Coastal Bend Bays & Estuaries Program

Environmental Indicators Report 2010

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. Often these issues become factors in the future health of our bays and estuaries.

The Program

The Coastal Bend Bays & Estuaries Program (CBBEP) is a local non-profit 501(c)(3) organization established in 1999. The CBBEP project 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 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 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.

Physical Landscape

The CBBEP area includes 75 miles of estuaries along the south-central coastline of Texas, encompassing 12 counties, 11,500 square miles of land, 515 square miles of bays, estuaries and bayous, including three of the seven major estuaries in Texas: Aransas Bay, Corpus Christi Bay, and Upper Laguna Madre.

Table of Contents

HABITATS WITHIN THE CBBEP AREA

Open Bay

The open bay community is defined as the unvegetated and soft-bottomed portion of the subtidal 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. The primary production is dominated by phytoplankton which are the base of the 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.

Seagrass Meadows

Seagrasses are submergent, flowering plants that grow in marine environments; they are not true grasses. Seagrass meadows are found primarily in shallow water (<1 m) in estuaries, hypersaline lagoons and brackish water 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 fauna including fish and waterfowl. Extensive seagrass meadows are found in the Upper Laguna Madre and Redfish Bay.

Coastal Marshes

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

Tidal Flats

Tidal flats are seemingly barren, relatively featureless sand and/or mud environments bordering lagoons and bays. Within the CBBEP area, most tidal flats are wind-tidal flats inferring that wind-associated tides are responsible for the frequent submergence that maintains this feature. Tidal flats provide essential habitat to migrating shorebirds and are highly productive. Tidal flats are found on the bay sides of St. Joseph Island, Mustang Island, and Padre Island, and at the bay margins of Baffin Bay and its secondary bays.

Barrier Islands

Barrier islands are elongate landforms that lie parallel to the mainland shoreline and are typically isolated from the mainland by bays and lagoons. Barrier islands extend along the easternmost 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 Texas mainland and shallow bays and lagoons. In addition, unique flora and fauna inhabit the islands and increase the biologic diversity of the CBBEP area.

Gulf Beach

The Gulf beach habitat encompasses the easternmost sandy shoreline and associated shallow, nearshore waters of the barrier island chain that fringes the Texas coast. This habitat community is often highly diverse and highly productive due to the transport of food by currents. Matagorda, St. Joseph, Mustang, and Padre islands serve as protective barriers to the three principal estuarine systems, Mission-Aransas, Nueces, and Baffin Bay-upper Laguna Madre, contained within the CBBEP area.

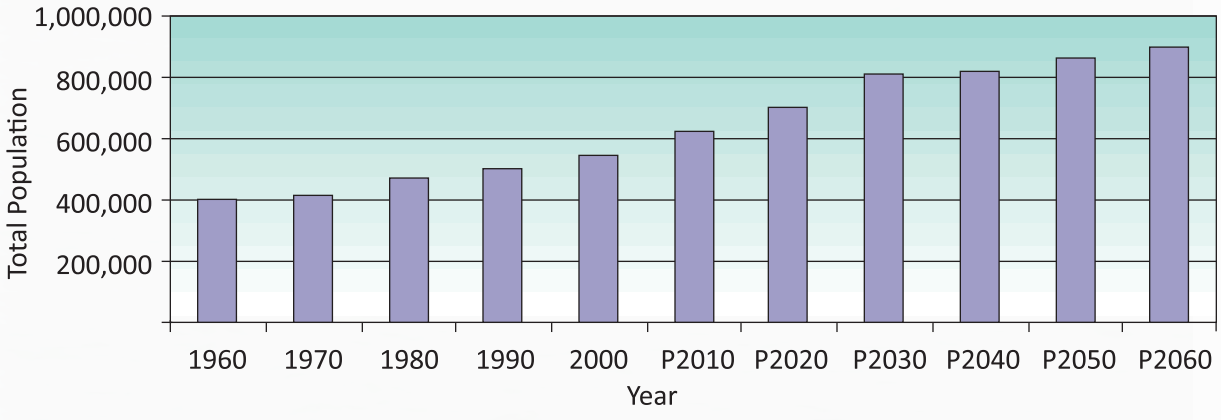
Background Information

Population Growth in the Coastal Bend

The population of the 12-county CBBEP coastal study area has increased by 36 percent between the years of 1960 and 2000, with a recorded population of 550,000 people in 2000. According to the Texas Water Development Board, the Coastal Bend population is projected to increase by 44%, to 886,000 (545,000 in Nueces County) by 2060. Many of Texas' major metropolitan areas (Dallas-Fort Worth, El Paso, Houston, Austin, San Antonio) are expected to double between 2000 and 2060. The Rio Grande Valley, our neighboring community to the south, will grow even more rapidly, more than tripling its population between 2000 and 2060.

Population growth can be an underlying cause of ecosystem stress due to the expansion of housing, transportation, and other infrastructures needed to accomodate additional residents. Along with population growth, the CBBEP area will experience a change in land use, an increase of pollutants released to the environment, and depletion of natural resources.

Below is a chart of population growth for the Coastal Bend between the years of 1960 to 2000 and the projected population growth through 2060.



Source: US Census data, Texas Water Development Board Population Projections

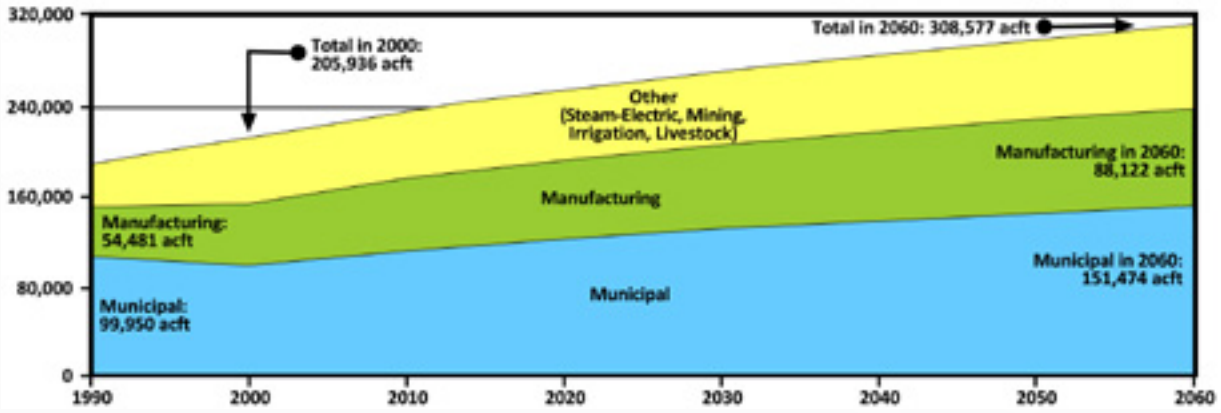
Municipal and Industrial Water Usage

With increasing population and growing industry comes increased demand for resources, including water. The existing and growing human population will need to manage water usage to protect the relatively pristine bays and estuaries of the Coastal Bend.

Over three-fourths of the Coastal Bend's existing water supply is associated with surface water resources. The majority of those supplies are provided by Nueces River Basin streamflows together with reservoirs in the Nueces River Basin (Lake Corpus Christi and Choke Canyon) and interbasin transfers from the Lavaca Region. The region relies on significant amounts of surface water transferred from Lake Texana via the Mary Rhodes Pipeline, which was designed with excess capacity to convey additional, future water supplies, such as an interbasin transfer from the Colorado River Basin.

Total water use for the Coastal Bend region is projected to increase from 205,936 acre feet in 2000 to 308,577 acre feet in 2060, a 50 percent increase. The major water user groups are industrial and municipal, which includes homes and businesses. Because irrigation is only used in a few locations, agricultural water usage is minimal in this area. Future water management strategies include a seawater desalination plant (converting saline water to potable water), two new reservoirs (Nueces off-channel reservoir and Lake Texana Stage II), and surface water from the Colorado River (Garwood Pipeline). While the Coastal Bend has made important strides in researching water conservation opportunities, it is imperative that education and outreach become more intensive as population increases along the coastal areas.

Below is a chart showing total water usage in 2000 and projected water usage in 2060 for the Coastal Bend region.



Source: Texas Water Development Board

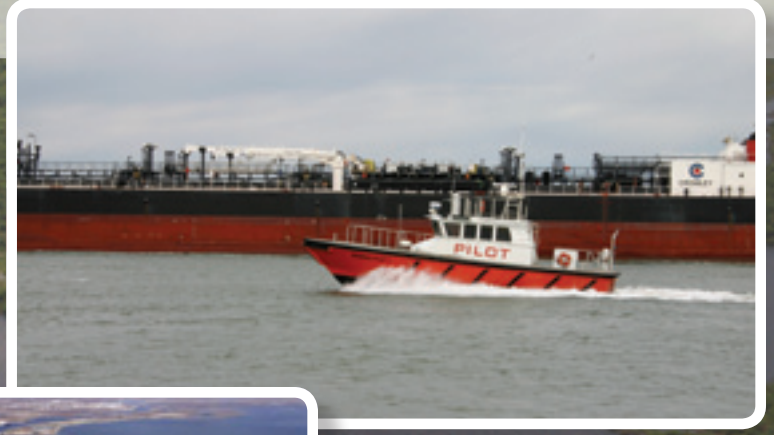
Air Quality

The Coastal Bend's air quality is deemed to be in attainment of the air quality standards established by the US Environmental Protection Agency, which means our area's ozone numbers fall below 75 parts per billion (ppb) over a 3 year period. Although the Coastal Bend enjoys vast areas of agricultural lands, an urbanized section exists. Because of a large concentration of industrial facilities and heavy motor vehicle usage, combined with various commercial practices in the urban areas, in 1995 the area was at risk of exceeding the air quality standard for ground-level ozone. In 1996, the community united to develop and implement a plan to voluntarily make reductions in pollutants that contributed to the elevated ground-level ozone concentrations, thus maintaining a status of "near non-attainment". Corpus Christi's current three year average is 63 ppb.

Port Tonnage

The Port of Corpus Christi is the sixth largest U.S. port in total tonnage. Petroleum products make up the bulk of tonnage entering the port. The Port is also expanding infrastructure to accommodate growing wind and military projects.

The top ten countries, by tonnage, the port did business with during 2007 are Venezuela, Nigeria, Mexico, Russia, Jamaica, United Kingdom, Kuwait, Saudi Arabia, Algeria, and Columbia. Ship and barge activity for the Port during 2008 totaled 6,032 vessels, which included 4,281 barges, 962 tankers, and 789 dry cargo ships.



Port of Corpus Christi Ship and Barge Activity

Number of Dockings

Year	2008	2007	2006	2005	2004	2003
Dry Cargo	789	1,077	942	1,037	905	906
Tankers	962	1,057	1,019	1,043	1,056	1,073
Barges	4,281	4,610	4,672	5,298	5,276	4,787
Total	6,032	6,744	6,633	7,378	7,237	6,766

Source: Port of Corpus Christi Accounting Department Monthly Reports

Climate Change

Buildup of carbon dioxide and other greenhouse gases in the atmosphere is heating the earth and changing our planet and our region. For the Coastal Bend area, changes to our climate could impact our temperature, rainfall, and sea level. Changes in our climate will likely affect the availability of our water resources (due to droughts) and plans to meet expected demands for future water use. Fluctuations in freshwater inflows and sea level rise would alter the salinity in our bays and estuaries, affecting birds and nursery areas for many invertebrates and fish. Sea level rise may also contribute to coastal erosion, coastal flooding, loss of coastal wetlands, and increased risk of property loss from storm surges.

Tourism

The Coastal Bend area is known for its outdoor activities. According to the Corpus Christi Convention and Visitors Bureau, 40 percent of all visitor trips are related to nature and wildlife tourism activities such as beach strolling, bird watching and fishing. Corpus Christi is the sixth most popular tourist destination in Texas with around 7.2 million people visiting in 2008. The tourism industry supports around 13,000 jobs and brings $1.1 billion into the local economy. Nature tourism alone accounts for 45 percent of spending by all visitors, totaling about $456.5 million annually. An increased focus on eco or nature tourism is expected.

References:

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- Lee, J. The Economic Significance of Tourism and Nature Tourism in Corpus Christi: 2009 Update. Corpus Christi Convention and Visitors Bureau. April 2009. 37pp.

FOCUS QUESTION 1:

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

What was measured:
Fecal bacteria levels and *Vibrio* bacteria

Answer: Based on the indicators below the answer is "not all the time". While many of the sites monitored for bacteria show levels safe for recreation, except after a rain, some sites in Corpus Christi Bay exceeded the Environmental Protection Agency health standards in 12% of the samples collected. Also, the risk of transmission of *Vibrio* is low, for healthy individuals, as long as the proper precautions are taken.

INDICATOR #1: Fecal bacteria levels.

Condition/Trend: Good/Stable

I. BACKGROUND

Each year Americans make 910 million trips to coastal areas and spend $44 billion. In Texas, beaches consistently rank among the state's top tourist destinations. Several programs are in place to address bacteria levels in the waters of the Coastal Bend area.

Texas Beach Watch Program, a non-regulatory program, implemented by the Texas General Land Office, monitors water for enterococcus bacteria as a surrogate of harder to detect, disease-causing microorganisms where sewage or storm runoff is present. Water quality advisories are recommended when enterococcus levels exceed limits established by the Environmental Protection Agency.

II. CONCERNS

Bay waters may become polluted when rainwater washes pollutants (like animal feces, fertilizer, pesticides, and trash) from yards, farms, streets, and construction sites. It is not unusual to measure higher concentrations of bacteria after a heavy rain. 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 from the water can accumulate in the tissue of oysters and other shellfish, making them unsafe to eat. 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 (irritation and inflammation of the stomach and intestines), but more serious conditions can occur.

Texas Beach Watch sign indicating the beach location is monitored for bacteria.

Texas Beach Watch advisory sign indicating the sample results have exceeded the standard.

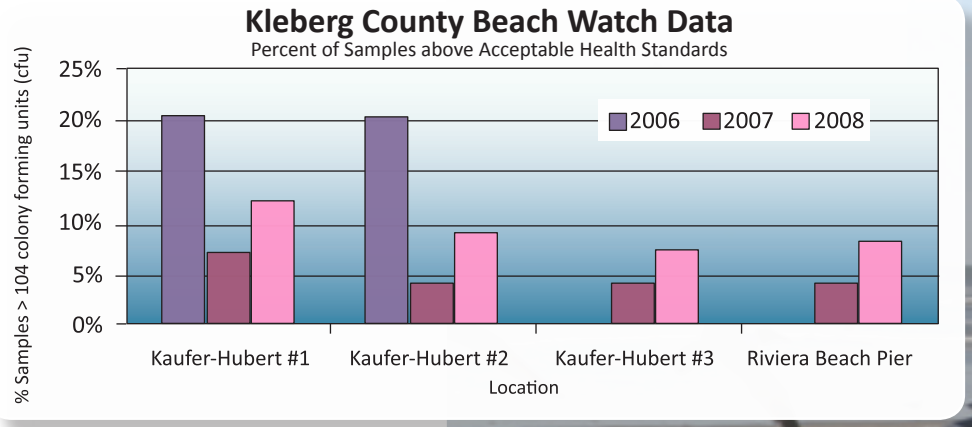
III. LOCAL LEVELS (Conditions)

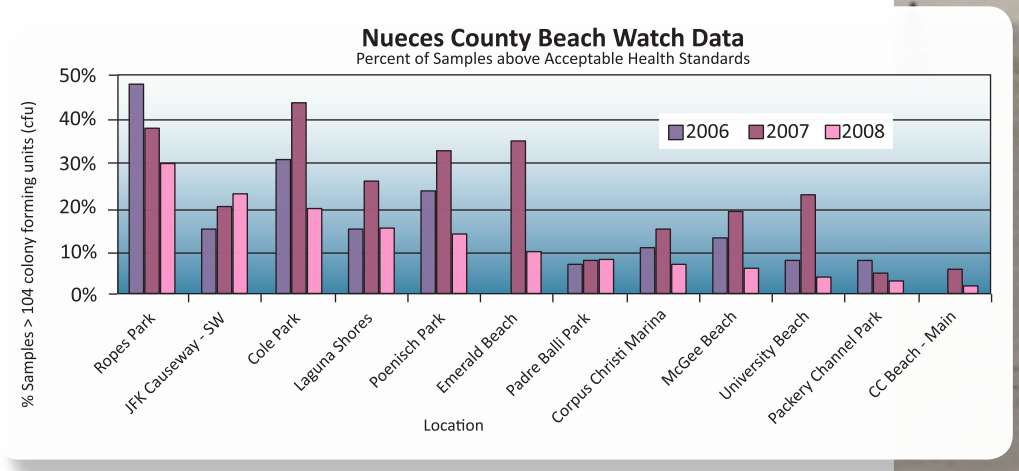
Four sites are monitored at Aransas County Beaches. In 2008, 7% of the total water samples collected exceeded national health standards at the Rockport Beach Park.

Four sites are monitored in Kleberg County. In 2008, bacteria levels at the Kaufer-Hubert #1 site reached the high category in 12% of times sampled. One site, Nueces Bay Causeway #4, in San Patricio County is monitored. In 2008, the San Patricio County site reached the high category 16% of the times sampled. An additional 44 sites were monitored at eight beach areas under the Beach Watch Program in Nueces County. These sites were in Port Aransas, Mustang Island, JP Luby Park, Bob Hall Pier/Seawall, Upper Corpus Christi Bay, Corpus Christi Marina, Corpus Christi Bay-Urban, and Upper Laguna Madre. During 2008, Ropes Park, JFK Causeway, and Cole Park bacteria levels reached the high category in 24% of the times sampled. In 2008, seven areas were monitored along Corpus Christi Bay. The samples exceeded the EPA health standards in 12% of the times sampled.

An overall look at the bacteria levels within the Coastal Bend area suggests that it is safe to have recreational activities in the bay waters as long as it's not immediately after a heavy rain, in a small creek, or next to a drainage system.

The Texas Beach Watch Program has a website which allows the public to view the current status of each Beach Watch station. To learn more, visit the website: http://www.texasbeachwatch.com/.





IV. REFERENCES

- Dorfman, M. and Rosselot, K. July 2009. Testing the Waters: A Guide to Water Quality at Vacation Beaches. National Resources Defense Council. 453 pp.
- Status of Texas Coastal Beaches: An Assessment of Texas Beach Watch Program Data. August 2008. http://www.tceq.state.tx.us/assets/public/compliance/monops/water/08twqi/tx_beach_assessment.pdf

INDICATOR #2: Vibrio concerns.

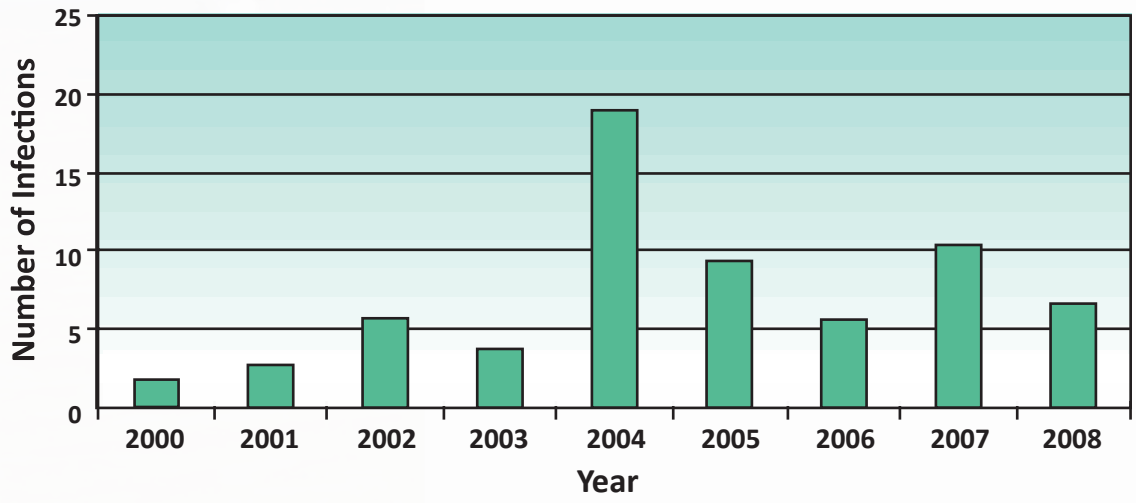
Condition/Trend: Good/Stable

I. BACKGROUND

The *Vibrio vulnificus* bacteria live in coastal waters around the world and are usually more prevalent in summer months when the waters are warmer. *V. vulnificus* is usually transmitted to humans by eating raw or undercooked shellfish, particularly oysters harvested from warmer waters. However, *V. vulnificus* infections may occur when wounds or soft tissues are exposed to warm seawater. The bacteria can also enter the body through open wounds when swimming or wading, or via puncture wounds from the spines of fish such as hardhead catfish. Symptoms include vomiting, diarrhea, abdominal pain, and a blistering dermatitis. Severe symptoms and even death can occur if the bacterium enters the bloodstream—something more common in people with compromised immune systems or liver disease. Environmental factors, such as warm water and moderate salinity, can increase the number of *V. vulnificus* organisms in the bay waters and shellfish, increasing risk of exposure.

Texas Department of State Health Services releases consumption advisories and bans on areas that have high levels of bacterium and other contamination. These consumption advisories serve as a warning to bay users that are in contact with bay waters.

Reported *Vibrio vulnificus* Infections (Water Contact) in Texas by Year



II. CONCERNS

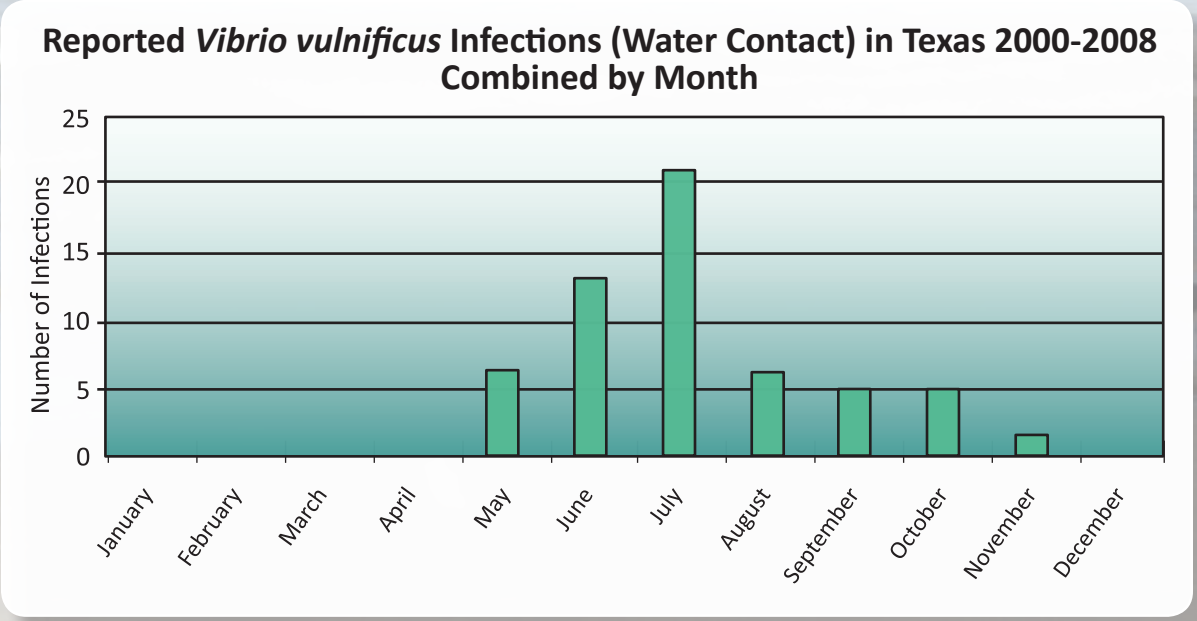
In healthy persons, *V. vulnificus* infections from consumption or wound infections cause diarrhea, vomiting, and abdominal pain. In persons with underlying medical conditions, especially liver disease, it can cause bloodstream infections characterized by fever, chills, decreased blood pressure, blistering skin lesions, and often death.

According to Texas Parks and Wildlife Department, there are really two main things to remember, 1. Don't come in contact with any coastal, bay, or Gulf waters if you have open sores or cuts. If you get a cut while in the water, immediately wash it with soap and freshwater. If it shows any signs of infection (redness, pain or swelling) or if the cuts are deep: get medical treatment as soon as you can; 2. Eat only fully cooked shellfish, especially if you are susceptible to liver problems, or have a chronic health condition like diabetes, or a weakened immune system.

III. LOCAL LEVELS

V. vulnificus infections have been reported along the Gulf Coast for many years. *Vibrio*, in wound infections, can cause skin ulcerations, fever, etc. When contacted from infested seawater, *Vibrio* can cause vomiting, diarrhea, abdominal pain, and death. Although it has recently received more attention and questions due to increased media activities, 2009 hasn't been any worse than previous years.

So, is the bay water safe to go in because *V. vulnificus* is in the water? The risk of transmission is low to healthy individuals as long as the proper precautions are taken.



Vibrio Infection

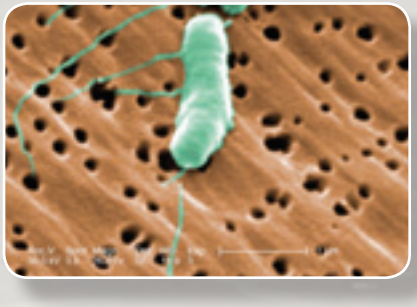


Image Source: CDC Phil/Janice Carr, Colorized scanning electron microscope depicting a flagellated *Vibrio vulnificus*.

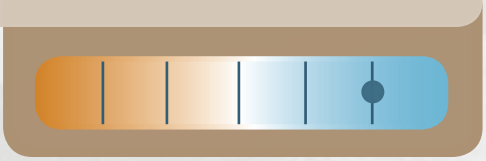
IV. REFERENCES

- Centers for Disease Control and Prevention. 2008. Vibrio vulnifucus. http://www.cdc.gov/nczved/dfbmd/disease_listing/vibriov_gi.html
- Gregg, B. 2007. Four Things You Hate to Think About When You Fish. http://www.tpwd.state.tx.us/fishboat/fish/didyouknow/darkside.phtml
- Ho. H. March 2009. Vibrio Infections. http://emedicine.medscape.com/article/232038-overview
- Mott, J., G. Ramirez, and G. Buck. 2008. Vibrio vulnificus Monitoring in Recreational Waters. Coastal Bend Bays and Estuaries Program. 71 pp.
- Texas Department of State Health Services. February 2010. Seafood and Aquatic Group. http://www.dshs.state.tx.us/seafood/fishConsump.shtm

FOCUS QUESTION 2:

Is it safe to eat seafood caught in area bays?

What was measured: Seafood tissue levels, seafood consumption advisories, and shellfish harvesting areas



Answer: Generally yes, but not in all areas. There is only one fish consumption advisory for the Coastal Bend area specifically for Gulf species. This is the statewide king mackerel advisory due to mercury contamination. The Texas Department of State Health Services also monitors whether shellfish harvesting areas are safe. Some areas of the local bays are closed due to high levels of bacteria.

INDICATOR #3: Seafood tissue monitoring data.
Condition/Trend: Good/Improving

I. BACKGROUND

The Texas Coastal Bend has a massive commercial fishing industry that annually harvests more than 8 million pounds of finfish, shrimp, and crab from the area's estuarine waters. Recreational fishing is just as important and contributes millions of dollars to the coastal communities each year. Texas Department of State Health Services (TDSHS) monitors fish in the state for the presence of environmental contaminants and alerts the public through bans (closures) and advisories when a threat to human health may occur from the consumption of contaminated fish.

Since fish and shellfish can accumulate contaminants from the waters in which they live, the TDSHS tests the organisms by looking at the chemicals or diseases within their tissue. TDSHS completed a project in late 2005 within Nueces Bay that involved blue crabs, oysters, and fish.

The CBBEP initiated a multi-year effort as part of the Regional Coastal Assessment Program (RCAP) and began sampling in 2000 through 2004 in order to assess the quality of water, sediment, and seafood tissue of the Coastal Bend region.

II. CONCERNS

Contaminants of concern consist of mercury (methyl-mercury), copper, chromium, zinc, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and dichlorodiphenyltrichlorethane (DDT) and other pesticides. At typical consumption levels, fish and shellfish in the Coastal Bend do not contain levels of contaminants high enough to cause an imminent threat to health. Health risks from contaminants may increase for people who regularly consume larger fish and predatory fish from an area of contaminated water over a long period of time.

Contaminants such as PCBs, pesticides (i.e. DDT, chlordane, toxaphene, and dieldrin), and dioxins readily accumulate in the fatty tissues of fish. Mercury accumulates primarily in the muscle tissue (fillet) of the fish. While most fish contain some level of mercury, long-lived fish such as gar, king mackerel, shark, and swordfish contain more mercury than small fish.

It is important for people to check seafood advisories to know which areas may produce unsafe fish and shellfish. TDSHS maintains a 24-hour toll-free number (1-800-685-0361) to determine status of approved and conditonally approved harvest areas.

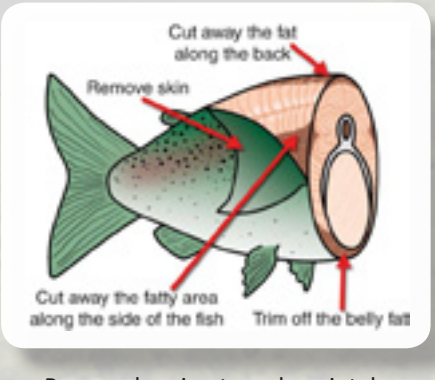


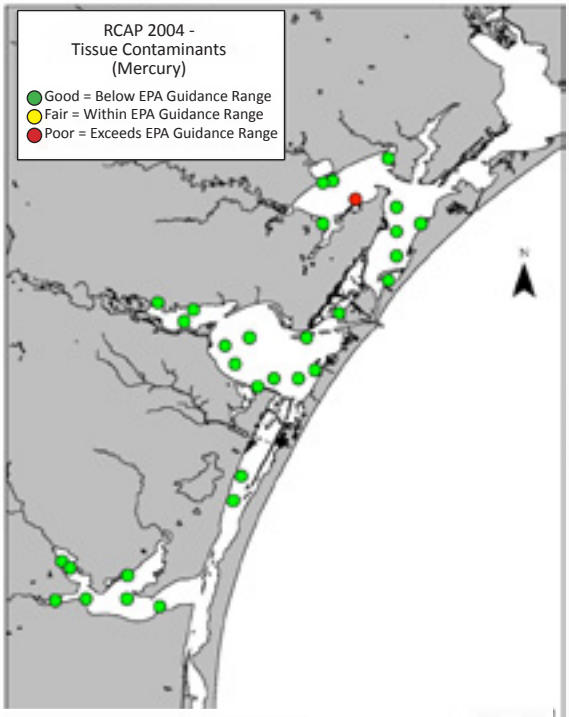
Image Source: TPWD

Proper cleaning to reduce intake of contaminant.

III. LOCAL CONTAMINATED TISSUE LEVELS

Data collected during the RCAP indicate the Coastal Bend region ranks good, since most contaminants were non-detectable, or well below any applicable screening level. Only one site exceeded the maximum concentration range value (>0.23 ppm) for mercury. Results from past RCAP sampling events indicate most sites had very low concentrations of aluminum, chromium, mercury, and iron. A limited amount of nickel, lead, and selenium followed by zinc and copper occurred at some locations, while many sites resulted in metals concentration values that were non-detectable.

In 2005 a study by TDSHS found oysters from Nueces Bay to have elevated zinc levels suggesting that regular or long-term consumption could result in systemic adverse health effects. Therefore, consumption of oysters from Nueces Bay constitutes a public health hazard. The good news is that spotted seatrout, red drum, and blue crabs from Nueces Bay do not contain quantities in excess of TDSHS guidelines for protection of human health. Therefore, consumption of spotted seatrout, red drum, and blue crabs from Nueces Bay poses no apparent public health hazard.



All PCB concentrations were well below screening levels. Detectable concentrations of DDT occurred at three sites. As seen with PCB, the highest DDT values were below screening levels. Total chlorinated pesticides, other than DDT, registered in whole-body tissue samples at one site in the Baffin Bay Complex, and consisted of small detectable amounts of lindane. No detectable concentrations of PAHs occurred in any of the 31 sites sampled.

Overall levels of fish tissue contamination in the Coastal Bend region are relatively low and consumption of fish is safe as long as consumption rates of fish follow the TDSHS guidelines.

EPA National Coastal Assessment guidelines for assessing fish tissue contaminants, by site (USEPA 2004).

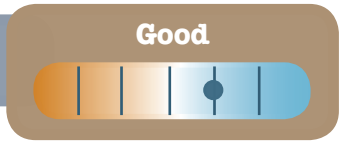
Rating		Fish Tissue Contaminant Guidelines
Good		The index score falls below the range of the guidance criteria for a risk-based consumption associated with four 8-ounce meals per month.
Fair		The index score falls within the range of the guidance criteria for a risk-based consumption associated with four 8-ounce meals per month.
Poor		The index score exceeds the maximum value of the range of the guidance criteria for a risk-based consumption associated with four 8-ounce meals per month.

IV. REFERENCES

- Environmental Protection Agency. 2004 National Coastal Condition Report II. EPA/620/R-03/002 Office of Research and Development and Office of Water, Washington D.C. 285 pp.
- Environmental Protection Agency. June 2007. NEP Coastal Conditions Report: CBBEP region. 12 pp.
- Nicolau, B. and A. Nuñez. October 2006. Regional Coastal Assessment Program 2004. Coastal Bend Bays and Estuaries Program. 119 pp.
- Texas Department of State Health Services. August 2005. Characterization of Potential Health Risks Associated with Consumption of Fish and Shellfish from Nueces Bay, Coastal Bend Bays and Estuaries Program. 30 pp.

INDICATOR #4: Seafood consumption advisories.

Condition/Trend: Good/Stable



I. 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 TDSHS is responsible for accumulating information on contaminated fish and shellfish, and for advising the general public when contamination of a certain species used as a food source has exceeded safe eating levels. The TDSHS has 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.

II. CONCERNS

The status of shellfish-growing waters in Texas estuaries 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, major 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.

King Mackerel

III. LOCAL LEVELS

A review of the consumption advisories by TDSHS for the Coastal Bend bays reveals that consumption of all sport fishes such as spotted seatrout, red drum, and Atlantic croaker are safe to eat. However, shellfish advisories differ from fish advisories and are explained in the next section (Indicator #5).

Nearshore, along the Texas Coastal Bend, king mackerel should not be eaten if greater than 43 inches in length due to high levels of mercury. For king mackerel 37-43 inches, adults should limit consumption to one, 8-ounce portion per week, and women in child bearing years and children should limit consumption to one, 8-ounce portion per month. King mackerel under 37 inches is safe to eat.

IV. REFERENCES

- National Marine Fisheries Services. October 2009. King Mackerel. http://www.nmfs.noaa.gov/fishwatch/species/king_mack.htm
- Texas Department of State Health Services. Survey Information – Current Advisories, Bans, and Rescinded Orders. http://www.dshs.state.tx.us/seafood/Survey.shtm
- Texas Parks and Wildlife Department. February 2010. Fish Consumption Bans and Advisories. http://www.tpwd.state.tx.us/publications/annual/fish/consumption_bans/

INDICATOR #5: Shellfish harvesting areas.

Condition/Trend: Good/Degrading

Improvement Needed

I. BACKGROUND

The TDSHS is also responsible for providing the public with maps and written locations where fish and shellfish contaminations have been found, and areas that are off limits for harvesting. In waters with consumption bans, possession and consumption of fish and/or shellfish is prohibited, only catch and release fishing from these areas is allowed.

II. CONCERNS

Molluscan shellfish are defined by TDSHS as oysters, clams, and mussels and pose risks that are different from fish and crabs. Because molluscan shellfish are filter feeders and are often eaten raw, a special program has been developed to reduce risk to consumers. Molluscan shellfish harvest areas are classified on shellfish 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. TDSHS issues a marine order to classify areas as restricted or prohibited. Before harvesting molluscan shellfish, individuals should have a current shellfish classification map and determine the status of the approved and conditionally approved harvest areas. The current status of shellfish harvesting areas may be obtained from your local Texas Parks and Wildlife office by calling toll-free 1-800-685-0361, or by downloading the current maps from the TDSHS website at: http://www.dshs.state.tx.us/seafood/Classification.shtm.

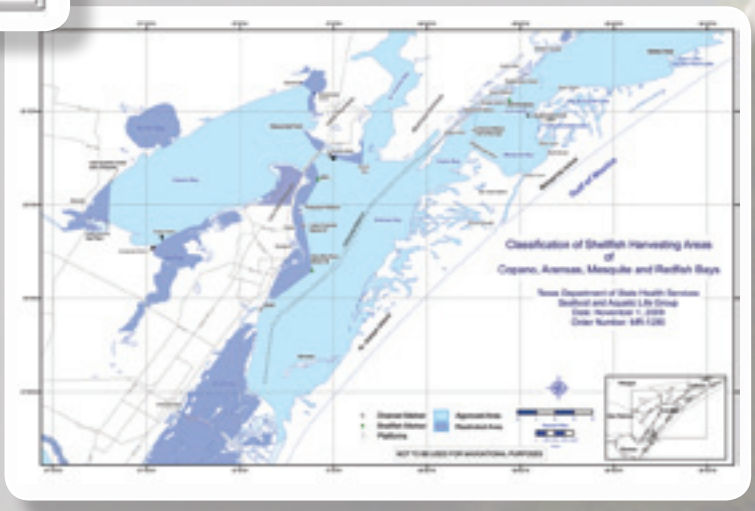
Classification of Shellfish Harvesting Areas of Corpus Christi and Nueces Bays

Locations shaded in dark blue are restricted areas.

III. LOCAL LEVELS

Consumption advisories for shellfish are mapped by TDSHS and include: Nueces Bay, Redfish Bay, Mission Bay, Port Bay, portions of San Antonio Bay, portions of Aransas Bay, portions of Corpus Christi Bay, portions of the Upper Laguna Madre, and portions of Copano Bay.

Shellfish, such as oysters, are not safe to eat in the majority of the Coastal Bend bays due to high levels of bacteria. Often, bacteria levels are increased after heavy rain events.



Classification of Shellfish Harvesting Areas of Copano, Aransas, Mesquite and Redfish Bays

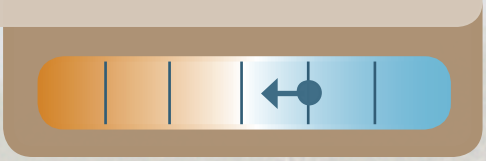
IV. REFERENCES

- Texas Department of State Health Services. October 2009. Classification Information. http://www.dshs.state.tx.us/seafood/classification.shtm

FOCUS QUESTION 3:

Are water and sediment quality improving or degrading?

What was measured: Water Quality Standards, number of impaired segments, harmful algal bloom levels, and nutrients



Answer: There are some areas within the CBBEP region that do not meet the TCEQ Water Quality Standards including Oso Bay, the Laguna Madre, Redfish Bay, and Corpus Christi Bay. In 2004, the Regional Coastal Assessment Program report listed nutrient levels that exceeded the TCEQ screening levels within the Copano Bay system, Nueces Bay, Oso Bay, and Baffin Bay. Harmful algae are always naturally present within the water column, just not in concentrations that are intolerable. The last widespread harmful red tide that occurred within the Coastal Bend region was in 2009.

INDICATOR #6: Water Quality Standards.
Condition/Trend: Good/Stable

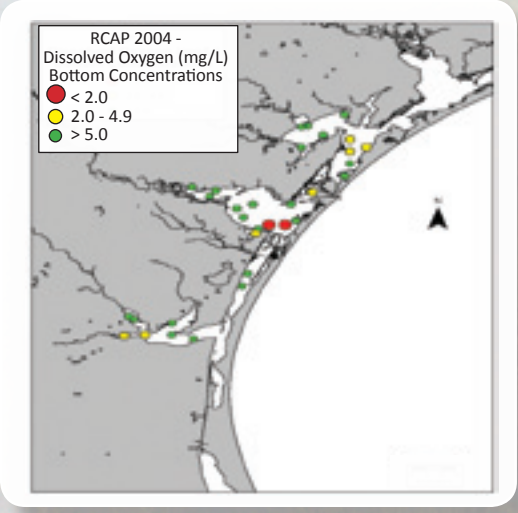
I. BACKGROUND

Water quality standards are the foundation of the water quality-based pollution control program mandated by the Clean Water Act. Water quality standards define the goals for a water body by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water bodies from pollutants.

The Texas Commission on Environmental Quality (TCEQ) monitors the quality of surface water to evaluate physical, chemical, and biological characteristics of aquatic systems. TCEQ's Water Quality Standards have screening levels for different physical and chemical parameters found in Texas waters.

Regulatory criteria do not exist for the majority of sediment contaminants; however, TCEQ uses sediment-screening levels to assess Secondary Concerns. Secondary Concerns are parameters for which there are no existing standards adopted, but that have elevated concentrations exceeding screening levels.

The CBBEP used these screening levels to assess the quality of our bay waters and sediment in a study called the Regional Coastal Assessment Program (RCAP), a multi-year project between 2000 and 2004. Many water and sediment quality parameters were studied under this report, both physical and chemical, such as dissolved oxygen, temperature, salinity, nutrients, metals, and organics.



RCAP 2004 - Dissolved Oxygen (mg/L) Bottom Concentrations

II. CONCERNS

Many factors, such as reduced freshwater inflow, habitat modification, and climate change can affect estuarine system health. The fundamental health of an estuarine system depends on the type and quantity of pollutants, such as heavy metals, excessive nutrients, and disease causing microorganisms, or pathogens, (viruses, bacteria, and parasites) that may enter the water. Elevated concentrations of priority pollutants in the water column, sediments, and tissues of aquatic animals may affect diverse groups of species, either through direct exposure or indirectly through the food chain, and eventually may be harmful to humans.

Sediment contamination with toxic chemicals due to the discharges of a wide variety of metal (arsenic, cadmium, chromium, lead, zinc, etc.) and organic substances (PCBs, DDT, etc.) poses environmental concerns.

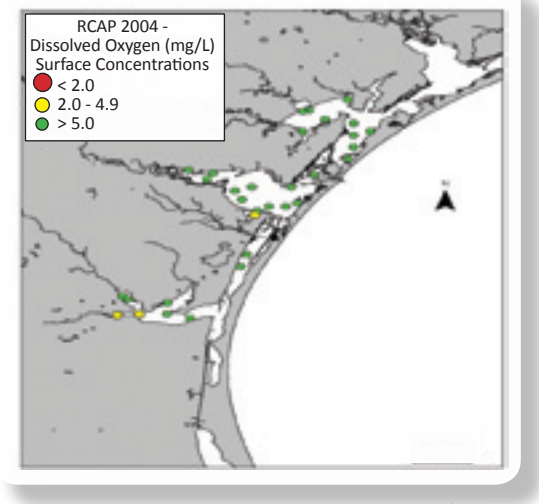
When contaminants enter estuarine systems, they bind to suspended particulates in the water column then settle out, or sink, to the underlying sediments. Because sediments also provide biological habitat, potential effects may result when benthic deposit-feeding organisms ingest sediment particles. While not all sediment contaminants are biologically available, some have the potential to yield harmful effects to humans through bioaccumulation and biomagnification through the food web.

III. LOCAL LEVELS

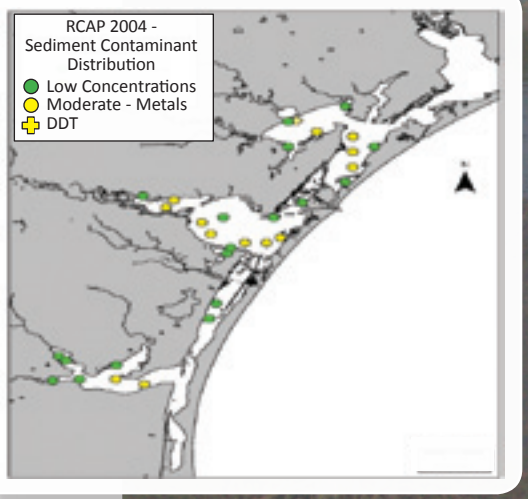
Overall, near-surface dissolved oxygen quality for the CBBEP region can be considered very good. However, analysis of RCAP 2004 near-bottom dissolved oxygen (DO) data causes concern as six sites expressed low near-bottom DO concentrations, of which two were hypoxic (<2.0 mg/L).

For RCAP 2004, sediment contamination throughout the CBBEP region was generally low. RCAP 2004 Sediment Contaminant Distribution (SCD) rankings utilized the same breaks as defined in the RCAP 2002 sediment assessment, and identified 14 sites as fair, or "moderately" contaminated out of 32 sites. Based on RCAP assessment procedures, 13 sites classified as "moderately" contaminated for metals and one site for DDT. Sites classified as "moderately" contaminated occurred in five of the eight TCEQ segments sampled. Concentrations of Polychlorinated Biphenyls (PCBs), DDT, Total Chlorinated Pesticides, and Polycyclic Aromatic Hydrocarbons (PAHs) were extremely low or undetectable throughout the region.

Although there are a couple of places of low DO (<2.0 mg/L) and several contaminants are distributed in moderate numbers around the Coastal Bend area, the bays and estuaries are fairly clean. The process of understanding water and sediment interactions within the CBBEP region continues to evolve. Additional data will provide a better understanding of trends in water and sediment quality.



RCAP 2004 - Dissolved Oxygen (mg/L) Surface Concentrations



RCAP 2004 - Sediment Contaminant Distribution

IV. REFERENCES

- Environmental Protection Agency. June 2007. National Estuary Program Coastal Conditions Report: CBBEP. 12 pp.
- Nicolau, B. and A. Nuñez. October 2006. Regional Coastal Assessment Program 2004. Coastal Bend Bays and Estuaries Program. 119 pp.
- Nueces River Authority. 2007. Basin highlights report. Report prepared in cooperation with the Texas Commission on Environmental Quality Clean Rivers Program. Corpus Christi, 82 pp.
- Texas Commission on Environmental Quality. January 2010. Texas Surface Water Quality Standards. http://www.tceq.state.tx.us/nav/eq/eq_swqs.html

INDICATOR #7: Number of impaired segments (303d list).

Condition/Trend: Good/Degrading

Improvement Needed

I. BACKGROUND

Under the federal Clean Water Act, water quality standards are established based on the use of the waterway, allowing for different standards for different uses. Texas uses four general categories for water use: aquatic life use, contact recreation, public water supply, and fish consumption. Each use defined in the standards is linked to measurements for specific conditions or pollutants. These measurements are used to evaluate whether water quality is high enough to maintain designated uses.

Standards associated with the aquatic life use are designed to protect plant and animal species that live in and around the water. The standard associated with the contact recreation use is 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 indicate whether 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 Water Quality Inventory and 303(d) List. The report 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 2008 and is available at the TCEQ website. http://www.tceq.state.tx.us/

Sampling in Oso Creek

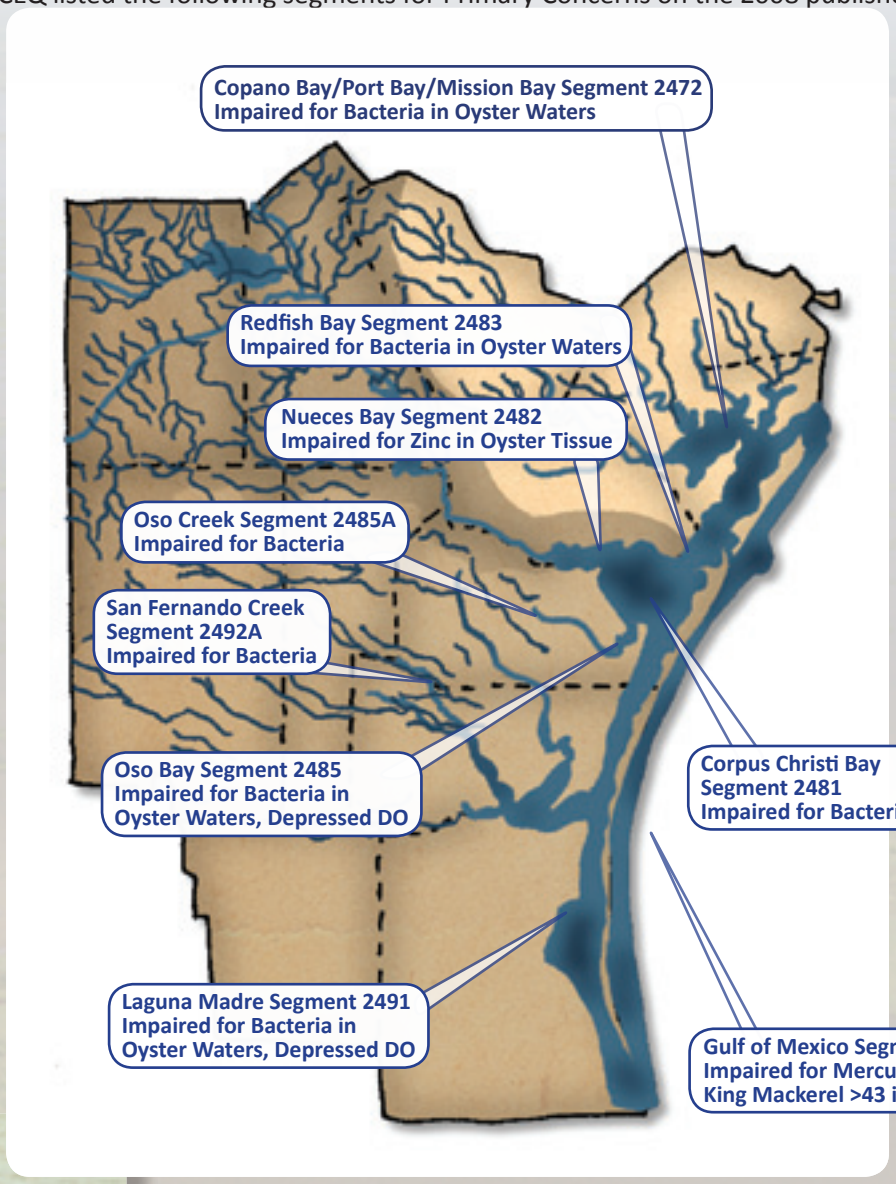
II. CONCERNS

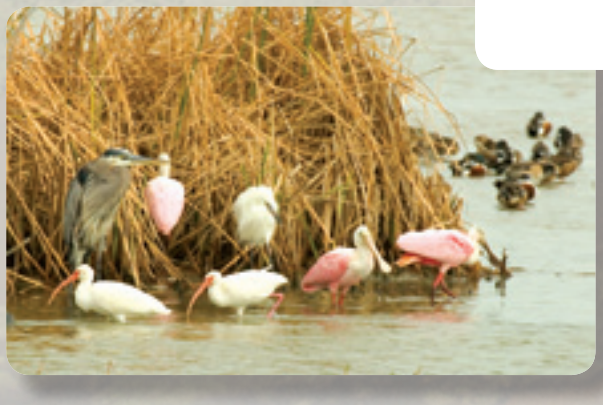
Water bodies listed on the 303(d) list have impairments and are not functioning at full ecological capacity, thus not performing ecological services of which they are capable. The development of a plan for improvement is required for every water body on the 303(d) list. Using this list, TCEQ developed a schedule to establish Total Maximum Daily Loads (TMDLs) for priority impaired waters in Texas. The goal of a TMDL is to restore the impaired water body to full use. The TMDL defines an environmental target and, based on that target, the state develops an implementation plan to mitigate pollution within the watershed to restore full use of the water body.

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. It is important that TCEQ maintain the 303(d) list to keep track to try and restore water quality back to a healthy state for fish and humans.

III. LOCAL LEVELS

Most segments listed are due to high bacteria and low oxygen levels. Low levels of dissolved oxygen (DO) are harmful to aquatic species. Oxygen levels reflect the ability of a water body to support a healthy, diverse aquatic population. Within the CBBEP area, TCEQ listed the following segments for Primary Concerns on the 2008 published 303(d) list:





IV. REFERENCES

- Nueces River Authority. 2007. Basin highlights report. Report prepared in cooperation with the Texas Commission on Environmental Quality Clean Rivers Program. Corpus Christi, 82 pp.
- Texas Commission on Environmental Quality. January 2010. Texas Integrated Report For Clean Water Act Sections 305(b) and 303(d). http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/wqm/305_303.html

INDICATOR #8: Harmful algal blooms (red/brown tides) frequency & severity. Condition/Trend: Good/Degrading

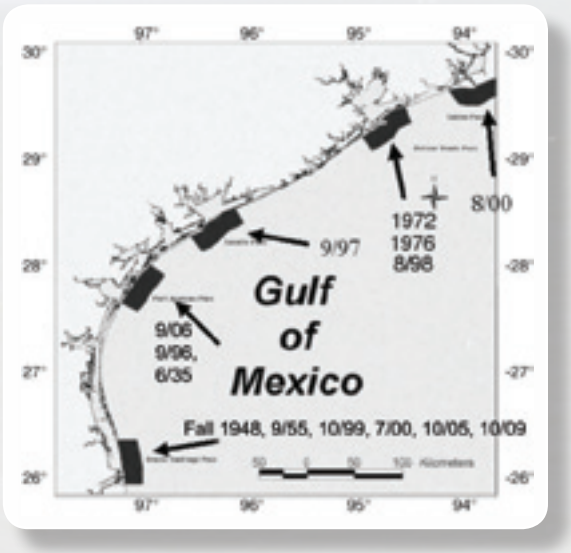
Improvement Needed

I. BACKGROUND

Algae are microscopic plants that are usually aquatic, unicellular, and lack true stems, roots, and leaves. Algal blooms occur in both marine and freshwater environments when an algal species out competes other species and reproduces rapidly. A harmful algal bloom (HAB) is a bloom that produces toxins that are detrimental to plants and animals.

Blooms can be caused by several factors. An increase in nutrients can cause algae growth and reproduction to increase dramatically into 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.

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. TPWD monitors ongoing harmful algal blooms during the full span of the bloom and communicates to the public through their web site, email alerts, and 1-800-792-1112 information number.



General dates and locations where red tides have originated.

II. CONCERNS

Two of the most common HABs in the Coastal Bend area are commonly called Brown Tide and Red Tide.

Texas brown tides result from blooms of a microscopic alga called *Aureoumbra lagunensis*. The water appears brown, taking on the color of the alga and thus the term "brown tide." In dense enough concentrations, and over a period of months, brown tide can kill seagrasses by blocking out the sunlight they need to survive. There is no evidence that brown tide poses any harm to people. Though brown tide apparently has no effect on juvenile or adult fish, it can be deadly to fish larvae.

In Texas, red tides are caused by high concentrations of a microscopic alga called *Karenia brevis*. These high concentrations may discolor the water, causing it to appear red, light or dark green, or brown. Red tide produces a toxin which can affect the central nervous system of fish, birds, mammals and other animals. The most visible result of red tide is dead fish on the beach or floating in the water.

Human health effects associated with eating brevetoxin-tainted (red tide toxin) shellfish are well documented. However, scientists know little about how other types of environmental exposures to brevetoxin—such as breathing the air near red tides or swimming in red tides—may affect humans. People who swim among brevetoxins 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.

III. 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 the bloom.

Texas red tides have occurred from August through February. They typically begin offshore in the Gulf of Mexico and are transported by currents and winds toward shore. The blooms mainly come up along Gulf beaches and less frequently into bays and estuaries.

Texas has historically recorded red tide events along coastal 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 most common location for the occurrence of red tide within the Coastal Bend region are the Corpus Christi and Padre Island National Seashore areas. 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.

Harmful algae are always naturally present within the water column, just not in concentrations that are intolerable. Since not much is known about these algae and what their entire role is within the ecosystem, 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.

Karenia brevis cell.

Brown tide bloom in Laguna Madre

Fish kill resulting from algae bloom.

IV. REFERENCES

- Magaña, H., Contreras, C., and T.A. Villareal. 2003. A historical assessment of Karenia brevis in the western Gulf of Mexico. Harmful Algae 2. 163-171., modified.
- National Park Service. 2006. Other Life Forms. http://www.nps.gov/pais/naturescience/otherlifeforms.htm
- Texas Parks and Wildlife. 2010. Harmful Algal Blooms. http://www.tpwd.state.tx.us/landwater/water/environconcerns/hab/

INDICATOR #9: Nutrients in the Water Column.

Condition/Trend: Good/Stable

I. BACKGROUND

Nutrients in a bay system are natural and needed in order for fish, wildlife and plants to survive, but problems arise when a disproportionate amount of nutrients enters the water. Excessive nutrients from sources such as failing septic tanks, sewage treatment plants, storm water runoff, atmospheric deposition, industrial organic waste discharge, and contaminated runoff from fertilized farms or yards, or from animal operations can adversely affect estuarine systems.

Currently, the State of Texas has no numerical criteria for nutrients in the Texas Surface Water Quality Standards. Nutrient controls do exist in the form of narrative criteria, watershed rules, and antidegradation considerations. The TCEQ screens phosphorus, nitrate nitrogen, and chlorophyll monitoring data as a preliminary indication of areas of possible concern for the 303(d) listings of impaired water bodies. The Environmental Protection Agency (EPA) has indicated that states must develop nutrient criteria and begin the process of incorporating them into their water quality standards. Therefore, the TCEQ is in the process of developing and evaluating criteria to address nutrients and eutrophication (condition where water bodies receive excess nutrients that stimulate excess plant growth commonly resulting in algal blooms) as well as complementary approaches toward controlling nutrients. The TCEQ is also developing procedures to implement the application of criteria to permitting, stream assessments, and to the TMDL process.

Drainage ditch to Oso Bay

Nitrogen levels control rates of primary production, with high input levels often producing significant increases in phytoplankton and macrophyte production.

Total phosphorus measures the various forms of phosphorus (particulate and dissolved) found in water. Phosphorus promotes surface water eutrophication. Recommended levels of phosphorus to avoid algal blooms are 0.01 mg/L to 0.10 mg/L or a 10:1 N:P ratio.

Stormwater Discharge to Corpus Christi Bay

II. CONCERNS

Excessive nutrients in estuaries can result in accelerated eutrophication and algal blooms. As the algae die, they decay and rob the water of oxygen. The algae also prevent sunlight from penetrating the water. Fish and shellfish are deprived of oxygen, and underwater sea grasses are deprived of light and can die. Animals that depend on sea grasses for food or shelter leave the area or die. In addition, the excessive algae growth can result in brown and red tides, which have been linked to fish kills. Increased algae can also cause foul odors and decrease aesthetic value.

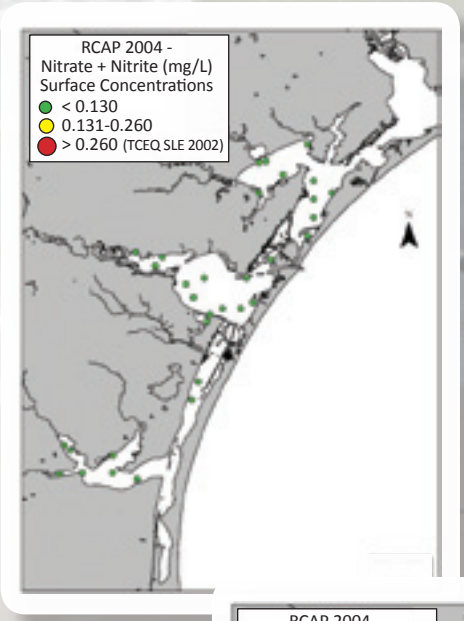
Nutrients such as nitrogen and phosphorus are necessary for growth of plants and animals, and support a healthy aquatic ecosystem. It's important to realize that natural levels of nutrients are good for the environment. The public should try reducing impacts of excessive nutrients into the bays from daily activities, such as proper maintenance of septic systems, following application recommendations for lawn and garden fertilizers, and proper disposal of pet and animal waste.

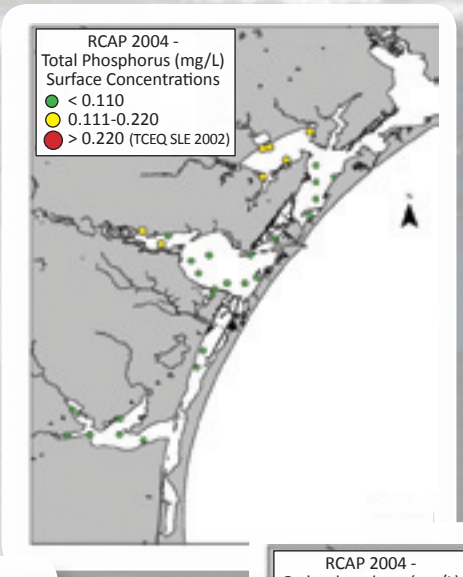
III. LOCAL LEVELS

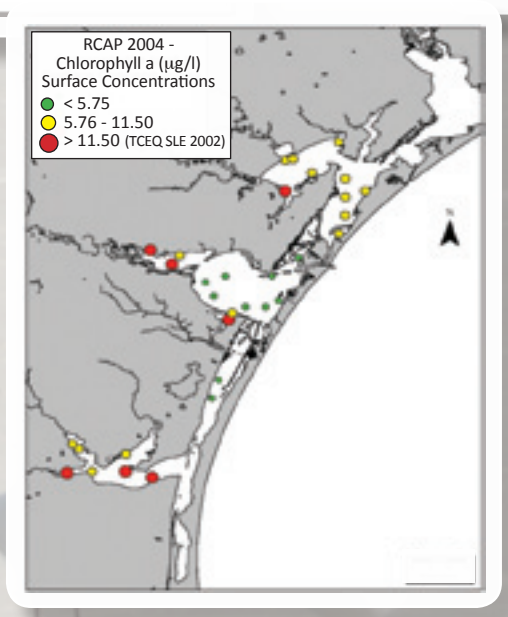
According to the 2004 RCAP Report that was completed on the Texas Coastal Bend region during 2004, some nutrient levels exceeded the TCEQ screening values. There was one ammonia exceedance level in Baffin Bay that warranted little concern. Nueces Bay and the Copano Bay system each had two exceedances of ortho-phosphorus and no exceedance of total phosphorus, nitrate, or nitrite was found.

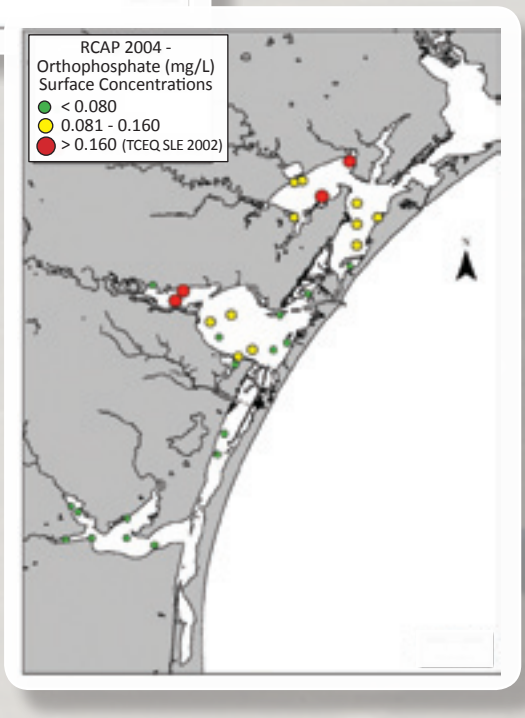
Chlorophyll a, which is not a nutrient but can sometimes be used as an indicator tool for nutrients, was found to have exceedances in Copano, Nueces, Oso, and Baffin bays.

Although scientists and state agencies are reviewing the effects of nutrient loadings into the Coastal Bend area, the full nutrient dynamics and impacts to the local bays and estuaries is not known.







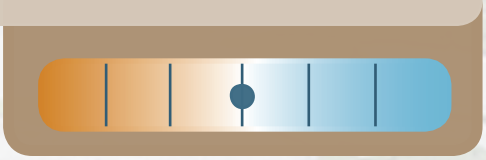


IV. REFERENCES

- Nicolau, B. and A. Nuñez. October 2006. Regional Coastal Assessment Program 2004. Coastal Bend Bays and Estuaries Program. 119 pp.
- Texas Commission on Environmental Quality. December 2009. Water Quality Assessment Standards. http://www.tceq.state.tx.us/permitting/water_quality/wq_assessment/standards

FOCUS QUESTION 4:

Are fish and wildlife populations stable, increasing or decreasing?



What was measured: recreationally important species abundance, ecologically important species abundance, commercially important species abundance, colonial waterbird populations

Answer: An overall view of the Coastal Bend area fish populations for spotted seatrout and red drum have an upward trend line due to management of the fisheries by TPWD starting back in the 1980s. Flounder populations have stabilized since TPWD implemented management changes in 1995. In the Coastal Bend region, the trend for Atlantic croaker in TPWD gill net data shows a slight increase in the relative abundance which is also true for the entire Texas coast.

Analysis of data from 1973-2000 show that of 14 bird species in the Coastal Bend, seven showed significant decreases (great blue heron, tricolored heron, reddish egret, snowy egret, black-crowned night-heron, black skimmer, gull-billed tern), while two showed significant increases (American white pelican, brown pelican).

INDICATOR #10: Recreationally important species abundance (red drum , spotted seatrout, southern flounder). Improving, except for the flounder which is leveling off.
Condition/Trend: Good/Improving

I. BACKGROUND

Catching and eating fish is fun and rewarding, but can also have a negative effect on fish population. Fortunately, fish populations have a remarkable ability to replenish themselves, so that, within limits, they can be harvested on a continuing basis without being eliminated.

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 than one that is heavily harvested. Also, since older fish are bigger than younger fish, a lightly harvested population will have more large fish than one that is heavily harvested.

II. CONCERNS

A fish population can be fished so hard that the number of mature females can be reduced below the level needed to produce enough young to replace the number of fish that are dying - potentially causing a collapse of the population. TPWD has created guidelines for catching fish using size and bag limits. These catch limits are important in order to sustain the number of females needed to produce a healthy group of young individuals for future generations.

Bag and Length Limits for Saltwater Fish

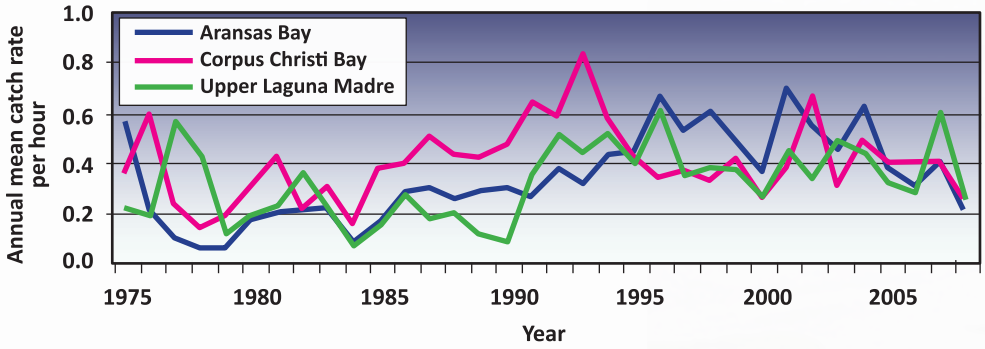
Species	Min. Size Limit	Max. Size Limit	Daily Bag Limit
Black Drum	14”	30”	5
Flounder	14”	NA	5 (two during November)*
Red Drum	20”	28”	3
Sheepshead	15”	NA	5
Spotted Seatrout	15”	NA	10 (no more than one >25”)**

* During the month of November, no gigging is allowed for flounder. v. FY 09-10
** For the lower Laguna Madre, the bag limit for spotted seatrout is five.

III. LOCAL LEVELS

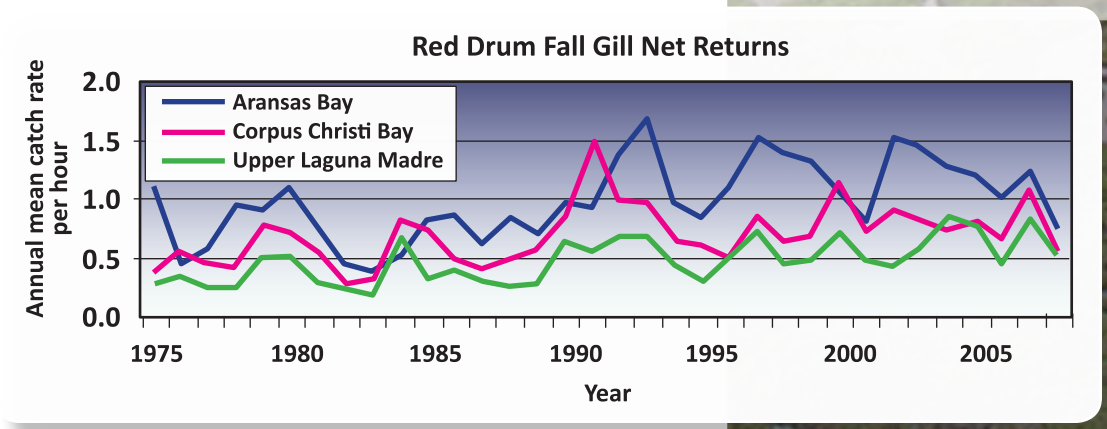
Spotted Seatrout

Spotted seatrout provides a good example of the effect of harvest. Spotted seatrout have a maximum lifespan of 9 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. Over 6 million spotted seatrout fingerlings are now stocked annually into our bays from fish hatcheries in Corpus Christi and Lake Jackson. All Texas bays are seeing an increase in spotted seatrout populations except for the Lower Laguna Madre, which has seen a steady downward trend since the 1980s due to elevated fishing pressures.



Red Drum

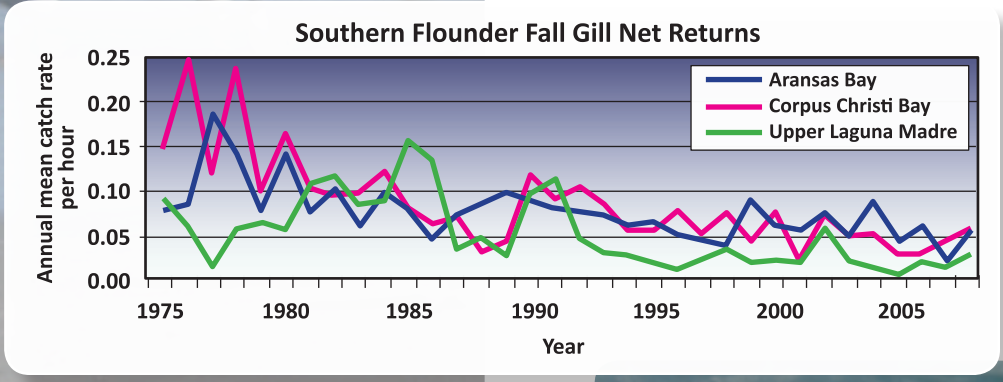
Revered for its power, speed and delectable flavor, red drum have become one of the most popular game fish in Texas marine waters. Many will remember in the late 1970s and early 1980s when red drum all but disappeared from our bays. Management measures were adopted in the late 1980s. In addition to implementing management measures, a stocking program to enhance the wild population of red drum was established. The fishery has recovered to arguably one of the best in the nation. For Corpus Christi Bay, the 2007 red drum annual catch rate was the highest observed since record highs recorded in 1991 and 2000.



Flounder

Southern flounder is one of the top three fish targeted by anglers in Texas bays. Flounder populations have decreased since the late 1970s measured by the catch per hour of flounder collected in TPWD gill net surveys. In order to try to counter declines in the flounder population, TPWD has implemented a number of management changes, including flounder size and bag limits. Flounder populations have stabilized since these changes. While this is a good indication that flounder populations might be improving, TPWD will continue to assess flounder status.

Overall views of the Coastal Bend area fish populations for spotted seatrout and red drum have an upward trend line due to management of the fisheries by TPWD since the 1980s. Flounder populations have stabilized since TPWD implemented management changes in 1995. It is hoped that flounder populations will soon begin an upward trend to follow the other successful sport fish.



Checking Gill Nets

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- Williams, L. 2007. Flounder Fishing in Texas. Texas Parks and Wildlife http://www.tpwd.state.tx.us/fishboat/fish/didyouknow/flounderfishing.phtml

INDICATOR #11: Ecologically important species (anchovy and Atlantic croaker abundance). Condition/Trend: Good/Improving

I. BACKGROUND

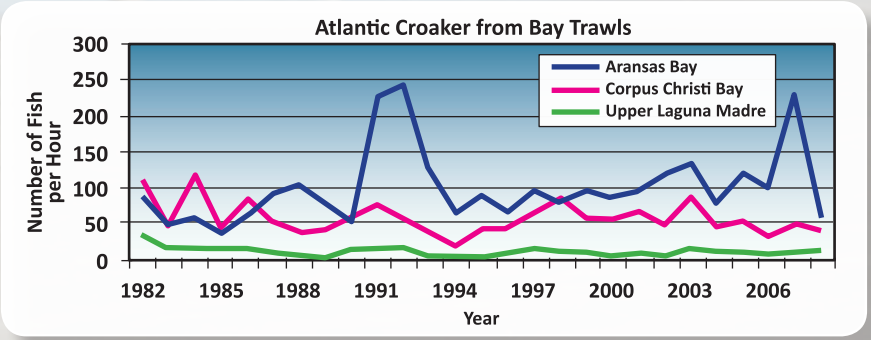
Anchovy and croaker are not typical game fish but they do play a very important role in whether the more common game fish, like red drum and spotted seatrout, will be plentiful and healthy in the coming years. These lower food chain fish are good indicators of estuary pollution stress and form an important trophic link in the Coastal Bend waters. For example, the bay anchovy consumes zooplankton and small invertebrates and, in turn, is prey base for several species of fish including the spotted seatrout.

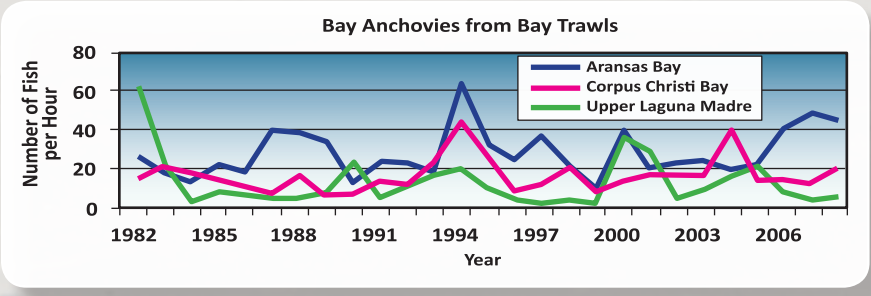
The croaker is also an important food source for some of the major sports fish. Both spotted seatrout and red drum feed on the croaker at some point in their life cycle and depend on the fish for a source of nutrients to survive.

TPWD gathers information and data on these fish species since they are indicators of how healthy the bays and estuaries might be in terms of game fish. Without the food source on the lower end of the chain, the larger recreationally important fish would have little to eat.

II. CONCERNS

Historically, the unintentional capture (bycatch) of juvenile croaker in shrimp nets was a concern. During 1995 and 1996, TPWD instituted a "limited entry" and "buy back" of commercial shrimping licenses program which relieved this concern. Over fishing is a potential problem for Atlantic croaker stocks. At this time, there are no conclusive stock assessment data to suggest the species is over fished in Texas. Because the species remains very common in coastal waters and it matures at a relatively small size, there appear to be adequate numbers able to reproduce to sustain the local stocks.





III. LOCAL LEVELS

Atlantic croaker abundance in Texas bays has almost doubled since 1994, and 2007 marked a record high catch in TPWD bay trawls. In the Coastal Bend region, the trend for Atlantic croaker in TPWD gill net data shows a slight increase in the relative abundance, which is also true for the entire Texas coast. For Corpus Christi Bay, the 2008 bay anchovy catch rate in TPWD bay trawls was higher than that of 2007. Overall Coastal Bend data for bay anchovies show a slight increase in TPWD bay trawls.

IV. REFERENCES

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- Texas Parks and Wildlife Department. May 2008. Donations, Angler Dollars Help Achieve Shrimp Buyback Goals. http://www.tpwd.state.tx.us/newsmedia/releases/?req=20080523a
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INDICATOR #12: Commercially important species abundance (brown shrimp, blue crab). Condition/Trend: Good/Decreasing

I. BACKGROUND

Many different species of shrimp are found in Texas coastal waters but the two most important commercially are the brown shrimp (*Penaeus aztecus*) and white shrimp (*Penaeus setiferus*). These two species are members of the family Penaeidae. The blue crab (*Callinectes sapidus*) is also a commercially important decapod found in Texas waters.

Texas Coastal Bend residents have always relied on the shrimp and crab bounty coming from the local bays and estuaries. Twenty-six million pounds of shrimp are annually harvested.

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 to inshore waters. Once they move into brackish waters, the post larvae become part of the benthic community. Young shrimp remain in the estuary until they approach maturity when they migrate offshore, and the cycle is repeated.

Whooping Crane

The blue crab is the most commercially important crab species in Texas. The crabs are sold live to processors (who boil, pick, and can the meat), to fish houses, and to 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, while the male remains in the estuary.

The Texas Parks and Wildlife Commission is charged with specifying opening and closing dates of shrimp and crab seasons. The TPWD records landings of crab and shrimp populations.

II. CONCERNS

Over fishing and loss of habitat are the biggest challenges for the Coastal Bend shrimp populations. 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 structural character and function of shrimp habitats. In Texas waters, bottom trawling for shrimp is the dominant fishing activity. This method of fishing disrupts the habitat by scraping the substrate to depths of a few inches.

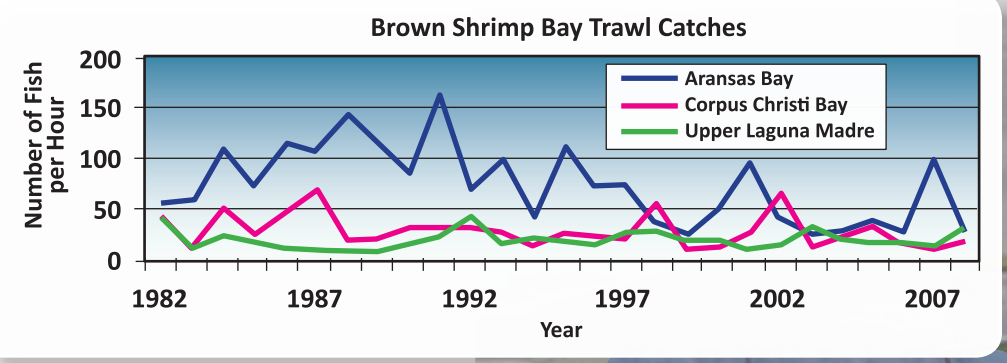
The recruitment, or number of juvenile crabs, is often dependent upon rainfall, both the quantity and the timing. Concerns about habitat loss are also key with this fishery. Marshes, seagrass meadows and muddy soft bottoms are critical habitat for juvenile blue crabs and are necessary for them to reach maturity. The loss of critical habitat for small crabs increases mortality from predation. Over harvesting is another concern.

Blue crab is also an important food source for the local whooping crane population. The lack of rainfall in 2009 reduced the freshwater inflows into the coastal marshes and bays, raising the salinity levels and threatening wildlife. The low water levels have decreased the number of blue crabs which has resulted in a decline in the whooping crane population.

III. LOCAL LEVELS

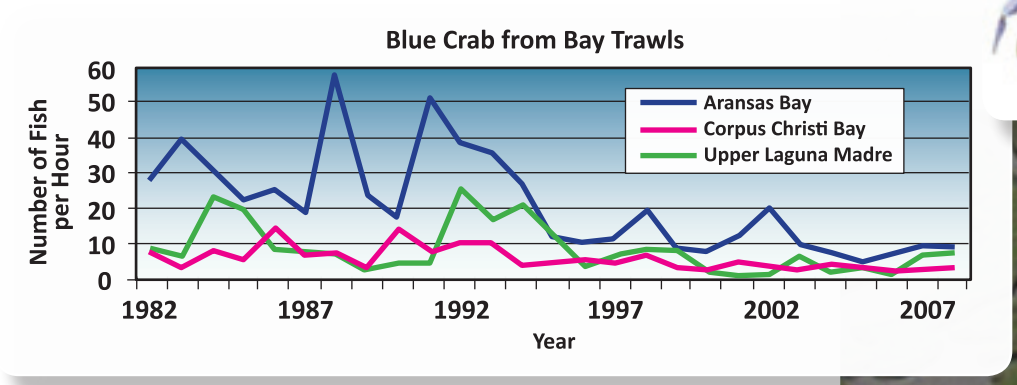
Shrimp

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. Bay trawl catches for brown shrimp appear to be stable for the Corpus Christi Bay and the Upper Laguna Madre.



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, had been declining, but indicates some stabilization since 1998. Only 3.1 million pounds were landed in 2005, 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.



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- Sutton, G. 2007. Fewer Crabs – Fewer Fish. http://www.tpwd.state.tx.us/fishboat/fish/didyouknow/bluecrabdecline.phtml
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INDICATOR #13: Colonial water bird nesting pairs.

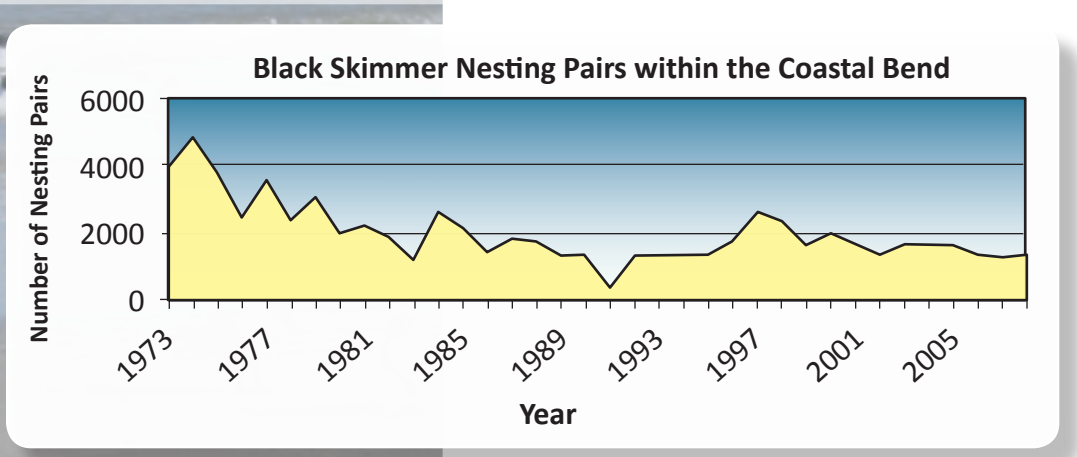
Condition/Trend: Poor/Degrading

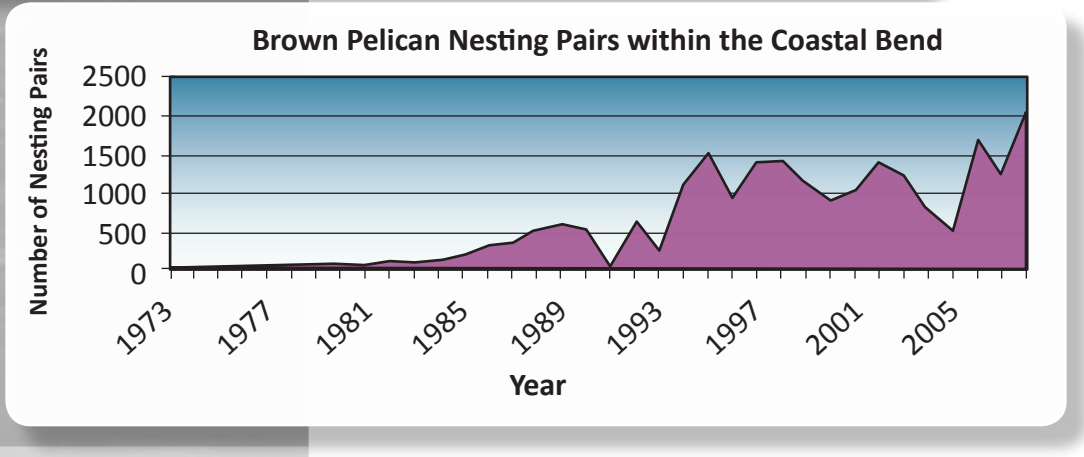
Improvement Needed

I. BACKGROUND

Colonial waterbird populations are key environmental indicators of estuary health and productivity. They represent the top of the food chain and reflect the system's overall health. Additionally, communities along the Texas coast enjoy economic benefit from the increasing popularity of birding ecotourism.

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.





II. CONCERNS

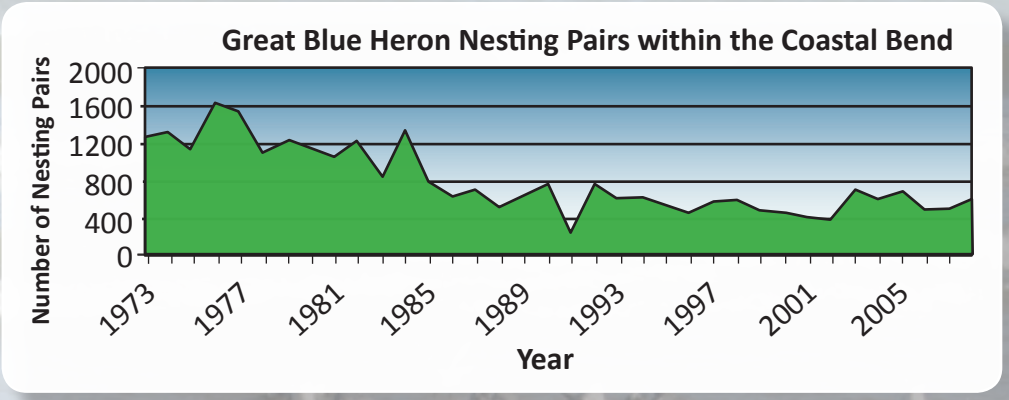
Waterbird populations were decimated prior to the early 1900s, mainly for the plume trade. Some species suffered nearly to the point of extinction. Since then, populations have been struggling to rebound. Further coastal development and other human impacts have limited their ability to recover to pre-settlement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

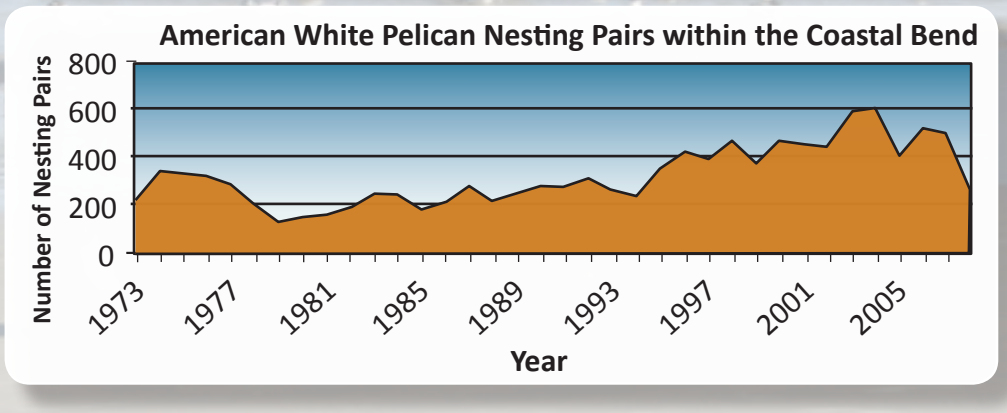
Current challenges to waterbird recovery include habitat loss – both of nesting and feeding areas -- proliferation of human-subsidized predatory mammals such as raccoons and coyotes, spread of the imported red fire ant, invasion of non-native trees and shrubs, increased human disturbance, pollution, scarcity of adequate nesting substrate, erosion and subsidence.

III. LOCAL LEVELS

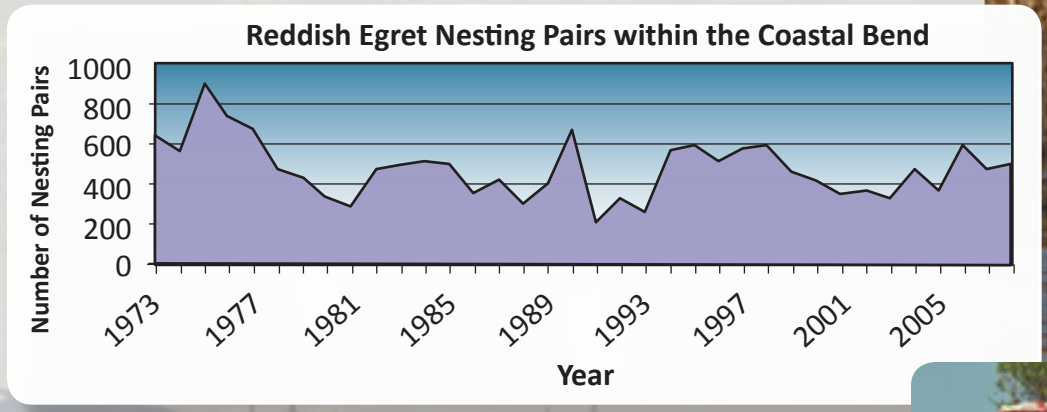
The effort to obtain accurate estimates of nesting waterbird populations began in earnest in 1973 with the Texas Colonial Waterbird Survey, which continues today. This has provided a long-term database, which is helpful in determining trends at the state level, and the effects of specific management actions at the individual island level.

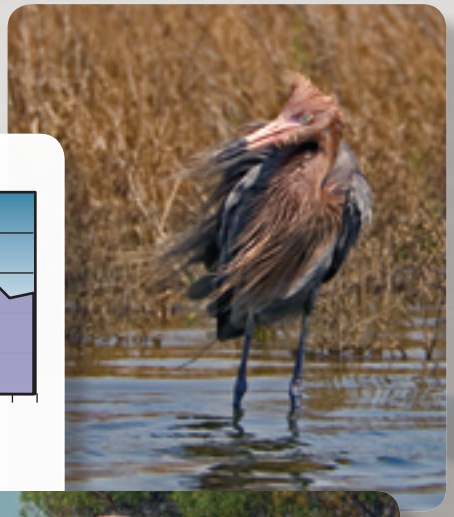
Analysis of data from 1973-2008 show that of 14 species for which the Coastal Bend hosts at least 25% of the state's coastal population, seven showed significant decreases (great blue heron, great egret, tricolored heron, snowy egret, black-crowned night-heron, black skimmer, gull-billed tern), while three showed significant increases (American white pelican, brown pelican, laughing gull). However, more recent short-term data shows that in the past 5 to 10 years, some of these trends may be reversing for some species.





It is thought that suitable nesting habitat is the most limiting factor for most of the waterbird species in the area. Increased and focused management efforts have been underway to improve that habitat over the past 5 to 10 years by US Fish & Wildlife Service, Texas Parks & Wildlife Department, Coastal Bend Bays & Estuaries Program, Audubon Texas, The Nature Conservancy, and local academic institutions.





IV. REFERENCES

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FOCUS QUESTION 5:

Are habitats for fish and wildlife increasing or decreasing?

What was measured: Acres of seagrass communities, acres of saltwater marsh, acres of freshwater marsh, number of rookery islands

Answer: Overall, seagrass communities are increasing along the Texas Coastal Bend. The Bureau of Economic Geology recorded 29,096 acres of seagrass in 1950 and 45,329 acres in 2004. The Texas Coastal Bend estuarine marshes are also increasing due to relative sea-level rise, where estuarine marsh spread into areas previously occupied by tidal flats. Coastal Bend palustrine (freshwater) marshes are decreasing due to island development, agricultural practices on the island, drier conditions and the landward movement of the salt/freshwater boundary.

There are currently around 185 rookery islands in CBBEP area and most have been eroding away at varying rates.

INDICATOR #14: Seagrass coverage.

Condition/Trend: Good/Improving

Good

I. BACKGROUND

Submerged seagrass meadows are a dominant, unique subtropical habitat in many Texas bays and estuaries. These marine plants play critical roles in the coastal environment, including nursery habitat for estuarine fisheries, a major source of organic biomass for coastal food webs, effective agents for stabilizing coastal erosion and sedimentation, and major biological agents in nutrient cycling and water quality processes.

Five seagrass species occur in Texas. These species represent highly specialized marine flowering plants (but not actually true grasses) that grow rooted and submersed in the higher salinity waters of most Texas bays and estuaries.

Propeller scars within turtle seagrass bed.

Seagrasses were determined to be worth $9,000 to $28,000 per acre for commercial, recreational, and storm protection functions in Texas. The importance of seagrasses is that they are highly productive plant communities that provide habitat and forage for fish and wildlife, stabilize coastal sediments, and decrease wave energy. The biodiversity and productivity of seagrass meadows are directly linked to coastal economies.

The three state agencies with coastal resource management responsibility for seagrasses are the TCEQ, TGLO, and TPWD. These three agencies collect substantial amounts of coastal data and monitor status and trends of seagrasses along the Texas coast.

II. CONCERNS

Seagrasses, like all green plants, must have sunlight to grow. Disturbances to seagrass meadows can be natural, such as hurricanes, algal blooms, or high runoff from rivers during floods. Man-made seagrass meadow disturbances include: dredging and filling, nutrient loading, and propeller scarring. 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. Prop scars on an individual basis may seem minimal compared to other threats, but when multiplied by the thousands become a serious impact as well.

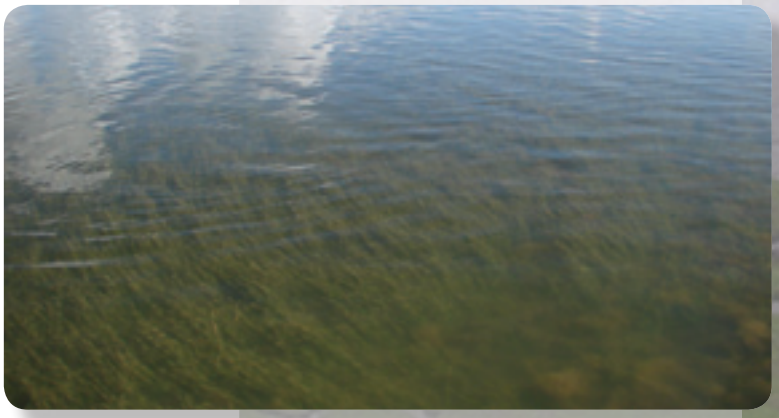
III. LOCAL LEVELS

For the combined Redfish Bay, Harbor Island, and Mustang Island segments of the Nueces estuary system, total seagrass bed area may appear fairly stable over 40 years, but this conclusion ignores the dynamic cycles in localized seagrass bed changes. Overall, a net increase occurred in total area for the system between 1958 and 1994 (1,981 acres). This gain was due primarily to the large expansion of seagrass into the Harbor Island complex between the late 1950s and 1975 (84% or 2,500 acres) and along Mustang Island (33% or 926 acres) between 1974 and 1994. The simultaneous 13.3% decrease (1,324 acres) and accompanying bed fragmentation in seagrass beds noted for Redfish Bay over the period from the late 1950s to 1994, suggest that seagrass conditions should be interpreted with caution for the entire system.

Dredging of Redfish Bay in the 1960s not only resulted in a loss of about 1,324 acres of seagrasses, turbidity associated with dredging Redfish Bay, Harbor Island, and the back side of Mustang Island for oil and gas exploration resulted in blanketing seagrass habitats with sediments and subsequent disappearance of seagrasses.

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 Island: Coastal Bend," overall seagrass communities are increasing along the Texas Coastal Bend. BEG recorded 10,297 acres of seagrass in 1950 and 20,752 acres in 2004. The conversion of tidal flats to seagrass beds is a result of a relative rise in sea level plus subsidence.

In a report completed in 2008 by the Bureau of Economic Geology titled "Status and Trends of Inland Wetland and Aquatic Habitats in the Corpus Christi Area," the BEG found that in 2004 a total of 24,577 acres of seagrasses were present within the estuarine systems of Corpus Christi and Aransas Bay. Seagrass is most extensive in the Corpus Christi Bay/Estuary, followed closely by Redfish Bay. In Redfish Bay, TPWD created a State Scientific Area, in order to develop seagrass protection measures.



Undisturbed Seagrass Meadow.

According to the 2008 BEG Report, seagrasses increased in total area during each period (1950's–1979 and 1979–2004), with a total net gain of 5,777 acres from the 1950's through 2004. Approximately 87% of this gain occurred from 1979 through 2004. The geographic area with the largest increase in seagrasses is Corpus Christi Bay; other areas experiencing an increase in seagrasses are Lamar Peninsula, Live Oak Peninsula, Port Bay, and Oso Bay. Expansion frequently occurred in areas previously mapped as tidal flats and open water.

IV. REFERENCES

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INDICATOR #15: Saltwater marsh.

Condition/Trend: Good/Improving

I. BACKGROUND

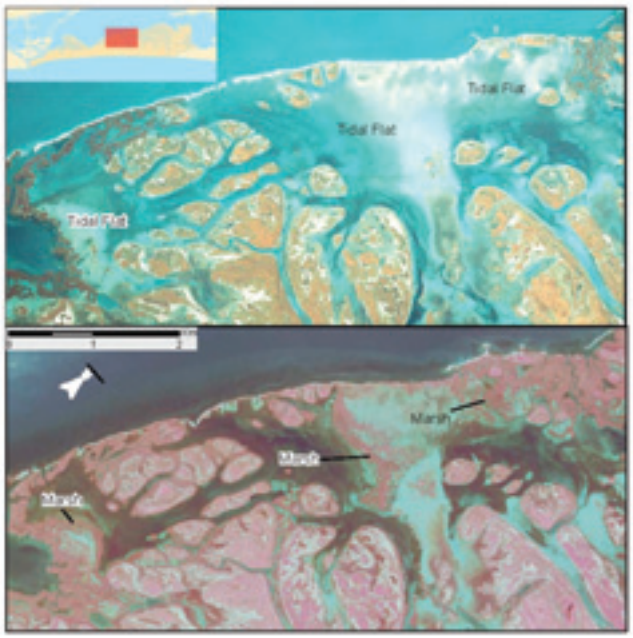
Saltwater marshes, also known as tidal marshes or estuarine marshes, are important habitats of the Texas Coastal Bend estuaries; functioning as nursery and foraging areas for wildlife, filtering water-borne contaminants, stabilizing sediments, protecting shorelines, and reducing floods. Marshes are also 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.

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 into waters of the U.S. The Texas General Land Office also regulates and permits projects associated with saltwater marshes. 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.

II. CONCERNS

Historically, marsh areas were not recognized as being a necessary part of the interconnected ecological system and were aggressively converted to agricultural lands, canals or filled in to create dry land. Now marsh areas are better understood and appreciated for their role in flood control, water quality, and wildlife habitat. Many state and federal incentives have been created to help conserve, restore, and create wetlands.



Spread of estuarine marsh into tidal flats on San Jose Island from 1979 (top) through 2004 (bottom).

Today, concerns that persist are: filling marsh for commercial development, public infrastructure, dams, and conversion of marsh for farming. Sea level rise and subsidence are the most recent developments being discussed that can change habitat types over a long period of time.

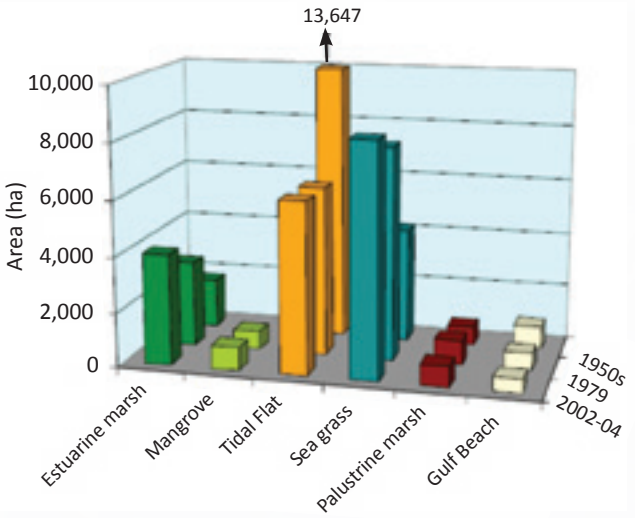
It is important to conserve the Coastal Bend marshes due to the ecological and economic values they bring to the area.

III. 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 a total of 9,906 acres of estuarine marsh existed, as well as scrub/shrub wetlands (primarily mangroves) which had a total area of 2,068 acres.

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 BEG study, Texas Coastal Bend barrier island estuarine marshes are increasing due to the expansion of marsh into low flats and into former uplands.

In a report completed in 2008 by the Bureau of Economic Geology titled "Status and Trends of Inland Wetland and Aquatic Habitats in the Corpus Christi Area," the BEG found a total of 26,728 acres of estuarine marsh within the estuarine systems of Corpus Christi and Aransas Bay in 2004.



Area distribution of major habitats in the Texas Coastal Bend barrier islands study area in the 1950s, 1979, and 2002-04.

Mouth of the Aransas River

Estuarine marshes, combined with scrub/shrub, increased in total area during the period 1950s–1979 and decreased in total area during the period 1979–2004, with a total net gain of 4,831 acres from the 1950s through 2004. The primary change was the result of relative sea-level rise, where marshes spread into areas previously occupied by tidal flats.

	1950s	1979	2004
Habitat	**acre**	**acre**	**acre**
Estuarine Marsh	26,230	36,647	36,634
Mangrove	not mapped	1,642	2,068

Total area of saltwater marshes in the 1950s, 1979, and 2004 in the estuarine systems of Corpus Christi Bay and Aransas Bay and the Coastal Bend Barrier Island complex.

IV. REFERENCES

- Tremblay, T., Vincent, J., and Calnan, T. March 2008. Status and Trends of Inland Wetland and Aquatic Habitats in the Corpus Christi Area. Bureau of Economic Geology. 101pp.
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INDICATOR #16: Freshwater marsh.

Condition/Trend: Good/Degrading

I. BACKGROUND

Fresh to brackish water marshes found on the Texas coast are unique features of the barrier island system. These marshes were formed as the barrier island grew seaward, and the series of swales that were left behind from the building of sand ridges form 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 survive.

Although ephemeral in nature, these wetlands play an important role in the barrier island ecosystem. 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.

The Army Corps of Engineers is also responsible for protecting certain freshwater wetlands in the same way as the saltwater wetlands.

II. CONCERNS

	1950s	1979	2004
Habitat	**acre**	**acre**	**acre**
Palustrine Marsh	22,611	19,785	15,801

Total area of palustrine marshes in the 1950s, 1979, and 2004 in the estuarine systems of Corpus Christi Bay and Aransas Bay.

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.

Mullen's Bayou, Refugio County

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.

III. 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.

According to BEG during 2004, North Padre Island had the largest amount 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.

According to the 2006 BEG study, 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 Bureau of Economic Geology 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/yr.

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 long-term drought 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.

Palustrine wetland along channel in Live Oak Ridge

IV. REFERENCES

- Tremblay, T., Vincent, J., and Calnan, T. March 2008. Status and Trends of Inland Wetland and Aquatic Habitats in the Corpus Christi Area. Bureau of Economic Geology. 101pp.
- White, W., Tremblay, T., Waldinger, R., and Calnan, T., 2006. Status and Trends of Wetland and Aquatic Habitats on Texas Barrier Islands Coastal Bend. Bureau of Economic Geology, 64 pp.

INDICATOR #17: Rookery islands.

Condition/Trend: Poor/Degrading

Improvement Needed

I. BACKGROUND

Colonial-nesting waterbirds within the coastal zone require islands for breeding that provide suitable nesting structure (such as shrubs for wading birds, bare ground for terns, etc.), are free from predators and disturbance sources, and are relatively close to feeding areas. Rookery islands, in contrast to barrier islands, are typically smaller and free from predators. Rookeries in the Coastal Bend 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 exist within the Coastal Bend region that have at some time in the last 30 years been used by nesting waterbirds.

Portland Causeway Island with Nesting Platforms

II. CONCERNS

Human presence and development on the coast have significantly altered the historical ecology of colonial waterbirds. 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/gas development. Large islands are typically unsuitable for nesting by waterbirds because they support permanent populations of predators such as raccoons and coyotes. Most rookery activity takes place on smaller islands or ones which have been aggressively managed to remove predators.

Erosion has led to the complete loss of several islands, and the partial (and ongoing) loss of almost all others. 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 rookery island shorelines, and a net loss of island area.

An increasing number of bay users, primarily recreational fishermen, create an additional stress to nesting birds. Especially when they are unaware of, or unconcerned with, the effects of their disturbance on nesting birds. Human disturbance can lead to egg and chick death, or even complete colony abandonment.

One of the best ways to address the loss of rookery islands is the creation of new , strategically located islands. New Island, in Nueces Bay, was created in 2001 and has provided several thousand pairs of birds a nesting opportunity in subsequent years. Island creation projects are expensive however, requiring extensive engineering, permitting, dredging, and equipment mobilization.

III. LOCAL ROOKERY ISLAND INVENTORY

There are currently around 185 islands in the CBBEP area, as identified in the Colonial Waterbird and Rookery Island Management Plan, from the northern extent of the Land Cut in the Upper Laguna Madre northward to Aransas Bay. In the past 10 years, one island (New Island in Nueces Bay) has been created, a few such as Pelican Island (Corpus Christi Bay) have received dredge deposits and a breakwater to provide erosion protection. Most other rookery islands have been eroding away at varying rates. Some have lost functionality as rookeries, most likely due to recreational activites and human disturbance, especially in Redfish Bay. In some cases, disturbance appears to have led to the loss of most species on an island while the more tenacious laughing gull (a human-subsidized species) has persisted.

Nesting Platforms

Incised bank due to erosion of southeast-facing shore of Causeway Island, Nueces Bay (November 2007)

Black Skimmers Nesting

Pelican Island in Corpus Christi Bay. The breakwater was constructed to provide erosion protection.

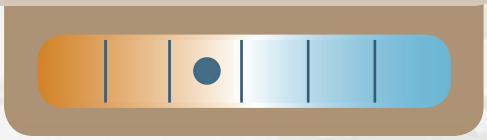
IV. REFERENCES

- Chaney, H., and Blacklock, G. April 2005. Colonial Waterbird and Rookery Island Management Plan. Coastal Bend Bays & Estuaries Program. 303 pp.

FOCUS QUESTION 6:

Are freshwater inflows adequate to maintain a healthy bay system?

What was measured: Freshwater inflows and Corpus Christi Bay system salinity levels



Answer: Maybe, because the freshwater inflows have been altered and managed. Studies are underway to determine the health of the bays and estuaries based on inflows and salinity.

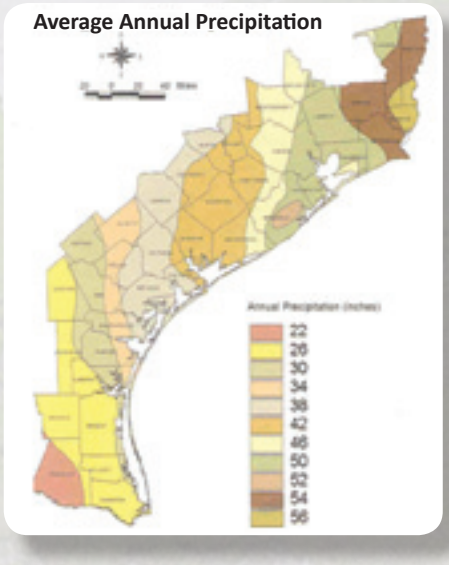
INDICATOR #18: Quantity and timing of freshwater inflows.
Condition/Trend: Good/Stable

I. BACKGROUND

The flow of freshwater into a bay system from its watershed (drainage areas to a particular body of water) helps to ensure that necessary salinity, nutrient, and sediment loading are adequate in order to maintain productivity of economically and ecologically important species. Sources of freshwater inflows entering into 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.

Nueces River Watershed

The Nueces River is one of the largest contributors of freshwater into our local bays and estuaries. Because of the altered freshwater inflows into Nueces Bay due to the Choke Canyon and Lake Corpus Christi Reservoirs, it is necessary to regulate inflows with "pass through" requirements that allow a certain amount of freshwater flow into the Nueces River each month.



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

II. CONCERNS

Natural fluctuations in 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) 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 living in the bays.

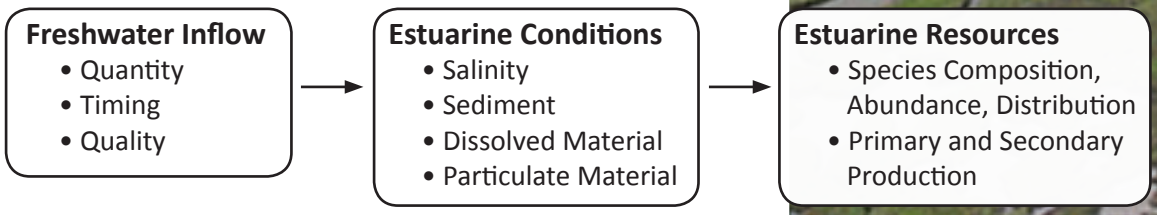
III. LOCAL FRESHWATER INFLOW LEVELS

When looking at the distribution of freshwater inflow into the Coastal Bend bays, there is a definite trend of less rain from north to south. While scientific work continues to determine the amount and location of monthly inflows needed, recommendations were made in 1991 that developed the current target levels of annual freshwater inflows to the bay system. Since the "pass through targets" attempt to mimic the natural freshwater inflow cycle into the Corpus Christi Bay system, there is a greater chance of maintaining a healthy estuary for fish and wildlife, as well as its human inhabitants.

Pass Through Targets (AcFt)				
Month	Capacity<=70%	40%<= Capacity<=70%	30%<= Capacity<=40%	Capacity<=30%
January	2,500	2,500	1,200	0
February	2,500	2,500	1,200	0
March	3,500	3,500	1,200	0
April	3,500	3,500	1,200	0
May	25,500	23,500	1,200	0
June	25,500	23,000	1,200	0
July	6,500	4,500	1,200	0
August	6,500	5,000	1,200	0
September	28,500	11,500	1,200	0
October	20,000	9,000	1,200	0
November	9,000	4,000	1,200	0
December	4,500	4,500	1,200	0

Choke Canyon/Lake Corpus Christi Reservoirs pass through targets measured in Acre Feet for the Nueces River which the City of Corpus Christi is required to follow:

Wesley Seale Dam



Freshwater Inflow cause and effect diagram.

IV. REFERENCES

- Asquith, W. H., Mosier, J.G., and P.W. Bush. 1997. Status, Trends, and Changes in Freshwater Inflows to Bays Systems in the Corpus Christi Bay National Estuary Program Study Area. Corpus Christi Bay National Estuary Program. 48 pp.
- City of Corpus Christi. 2007. Frequently Asked Questions About Water Related Issues In Corpus Christi. http://www.cctexas.com/?fuseaction=main.view&page=2841
- Nueces River Authority. 2007. Basin highlights report. Report prepared in cooperation with the Texas Commission on Environmental Quality Clean Rivers Program. Corpus Christi, 82 pp.

INDICATOR #19: Bay salinity levels (within desired target ranges).

Condition/Trend: Good/Stable

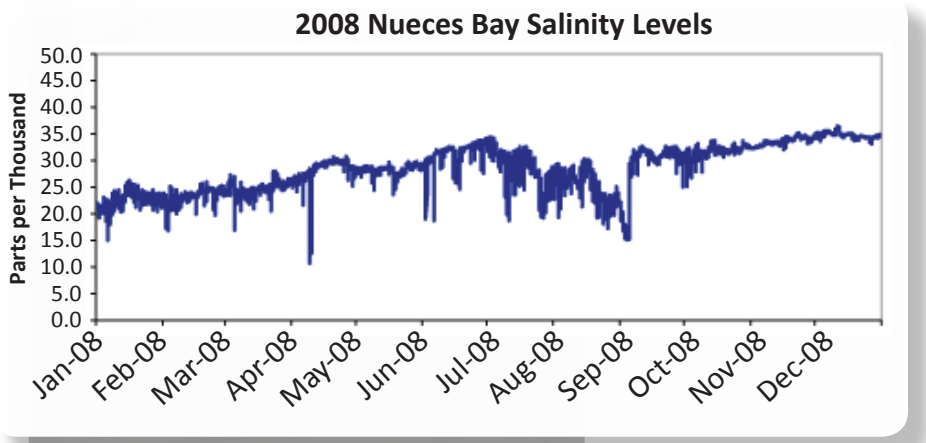
Improvement Needed

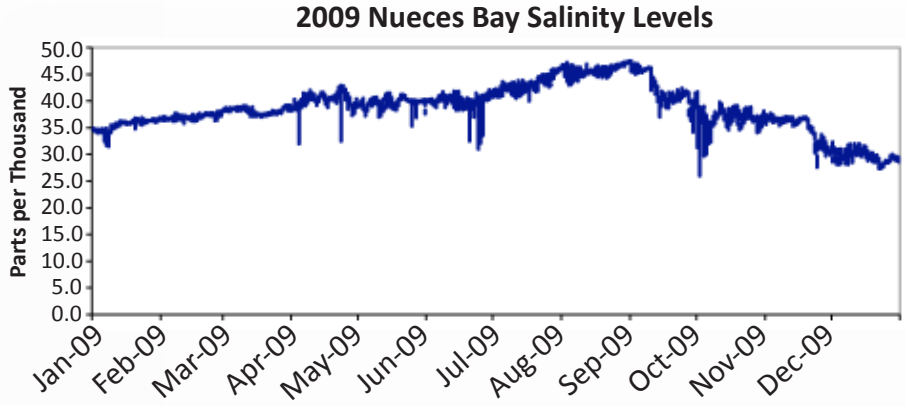
I. BACKGROUND

Salinity is a measure of how much sea salt is contained in a unit of water. The Gulf of Mexico coastal seawater is relatively constant at about 35 parts sea salt per thousand parts water by weight. Salinity of freshwater is near zero. Therefore, most of the salinity variations in the estuary are responses to river inflow, evaporation and mixing by winds and ocean tides.

The ability of resource agencies to manage fish, wildlife and freshwater supplies to the Corpus Christi Bay estuary requires an integrated knowledge of the relations between the organisms and their environment. The salinity of the water, and particularly its seasonality patterns, affect which aquatic species can survive. In short, salinity is a fundamental property of the estuary that determines its biological characteristics.

The Texas Water Development Board has been recording salinity levels since 1987 for the various bays around the Coastal Bend. The Conrad Blucher Institute's Division of Nearshore Research at Texas A&M University-Corpus Christi maintains salinity monitoring stations within the Corpus Christi Bay system and posts a salinity relief check page that is updated daily. The site can be accessed at http://lighthouse.tamucc.edu/Salinity/HomePage.





II. 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. When freshwater runoff from the Nueces Watershed is scarce, as in dry years, a proportionally greater amount of available freshwater from the estuary is needed for human use as well as for salinity control.

In order to relieve some salinity stress from within the estuary, salinity pass through targets were developed, based on historical salinity levels, in attempts to mimic natural salinity levels within the bay system. In simple terms, if salinity is too high, freshwater is released to lower salinity levels. When salinity is too low, the City of Corpus Christi gets a Salinity Relief Credit which allows for less freshwater pass through entering into the bay system, allowing salinity levels a chance to increase back to normal levels.

III. LOCAL LEVELS

Salinity gradients along the Texas Coastal Bend bays from the upper to lower regions are a normal feature. Salinity measured within each bay system such as the San Antonio Bay may be as low as zero parts per thousand (ppt), while values as high as 70 ppt may occur in Baffin Bay and the Upper Laguna Madre.

The Corpus Christi Bay system, which receives runoff from urban areas in addition to Nueces River inflow, experiences lower average salinities than the southern region of the Coastal Bend area with an average salinity in 2008 of around 28 ppt compared to an average salinity of 39 ppt in 2009 for Nueces Bay. 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. By keeping salinities within this target range, fish, wildlife, and plants will be less stressed and more productive.

The City of Corpus Christi receives 500 acre feet per month return flow credit for all return flows into Nueces Bay and possibly one of the following: up to half of the monthly target from flows exceeding the freshwater inflow requirement of the previous month or the salinity relief credit when the salinity in Nueces Bay is low.

Salinity Relief Credit Chart

Months	Salinity Lower Bounds	Salinity Upper Bounds	Reduction for Average Salinity		
			5 psu below SUB	10 psu below SUB	15 psu below SUB
January	5	30	25%	50%	75%
February	5	30	25%	50%	75%
March	5	30	25%	50%	75%
April	5	30	25%	50%	75%
May	1	20	0%	25%	75%
June	1	20	0%	25%	75%
July	2	25	25%	50%	75%
August	2	25	25%	50%	75%
September	5	20	0%	25%	75%
October	5	30	0%	25%	75%
November	5	30	25%	50%	75%
December	5	30	25%	50%	75%

Measuring salinity using a refractometer.

IV. REFERENCES

- City of Corpus Christi. 2007. Frequently Asked Questions About Water Related Issues In Corpus Christi. http://www.cctexas.com/?fuseaction=main.view&page=2841
- Conrad Blucher Institute – Division of Nearshore Research. 2010. Nueces Bay Salinity. http://lighthouse.tamucc.edu/Salinity/HomePage

HOW YOU CAN HELP...

Estuaries are an important component of the complex and dynamic coastal watershed. The economy of many coastal areas relies on the natural beauty and bounty of estuaries. When those natural resources are imperiled, so are the livelihoods of the many people who live and work along the coast. As our population grows, the demands imposed on our natural resources increase. Protecting these resources for all their natural, economic, and aesthetic values becomes even more important.

People have an impact on the quality and health of our bays and estuaries. From learning more to watching what goes down storm drains, we have an opportunity to help take better care of our waterways. Examine your everyday activities and think how you can make a difference. Here are some suggestions and tips.

☑ **Join a local environmental group such as Coastal Bend Bays Foundation (www.baysfoundation.org) , Sierra Club (www.sierraclub.org), Audubon (www.coastalbendaudubon.org) or Surfrider Foundation (www.surfrider.org). Attend meetings, lectures and festivals to learn more about local environmental issues.**

☑ **Use native plants or plants with low-maintenance needs for landscaping.**

☑ **Limit fertilizer use to only what's needed, as excess can cause water quality issues.**

☑ **Water your lawn conservatively.**

☑ **Plant trees and shrubs to prevent erosion and promote infiltration of water into the soil.**

☑ **Keep litter, pet waste, leaves and grass clippings out of street gutters and storm drains to keep them from ending up in estuaries and bays.**

☑ **Never put household, automotive or gardening waste into storm drains.**

☑ **Keep septic systems in good working order.**

☑ **Replace any dripping or leaking faucets or pipes and install water-saving devices in showers and toilets.**

☑ **Properly dispose of hazardous materials at approved service stations or designated landfills.**

☑ **Keep a respectful distance from birds and wildlife, especially bird rookery islands during nesting season. Use binoculars for observation. Don't allow your dog to chase birds and other wildlife.**

☑ **Practice catch and release fishing. Releasing fish helps with population recovery.**

☑ **Maintain your boat and vehicle to prevent leaks and energy inefficiencies.**

☑ **Reduce your energy consumption to keep nitrogen and toxic pollutants from entering estuaries and bays through exhaust emissions. Examples include unplugging seldom-used appliances, unplugging chargers when not charging, turn off the lights when you leave the room, use compact flourescent bulbs, and buy energy-efficient appliances.**

CBBEP attributes its successes to collaboration and cooperation of its many partners:

U.S. Environmental Protection Agency
Texas Commission on Environmental Quality
Port of Corpus Christi
City of Corpus Christi
Port Industries of Corpus Christi
San Patricio County
Nueces County
Aransas County
City of Aransas Pass
City of Ingleside
City of Portland
City of Port Aransas
City of Rockport
and many others

The Coastal Bend Bays & Estuaries Program is a non-profit organization dedicated to protecting and restoring bays and estuaries in the 12-county region of the Texas Coastal Bend. The views expressed in this report belong to the CBBEP and do not necessarily reflect those of our partners.

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For more information, visit www.cbbep.org

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