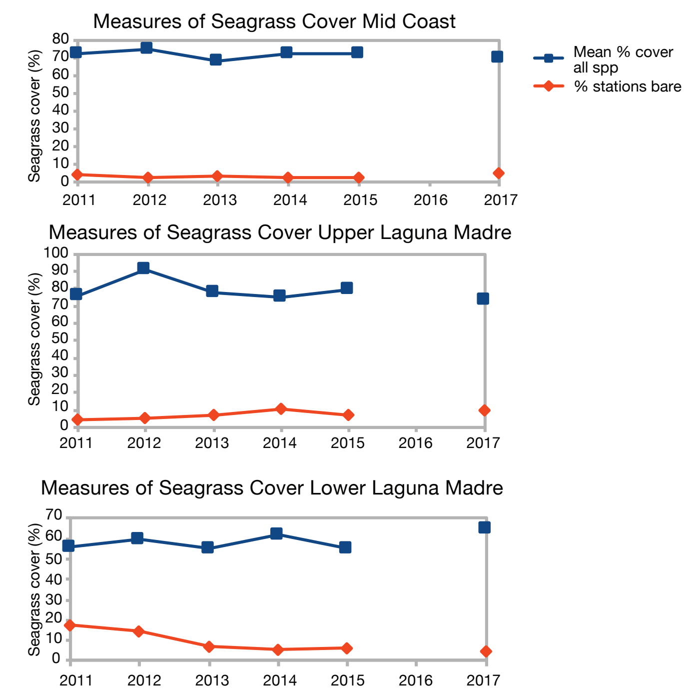


Figure 1. Measures of seagrass cover in coastal regions by time.

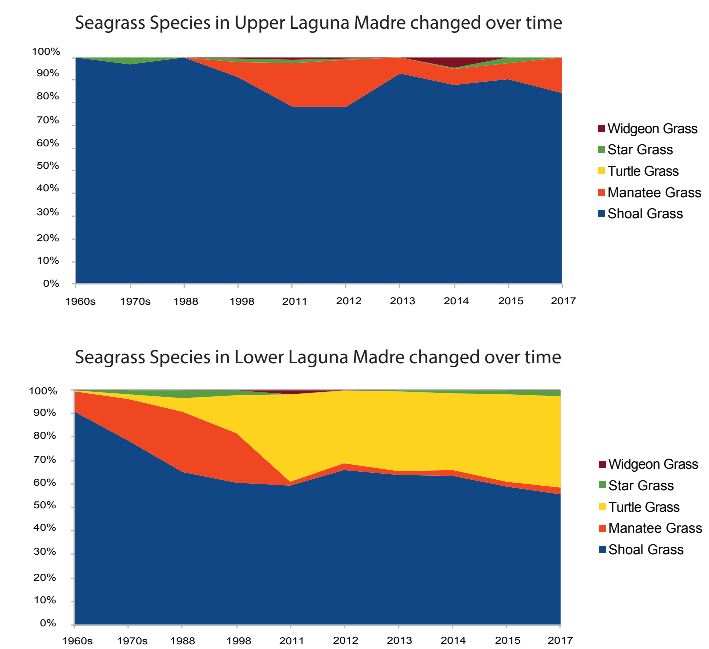


Figure 2. Seagrass species composition in the Laguna Madre regions by time.

Methodology

Measures of seagrass condition are derived from data collected by the Texas Statewide Seagrass Monitoring Program, designed and carried out by Ken Dunton and colleagues at the University of Texas. From 2011 to 2017, his lab sampled seagrasses and water quality yearly from Aransas Bay to the south end of Laguna Madre. In 2018, the program was expanded to the rest of the bays along the Texas coast. Permanent locations were randomly set in each of 567 tessellated hexagons with >50% seagrass cover determined from vegetation maps generated during the 2004/2007 NOAA Benthic Habitats Assessment. Species composition and % cover were obtained from four replicate 0.5 m^2 quadrat samples per station at each of the cardinal directions from the vessel (texasseagrass.org). The mean % total quadrat cover for vegetated stations was used to determine trends in seagrass cover at all sites in each of the Mid Coast, Upper Laguna Madre, and Lower Laguna Madre reporting regions. Scoring of trends was based on the significance of the trend in the percent cover: for positive trends, statistically significant trends in seagrass cover with p-values ≤ 0.01 were graded "A", and p-values $0.01 < p \leq 0.05$ were graded "B". Negative trends were graded the same way. No trend in seagrass cover was graded "C".

Texas Coast Oyster Results

Twenty years of oyster data from the Texas Parks and Wildlife Fisheries Independent Monitoring program were assessed to determine the current status and trends of oysters across the state. In the North region (Sabine Lake and Galveston Bay), the current status of oysters is poor (rated F) and abundances demonstrate a decreasing trend over time. In the Mid region (Matagorda, San Antonio and Aransas Bays), the current status of oysters is good to fair with stable abundances over time. Minimal natural oyster populations occur in Corpus Christi Bay (Mid region), as well as in the Upper and Lower Laguna Madre; no long-term monitoring data are available to determine status and trends of oysters in these systems.

Why do we care?

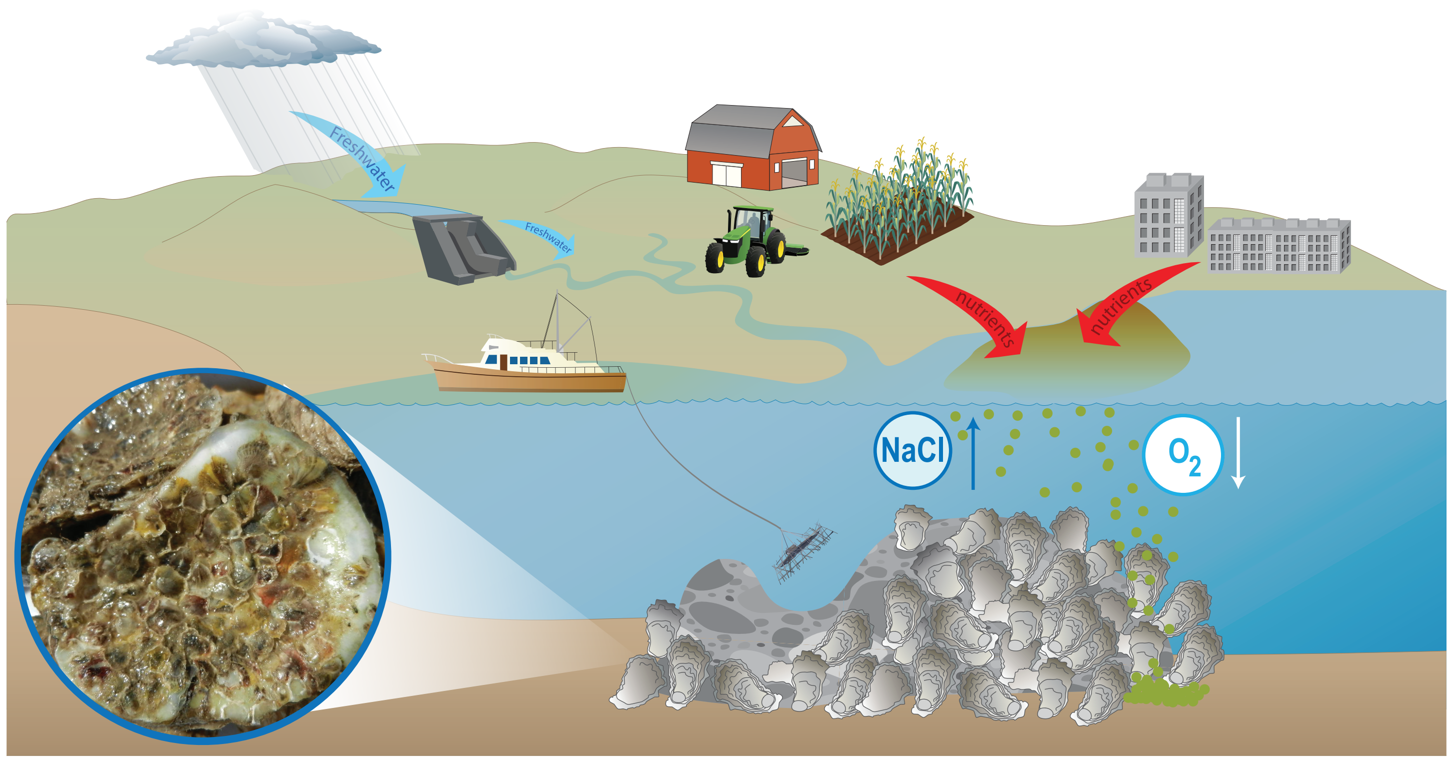
Oysters are important ecological and economic resources. As suspension feeders, they filter bay waters and may mitigate excessive nitrogen loads. As reef-builders, oysters create three-dimensional complex habitat for numerous fish and invertebrates, enhancing recreational angling. Oyster reefs can act as natural breakwaters, protecting shorelines from erosion and reducing wetland loss. Oysters also support a robust seafood industry, generating over $16 million annually in Texas over the past decade.

Many factors are driving conditions

Declines in the abundance of oysters are a consequence of habitat loss, hydrologic alterations, water quality degradation, resource overharvest, disease, and storms. Because oysters depend on a delicate balance of salt and freshwater, they are sensitive to changes in salinity regime. After Hurricane Harvey in 2017, a severe oyster mortality event occurred along the upper coast due to massive inputs of freshwater that decreased salinity below oyster tolerance levels. Increasing salinities can also harm oysters. Upstream water diversions and reduced freshwater inflow can increase oyster mortalities by allowing marine predators and diseases to thrive. Excess nutrient inputs to coastal waters can lead to hypoxic areas where low oxygen stresses oysters and leads to higher mortalities. Oyster harvest occurs by dragging a dredge along the bay bottom. Because free-swimming larval oysters depend on the shells of older generations for attachment and growth, when oyster harvests occur at unsustainable rates, the lack of shells inhibits natural recovery processes and essential habitat is lost. Poor or declining populations of oysters in Texas likely result from the interaction of these and other factors.

Historical trends

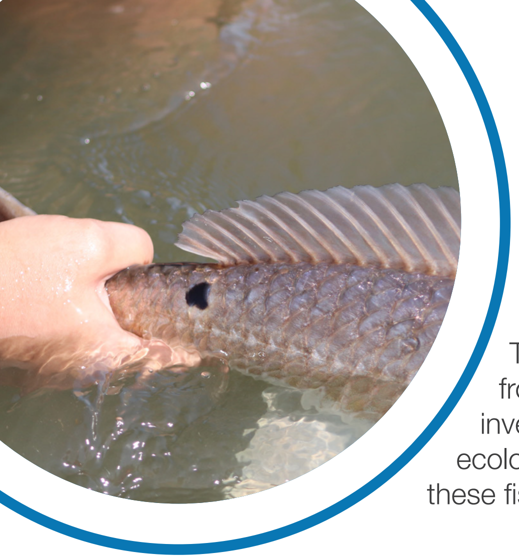
Oyster reefs are among the most threatened marine habitats on earth. Historically, oyster fishery development in the U.S. followed human population centers as they expanded down the east coast and into the Gulf of Mexico, with oyster fisheries in Texas starting in the 1860s. Texas also has a long history—from at least as far back as the 1930s—of removing oyster shells for commercial use, including for the production of lime and poultry feed, for use in concrete aggregate and road construction. Contemporaneously, the effect of dermo disease, facilitated by the high salinities and temperatures standard to Texas estuaries, has caused massive mortalities of oysters across the Gulf of Mexico. The overexploitation of oysters and shell resource, in combination with contemporary environmental stressors such as storms, droughts, and disease, will continue to challenge oyster sustainability across Texas.



Oyster reefs face threats from a variety of environmental factors. Overharvesting oyster reefs can diminish shell substrate for oyster larvae to colonize. In addition, decreased freshwater inflow through damming can raise salinity, and runoff from urban and agricultural sources can decrease available oxygen for oysters and bury oyster reefs.

Methodology

For the regional evaluation criteria for the report card, the North region includes Sabine Lake and Galveston Bay. The Mid region includes Matagorda, San Antonio, and Aransas Bays. Corpus Christi Bay is within the Mid region but TPWD does not collect oyster count data there. Current status was determined by comparing 5-year average oyster abundance (2011–2015) to quartiles of abundance calculated using all years (1986–2015). Trends were determined by assessing Spearman correlation between oyster abundance and years. Adapting this approach to an A-F rating scale, North = F (because poor and decreasing), Mid = C (because it was borderline "fair"), ULM = N/A and LLM = N/A. Coastwide, the overall score = D (splitting the difference for the 2 regions that have scores). Note that ULM and LLM have very minimal natural oyster populations; we have no data to assess status and/or trends.



Texas Coast Fisheries Results

The Texas coast supports a diverse array of inshore and offshore fisheries from finfish such as Red Drum, Spotted Seatrout, and Southern Flounder, to invertebrates including shrimp and Blue Crabs. These resources support vital ecological and economic roles. Understanding and maintaining the sustainability of these fisheries is key to a healthy Gulf of Mexico.

Why do we care?

Texas' fisheries are billion-dollar industries and create thousands of jobs. Aside from the obvious economic benefits, Texas' fisheries also provide robust recreational opportunities that are part of the region's historical and cultural fabric. Monitoring the health of key fisheries is critical to conserving this resource for future generations to use and enjoy.

Many factors are driving conditions

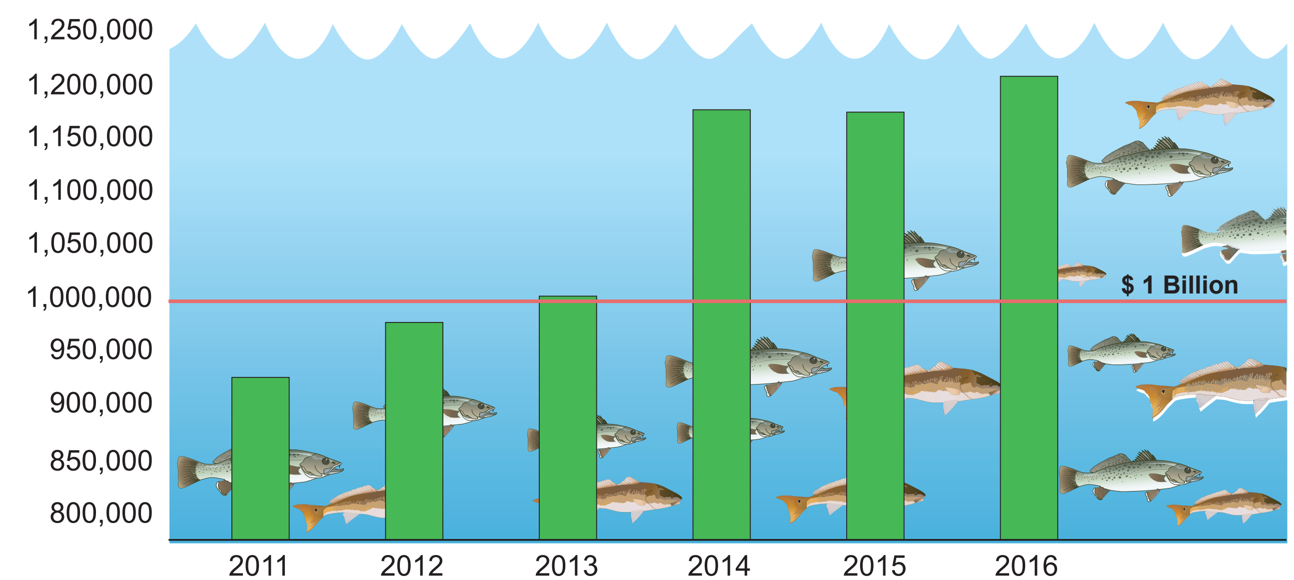
Every fishery faces certain conditions that can negatively affect the population. These conditions, or stressors, can be natural or manmade. In addition, not every fishery or area responds to stressors in the same manner, meaning that stressors must be evaluated by species and by region. Effective management has resulted in healthy, sustainable populations for many of Texas' fisheries. However, overharvesting, illegal fishing, discard mortality, disease, increased water temperatures, and a suite of physical changes such as decreased freshwater inflow have the potential to destabilize several fisheries along the Texas coast.

Historical trends

Many fish populations that are abundant along the Texas coast today were once near collapse. Science-based fisheries management coupled with wise conservation have led to dramatic recovery for many fisheries. World-class resource monitoring, improved research, and emerging technologies have allowed fisheries managers to detect changes to a fishery, make the most informed decisions, and implement proactive management strategies. Together, these afford Texas world-class fisheries.

Proper management has led to plentiful populations of Redfish, Spotted Seatrout, Black Drum, and Gulf Shrimp, despite heavy fishing pressure. Stressors to these fisheries have had minimal effect on their productivity. Monitoring data indicate that they have been stable, and in some cases increasing, over the past decade, particularly in State waters. Some challenges still exist with the Southern Flounder and Blue Crab fisheries, which have exhibited their lowest population sizes and an overall decline during the past 20 years. Abundance and landings data for these species suggest that overfishing or other environmental factors may be causing their decline and preventing recovery. Additional assessments and regulations may be required to facilitate rebuilding these populations.

Texas Recreational Fisheries Value Added (In Thousands)



Methodology

Catch-per-unit-effort data were obtained from the Texas Parks and Wildlife Department for each species within nine bay systems. These data were collected from a long-standing monitoring program using data from 1980 to the present. Data were parsed by species with bay systems being pooled by region. Regressions were fit to establish long-term trends and short-term trends and to determine if recent trends were stable, increasing, or decreasing. Letter grades were established based on the change of slope for these analyses as well as stressors facing these fisheries.

Lower Laguna Madre and Upper Laguna Madre Expansion

The Upper and Lower Laguna Madre systems are known for their diverse and abundant sportfish populations. Redfish, Black Drum, and Spotted Seatrout numbers are at all-time highs despite increasing fishing pressure. However, Blue Crab and Southern Flounder populations are decreasing at faster rates in these areas than anywhere else on the Texas Coast. Factors like disease and decreased freshwater inflow make these fisheries difficult to stabilize. More research is crucial to elucidate problem factors and alleviate impacts on these fisheries.

Texas Coast
Water Quality Results

The Texas coast consists of nearshore coastal waters as well as seven major estuaries, each of which has one primary bay and one or more secondary bays. Each system has a unique water quality signature, which is one of the most important influences on the types of habitat and organisms that inhabit the system. The report card contains a brief snapshot of water quality conditions in the estuaries. Future studies will assess a broader suite of water quality indicators (e.g., plastics, heavy metals) and will also include targeted site-specific assessments.

Why do we care?

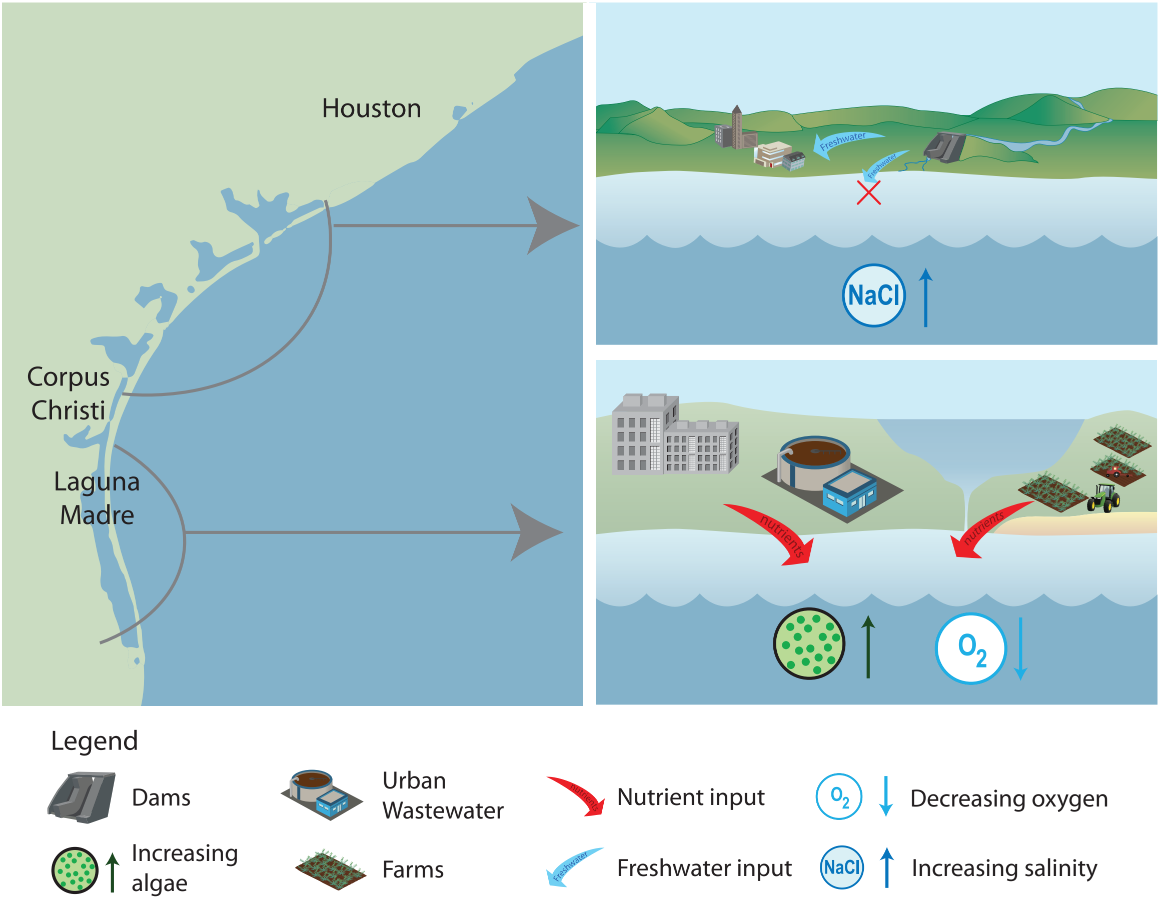
Estuarine and nearshore coastal waters are among the most productive ecosystems on the planet, providing food resources and habitat for ecologically and economically important fish and shellfish species, recreational opportunities, and other important ecosystem services. Without good water quality, this productivity and ability to support fisheries would not be possible.

Many factors are driving conditions

Coastal waters worldwide are being exposed to an increasingly complex suite of stressors. On lands surrounding the coast, urbanization and intensive agriculture can negatively affect the water quality of streams, rivers, and coastal waterbodies. One of the most pervasive problems is a process called eutrophication, where too much nitrogen and phosphorus input to a waterbody leads to excessive algal growth and overall water quality degradation. Climate stressors, such as increasing air and water temperature, can speed up this algal growth, and at the same time reduce the oxygen content of a waterbody. In Texas, there is growing concern about increasing human freshwater needs, which reduces the amount of freshwater that flows to the coast and leads to increasing salinity in coastal waters. The cumulative effects of these perturbations often include declining water quality and ecosystem health.

Historical Trends

Analysis of historical data on key water quality variables shows that the Texas coast has fair to good overall water quality conditions, but with some localized areas of concern. For example, levels of chlorophyll (an indicator of algal biomass) are high and increasing in Baffin Bay and Upper Laguna Madre. At the same time, dissolved oxygen levels are decreasing. Both of these indicate that the system is experiencing symptoms of nutrient pollution. In contrast, chlorophyll levels are largely decreasing in Nueces Bay. This is likely a result of reduced freshwater inputs of nutrients due to damming of its river systems. Thus, the system is being “starved” of the nutrients that would otherwise support its productivity. Another major water quality concern is a long-term increase in the salinity of mid-coast estuaries from Nueces Bay to Matagorda Bay. This is largely a consequence of increasing human freshwater demands in the watersheds of these estuaries.



Methodology

To quantify region specific averages of various water quality variables as well as long-term water quality trends along the Texas coastline, data were obtained from the Texas Commission on Environmental Quality’s (TCEQ’s) Surface Water Quality Monitoring (SWQM) program (https://www.tceq.texas.gov/waterquality/monitoring). The SWQM program collects water samples on a quarterly basis from all bay systems on the Texas coast. SWQM sites chosen for trend analysis had active monitoring up to 2016, and also had at least 20 years of data (back to 1996 or earlier). Spatial patterns in water quality were calculated using averages of data collected between 2009 and 2016. Kendall’s τ_a regression was used to determine relationships between water quality variables and time (Kendall 1955).

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Texas A&M University -- Corpus Christi
Harte Research Institute for Gulf of Mexico Studies
6300 Ocean Drive, Unit 5869
Corpus Christi, Texas 78412
361-825-2020
harteresearchinstitute.org
info@harteresearchinstitute.org

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