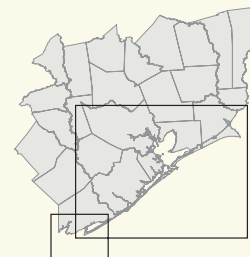
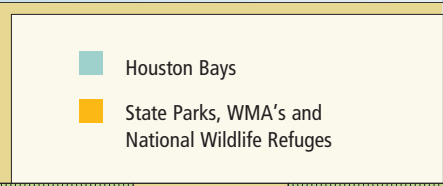
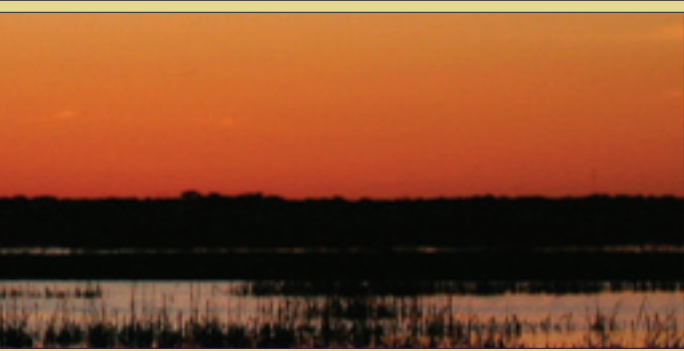


# Estuaries & Bays



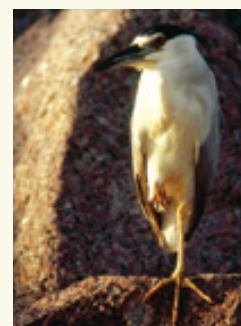




A GULF OF MEXICO ESTUARY has a definite geometry, a pairing of one river or several with a pass or passes connecting the bay to the Gulf. Within the last few thousand years—just the other day, geologically speaking—the sea level was about two hundred feet lower than it is today. In places the coastline was dozens or hundreds of miles farther out into the Gulf than it is now. As frozen water was unlocked when the last ice age retreated, the Gulf began to rise to its current level, flooding river valleys that had cut into the shelf.

Three of these flooded river valleys became the three great estuaries of the upper Texas coast: the Sabine Lake system that we share with Louisiana; the Galveston Bay system south and east of Houston; and the Matagorda Bay system to the southwest. Over time, river and Gulf sediments formed barrier islands paralleling the coast and almost blocking the mouths of flooded valleys, so that only one or two openings allow the energy from the uplands to flow through the bays and into the Gulf. We have been slow to appreciate what tremendous natural resources these water bodies are.

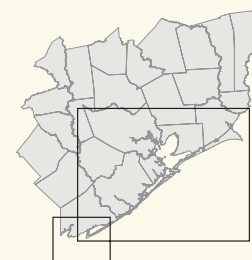
Sabine Lake receives its fresh water from the Sabine and Neches rivers and Taylor Bayou and is connected to the Gulf by Sabine Pass. Galveston



*The Black-crowned night heron, Nycticorax nycticorax, a resident of our estuaries, stalks its prey at night, hence its name.*



*Left: A lone fisherman cast-nets for bait near Matagorda. Recreational fishing is a favorite pastime and important industry in the Estuaries & Bays ecoregion of Houston Wilderness.*



Bay is fed by the Trinity and San Jacinto rivers and numerous smaller creeks and bayous and is linked with the Gulf via the Bolivar Roads, San Luis Pass, and through the artificial cut called Rollover Pass. Matagorda Bay receives inflow from the Colorado and Lavaca rivers and several other creeks and bayous and is connected with the Gulf via the artificial channel at the Port O'Connor jetties and Mitchell's Cut to East Matagorda Bay near Sargent.

San Luis Pass is a dynamic place with 20 percent of the tidal flow for all of Galveston Bay moving through it. The sand bars around the pass change with each storm, causing changes in the pattern of water movement. When the tide is going out the water moves very quickly, and when the current hits the southerly longshore current that flows in the summertime, dangerous rip currents are produced. More people have drowned near San Luis Pass than at any other site along Texas' beaches.

Coastal hydrologist Dr. George Ward, of the University of Texas Water Resources Center in Austin, has described estuaries as a salad bar because of the immense natural productivity typical of their high-energy areas. An estuary converts tremendous amounts of sunlight into food through the photosynthetic action of microscopic plants called phytoplankton, which make up a veritable salad bar for bay organisms to graze upon.

An estuary such as Galveston Bay converts as much carbon dioxide into plant material as does a tropical rain forest. However, there is one huge difference. In the rain forest the carbon dioxide becomes the leaves and wood of trees, but in an estuary the carbon dioxide is converted into microscopic plants, which are immediately eaten by other organisms, supporting life within the estuary by passing the sun's energy up the bay food chain to other forms of life.

These microscopic plants flourish in the estuary because the freshwater inflow brings with it

nutrients such as nitrogen and phosphorus and silica that allow the tiny plants to grow. The bays of the Houston Wilderness area receive the highest inflows of any estuaries on the Texas Coast. Sabine Lake in water-rich East Texas receives over 12 million acre-feet of water inflow per year, and the Galveston Bay system receives just over 10 million acre-feet of inflow. By contrast, Matagorda Bay receives only about 2 million acre-feet, reflecting the sharp decline in rainfall as one moves south and west in Texas.

An acre-foot is a lot of water: 325,000 gallons. In gallons, Sabine Lake and Galveston Bay receive 3.9 and 3.2 trillion gallons of freshwater inflow respectively, with Matagorda Bay receiving 650 billion gallons. The fresh water flowing in is a defining element of our estuaries, the places where fresh and salt water meet, and it is essential to their productivity.

A significant amount of scientific research has been conducted regarding the amount of fresh water that is absolutely necessary to maintain the bays' productivity. To date, estimates have been based upon computer models developed by the Texas Parks and Wildlife Department and the Texas Water Development Board. However, it is not easy to understand or describe mathematically the interrelated workings of the estuarine food chain.

Simply stated, the food chain of an estuary is one of the marvels of nature. Microscopic phytoplankton are tiny plants eaten by microscopic animals called zooplankton as well as by higher organisms such as oysters. Both the phytoplankton and zooplankton are fed upon by larval shellfish, such as the early life stages of crabs and shrimp, as well as by juvenile finfish such as croaker, mullet and many more. In turn, larger fish feed upon the juveniles. At the top of the food chain are the predators, such as the trout and redfish that support our popular sport fishery and the crabs that end up in local restaurants.





*Birds of the Estuaries & Bays ecoregion from top left to right: Black-necked stilt, Himantopus mexicanus; Wilson's plover, Charadrius wilsonia; Laughing gulls, Larus atricilla (background) and Forster's terns, Sterna forsteri (foreground).*

One difficulty in modeling this system is the large number of variables that must be considered. There is variability in rainfall and thus in inflow quantity and quality. There is the need to collect biological data describing all elements of the system, from the microscopic plants to the large predators. And one has to explain away any other factors that might limit productivity in one bay in one year—a hurricane, perhaps, or a period of prolonged cold.

But make no mistake—our bays and estuaries are incredibly productive. Galveston Bay is the national leader in the production of oysters. Port Arthur, Galveston and Palacios lead the Texas coast in shrimp landings, and Texas leads the nation in brown shrimp landings. Together, Sabine Lake and Galveston and Matagorda bays provide over half of the blue crab catch on the Texas coast. And for recreational fishing, Galveston Bay—the most heavily fished of our coastal bays—also has the highest catch per unit of effort by sport fishermen.

One of the best ways to begin to grasp the productivity of an estuary is to take a trip designed with this as its objective. Among the best of these are the excursions conducted by the nonprofit Waterborne Education Center operating out of Anahuac, which performs the important function of educating schoolchildren as well as the general public about the roles and functions of the bays. Private guides based around Matagorda Bay and Sabine Lake lead both scheduled and customized ecology tours by boat and kayak—an Internet search will turn up current offerings out of Galveston, Palacios, Bay City and Orange.

A Waterborne Education Center trip takes in both the shallow and deepwater habitats of Trinity Bay. Chambers and Jefferson County Marine Agent Terri Ling is among those who guide such excursions, offering her considerable

knowledge. In the shallow waters off Smith Point, the peninsula dividing Trinity Bay from East Bay, Terri asks for a volunteer to help her pull a seine near the edge of the marsh.

The seine is a small-mesh net with weights to hold one side of it on the bottom and floats to suspend the net within the water column. On either end are poles. One person stays near the shoreline while the other takes the net out away from the shore and then brings it back in a wide arc, encircling whatever is between the net and the shore. The suspense builds as the net nears the shore. With a flourish, the weighted bottom is slid up the bank, trapping the small organisms of the estuary edge. Immediately, hundreds of small brown shrimp are hopping in the net, along with several small finfish of different species, likely including flounder. The catch in the net is carefully emptied back into the water after everyone has understood how much life seethes in the shallows near the edge, and the visitors move back to the large boat that is the bay home of the Waterborne Education Center.

The Chambers-Liberty Navigation District bought two old U.S. Coast Guard buoy tenders and leased them to the center for educational usage. Each boat can accommodate about forty passengers and is rigged to pull nets that capture the organisms of the deeper waters of the bay system.

The first try may be with a plankton net, which has very fine mesh intended to trap the microscopic organisms that fuel the food chain. After a minute or two, the net is pulled in and its contents are emptied into a jar: a soupy-looking mixture. This soup is what we can see of the microscopic plants and animals, visible only by their interference with light penetrating the water.

The next try may be with the larger trawl net, similar to the kind used on shrimp boats. Guides test the salinity of the water, which may be quite low if there have recently been rains intensifying



the freshwater inflow. In that case the trawl for this day may reveal a relatively meager harvest of shrimp and finfish, reflecting the response of the estuarine organisms to sudden incoming fresh water. The catch results further illustrate some of the difficulties of modeling the activity in the bays since estuarine organisms move, responding to pulses of fresh water or to increases in salinity.

The organism that most clearly reflects the chameleon character of the estuary is the oyster, a wonderful example of adaptation to the estuarine environment. Mature oysters are immobile, encased in calcite shells that cement to clay and to each other to form reefs in the Sabine, Galveston and Matagorda systems. They feed by pulling water in and filtering out microorganisms that are floating in the water column, rather like the operation of our plankton net.

Oyster reefs are found in that portion of a bay that is neither too fresh nor too salty. In the Sabine Lake system, they are found in the southern end of the lake nearer to Sabine Pass, reflecting the high volume of inflow and the relatively small size of Sabine Lake. In Galveston Bay, the oysters are found nearer the middle of the bay system, with large reefs also appearing in East and West Bays. In the Matagorda Bay system, the reefs are in the process of reestablishing themselves in response to the man-made diversion of the Colorado River and the new salinity regimes that have followed that attempt to increase productivity by ensuring that more fresh water reaches Matagorda Bay.

Although the mature oyster is immobile, its reproductive strategy provides for options and adaptation. Millions and millions of eggs are released and fertilized, and they can disperse and settle throughout the estuary. In average years the main reefs are where the young oysters, called spat, will settle and grow. During a dry year when the bay is saltier, the spat settle and thrive closer to the

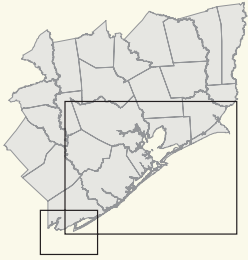
freshwater inflow. And in a wet year with a fresher bay, the spat settle and thrive closer to the outlet to the Gulf. In this way the oyster is able to adjust to conditions, but note that young oysters need freshwater inflow in order to thrive.

The oyster reef is a center of biological diversity in our bays. It provides habitat for smaller finfish. It provides attack points for predators. Where oyster reefs extend close to or above the water line, they provide excellent fishing stations for fish-eating birds. In any of our bays, biological action abounds on and around the oyster reefs.

Humans have intervened in many ways to alter our estuaries. These water bodies are relatively shallow, with a natural depth of approximately ten feet in the deeper portions. Navigation through the passes and reefs was quite dangerous and was limited to shallow-draft vessels prior to the construction of navigation channels through each of the bay systems. Today Sabine Pass has been deepened to forty feet to provide navigation to Port Arthur, Beaumont and Orange; Bolivar Roads has been deepened to forty-five feet to provide navigation to Galveston, Texas City and Houston; and an artificial channel has been constructed at Port O'Connor to provide deepwater navigation to Point Comfort and Port Lavaca on Matagorda Bay.

As a result of this channelization, natural passes are rarer than they once were. In the Houston Wilderness area only two natural passes still exist—San Luis Pass at the southern end of Galveston Island and Pass Cavallo on Matagorda Bay near Port O'Connor. And of these two, Pass Cavallo is slowly silting in because most of the interchange between Matagorda Bay and the Gulf flows through the artificial cut at the Port O'Connor jetties.

Among the upper coast bay systems, none has been modified by humans to the extent that Matagorda Bay has been. In the 1930s, the



Colorado River emptied into it at Matagorda. However, a major logjam upstream was causing flooding on the river. When the U.S. Army Corps of Engineers blew up the logjam, the silt and other debris rapidly formed a delta into the bay, causing a different flooding problem at Matagorda. To remedy this problem, a channel was constructed through the isthmus that connected the mainland to Matagorda Peninsula on the Gulf side of the bay. For several decades the Colorado River thus flowed directly into the Gulf.

In the late 1980s the U.S. Fish and Wildlife Service, Texas Parks and Wildlife and the Corps of Engineers determined that productivity in the bay could be improved if the river were diverted into Matagorda Bay. A diversion channel was constructed in 1991, and a major flood occurred shortly thereafter, forever changing the geometry of Matagorda Bay. Today, a new delta is being built into the bay. The diversion channel is disgorging tons of sediment along with hundreds of large trees that lined the channel. This is an active geological process set in motion by human intervention.

At the south end of Matagorda Bay, a different type of intervention has occurred. At the Port O'Connor jetties, the channel that was dug out to a depth of forty feet has been deepened by the currents to more than one hundred feet. In turn, this deeper channel is interfering with the movement of larval shrimp and crabs and finfish, because they move with the tides and drop to the bottom of the passes to hold on during tidal changes. With such a deep channel, the bottom cannot easily be found, and the organisms get washed back to the Gulf.

The migration of larval fish and shellfish from the Gulf to our bays and estuarine nurseries is one of many phenomena that have been documented but that remain poorly understood. The success of these species depends upon the movement of their larval forms from the Gulf to the bay and into the

*Top right: The Red-winged blackbird, *Agelaius phoeniceus*, perched on a branch and the Great egret, *Casmerodius albus*, in flight. Bottom Right: The Black skimmer, *Rynchops niger*, is the only bird species in the United States that has a larger lower mandible than upper mandible, and when in flight, hangs its lower mandible into the water to forage for food.*

sheltering nursery areas where they are nourished and grow into mature organisms. If they do not reach these nurseries, the species will not survive.

As the birdwatchers of the world have long since been aware, the rich fish and shellfish resources of our bays make them attractive to many types of fish-eating birds. During the winter months, sea ducks such as mergansers and buffleheads can be found around the bay systems, along with wintering white pelicans and native brown pelicans. With the advance of spring the islands are astir with the noisy nesting activity of colonial water birds—herons, night-herons, egrets, pelicans, cormorants, gulls, terns and skimmers.

In the spring, there is nothing quite like paddling a kayak on Christmas Bay or Drum Bay, near the nesting sites of these magnificent water birds at the southwestern end of the Galveston Bay system. The birds are dazzling during breeding season. Roseate spoonbills, an unlikely and outrageous bright pink, compete for nesting space among the salt cedars with the dark cormorants and the flashing white great egrets.

At the grassy end of an island, the heads pop up as a kayak quietly moves past. One after another, tricolored herons reveal a purple neck and a single extended white head feather. Black-crowned night-herons crouch and watch with a wary red eye from the low brush next to laughing gulls paired on the shell beach. At the end of the rookery island, standing on exposed sand and shell, may be a pair of oystercatchers, their orange-red bills in startling contrast to black heads.

Paddling, fishing or birding in an estuary, one begins to grasp the richness of the surrounding life, birds swirling, brown shrimp jumping in the shallows, schools of mullet moving the water before the kayak. Our bays and estuaries are living, vibrant systems that have immense value to us ecologically, economically and recreationally.



