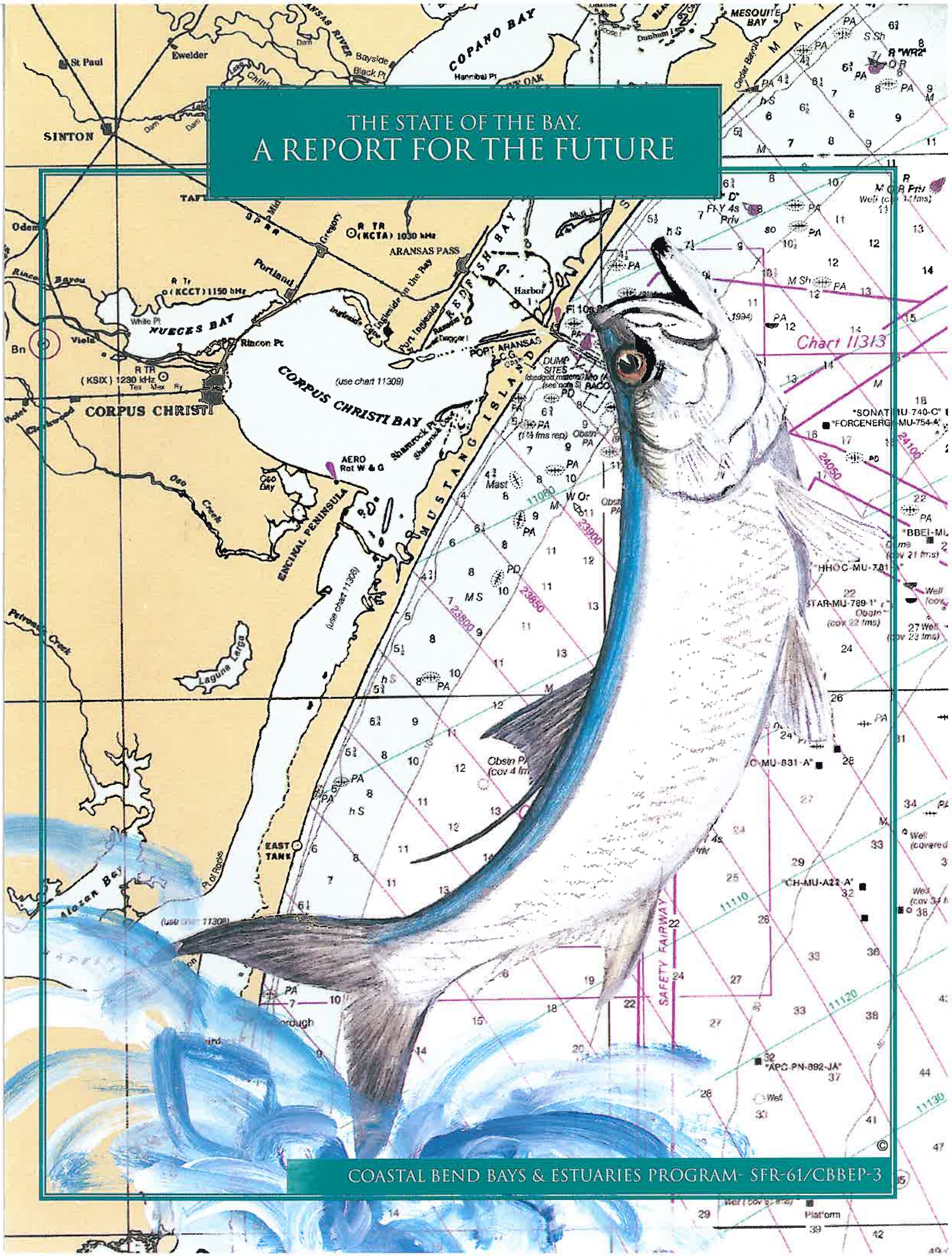

THE STATE OF THE BAY.
A REPORT FOR THE FUTURE
COASTAL BEND BAYS & ESTUARIES PROGRAM- SFR-61/CBBEP-3
©

The National Estuary Program was established by the Clean Water Act Amendments of 1987 to protect nationally significant estuaries threatened by pollution, development, and overuse. National Estuary Programs combine the knowledge and talents of citizen and technical advisors, senior governmental officials and staff, and elected officials (working through a Management Conference) to develop sound scientific information about the estuary and to promote effective management solutions to identified problems. The Coastal Bend estuaries were selected for inclusion in the elite ranks of this 28-member national program in October 1992.

During the first year of the program, the Management Conference identified a list of priority issues that affect not only the health of the estuaries, but also the regional economy and the region's high quality of life. Potential issues were discussed by more than 300 people in 13 public meetings held around the region. Six of the priority issues were confirmed through this process and one additional priority issue, public health, was added as a result of public comment. The seven priority issues are altered freshwater inflows, loss of wetlands and other estuarine habitats, condition of living resources, degradation of water and sediment quality, altered estuarine circulation, bay debris, and public health issues.

A draft Management Plan (the Coastal Bend Bays Plan) was released for public review in early 1998 and a revised plan is expected to be approved in late 1998. This plan identifies the recommended actions developed, through a consensus-based process, to address the priority issues and their contributing factors.

The Coastal Bend Bays Plan, along with more than 30 technical characterization reports which serve as the information base for this report, was prepared under the auspices of the Corpus Christi Bay National Estuary Program. The Program's name was changed to the Coastal Bend Bays & Estuaries Program in recognition of the wider geographic area described herein as the "project area".

Editor: G. Joan Holt
Scientific Writing: Sharon Herzka, Joan Holt, Scott Holt, Robert Ricklis
Technical Writing and Editing: Ginger Webster
Illustrations: Dinah Bowman
Graphic design: Pat Marince, Chris Colton
Photo Credits: Leon Loeb, Jim Maloney, Pat Marince

THE STATE OF THE BAY:
PREFACE

Estuaries, the transition zone between fresh and salt water, provide a vast array of services to the Coastal Bend human population, as well as a home and food for a huge percentage of our fish and shrimp during some stage of their lives. Many of our diverse plants and wildife use these waters for a home and food as well. Because of their great productivity, Coastal Bend estuaries support prime commercial and recreational fishing activities for both residents and visitors. They also provide many other valuable services like water purification, storm protection, and education. In addition to all these services, Coastal Bend estuaries are used for other recreational activities, such as swimming and boating, and for commercial activities, such as marine transportation, oil and gas production, business and residential development. These varied uses of our estuaries and their resources influence the way the estuaries function and their ability to sustain productivity.

Along the Texas coast there are seven major estuaries. Three of these estuaries -- the Aransas, Corpus Christi, and upper Laguna Madre -- are in the 12 county region known as the Coastal Bend. The Coastal Bend is home to over 540,000 people, representing about three percent of the population of Texas. Over time, human use of the Coastal Bend's land and water resources for economic and recreational activities has changed the natural environment, and even stressed the environment in some areas.

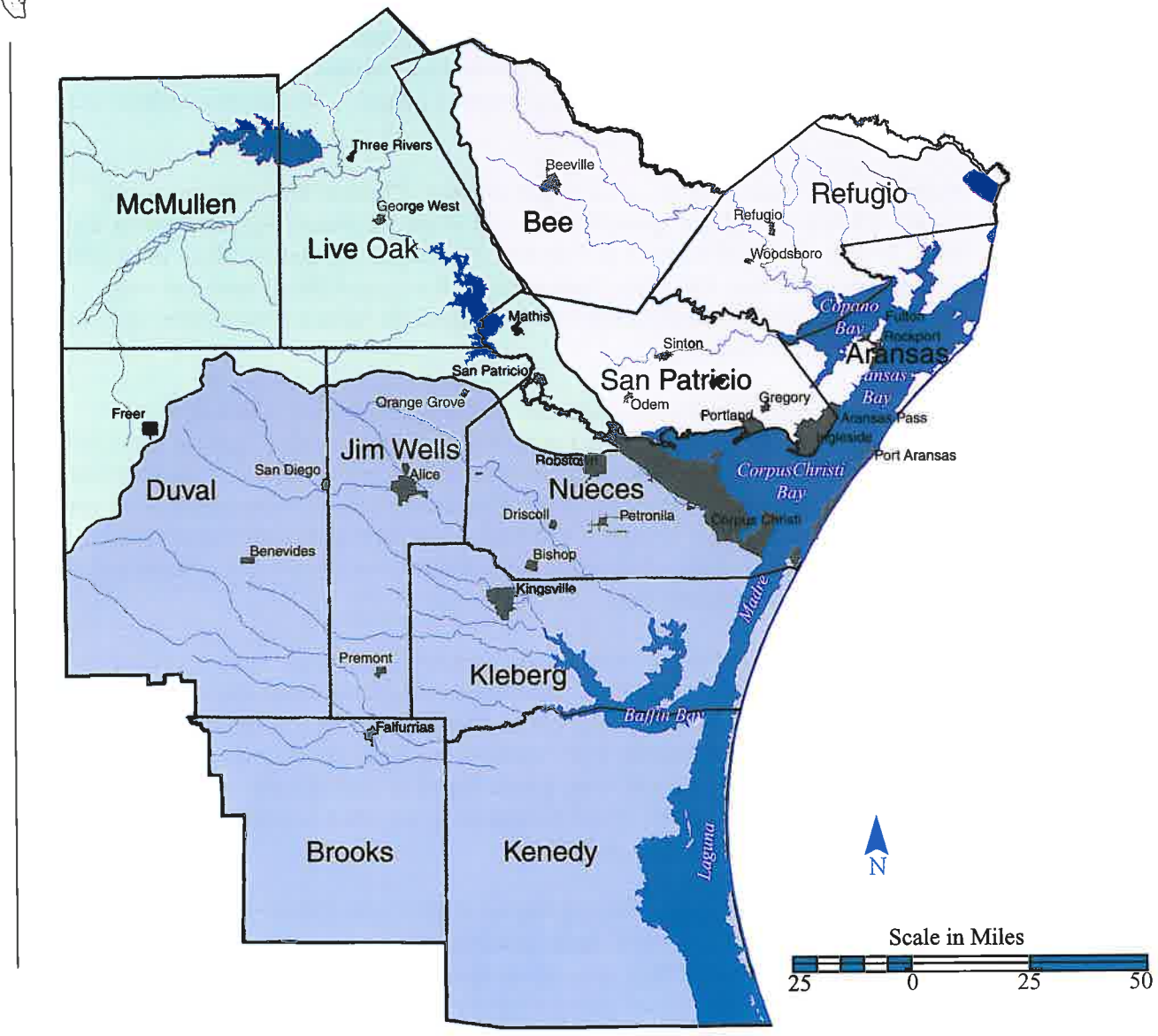
The dredging of the ship channel and inner coastal waterway and damming of the Nueces, Frio, and Atascosa Rivers have resulted in profound changes in water flows in the estuaries and associated habitats. Agricultural activities have sometimes led to erosion of the land and to increases in pesticides and nutrients in the estuaries. The installation and maintenance of oil and gas pipelines have disrupted aquatic habitats. Other uses of the land and water resources can cause problems as well. For example, boating and bay shrimping can disturb bay bottoms and the organisms that depend on this environment.

An increasing number of visitors results in an increased demand for more public access points so people can use the beaches and bays. However, increased bay usage threatens habitat integrity and imperils the natural resources that attract visitors to the area in the first place. The challenge for the Coastal Bend community is to continue to provide for the many important uses of the estuaries and their natural resources while protecting these resources for many generations to come. This is one reason that citizens of the Coastal Bend launched an initiative to designate the region as a National Estuary Program site.

The following chapters explore the rich history of the Coastal Bend region, from before the first settlers through today. The natural characteristics of the bays and estuaries of the Coastal Bend region are described, including their physical structure, diverse habitats, and luxuriant plant and animal life. The extent of historic and current human impacts are summarized. Additionally, the economic, public health, and ecological issues as researched and defined by the Coastal Bend Bays & Estuaries Program (CBBEP) are presented. Most of the information presented in this State of the Bay is taken from technical reports prepared for the CBBEP and are available from the CBBEP office.

THE COASTAL BEND BAYS & ESTUARIES: MAP

The Coastal Bend Bays & Estuaries Program (CBBEP) project area is made up of a network of bays and rivers in the 12 counties of the Coastal Bend area of South Texas. The CBBEP encompasses the area from the eastern edge of Mesquite Bay in the north to the southern limit of "The Hole", or the northern edge of the land cut in Laguna Madre. It is bounded on the east by four barrier islands: Matagorda, San Jose, Mustang, and Padre Islands. Only one major pass, the Aransas Pass, connects the estuary system to the Gulf of Mexico.



Legend

- San Antonio - Nueces Coastal Basin
- Nueces River Basin
- Nueces - Rio Grande Coastal Basin

CONTENTS

Published and distributed by the
Texas Natural Resource Conservation Commission
Post Office Box 13087
Austin, Texas 78711-3087
SFR-61

THE STATE OF THE BAY: A SUMMARY OF FINDINGS

Habitat and Living Resources

The type and distribution of habitats in the Coastal Bend bays have significantly changed over the past century due to natural phenomena and human activities. Wind-tidal flats have declined the most, losing more than 24,710 acres during this time. Intertidal marsh losses in some areas have been offset by substantial gains in other areas. The total area of bay bottom covered by seagrass beds has increased substantially since the first surveys in the late 1950s. Seagrasses in Coastal Bend bays now represent about 40 percent of all seagrasses in Texas. Seagrass coverage in some areas has declined, however, due to motorboat propeller scarring and shading caused by plankton blooms and algal growth.

The most recent list of the living resources found in the Coastal Bend bays and marshes includes at least 835 species of plants and 2,340 species of animals. Since many small and inconspicuous animals have not been identified, the actual number of species may be as high as 5,000. There are 19 species of plants and animals in the Coastal Bend that are threatened or endangered.

The Coastal Bend is one of the richest sources of fisheries in Texas, providing over 28 percent of the state's commercial harvest of finfish, shrimp, crabs, and other aquatic species each year. There is evidence, however, of declines in populations of pink and brown shrimp, adult blue crabs, Atlantic croaker, and Gulf menhaden. Populations of other species, such as spotted seatrout and red drum, have increased over the past several decades, largely as a result of fisheries management practices.

Over 490 species of birds have been recorded in the Coastal Bend. This enormous diversity is attributed to the availability of numerous habitats, and to the geographical location of the Coastal Bend within a major migration route. Several species are in serious decline in the Coastal Bend, however, including the great egret, snowy egret, and Forester's tern.

Red tide and brown tide have caused biological and economic damage in recent years. The causes of these excessive growths of algae are not clear.

Freshwater Resources

Freshwater inflow to the estuaries comes from the Nueces River basin and from other streams and rivers that flow into the Coastal Bend bays. The region is drought-prone with infrequent occurrences of excess rainfall events, thus freshwater inflow into the system is of critical concern.

Annual flow from the Nueces River declined by 55 percent over the past 60 years. This change in flow is associated primarily with reduced inflows to the Nueces basin and construction of Lake Corpus Christi and Choke Canyon Reservoir. Overall, there has been a 19 percent reduction in freshwater inflow to all the Coastal Bend estuaries. At present, the Aransas Estuary receives about 53 percent of the total 1.2 million acre-feet of freshwater inflow to the region. The Corpus Christi Estuary currently receives 35 percent of the total inflow, while the upper Laguna Madre receives about 12 percent.

Low freshwater inflow rates and high evaporation rates combine to produce a 50 month freshwater replacement rate for the Corpus Christi Estuary, which is quite long relative to other estuaries throughout the nation. This means that the estuary is not well flushed and is potentially more sensitive to wasteloads, including pollutants. In addition, warm water temperatures and high salinities result in low oxygen levels that are only slightly above the state water quality standard (5 parts per million), established to avoid physiological stress to living resources. Thus, the estuary has little capacity to absorb additional pollutants without harm.

Human Uses

Tourism and bay-related activities clearly impact the Coastal Bend economy, providing nearly 25 percent of area jobs. Sport-fishing, bird watching, and windsurfing together contribute over $90 million a year to the local economy. Over the last 20 years, the Coastal Bend's recreational fishery contributed about 28 percent of the total catch from all Texas Bays.

The growing number of bay users, however, is putting increased pressure on the natural resources of the Coastal Bend and has resulted in losses of critical habitats and reductions in animal populations. Residential and industrial developments have led to the conversion of about 17 percent of natural beach and marsh shoreline into hardened shorelines with bulkheads, riprap, and other solid structures.

Public health threats from water contact or consumption of local seafoods are not significant at the present time. However, oysters from Nueces Bay and blue crabs from Redfish and Baffin Bays have elevated tissue levels of several heavy metals, suggesting the need for additional monitoring to ensure seafood safety.

Maritime Commerce and Dredging

Both vessel traffic and the volume of freight transported within the estuaries of the Coastal Bend have increased substantially over the past two decades. More than 90 percent of this cargo is oil and petrochemicals. Spills of these hazardous materials have been substantially reduced since enactment and enforcement of the Oil Pollution Act of 1990.

Dredging is a necessary and ongoing activity to maintain navigable waterways in the Coastal Bend estuaries. There is, however, a lack of consensus about the beneficial or adverse effects of dredging projects and the disposal of dredged material.

Water and Sediment Quality

Water and sediment quality within the Coastal Bend estuaries is generally good to moderate but some areas of fair to poor quality have been identified. The Inner Harbor has the highest levels of many pollutants including metals, PCBs, organic contaminants, and fecal coliforms. Nueces Bay has consistently high metal concentrations in both the sediment and water column. Zinc levels appear to be increasing in some regions of the bays and are 10 times higher in the Inner Harbor sediment than in portions of the Houston Ship Channel. Trends in concentrations of other metals cannot be determined from the available data. It is unlikely that metal contaminants in the bays pose a threat to aquatic life.

Most identifiable or "point source" loadings of pollutants are found in the central portion of the Coastal Bend bays, primarily in Nueces and Corpus Christi Bays, while the upper bays receive the least. However, pollutants from these sources have decreased over the past 25 years.

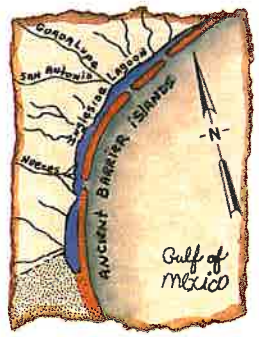
Urban and agricultural runoff and airborne pollutants, often from far away sources, all contribute to what is known as "nonpoint source" pollution. The central bays receive most of the urban runoff while the upper bays receive much of the agricultural runoff. Chemicals in the water from these sources are found at levels more-or-less typical of other Texas bays. The highest concentrations of the common pesticides are found in Baffin and Copano Bays, but concentrations do not exceed standards. Sediments from some urban storm drain outfall sites have elevated levels of contaminants, are toxic to sensitive life stages of test organisms, and have a low diversity of bottom dwelling organisms.

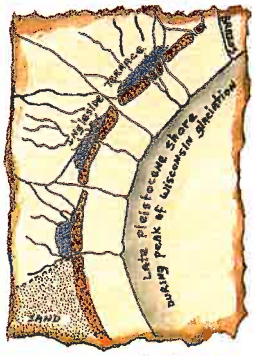

Canadian R.
Cherokee Indians
Little Rock
ARKAN
South Fork
TERRITORY
Choctaw Indians
Red R.
Washington
Fulton
prairies
T E X A S
Whaco Ind
Nacogdoches
Cumanches Ind
F. del Norte
Apaches Mescaleros
CHIHUAHUA
S. Diego
S. Pablo
Rio Grande
Monclova
BOLSON DE MAPIMI
Aguaverde
Laredo
Revilla
Mier
Salt L.
Goliad
Victoria
Matagorda
Galveston In.
West Pass
Matagorda B.
Aransaso In. & B.
COAHUILA
NEW LEON
TAMAULIPAS
Parras
L. Cayman
S. Fernando
Baquillas
Cerradas
Charcoal Fur.
Bar of Santander
Sierra de Palma
Bar of Tarda
Diego Bar.
S. Barbara
Tampico
Escandon
Llera
ZACATECAS
Sombrerete
Nombre de Dios
DURANGO
S. Lucia
S. Andres
Teresa
S. Juan
S. Diego
S. Antonio
Santiago
Aguas Calientes
Pochotitan
Tepic
JALISCO
Lagos
SAN LUIS POTOSI
Valles
G U L F

THE STATE OF THE BAY:
A STORY OF CHANGE

"The estuary is the point where man, the sea -- his immemorial ally and adversary -- and the land meet and challenge each other."

(U.S. Department of the Interior, National Estuarine Pollution study, November 1969)



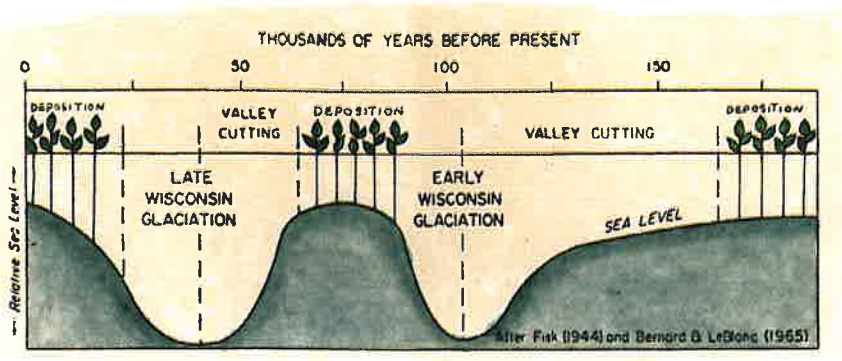


Within the 12 county Coastal Bend area of Texas, there are three estuarine systems (the Aransas, the Corpus Christi, and the upper Laguna Madre), which include 25 bays. These estuaries have evolved over the last several thousand years, and the natural environment as we know it today is the product of dynamic geological and ecological change. Because, historically, human settlements have thrived in areas which provided a suitable living place and abundant resources, the chronology of settlement in the Coastal Bend has been intimately linked to periods when natural changes in the environment favored colonization.

At the peak of the last Ice Age (called the "Pleistocene" by geologists), around 18,000 B.C., much of the world's water supply was captured within massive continental glaciers. Hence, the coastal estuaries as known today did not exist. Sea level was 300 feet or more below its present position, and the Gulf shoreline was far east of its modern location. As global temperatures warmed toward the end of the Pleistocene, around 16,000 B.C., glacial ice began to melt causing the sea level to rise. Geologic studies show that, by 7,000 B.C., the rising sea had begun to flood the river valleys along the Texas coastline, creating the early forms of the Coastal Bend estuaries as well as the other major estuaries and bays currently found along the Texas coast.

The modern estuarine system evolved over the next few thousand years as sea level continued to rise at a slower rate. Between 7,000 and 1,000 B.C., sea level rose unevenly. Periods of stable or slowly rising sea level alternated with times of rapid rise. Recent geologic studies suggest sea level was relatively stable between about 6,000 and 5,000 B.C., again between 4,000 and 2,500 B.C., and finally during the last 3,000 years or so, when the sea has been at about its present level.

The major time frames during which prehistoric people lived along the shores of the Coastal Bend are roughly the same as those periods when sea level was relatively stable. This is probably because stable sea level tends to favor an abundance of aquatic life. The gradual accumulation of clay, sand, and silt on bay bottoms formed broad areas of shallow-water vegetation and marshes. Decaying plant material in these areas contributed organic nutrients important for sustaining life in the estuaries. With abundant nutrients, the bays and lagoons could support large populations of crustaceans, mollusks, and fish, which would have pro-



vided a rich source of food for prehistoric peoples.

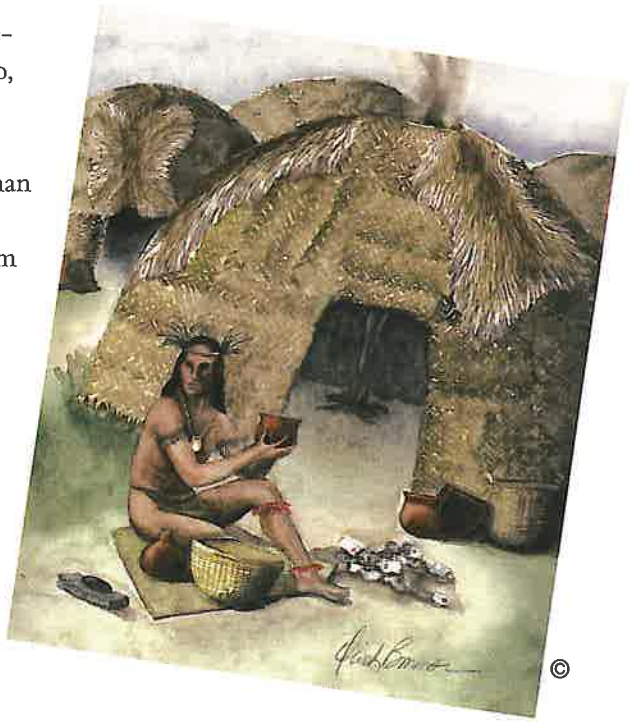
The Archaic Period

Archaeological studies at sites around Corpus Christi and Nueces Bays show that prehistoric Native Americans camped along the shorelines as early as 5,500 B.C. This period of occupation is known as the "Archaic" Period. In Texas, the Archaic Period lasted until the appearance of the bow and arrow and pottery between about 500 and 800 A.D.

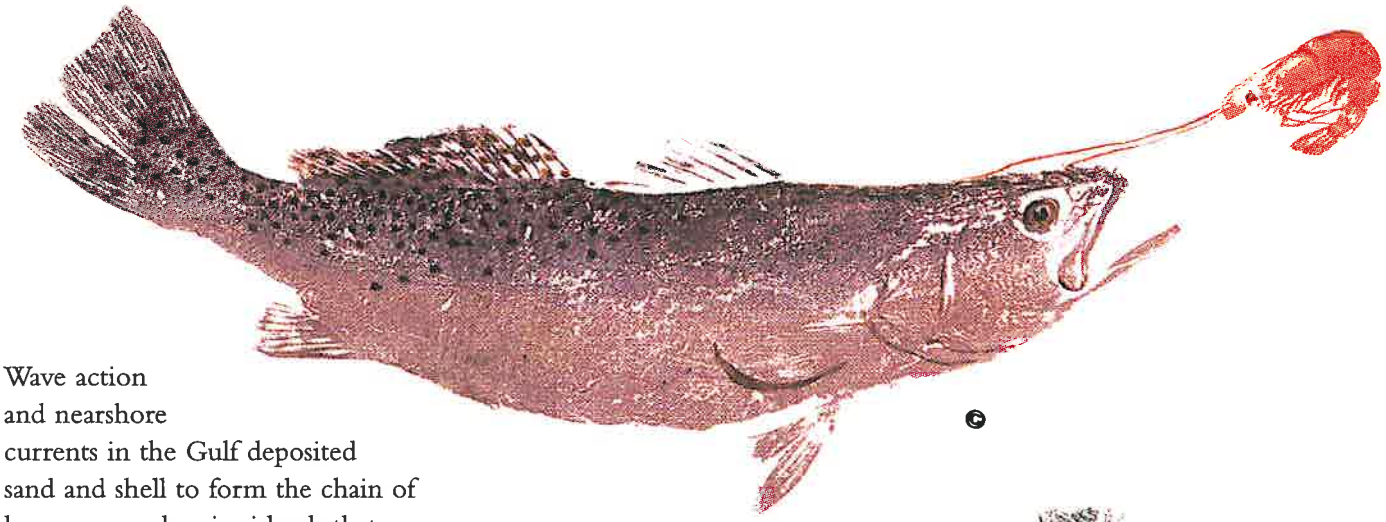
Based on the lack of archaeological sites, there was little human presence in the Coastal Bend between 4,800 and 4,000 B.C. Geologic evidence suggests that sea level may have been rising rapidly at this time. The food-rich shoreline shallows would have been inundated and too small in area to offer an abundance of resources for prehistoric peoples. However, for the subsequent 1,400 years or so, until 2,500 B.C., the shorelines were once again attractive to human settlement. Archeological sites from this period typically contain dense deposits of discarded shells of oysters and Rangia flexuosa clams. There is also evidence of fishing, as indicated by the remains of black drum, red drum, spotted seatrout, Atlantic croaker, and saltwater catfish.

A gap in archeological evidence of shoreline settlement occurred again between about 2,500 and 1,000 B.C. There is geologic evidence for rapid sea level rise during this period. Once again, the vegetated shallows and marshes important for production of nutrients may have been greatly reduced in area. Consequently, the food resources necessary to favor the residence of sizeable numbers of people were absent.

By around 1,000 B.C., sea level had stabilized close to its modern position and the estuarine environment began to resemble its present form. In fact, without the sprawl of today's commercial and residential development, the Coastal Bend bay system would look much like it did during the days of the Karankawa Indians, the first settlers.



©



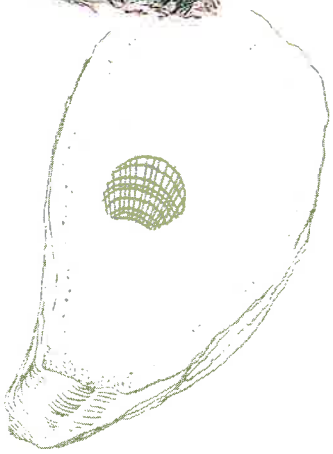
Wave action and nearshore currents in the Gulf deposited sand and shell to form the chain of long, narrow barrier islands that are a prominent feature of today's coastline. Behind the barrier islands, river-borne sand, silt, and clay sediments partially filled the bays and lagoons, creating broad shallow water areas and supporting marshes along bay shorelines and around the head of Nueces Bay and the Nueces River Delta. The plant communities in these areas provided a rich source of organic nutrients as a food source. The broad, vegetated shallows became ideal protective nursery areas for the young of many of the fish and shrimp species that have historically abounded in the bays and lagoons. A growing reliance on fish by prehistoric people is shown by dramatic increases in the numbers of fish remains found in archaeological sites dating about 2,000 years ago. As the estuaries became an increasingly rich source of food, the population of coastal Indian groups increased, as shown by larger campsites with thicker deposits of camp debris than in earlier times.

The Late Prehistoric Period

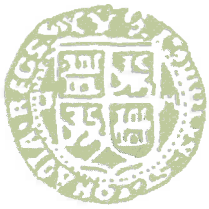
The Late Prehistoric Period began around 800 to 1,000 A.D. Native American people, notably the Karankawa Indians, began to acquire new technologies. The bow and arrow replaced the dart and spear as the main hunting weapon. Pottery, a technology introduced from the north, was commonly used.

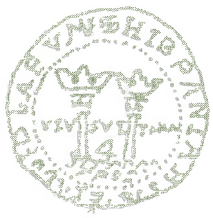
During the Late Prehistoric Period, the rich resources of the estuaries were of great importance to native peoples. Fish bones are found in tremendous quantities on archaeological sites, indicating that species such as black drum, red drum, spotted seatrout, and Atlantic croaker had become important dietary staples. Large numbers of perforated oyster shells, probably used as net weights, suggest that fish were commonly harvested in nets. Shellfish such as oyster, lightning whelk, and bay scallop were gathered. Bones of deer and bison indicate that hunting of game animals was also common.

Large shoreline fishing camps were occupied mainly from the fall through the winter and early spring. This seasonal presence of fishing camps may be related to the fall and winter early spring spawning cycles of red and black drum, large fish species which would have been abundant in the bays during their reproductive season. During the spring and summer, much of the population left the shorelines to set up hunting camps along the lower



The wreck of LaSalle's ship, the Belle, was discovered in Matagorda Bay's murky waters more than 300 years after LaSalle's ill fated mission to reach the Mississippi by sea. Another French ship L'Aimable, found just this year, was part of the colonization effort by La Salle. With 300 French colonists aboard, L'Aimable went aground off Matagorda Island in 1685. Fearing further French settlement, the Spanish authorities in New Spain (Mexico) built a series of missions and presidios. The earliest mission near the coast was Espiritu Santo, which unsuccessfully attempted to convert the Karankawas to Christianity.





reaches of the Nueces River and other streams flowing into coastal bays. Studies of animal bone refuse at these sites show that the main sources of meat at hunting camps were white-tailed deer and buffalo.

The Early Historic Period

The first European to leave a record of native life on the Texas coast was Cabeza de Vaca, who was shipwrecked and marooned on the upper part of the coast in 1528, possibly at Galveston Island. Cabeza de Vaca's account states that native people lived on this island during the fall and winter, subsisting mainly on fish and plant roots gathered from the lagoonal waters on the back side of the island. In the spring, the Indians moved to the mainland, where they gathered oysters from the shoreline, and probably hunted and gathered plants as well.

The Karankawa Indians were encountered by various European explorers and Spanish missionaries and soldiers beginning in the late 1600s. Early records indicate that these Indians had detailed knowledge of their environment and its resources. Dugout canoes were made for transportation on the rivers, bays, and lagoons behind the barrier islands, although they were unsuitable for travel in the open sea. The bow and arrow was used for hunting and even some fishing.

European Colonization

The French were the first Europeans to colonize the Texas central coast region, beginning with La Salle's Fort St. Louis settlement (near Matagorda Bay) in 1685.

After many years of conflict between the Karankawas and the Spanish colonists, a treaty of peace was concluded in 1790. Historical documents indicate that this was the beginning of some 40 years of peace and alliance between the two parties. In fact, the final Spanish mission of Nuestra SeÒora del Refugio, established in 1795 at the site of present-day Refugio, Texas, became a focal point for conversion of many Karankawas to Christianity. The peaceful interaction between the Karankawas and the Spanish colony ended abruptly when the revolution in Mexico expelled Spanish authority and the newly formed Mexican government grant-

ed large tracts of land to cattle ranchers. By the 1850s, the Karankawas had been driven from their homeland, and many probably fled to northern Mexico. Over the next two decades, the Karankawas disappeared.

The Wartime Years

Between 1834 and 1835, as Texas struggled for independence from Mexico, there were skirmishes and battles throughout the Coastal Bend region. Although the revolution ended in 1836, the border between Texas and Mexico -- between the Nueces River and the Rio Grande -- was under dispute for many years. In 1839, a small lucrative trading post was founded on the site of present day Corpus Christi, considered the furthermost outpost of both Texas and Mexico.

During the 1840s and 1850s, the main concerns in the region were Indian attacks and commerce. An interest in improving commerce resulted in several unsuccessful attempts to deepen the pass into Corpus Christi Bay. The citizens of the region also failed in their attempt to petition the U.S. government to base troops in the area to provide protection from the Indians.

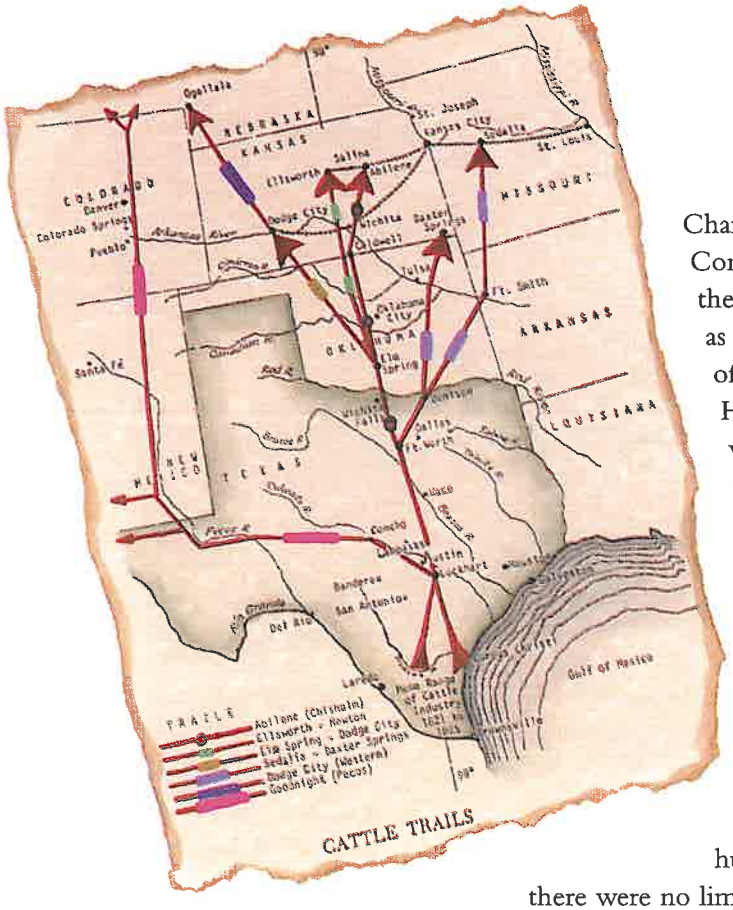
By the time of the Civil War, the region was firmly behind the southern cause, even though slavery was not very prevalent. This position seems to have been an outgrowth of the lack of federal government response to petitions for protection and support. During the Civil War, the Union successfully blockaded the Texas coast, including entry into Corpus Christi Bay. This resulted in the opening of a Confederate overland highway of trade between East Texas and Mexico.

Early ranchers received vast tracts of land as grants from the Mexican or Spanish governments. Among these ranches were the King Ranch (headquartered in Kleberg County), the O'Connor Ranch (headquartered in Refugio County), the Welder Ranch (headquartered in Refugio County), and the Coleman-Fulton Pasture Company (later the Taft Ranch) (headquartered in San Patricio County).

The Late 1800s

The reconstruction period following the Civil War was a time of lawlessness in the region. It was also during this time that the cattle industry flourished, stimulated by the unregulated growth of herds during the War. Tanning and tallow factories sprang up along the coast between Corpus Christi and Galveston. Cattle were so numerous that many were slaughtered for their hides alone, leaving their carcasses to rot in city streets.

The city of Rockport was founded in 1866 and provided the first cattle pens and a wharf. The first hide and tallow factory in Rockport was built in 1867, and the city grew to become the center of commerce in the region. In 1888, Rockport was twice the size of Corpus Christi, and the



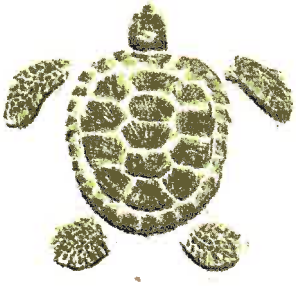
Chamber of Commerce advertised the future Rockport as the "Coming City of 200,000 people". Hides and tallow were shipped via schooner; over 300,000 hides were shipped from Rockport and Corpus Christi in 1872.

The sand flats were a hunter's paradise; there were no limits on ducks, geese, cranes, and other waterfowl. Egg-hunting expeditions brought in thousands of bird eggs. A news report said of one weekend foray: "crane, shear-water, pelican, snipe, duck, dove, mockingbird, etc." Boston and New York milliners advertised premium prices for heron plumes, egret plumes, and alligator skins, as well as for feathers and skins from sea birds of all species, blue jays, yellow hammers, silver grey herons, white pelicans, and swans.

A hurricane in September 1874 was a harbinger of things to come for those who would build their homes and businesses on a low lying sandspit. The 1874 storm wrecked the Corpus Christi bayfront, destroying structures and boats along the main street, Water Street.

The arrival of the railroad and the ice plant business enabled fresh fish and game to be shipped to far points and boosted fishing to a major industry. The Corpus Christi Caller reported in 1892: "Fishermen have been getting rich in quick order. On Saturday, the fish boats made one haul near the reef and captured 20,000 pounds, which netted them $750".

Between 1865 and 1900, local governments undertook several public works projects. Deepening the channel into Corpus Christi became a hot local political issue which was resolved in 1874 by increasing the channel depth to eight feet. In 1891, Corpus Christi had telephones, telegraph service, two railroads, two fine hotels, an electric system was pending, and the economy was booming. In the late 1890s, however, a financial panic gripped the country and the Eastern money that had fueled the boom dried up. Progress on public works projects was stymied. For example, the dredge broke down on Mustang Island and, for lack of spare parts, was swallowed up by the sands of the barrier island.



In 1894, the total marine harvest for Aransas, Refugio, and Nueces Counties was approximately 3 million pounds, including fish, oysters, and sea turtles, valued at approximately $115,000.

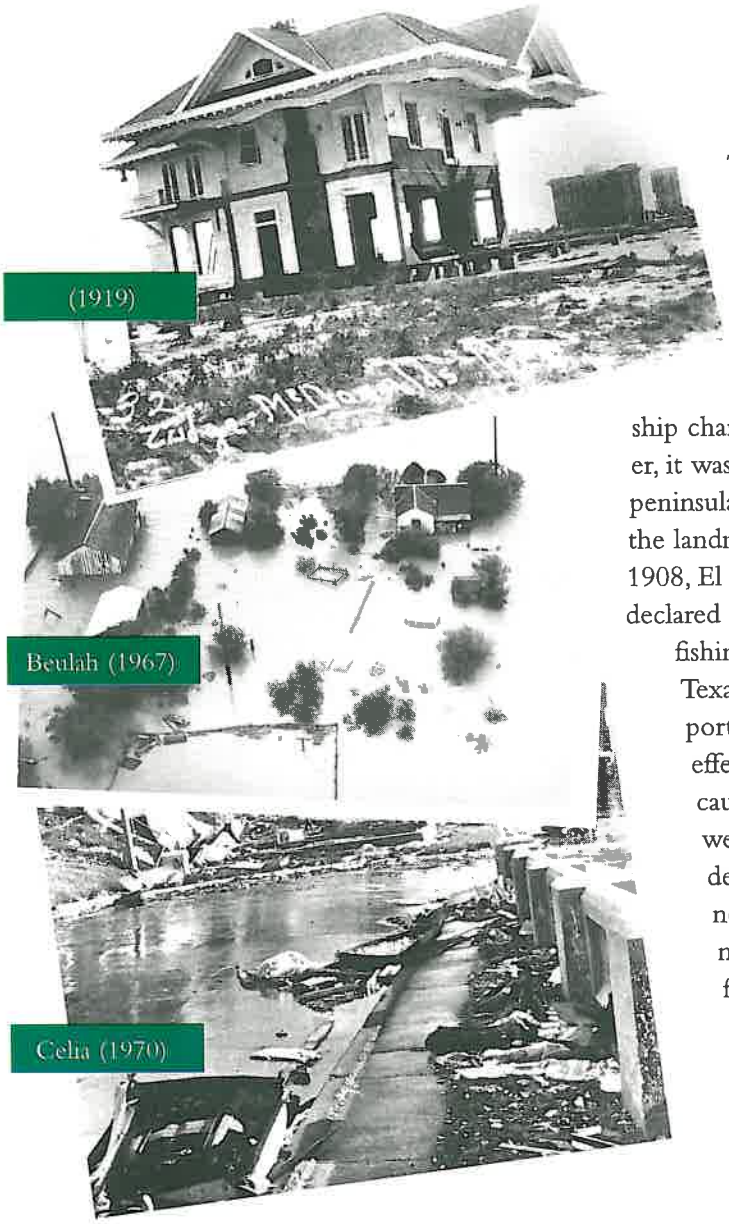
Crossing the oyster reef from Portland to Corpus Christi circa 1900.

The 20th Century: Human Development and Impacts

"We all like to congregate," he went on, "at boundary conditions. Where land meets water. Where earth meets air. Where body meets mind. Where space meets time. We like to be on one side and look at the other." (Mostly Harmless, Douglas Adams, Crown Publishers Inc.)

Corpus Christi in 1900 was an unusual combination of cowtown and coastal village. Rockport was still the center of commerce for the region and its population had grown from a few hundred settlers to over 35,000 people. The primary industries were cattle, cotton, and shipping. However, both natural and human related events would change the relationship between Rockport and Corpus Christi, starting with a hurricane in 1919 which virtually destroyed Rockport.

While courting the farmer, Corpus Christi promoters did not overlook the tourist. The city was billed as an all year seaside resort, "where the weary can come for rest, the invalid come for health, and the gay devotee come for pleasure". It was surely a paradise for sportsmen; no piece of promotional literature was complete without pictures of shotgunners festooned with dozens of ducks, a gigantic tarpon towering over a man with a rod, or long stringers of trout.



(1919)

Beulah (1967)

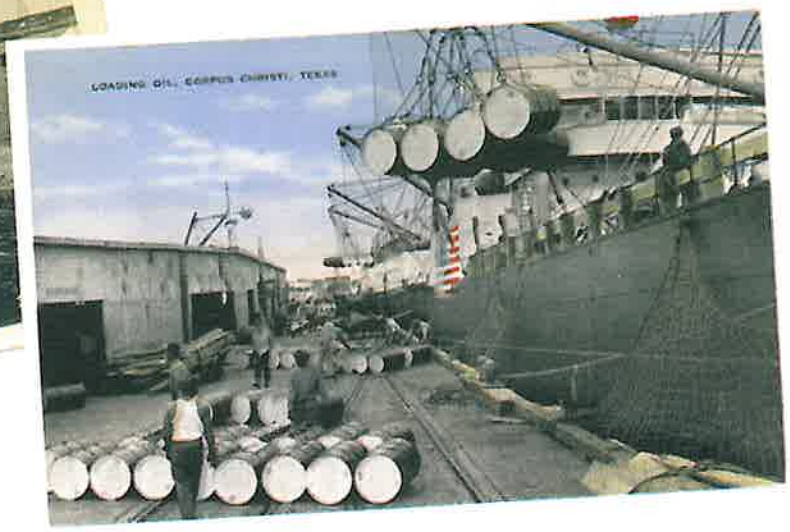
Celia (1970)

Today, Corpus Christi Beach is an island, connected to the city by Harbor Bridge, which was constructed over the ship channel. Once, however, it was El Rincon, a peninsula jutting out from the landmass of the city. In 1908, El Rincon was declared to have the best fishing waters along the Texas coast. The transportation system was so effective that fish caught in the morning were often at their destination by afternoon. Four companies were packing fish and oysters. In 1907 alone, one million pounds of fish and 10 million oysters were shipped.

A municipal administration elected in 1913 under Mayor Roy Miller began the transformation of Corpus Christi into a modern city. Within 3 years, the administration paved 12 miles of streets, laid 26 miles of storm and sanitary sewers, installed a modern water system, built a new city hall and municipal wharf, and installed a paid fire department.

In 1922, Corpus Christi was selected under the Federal Rivers and Harbor Act as the location for a "safe and adequate harbor" for this area of Texas.

The 1926 dredging of the ship channel and opening of the Port of Corpus Christi ushered in an era of rapid growth for the region -- wharves, oil docks, warehouses, storage tanks, manufacturing facilities, and other industrial plants were built.



By 1930, the changes in Corpus Christi were evident. The cowtown had fulfilled its promise to the farmer and homeseeker; for example, in 1930, Nueces County was the top cotton producing county in the United States. The coastal village had become a modern city as well as a seaport. The area's great natural gas supplies and oilfields had been tapped and the first large industrial plant would be built in three years. Seawall construction and dredging extended the shoreline from present-day Water Street to Ocean Drive. In the early 1940s, the Gulf Intracoastal Waterway was constructed from Galveston to Corpus Christi, enabling large volumes of bulk commodities to be shipped and received at relatively low cost. The link to Brownsville was constructed a decade later.

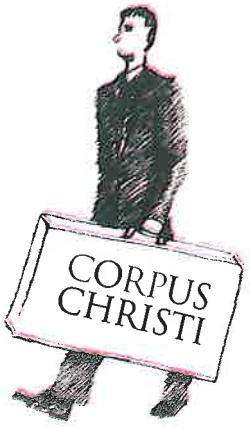
There was an increase in fishing and a decline in oystering. During the early and mid 1900s, tarpon drew tourists from around the world and Port Aransas, first known as Tarpon, was a fishing mecca for this fish. Today, tarpon are rarely caught in the area. There has been much speculation about what might have contributed to the loss of the tarpon and other species but, to date, scientists do not have a definitive answer. Decreasing freshwater inflows, increased use of pesticides, habitat loss, and overfishing have all been suspected as causes for the decline.

By the mid-1960s, the years of intense growth and change had been replaced with decidedly slower growth and little change. However, five economic sectors had risen to prominence in the region: agriculture, oil and gas production, manufacturing and port related transportation, government activities (largely national defense), and the visitor industry.

Today's Economy

Today, over 540,000 people live within the 12 county region of the Coastal Bend. By the year 2050 close to a million people will call the Coastal Bend home.

In Texas, tourism is a $23 billion a year business, the third largest industry in the state. Tourism



Corpus Christi's population increased from 10,522 in 1920 to 27,410 in 1930 and was destined to double again in each of the two following decades.

A profitable and sustainable nature tourism industry is dependent upon an enduring nature resource base.

generates more than $250 million annually in the Coastal Bend. Nature related tourism is the fastest growing component of the growing tourist industry.

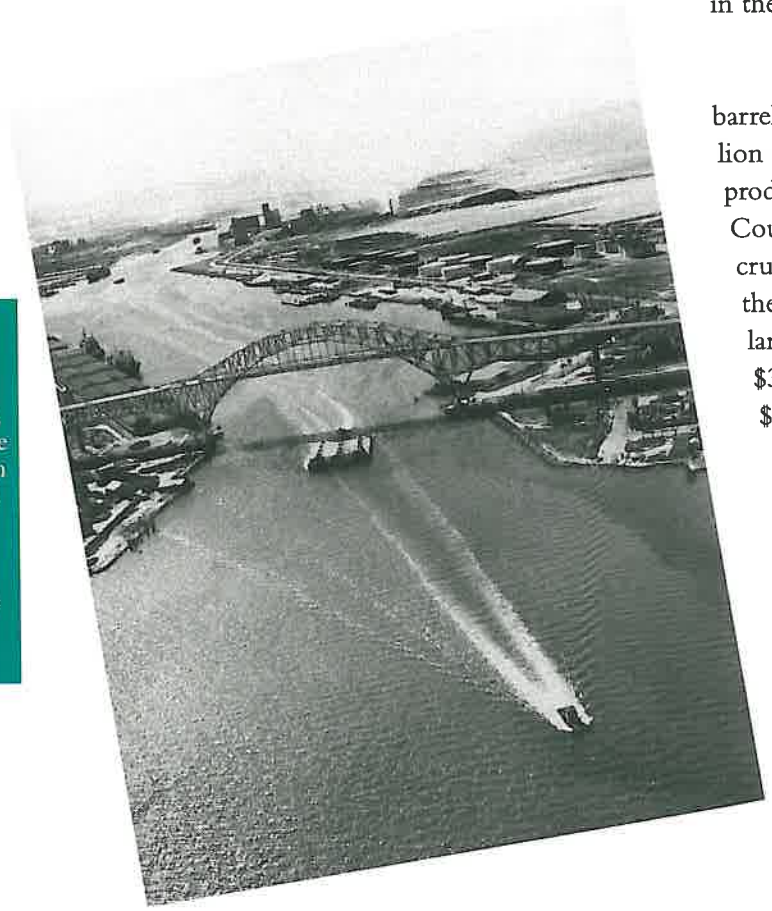
Nature tourists are travelers who spend their time and money enjoying and appreciating a broad range of outdoor activities that have a minimum impact on the environment.

For a combination of reasons, including regulatory controls, the total landings of commercial finfish have dropped from three million pounds in 1977 to less than one million pounds per year since 1984.

During this same period, the total pounds of shrimp landed in the region have increased 400 percent.

The Port of Corpus Christi, the nation's sixth largest, generates over $1 billion of revenue for related businesses. Dredging to a depth of 45 feet was completed in 1990.

Of the approximately 100 estuaries around the nation, the Coastal Bend ranks fourth in agricultural acreage. Row crops (cotton, sorghum, and corn) and livestock generated $480 million in 1994, with a statewide economic impact of $1.6 billion. In 1993, there were 4,500 ranches supporting 280,000 head of cattle in the Coastal Bend.



The Corpus Christi Port (the nation's 6th largest) generates over $1 billion of revenue for related businesses, more than $60 million in state and local taxes, and more than 31,000 jobs for Coastal Bend residents. A total of 6,618 vessels traveled through the Port's channels in 1994. That same year, total tonnage exceeded 77 million.

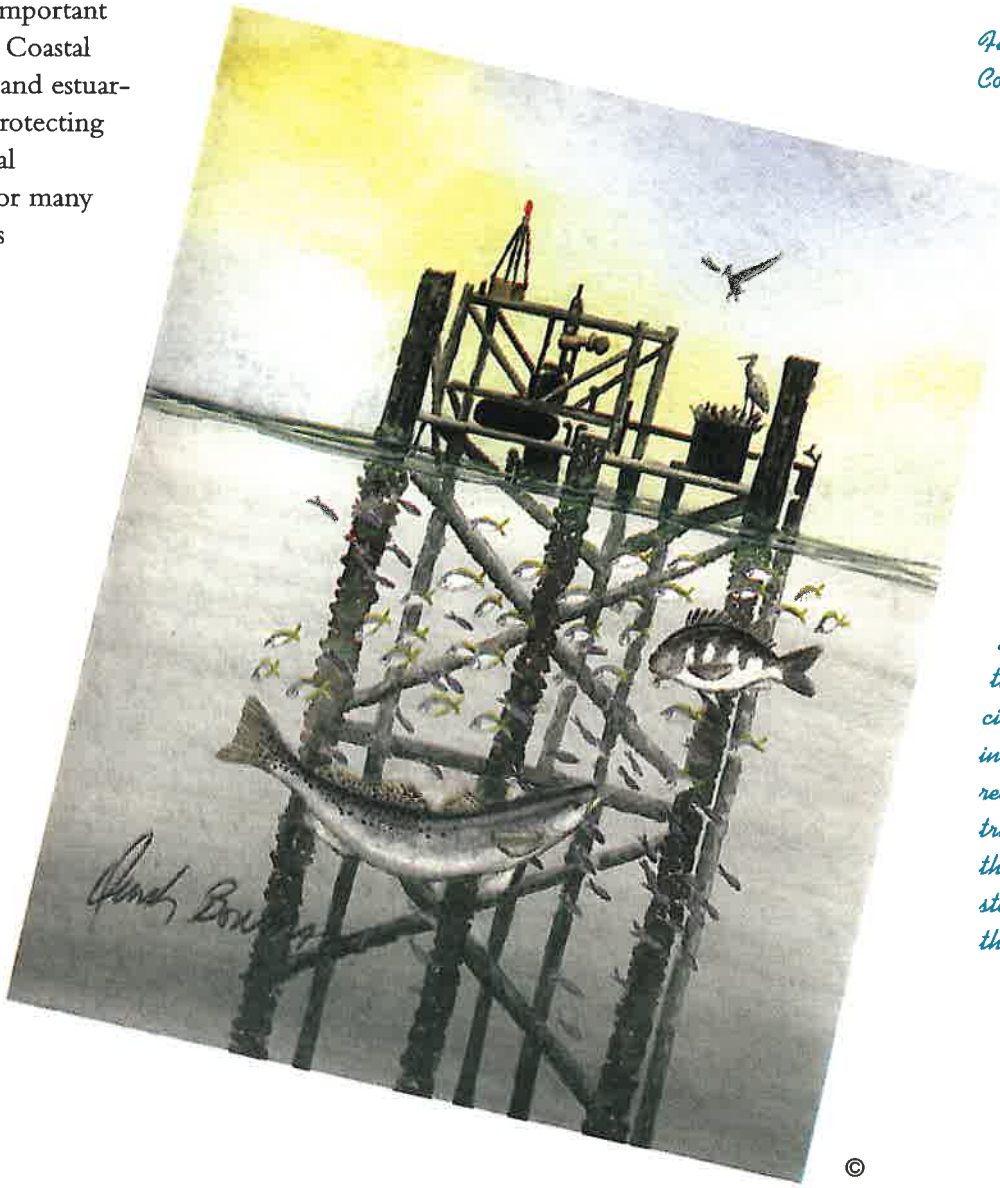
In 1994, 15.3 million barrels of crude oil and 399 million cubic feet of natural gas were produced in the region. Refugio County led in the production of crude oil and Duval County in the production of gas. The dollar value at the wellhead was $324 million for oil (1993) and $685 million for gas (1992).

There are four military facilities in the Coastal Bend region: Corpus Christi Army Depot, Naval Air Station Corpus Christi, Naval Station Ingleside, and Naval Air Station Kingsville. Employees at these facilities number

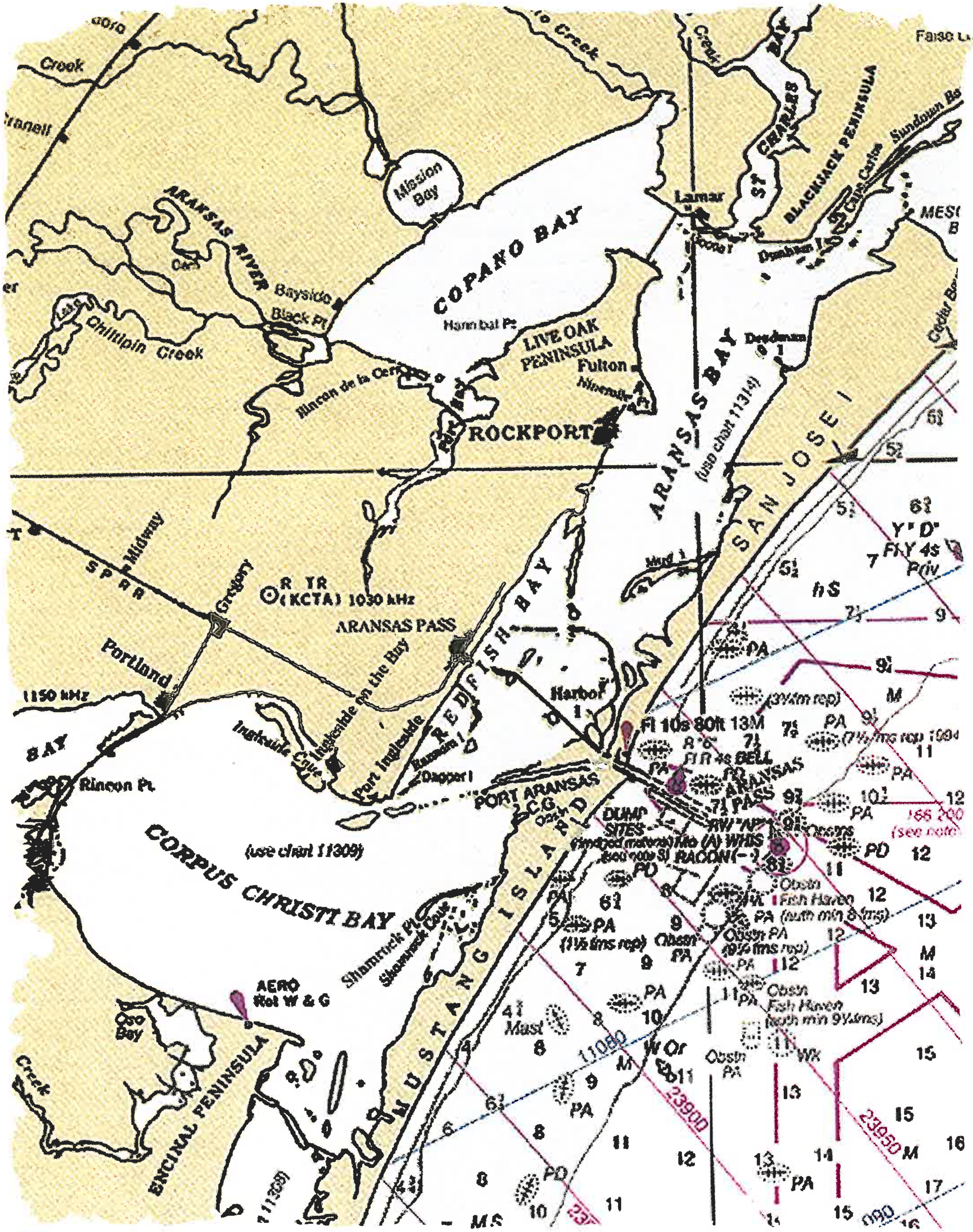
over 11,800 with an annual payroll of over $316 million.

The use of the land and water resources for these activities has changed the natural environment in some cases and created stress in others. The challenge is to continue to provide for the many important uses of the Coastal Bend bays and estuaries while protecting their natural resources for many generations to come.

Shrimp is the state's most valuable commercial food fishery with 1993 landings of 74 million pounds worth $131 million. The total market impact of the shrimp harvest on the state economy is estimated at half a billion dollars. The ex-vessel value of commercial landings of marine species within the Coastal Bend has increased from $2 million in 1972 to $5.8 million in 1982, and $13.2 million in 1992.



Five million people visited the Coastal Bend in 1996. Recreational fishing generates $37 million per year in state and local taxes, with a regional economic impact of $546 million. Non-fishing recreational activity adds another $23 million in state and local taxes, and $340 million in regional economic impact. A study by the Texas Agricultural Experiment Station in 1987 found that the recreational and commercial fisheries and related industries, along with other recreational activities, contributed nearly $760 million to the local economy, with a statewide impact of $1.3 billion that year.


COPANO BAY
Mission Bay
ARANSAS RIVER
Bayside
Black Pt
Chiltipin Creek
Hannibal Pt
LIVE OAK PENINSULA
Fulton
ROCKPORT
ARANSAS BAY
(use chart 11314)
SAN JOSE I
Lamar
ST CHARLES BAY
BLACKJACK PENINSULA
Gregory
Portland
R TR (KCTA) 1030 kHz
ARANSAS PASS
Ingleside on the Bay
Port Ingleside
REDFISH BAY
Harbor I
PORT ARANSAS
CORPUS CHRISTI BAY
(use chart 11309)
Rincon Pt.
Shamrock Pt
MUSTANG ISLAND
ENCINAL PENINSULA
Oso Bay
AERO
DUMP SITES
ARANSAS PASS
Fl 10s 80ft 13M
1150 kHz

THE STATE OF THE BAY: WHAT MAKES AN ESTUARY WORK?

"An estuary is a partially enclosed coastal body of water which is either permanently or periodically open to the sea, and within which there is a measurable variation of salinity due to the mixture of sea water with fresh water derived from land." J.H. Day

Estuaries are unique and complex transitional zones between freshwater and saltwater that provide tremendous economic, ecological, and aesthetic values. They contain a variety of habitat types, which, in turn, support luxuriant vegetation and substantial numbers of animals. Throughout human history, the richness of estuarine waters and their surrounding habitats have led to colonization and the rise of civilizations. Today, estuarine areas are important economically for their commercial and sport fisheries, navigational waterways, and various types of recreation.

The most defining features of estuaries are best observed from the air. A curious observer on an aerial tour of a Texas estuary would first see a river at the head of the estuary, away from the ocean. The river mouth may be difficult to pinpoint due to the natural widening and meandering of the river and the presence of marsh vegetation. In this area of the estuary, freshwater carries large amounts of sediment and the water appears brown and murky.

In the direction of the ocean, the water becomes greenish and transparent as sediment settles to the bottom. Marshes, dunes, and mud flats border the shoreline of the estuary, while submerged seagrass beds appear as dark green smudges on a light brown mud bottom. A wide opening or narrow pass through a barrier island provides an opening to the sea.

Viewing an estuary from the air, however, does not do justice to its diverse assemblage of plants and animals and its life-sustaining functions. To appreciate this biodiversity, one would have to walk through salt marsh wetlands and dunes, swim in shallow areas to observe plants, young fish, and crustaceans, dig in the mud for small organisms, and tow nets of various shapes and sizes to reveal other hidden secrets. Even then, one would see only a fraction of the species that the estuary supports. Understanding this complexity is a key step in preserving the delicate balance between the living resources and the environment on which they depend.

Within the estuary and the marsh lives a fascinating diversity of creatures ranging in size and development from one-celled plants to migrant birds and shrimp; permanent residents such as clams, blue crabs, and fish; and even marine mammals like the bottlenosed dolphin. The ultimate benefits to us for preserving this biodiversity are a bountiful harvest, aesthetic pleasure, recreational opportunities, tourism, and other economic rewards.

Formation of Estuaries

Barrier island estuaries, such as those found along the Texas coast, are common on the Atlantic and Gulf Coasts of the United States. The barrier island, composed mainly of sand and shell, lies parallel to the coast and separates estuarine waters from ocean waters. An extensive network of these barrier islands runs from Maine to Texas, a distance of over 2,500 miles. While some are mere

Tropical storms and hurricanes strike the Coastal Bend on average every five to ten years. They often produce very heavy rainfall and, occasionally, significant storm-surge flooding as well. These powerful storms reshape the coastal landscape by moving massive amounts of sand and mud from one place to another, especially on the barrier islands and in the bays. They can temporally open new tidal passes and close others.

Estuaries such as the Laguna Madre experience limited exchange with the sea and little riverine inflow. The high water temperatures typical of subtropical climates lead to extensive evaporation. As a consequence, salinities tend to be even higher than seawater. Such estuaries are known as hypersaline lagoons. The Laguna Madre is one of only a few hypersaline lagoons in the world.

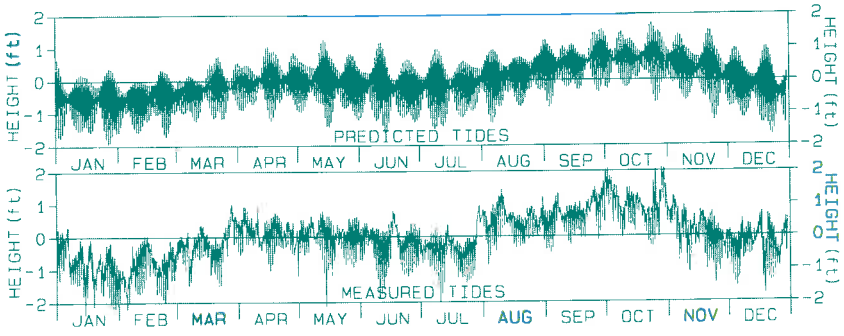
shoals, others extend continuously for hundreds of miles. Padre Island in Texas is one of the world's longest barrier islands.

These estuaries are formed by the interaction of the coastline with the rising ocean following a glaciation event. The complex of bars built by marine processes, and coastal dunes formed by wind-blown sand are slowly eroded by waves and storms. Eventually a pass is opened, allowing seawater to flood the area behind the dunes. The flooded area becomes a shallow estuary, and what was once a dune is now a barrier island.

Barrier islands offer protection to coastal areas and estuarine habitats from storms, hurricanes, and wave action. They also provide extensive habitat for animals and plants, ranging from clams, worms, and ghost shrimp buried among sand grains on the beach, to drought-resistant dune vegetation. Given the turbulent nature of their formation, sea level changes which may occur over time, and storm-caused erosion, barrier islands are not stable over long time periods. The ocean will eventually claim that which it owns.

Tides and Salinity

Tides are caused by the gravitational pull of the moon and sun on ocean waters. As the tide rises (flood tide), water is pushed into an estuary through one or more tidal passes and the estuary gets temporarily deeper. Likewise, receding water (ebb tide) results in a lowering of the water level within an estuary. The timing and height of low and high tides along the coast depend on the shape and size of the estuaries and the orientation



Predicted v/s actual tides at the UTMSI Pier Laboratory (27 50.3'N, 097 03.0'W) for 1995

The climate of the Coastal Bend is sub-humid and sub-tropical, with short, mild winters and long, hot, humid summers. At any time of the year there can be one-day rainfall totals in excess of 5 inches, and much higher totals are possible during hurricanes. On the other hand, it is not uncommon for the region to go 30 to 40 days without measurable rainfall. Annual rainfall at Corpus Christi has ranged from about 19 inches to almost 50 inches with an annual average of about 30 inches. Extreme conditions are essentially the norm in the Coastal Bend, and this climate pattern has substantial impacts on physical and biological processes in the estuaries. Local climate patterns also play an important role in an area's ecology.

of the coastline. In the Coastal Bend, these factors combine to produce a relatively small daily tidal range of about 1.5 feet on Gulf beaches and only 0.5 feet in the upper bays like Nueces Bay.

The action of tides plays an important role in estuarine circulation, primarily by mixing seawater with the lighter freshwater. As freshwater enters an estuary from a river, it can form a "lens" which floats above seawater. In most shallow estuaries, the action of tides, storms, and wind leads to extensive mixing of both fresh and salt water. Such estuaries are considered well mixed.

Salinity varies widely within an estuary. It is lowest near the river mouth because of the influence of freshwater. Conversely, salinities are usually much higher closer to the tidal pass as a result of the influence of seawater.

In Texas, the salinity characteristics of estuaries follow a distinct latitudinal pattern. Low-salinity estuaries are found toward the northeast due to the significant influence of rivers and rainfall.

Fresh water flowing into the bays makes the bay water fresher, while evaporation of water from the surface of the bays increases the salinity. The evaporation/precipitation cycle is important in regulating salinity in Coastal Bend Bays.

Nutrients are necessary for plant growth and are delivered naturally to an estuary by rivers and local runoff from rainfall. Flourishing plants can, in turn, support large numbers of organisms higher in the food web. The productivity of a system is measured by the quantity and growth of its organisms. Estuaries are among the most productive ecosystems in the world .

Salinities tend to be higher in southern estuaries due to scant rainfall, low freshwater inflow, and high evaporation.

The salinity structure of an estuary plays an important role in defining the distribution of different kinds of animals and plants. Some living resources are tolerant of only freshwater or seawater. Other living resources are capable of surviving within a range of salinities to which they have adapted. Because of salinity differences, estuarine ecosystems encompass many different types of habitats and support diverse plant and animal life.

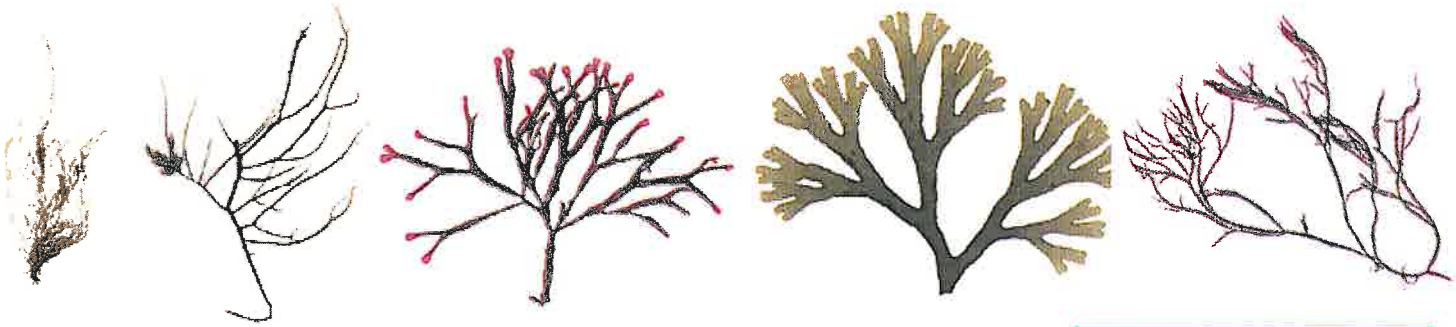
Occasional events, such as heavy rain or a hurricane, can completely change the salinity of an entire estuary in a very short time period. In an extreme case, an estuary could resemble a giant lake, or, alternatively, a lack of freshwater inflow could raise the salinity way above normal. Both of these conditions, when extended for long periods of time, can be harmful to many plants and animals.

Biota - The Plants and Animals

"What makes it so hard to organize the environment sensibly is that everything we touch is hooked up to everything else."
Isaac Asimov

Estuaries include a variety of habitats, such as marshes, seagrass beds, unvegetated bay bottoms, oyster reefs, and wind tidal flats. The species composition of a particular habitat results from the interaction of many factors, including salinity, nutrients, currents, light and oxygen availability, sediment distribution, and temperature. The land and waters of the Coastal Bend provide a home for over 2,000 kinds of animals. Nearly 500 species of resident and migratory birds make this area one of the richest birding regions in North America.

At the base of the estuarine food web are plants, the primary producers. Plants require both light and nutrients. Plants need sufficient light for photosynthesis and there-



fore are found in shallow areas or floating near the water surface.

There are a variety of primary producers. For example, phytoplankton are microscopic plants that abound in the water or are embedded in the top layer of bottom sediment where light is still available. Algae are much larger aquatic plants that exhibit a dazzling display of color and form. They lack roots and stems, and their fronds (leaves) soak up nutrients directly from the water. Algae usually thrive attached to rocks, other plants, or even while drifting freely.

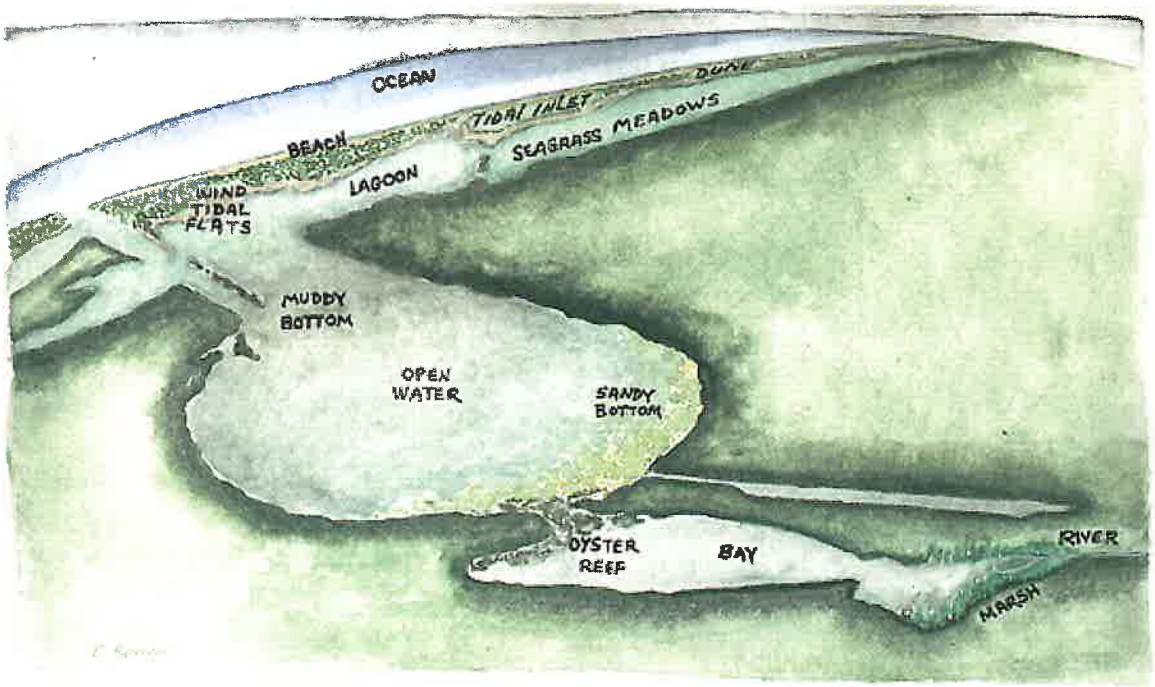
Seagrasses have roots and other structures commonly found in the terrestrial plants, from which they evolved. As the only group of true marine flowering plants, seagrasses have the capacity to remain permanently submerged in estuarine areas.

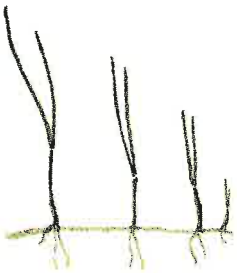
Seagrass habitats typically contain large numbers of animals. Often called "nursery areas", seagrass meadows provide both food and shelter for the young of numerous fish and shrimp, including red drum, spotted seatrout, and brown shrimp. Adult fish like to feed in this lush habitat too. Seagrass meadows also have numerous permanent residents, but these are mostly small and relatively inconspicuous species such as seahorses, gobies, and grass shrimp.

The distribution and coverage of seagrass meadows vary over time due to both human distur-

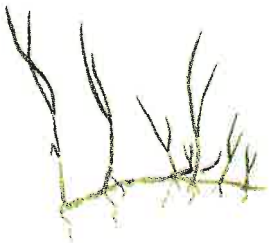
Seaweeds are found attatched to jetties, piers, oysters and other hard substrates.

All plant groups contribute to the productivity of an estuary. A relatively small fraction of plant material is directly consumed by animals, while a significant portion is consumed by bacteria. The bacteria are, in turn, consumed by larger organisms. Bacteria also aid in the regeneration of nutrients from decaying plant and animal material. Hence, they are in essence the "recyclers" of the estuarine environment and are largely responsible for sustaining the productivity of the system.

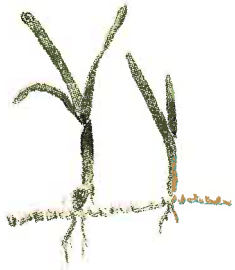




Shoal Grass



Manatee Grass



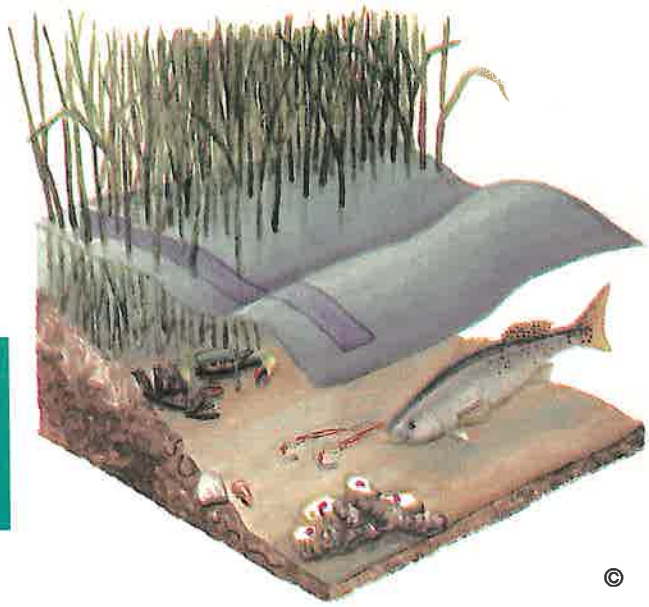
Turtle Grass

Clover Grass

Marshes and shallow vegetated bays slow the velocity of flood waters and buffer coastal lands against storm and wave damage.

bances and natural processes. Because seagrasses require large amounts of light for growth, disturbances that cause long-term reductions in available light are among the primary factors that impact seagrass health. These disturbances include changes in land use patterns, erosion, channel dredging, and placement of dredged material, all of which may increase turbidity.

Reduced light availability can also result from excessive nutrient loadings from fertilizers, sewage disposal, and other sources. This can lead to an increase in phytoplankton blooms which can reduce light penetration. In addition to reducing light availability, channel dredging can directly impact seagrasses if channels are dug through seagrass beds, or if dredged material is placed on the seagrasses. However, federal and state regulations enacted over the past two decades have substantially reduced dredging activity through seagrass meadows.



©

There are many potential fates for primary producers. Zooplankton, a community composed of tiny animals such as protozoans, crustaceans, and the larvae of crabs and shrimp, may graze on phytoplankton or on each other. Zooplankton serve as food for small fish and some birds, which are capable of filtering them from the water.

Bay bottoms teem with life and provide a rich food supply for other animals. The term "benthos" is used for the wide assortment of plants and animals associated with the bottom of an estuary, including clams that filter water for small particles of food and burrowing worms and shrimp that consume the remains of plant and animal material. These organisms are key components in the movement of energy from plants to higher level consumers in the estuaries. Birds and fish, as well as crabs, feed on these bottom dwelling animals.

Services Provided by Estuaries

Estuaries provide a vast array of services to Coastal Bend residents and visitors. In addition to providing a home and food for many diverse plants and animals and a bountiful harvest of seafood, these services include water purification, storm protection, recreation, education, and maritime commerce.

Estuaries provide natural flood control and function as pollution filtration systems. As water circulates through an estuary, plants use some of the potential pollutants,

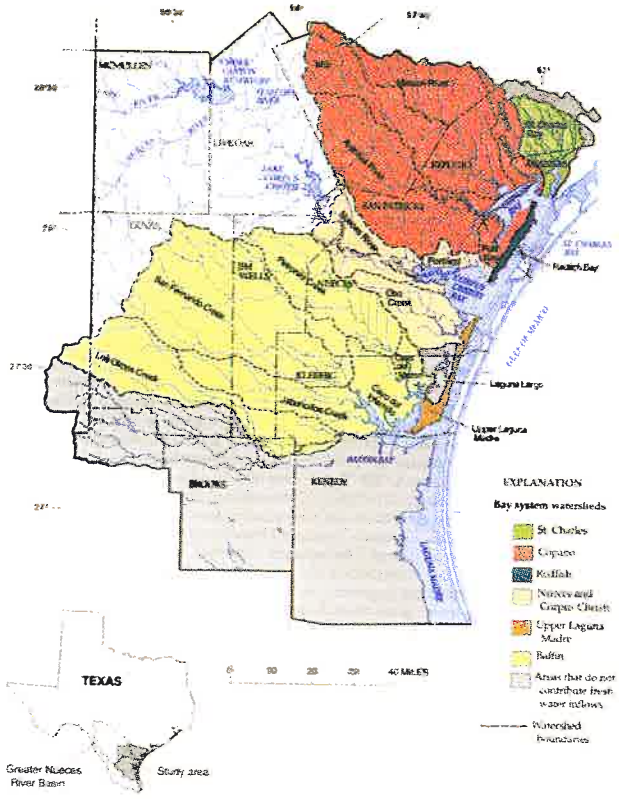
such as phosphorus and nitrogen, as nutrients. The natural capacity of plants to use pollutants for healthy growth is limited, however. If estuarine waters are excessively contaminated with toxins such as pesticides, heavy metals, or industrial chemicals, these pollutants can pass into the food web and potentially degrade the system.

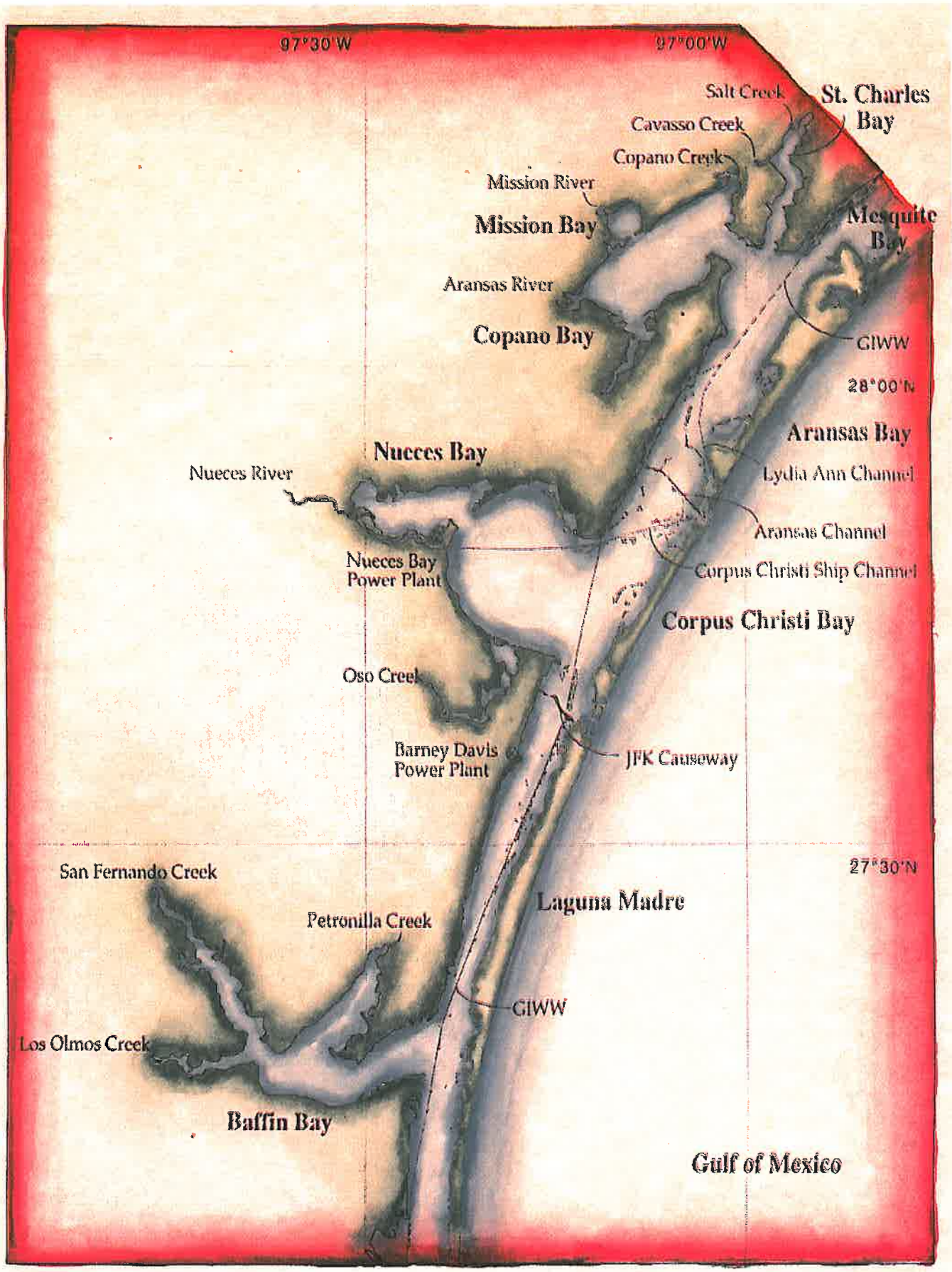
Seagrasses and marsh plants prevent erosion because their underground root structure binds sediments in place. In addition, the submerged leaves of seagrasses promote sediment deposition. During heavy rainfall events water flows into marshes where it can be stored and slowly released.

To properly function and maintain these many beneficial uses, an estuary relies on a blend of biology, chemistry, physics, and geology. A growing human population can unbalance and threaten these unique systems. For example, habitats can be lost (e.g., converting a seagrass bed to a dredged material island), or natural functions can be degraded (e.g., limiting the flow of fresh water, which, in turn, inhibits the natural function of estuaries to filter contaminants). Any of these changes could have direct negative impacts on human health and happiness.

The Human Connection

Over 540,000 people live in the Coastal Bend, a 10 percent increase in just seven years, and population growth is expected to continue rapidly. This growing population, while placing enormous pressure on our estuarine waters and surrounding habitats, also provides a unique opportunity to nurture and protect the beauty and bounty of these natural resources. The bays and estuaries of the Coastal Bend provide us with a wonderful quality of life -- abundant plant and animal life and recreational, educational, and job opportunities unlike anywhere else. We derive pleasure and economic value from tourism, sport and commercial fishing, shipping, sailing, bird watching, hunting, and beach-combing. Above all, our lives are enriched by seeing a sunset over the bay, a redfish in the flats turning to strike our lure, a dolphin leading the ferry, or hearing a laughing gull call.




97°30'W
97°00'W
Salt Creek
St. Charles Bay
Cavasso Creek
Copano Creek
Mission River
Mission Bay
Mesquite Bay
Aransas River
Copano Bay
GIWW
28°00'N
Aransas Bay
Nueces Bay
Nueces River
Lydia Ann Channel
Aransas Channel
Nueces Bay Power Plant
Corpus Christi Ship Channel
Corpus Christi Bay
Oso Creek
Barney Davis Power Plant
JFK Causeway
27°30'N
San Fernando Creek
Laguna Madre
Petronilla Creek
GIWW
Los Olmos Creek
Baffin Bay
Gulf of Mexico

HABITAT AND LIVING RESOURCES

Habitat Gains and Losses

Estuaries like those in the Coastal Bend are among the most productive environments in the world. The variety of habitats found in and surrounding the estuaries of the Coastal Bend offer bountiful food and shelter for a diversity of plants and animals. However, these estuarine plants and animals are threatened by loss of habitat, pollution, and over-harvesting.

Although all estuarine habitats are linked to each other in one way or another, each has its own set of characteristics and its own suite of perils. Typical habitats in Coastal Bend estuaries include the open bay mud bottom and water column, seagrass meadows, coastal wetlands, tidal flats, beaches and barrier islands, oyster reefs, and other hard substrates. It is not possible to understand or measure changes in the health or status of living resources without having a good understanding of the status and health of their habitats.

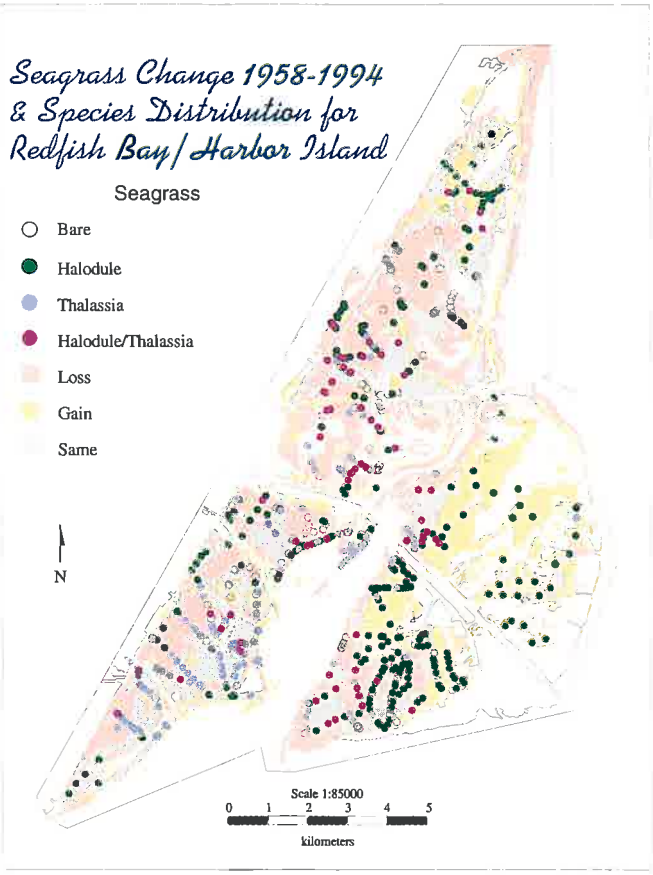
By far, the most extensive habitat in Coastal Bend estuaries is Open Water Habitat

Open Water Habitat

The unvegetated bay bottom and its overlying water column constitute the open water habitat. Covering over 275,000 acres, this is by far the most extensive habitat in Coastal Bend estuaries, especially in the Nueces and Aransas estuaries, where water depth, turbidity, and salinity limit the distribution of other habitats. Only in Redfish Bay and the Laguna Madre are other habitats, primarily seagrass meadows, more widespread than open water. The dominant plants in the open water environment are phytoplankton algae. Many small animals also live in this environment and provide food for larger animals.

Various natural processes and human modifications can alter the size of open water habitat. Over geological time scales, sediments brought into estuaries by river flow will ultimately fill the estuaries, changing open water habitat to extensive marsh and to upland habitat. On shorter, more relevant, time scales, there are three major disturbances that can change the relative amount of open water habitat: subsidence (a geologic process whereby the land sinks), shoreline modification, and dredging and dredged material placement.

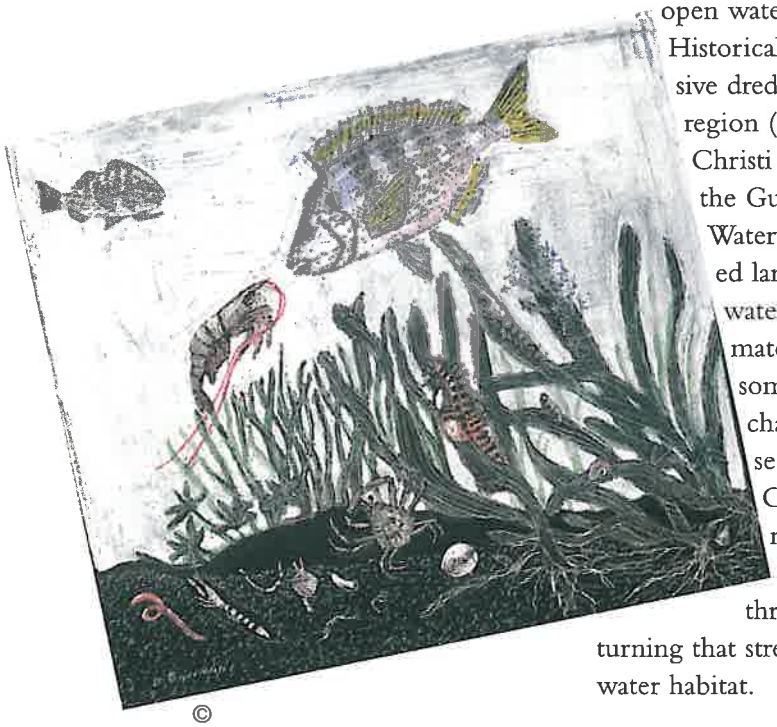
Subsidence could enlarge the area of open water at the expense of seagrass and marsh habitats. However, subsidence rates are very low in the Coastal Bend and do not currently pose a problem. Shoreline modification typically impacts shallow water marsh and seagrass habitats more than open water habitats. It has been estimated, however, that about 15 percent of the surface area of Nueces Bay



Halodule is shoal grass.
Thalassia is turtle grass.

was lost during the development of the Inner Harbor and its associated industrial complex during the period from 1924 to 1995. A substantial portion of that area was previously open water habitat.

Extensive dredging in shallow habitats like seagrasses, tidal flats, or marshes could potentially increase the amount of open water habitat. Conversely, the placement of dredged material in open water areas may decrease the depth of the bottom and form seagrass beds, marsh land, or even dry land, where open water once existed. Historically, the most extensive dredging projects in the region (e.g., the Corpus Christi Ship Channel and the Gulf Intracoastal Waterway) were conducted largely through open water, creating dredged material islands along some sections of the channels. A five mile section of the Corpus Christi Ship Channel near Port Aransas was originally dredged through shallow flats, turning that stretch into open water habitat.



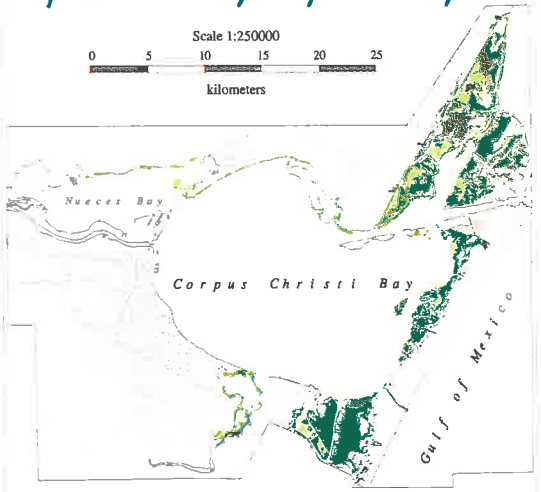
©

Seagrass Meadows

Seagrass meadows cover over 92,000 acres of bay bottom in the Coastal Bend, representing almost 40 percent of the seagrasses found in all Texas waters. Seagrasses do best in shallow, low energy areas where wave action is limited and gentle currents flow. They are found along the shallow bay margins of barrier and dredged material islands and on the shallow "flats" typical of estuaries like the Laguna Madre and Redfish Bay. Coastal Bend seagrasses cover a substantial portion of the upper Laguna Madre, Redfish Bay, and the shorelines of Mustang and San Jose Islands; the majority, over 61,000 acres, are found in the upper Laguna Madre and Baffin Bay. In fact, the upper Laguna Madre hosts the largest expanse of continuous seagrass habitat on the Texas coast. Coastal Bend seagrasses are actually composed of five different species, but shoal grass and turtle grass are the two most common.

Both natural phenomena and human disturbances can impact seagrass meadows in the Coastal Bend. Waves and currents associated with hurricanes can tear the plants from the ground or cover them with sediments. Small changes in sea level can produce large scale changes in seagrass coverage, as seagrasses in the Coastal Bend are generally limited to a narrow depth range of a few inches to no more than 4 to 5 feet.

Corpus Christi Bay Seagrass Study Area



HABITAT(ha)	CORPUS	LAGUNA	NUECES	RED/HAR
Patchy SAV	1086.05	448.50	279.05	2156.88
Continuous SAV	1117.68	1873.93	20.77	2893.24
Algal Mat	326.90	83.96	0.00	35.23
Oyster	0.46	0.00	10.12	45.57
Wrack	2.56	0.00	0.00	151.72
Wrack & SAV	10.69	110.61	2.08	694.04

Mapping the distribution of submerged aquatic vegetation (SAV) like seagrass and algae allow managers to track critical habitat.

Motorboat propeller scarring has a direct mechanical impact on seagrass meadows. A recent study of the extent of propeller scarring in the Coastal Bend indicated that a third of the 16,300 acres of seagrass meadows surveyed have moderate (5-20%) or heavy (greater than 20%) scarring. The East Flats and Shamrock Island regions of the Corpus Christi estuary are heavily scarred, as are some areas of Redfish Bay. The most highly impacted area is Estes Flats, in Redfish Bay, where over 97 percent of seagrasses are scarred.

The dynamic nature of seagrass beds means that some areas are gaining and some are losing coverage at any one time, and often for different reasons. The overall trend in the Coastal Bend has been a substantial increase in seagrass coverage from 1958 to 1974, followed by a continued but less rapid expansion between 1974 and 1994. Over the past 35 years, total seagrass coverage in Coastal Bend estuaries has increased by about 38,000 acres. There have been net gains of about 815 acres in the Redfish Bay/Harbor Island complex, about 5,722 acres along the Mustang Island shore, and about 32,123 acres in the upper Laguna Madre. The sustained increase in coverage along Mustang Island has been largely due to a rise in sea level over the period and also the pristine nature of the area.

Although seagrass coverage has generally increased in the Coastal Bend, some areas have lost large tracts of meadows. For example, there has been a decline in seagrass coverage in the northern portion of Redfish Bay adjacent to the mainland, especially between 1974 and 1994. It is believed that this decline is due to a combination of excessive nutrients in runoff from surrounding developments and physical damage from motorboat propeller scars.

The Laguna Madre has experienced a decline in seagrass coverage since 1990. This followed a dramatic increase in shoal grass coverage between 1967 and 1988 mainly resulting from reduced salinity extremes and improved water quality following construction of the Gulf Intracoastal Waterway. The more recent decline was caused by the presence of a brown tide algal bloom which has shaded the seagrasses and deprived them of their energy supply. It is estimated that 3.8 percent of the seagrass beds in the Laguna Madre were lost between 1990 and 1995.

Intentional selection by motorboat operators of "shortcuts" to traverse seagrass meadows contributes to seagrass damage. Propeller scarring can also occur accidentally if motorboat operators misjudge water depth or the location of navigation channels. There is a need for public information and awareness on the extent of seagrass damage caused by propellers, the length of time required for seagrass recovery, and the importance of seagrass habitats in the healthy functioning of estuaries.

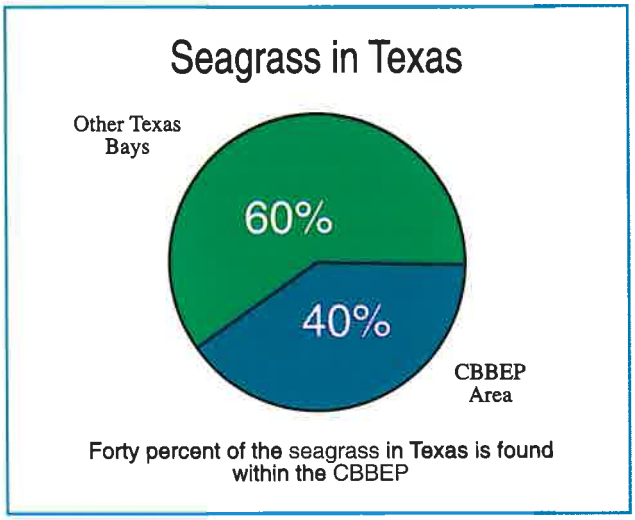
A potential conflict exists between tourism and habitat quality. An increasing number of visitors produces an increased demand for more public access points so people can use the beaches and bays. However, increased usage of beaches and bays threatens habitat integrity and imperils the natural resources that attract visitors to the area in the first place. For example, the relatively pristine nature of the bay shoreline of Mustang Island and its expanding seagrass meadows is due, at least in part, to limited public access to that area. On the other hand, the northern Redfish Bay area, characterized by extensive shoreline development and relatively abundant public access points, is showing signs of seagrass stress.

Coastal Marshes

Coastal Marshes cover about 113,000 acres or about 11 percent of all aquatic habitats in the Coastal Bend. These habitats occur along the intertidal area between the land and estuarine waters and at the mouths of rivers and streams where they discharge into the estuaries. Extensive coastal marshes occur in the northern portion of the Coastal Bend, where freshwater inflow and precipitation are higher. In the southern areas, extensive marshes are largely replaced by wind-tidal flats. Vegetation in Coastal Bend marshes is dominated by smooth cordgrass, especially in the lower portion of the marshes. Glasswort, sea-oxeye daisy, and other flowering plants occupy the higher reach of the marshes.

The primary threats to coastal marshes are dredge and fill operations, oil and chemical spills, coastal development, and changes in sea level. In the first part of the century, some Coastal Bend marshes were dredged, filled, and drained to convert them to agricultural and urban lands. The more prominent of these losses were associated with pothole wetlands on the coastal mainland. Overall, however, coastal marshes in the Coastal Bend have expanded in area since the first comprehensive survey in the 1950s. This increase is largely due to the permanent flooding of intertidal mudflats caused by persistent sea level rise over that period, allowing marsh plants to expand into the margins of those wetter areas.

Currently, regulations designed to protect aquatic resources often require mitigation projects, in which new marsh is created to replace habitat destroyed elsewhere. In the Coastal Bend, a number of potential sites have been identified for marsh creation, restoration, or enhancement. However, while it is often possible to create a new marsh that resembles a natural marsh, our ability to replace the ecological function of a natural marsh is controversial and will require more information. Until such information is available, avoiding disturbance of marshland is the preferred objective.



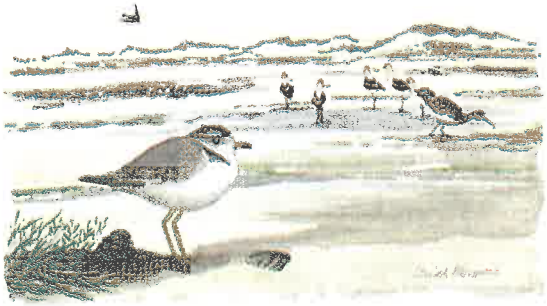
Wind-tidal Flats

Wind-tidal Flats are the seemingly barren, relatively featureless, sand and mud environments bordering lagoons and bays. The term "wind-tidal flat" is used because flooding is more often caused by wind driving water onto the flats than by tides. Primary production in these habitats is typically dominated by mats of tiny algae and bacteria rather than by the

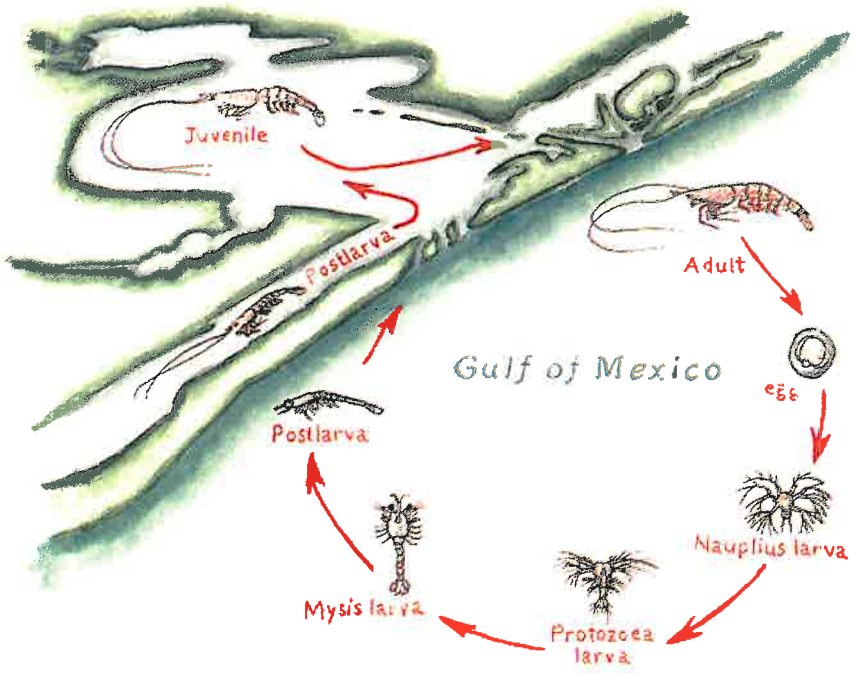
phytoplankton, filamentous algae, or flowering plants typical of other estuarine habitats. Despite their barren appearance, wind-tidal flats can be very productive. In addition, these flats may contribute a significant amount of new nitrogen to the ecosystem. Bacteria in these flats are very efficient at transforming atmospheric nitrogen into forms that supply nutrition to other aquatic plants, similar to the way in which peas and beans supply nitrogen to soils in farms and gardens.

The variety of plant and animal life on tidal flats is rather limited compared to other habitats, but the numbers of residents can be quite high. Tidal flats are home to small crustaceans, worms, and insect larvae that are of critical importance to shorebirds. They are essential habitat for the Piping Plover, a threatened species, and are significant feeding and loafing areas for numerous other shorebirds as well.

Wind-tidal flats currently cover about 21,442 acres or about 14 percent of wetlands in the Coastal Bend area. Since the early 1950s, over 24,000 acres of wind-tidal flats have disappeared. About 95 percent of this loss is due to a rise in sea level which, between mid-1960 and the mid-1970s, averaged over 0.6 inches per year. The rising sea level permanently flooded about 55 percent of the lost flats and allowed seagrasses and marshes to colonize another 40 percent of the lost flats. Human disturbances led to the remaining 5 percent loss.



A new birding site on Mustang Island, the Port Aransas Wetlands Park (site 59), designated as part of the Great Texas Coastal Birding Trail, showcases the importance of these tidal flats for birds.



Shrimp life cycle

The image of tidal flats as wastelands that do not contribute aesthetically, economically, or ecologically to an area is the underlying cause of most human disturbances and alterations. Channels have often been dredged through these flats, dramatically changing the water flow pattern. Dredged material is often placed on the flats, smothering the plant and animal communities and often blocking the normal water flow across the remainder of the flat. In addition, tracking by off-road vehicles can destroy this fragile habitat.

Buried reefs found as deep as 4 meters below the sediment surface in Corpus Christi Bay and up to 18 meters deep in Baffin Bay tell us that conditions for oysters, as well as other animals, have changed dramatically over the past 10,000 years as sea level rose and the climate changed to drier conditions.

Beaches, Dunes, and Tidal Inlets

Longshore currents and wave energy on the ocean shore work together to form barrier islands, the elongated strips of sand that lie parallel to the mainland and separate the estuaries and lagoons from the oceans. Barrier islands play a vital role in protecting the relatively tranquil estuaries and lagoons from the often turbulent ocean. In fact, without the barrier islands, our form of estuaries and lagoons would not exist. These coastal land forms are very dynamic, constantly being reshaped by winds, waves, and currents. The dynamic processes are most apparent at the breaks between islands where tides flow between the oceans and the estuaries. Over time, these inlets have migrated up and down the coast. In recent times, however, most have been stabilized by jetty construction and channel dredging to provide for safe navigation.

Tidal inlets play a critical role in the life cycle of shrimp, croaker, redfish, mullet, and many other common species. Many adult species spawn offshore, and their offspring flow with the currents to the coast and through the tidal inlets into the estuaries. Within the estuaries, the larvae and juveniles of fish, shrimp, and other species use the seagrass beds, marshes, and bay bottoms for food and shelter. After a few months to a few years, maturing adults move into the deeper waters and find their way back through the tidal inlets to offshore spawning