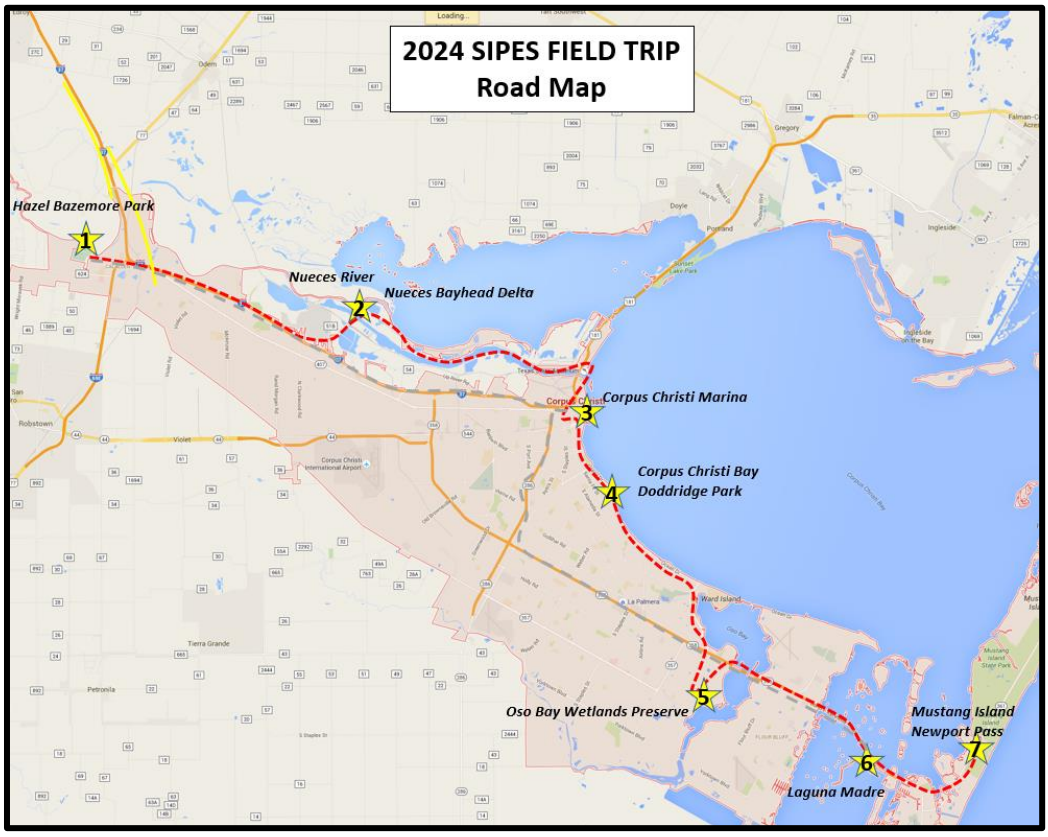
SIPES Field Trip: Geomorphology and Geologic History with Ecological Observations of the Nueces River Valley - Corpus Christi Bay, Laguna Madre, and Barrier Islands
June 13, 2024

Field Trip Leaders – Mr. Randy Bissell, Texas A&M Corpus Christi & Texas Master Naturalist™
Dr. Mark Besonen, Harte Research Institute at Texas A&M Corpus Christi
Mr. Ben Horstmann, Texas Parks & Wildlife Department

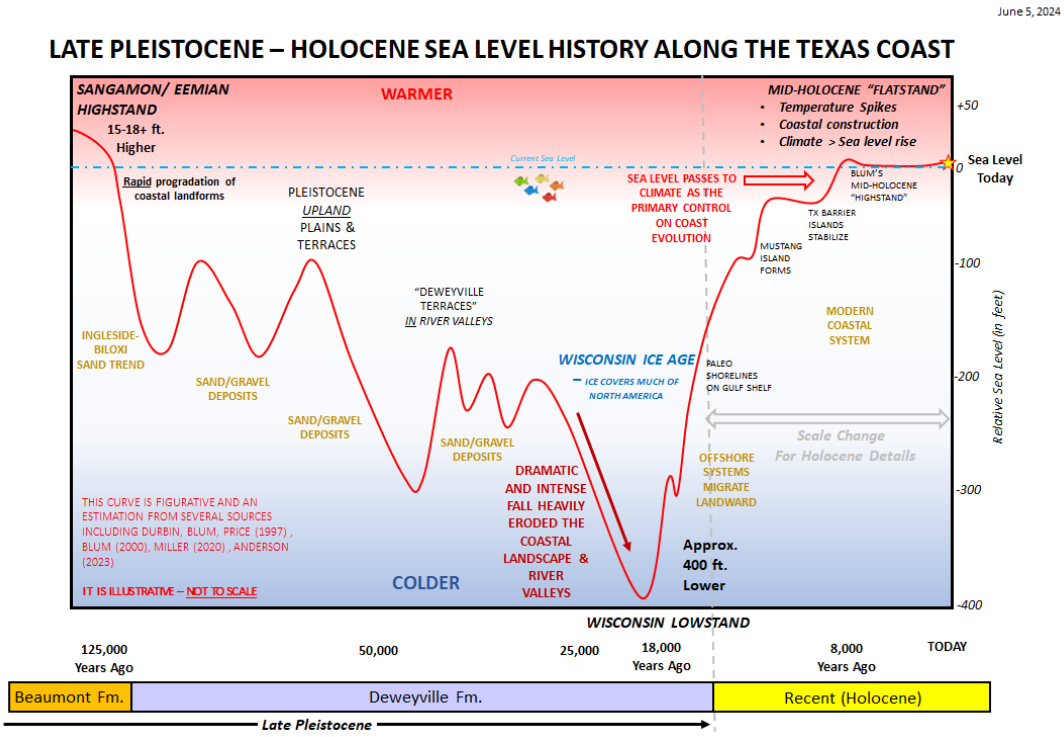
South Texas with its lower Nueces river valley and estuarine bay system demonstrates a rich and diverse array of modern geological processes. The landscape and waterways of our present-day coast exhibit landforms reflecting several stages of formation in the last 200,000 years - a relatively "near-recent" geologic past considering that the oldest rocks in Texas are over a billion years old, and the Gulf of Mexico passive margin has been forming for 250 million years.

This multi-stop field trip will explore the lower Nueces River Valley to examine the geomorphology of the Nueces River flood plain; the Nueces River Bayhead delta; the origins of Corpus Christi Bay; the history of Flour Bluff and Laguna Madre; and the beach processes on Mustang Island.



South Texas and the lower Nueces River Valley are unique amongst the world's geological study areas because of access to the range of environments and ecosystems within publicly accessible lands, parks, preserves, and refuges. Better yet, these locales are relatively close to each other. Every precious South Texas natural site is a

distinctive piece of the geological puzzle for our area. At almost any site in the Corpus Christi area, geologic stages corresponding to dramatic changes in sea level can be deciphered from the landscape. The landform history of South Texas *is* our sea level history.



The latest aggregated Pleistocene-Holocene Sea Level model for the Texas Gulf Coast (Bissell TMN figure).

This field day affords the continual integration of geology and ecology. The coastal geomorphological landforms underpin a variety of thriving ecosystems within the entire spectrum of wetland classifications: riverine, estuarine, palustrine, lacustrine, and marine. Amazing biodiversity is hosted in the Lower Nueces River Valley, Estuarine Bays, and Gulf Marine System due to the changes in elevation, variations in wetness, and changes in salinity.

Corpus Christi is further distinguished as the "Birdiest City in America" with a few hundred species often observed in annual migrations. For example, over 1 million raptors were counted in the fall 2023 at our Hazel Bazemore Park location.

Stop 1: Hazel Bazemore County Park - 9:00 am
Restroom facilities, short walk with stairs.

Geology: The first stop on the field trip will be at Hazel Bazemore County Park to look across the Nueces River Valley from the high cliff along the Nueces River. The road to the park takes us across the modern coastal plain at an elevation of 90 ft. above sea level. The park road drops us into the valley along the river. Our stop at the Hawkwatch Tower gives us a perspective 70 ft. above the valley floor. From this high perch, we see the Nueces River below, steep erosion along the valley edge, and the terraced landscape of the floodplain. Here, the general history of the Nueces River valley and the timeline for coastal evolution will be introduced.

CCGS South Texas Ice Age Poster for Classrooms – Original by artist Dinah Bowman

Pleistocene Fossils - Mr. Mike Lucente of the Corpus Christi Geological Society will present an impressive collection of Pleistocene megafauna fossils mined from the Wright Gravel Pits seen in the distance, one of the finest collection sites in North America. Numerous species have been pulled from the "Deweyville" sand and gravel deposits on the Nueces floodplain. Common fossilized bones include parts of Columbian mammoths, mastodons, camels, sloths, horses, bears, and many others. Grand megafaunas were common across the Pleistocene coastal plain 14,000 years ago when the worldwide sea level was over 300 ft. lower than today. Fossils of diverse animals can be found throughout Nueces County.

Ecology: Hazel Bazemore is notable as an example of a riparian (riverine) wetland with elements of palustrine (a freshwater bog) and lacustrine (lake) wetlands at the base of the valley-edge cliff which formed due to severe sea level falls during Pleistocene glacial maxima some 15,000 years ago. The freshwater of the river and wooded

thicket in the valley host a variety of plants and animals, including alligators! These thickets and waters are important to migratory birds and the cliff provides updraft for impressive numbers and species of raptors, including eagles, hawks, kites, and vultures, during their southerly migration observed during the annual Hawkwatch.

Further reading: Blum, Michael D., Robert A. Morton, and James M. Durban. "Deweyville" Terraces and Deposits of the Texas Gulf Coastal Plain." Gulf Coast Association of Geological Societies Transactions XLV, (1995): 53-60.

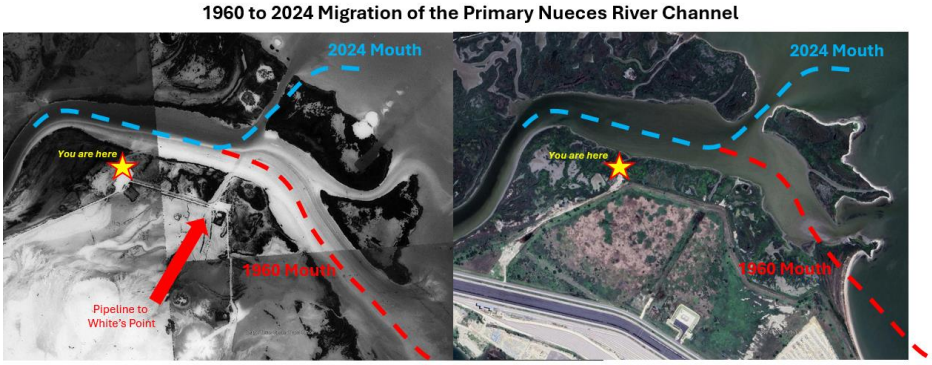
Cornish, Frank G., and Jon A. Baskin. "Late Quaternary Sedimentation, Lower Nueces River, South Texas." Texas Journal of Science 47 (3), (1995): 191-202.

Durbin, James M., Michael D. Blum, and David M. Price. "Late Pleistocene Stratigraphy of the Lower Nueces River, Corpus Christi, Texas: Glacio-eustatic Influences on Valley-fill Architecture." Gulf Coast Association of Geological Societies Transactions XLVII, (1997): 119-130.

Stop 2: Nueces River & Bayhead Delta – Joe Fulton Corridor - 10:15 am
No restroom facilities, short grassland hike.

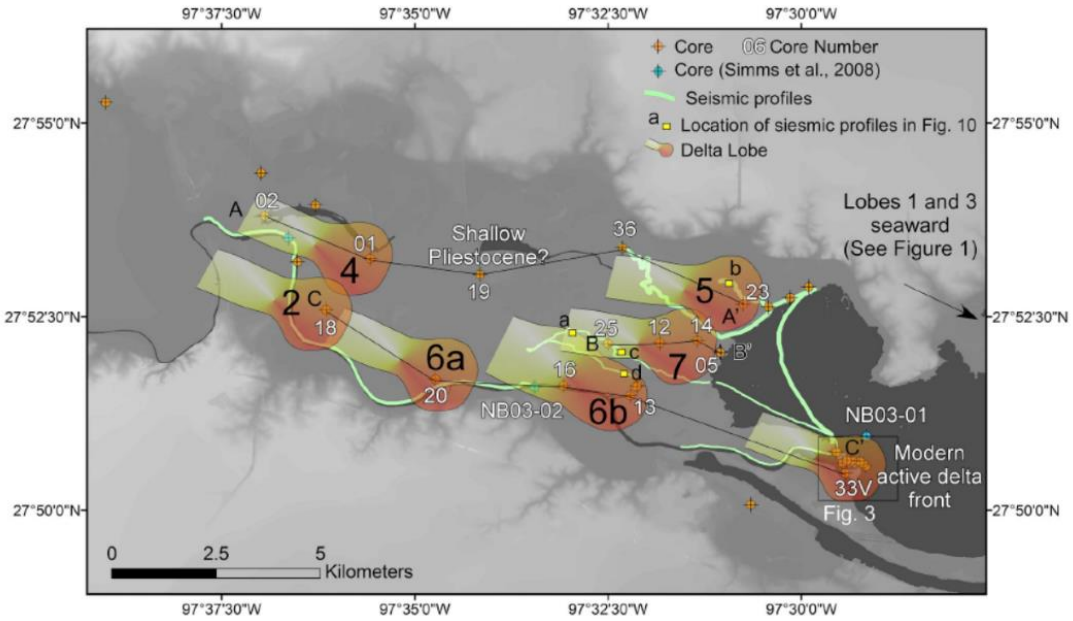
Geology: From Hazel Bazemore Park, the field trip will proceed eastward towards Nueces Bay along the Joe Fulton Corridor. Leaving the coastal plain Pleistocene Beaumont Formation, the roadway "flies over" the edge of the Nueces River Valley onto the lower Nueces River delta plain. The Nueces River will be seen coursing along the left of the bus with the man-made Port of Corpus Christi earthworks to the right. The Nueces River seen here is not the river of 150 years ago. Virtually all the discharge of the river today is consumed upriver, and the nourishing sediment is trapped behind the dams at Lake Corpus Christi and Choke Canyon Reservoir. Building reservoirs in arid climates is risky and somewhat wasteful. Now, in Spring 2024, these reservoirs are less than 30% full due to drought and the daily loss due to evaporation of these lakes compared to Corpus Christi's water utilization.

Looking to the northeast from a manmade berm, we can spot the mouth of the Nueces River entering Nueces Bay. Walking to the lobes of the bayhead delta is possible but only beyond a rough jeep trail. The mouth of the river has changed in the last 60 years because of redirection through a pipeline cut across Nueces Bay to White's Point, the white bay cliff (Beaumont Fm.) seen across the bay. Longshore transport of sediment dredged from the Port of Corpus Christi has closed the original mouth of the river completely. To the northwest, there is a recently initiated effort to replenish the wetlands of the Nueces Delta Preserve with sediments from the channel dredging.



The migration of the Nueces River Mouth through time (Google Earth).

Under natural circumstances, the Nueces River would periodically shift across this lower delta plain, back and forth with sediment volume and sea level changes. Each avulsion event creates and nourishes delta wetlands. In contrast, the present-day lack of water, absence of river sediment, increased rates of rise in sea level, and coastal subsidence have dramatically accelerated the loss of wetlands. These kinds of restoration remedies are experimental (and temporary) but will become more common in Texas.



Rice and Simms (2020) – Holocene positions of the Nueces Bayhead Delta. Movement east and west are attributed to climate, sedimentation, and a lesser degree sea level changes.

Ecology: The Nueces River at this location is not classified as "riverine," but rather estuarine. Little to no fresh water is moving down the river. This stretch can act as a "reverse" estuary when the river waters are salty due to seawater incursion and high evaporation compared to fresh river discharge. Thus, the dominant types of fish in lower the river tend towards saltwater-tolerant species, occasionally including sharks and rays. Like the fish, the vegetation along the river's edge and the delta plain must be very salt tolerant, like saltwort, glasswort, and pickle wort. In the estuary, egrets and herons are commonly seen feeding on small fish and crabs. This transitional wetland in the back of Nueces Bay is a vital nursery for many fish and bird species.

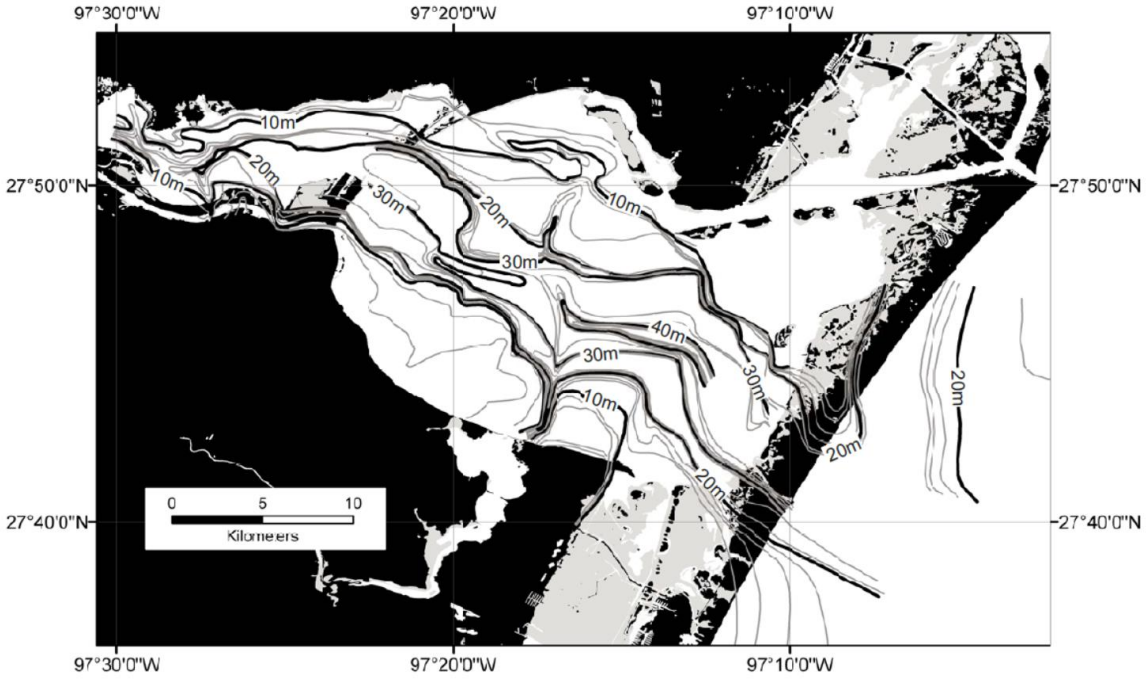
Further reading: *Rice, Johnathan A., Alexander R. Simms, Pamela Buza-Stephens, Elisabeth Steele, Daniel Livsey, Laura C. Reynolds, Yusuke Yokoyama, and Todd Halihan. "Deltaic Response to Climate Change: The Holocene History of the Nueces Delta." Global and Planetary Change - Elsevier 191, (2020): 1-13. https://doi.org/10.1016/j.gloplacha.2020.103213.*

Stop 3: Restroom at Corpus Christi Marina - 11:15 am

Stop 4: Doddridge Park – Corpus Christi Bay – 11:45 am
No restroom facilities, short hike in the park.

Geology: Corpus Christi Bay represents a recently flooded Pleistocene river valley, not unlike estuarine bays across the Gulf Coast and along the Atlantic. Standing along the bay cliff at Doddridge Park, we are on the same escarpment as Hazel Bazemore, our first stop. The difference here is that the Holocene rise of sea level has encroached and inundated the valley before us. Seismic surveys of Corpus Christi Bay have shown that the Nueces River Valley bottom was about 100 ft. below the bay level today under Holocene bay fill. In your mind's eye, step back some 20,000 years to imagine a fast-moving gravel-laden braided river coursing through a verdant valley before you. A herd of mammoths or mastodons passes by…the roar of a saber-toothed cat can be heard in the distance. Recall the Dinah Bowman Ice Age poster.

The coastal plain here is Beaumont Formation clay. This clay shoreline is unstable and prone to severe cliff undercutting and collapse. The failure of the bay cliff usually follows surges in the bay and the torrential rains associated with tropical storms and hurricanes. The generally circular shape of the bay, with the obvious curvature formed by a series of cuspate bights of the shoreline, attests to the process of undercutting and collapse. Note the active scarp forming today and the offset. The process is ongoing and remediation efforts are increasing in magnitude and cost.



Map showing the subsea depth to the Pleistocene Nueces valley surface in Corpus Christi Bay (Simms, et al., 2008)

Ecology: Corpus Christi Bay is a shallow estuarine bay sheltered by Mustang Island and connected to the marine Gulf of Mexico by two man-reinforced natural passes, the Aransas Pass and Corpus Christi Pass (now known as Packery Channel). Balancing the ecology and needs of industry in this heavily utilized waterway is challenging on several fronts.

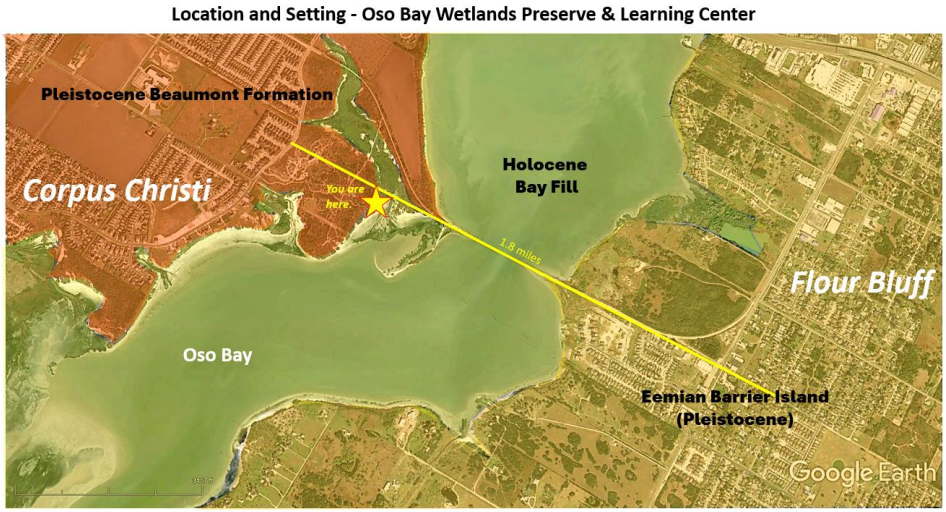
The average bay water depth is less than about 10 ft., but the 50 ft. deep Port of Corpus Christi Ship Channel slices through the bay from Port Aransas to downtown. Muddy and sandy spoil from the continual dredging of the channel is spread across the bay and reworked by the wind-generated waves. The salinity in the bay varies from

brackish near the Nueces River to seasonal hypersalinity in parts. Purposeful discharge of fresh water from the Nueces River is required to balance salinity and provide nutrients for shrimp and fish nurseries. Overharvesting and the typically murky waters have resulted in the elimination of commercial oystering in the bay. The bay is still home to a reliable game fish population, including red drum and speckled trout. There remains a small shrimp industry in the bay. Tours can often spot porpoises frolicking in the waves. Sea birds are common, including pelicans, laughing gulls, terns, ruddy turnstones, and the occasional magnificent frigatebird.

Further reading: *Simms, Alexander R., John B. Anderson, Antonio B. Rodriguez, et al. "Mechanism Controlling Environmental Change within an Estuary: Corpus Christi Bay, Texas, USA." Geological Society of America Special Papers 443, (2008): 121-146. https://doi.org/10.1130/2008.2443(08).*

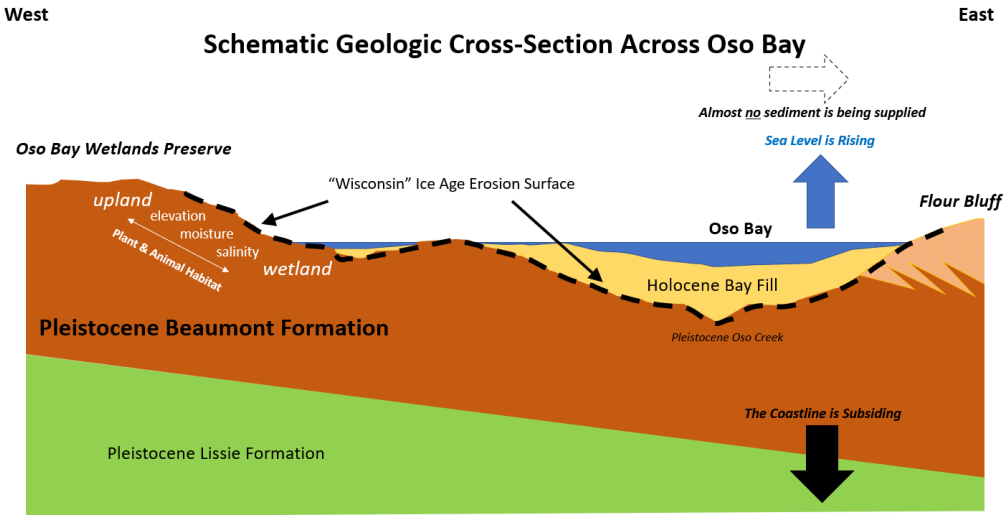
Stop 5: Oso Bay Wetlands Preserve & Lunch – 12:30 pm
Air-conditioned space, benches, restrooms.
Moderate hike (likely in heat).

Geology: The City of Corpus Christi christened the Oso Bay Wetlands Preserve in 2008 to provide a public Nature Learning Center and outdoor experience for citizens. The Oso Bay Wetlands Preserve is located along the western shore of the Oso Bay estuary, which occupies a relic lagoon behind the large barrier island that formed along the Texas Coast during the last interglacial warm period known as the Sangamon or Eemian highstand about 140,000 - 125,000 years ago.



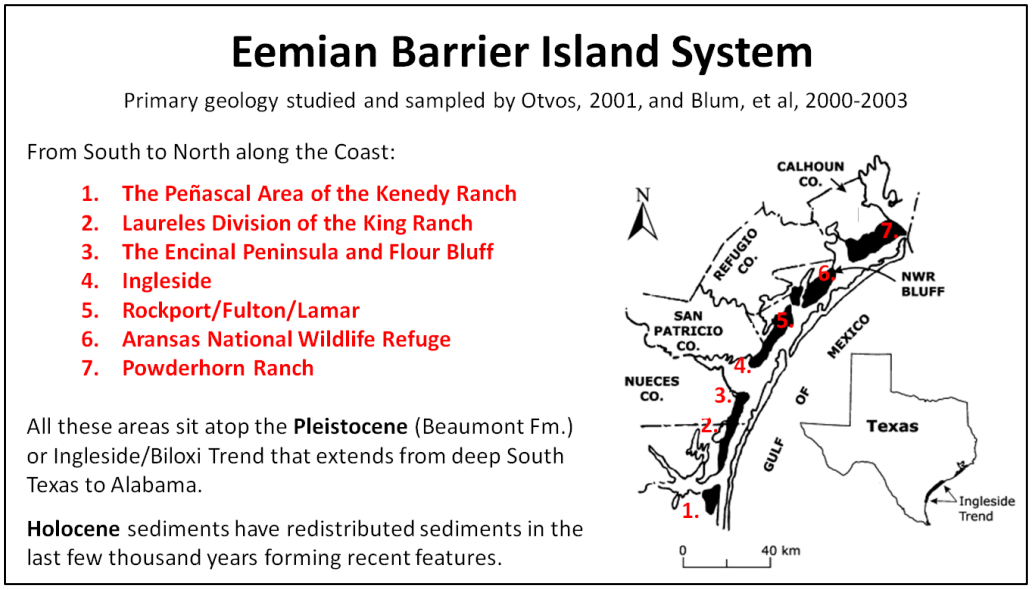
Map of the Oso Bay Wetlands Preserve location illustrating the Pleistocene Beaumont Formation mainland and the relationship between the Holocene bay fill in the Oso (an ancient lagoon) with the late Pleistocene "Eemian" Barrier Island now known as Flour Bluff (Bissell TMN figure).

The uplands of the Oso Bay Preserve are Beaumont Formation sandy clay at 25 ft. of elevation which provides a unique upland overlook of the Oso Bay and Flour Bluff Peninsula. The contact between the Pleistocene Beaumont Formation and modern Holocene sediment can be traced along the bay cliff as the sharp break in slope between the cliff and upland and the flat-lying and onlapping Holocene bay fill.



Basic geological elements of the Oso Bay Wetlands Preserve (Bissell TMN figure).

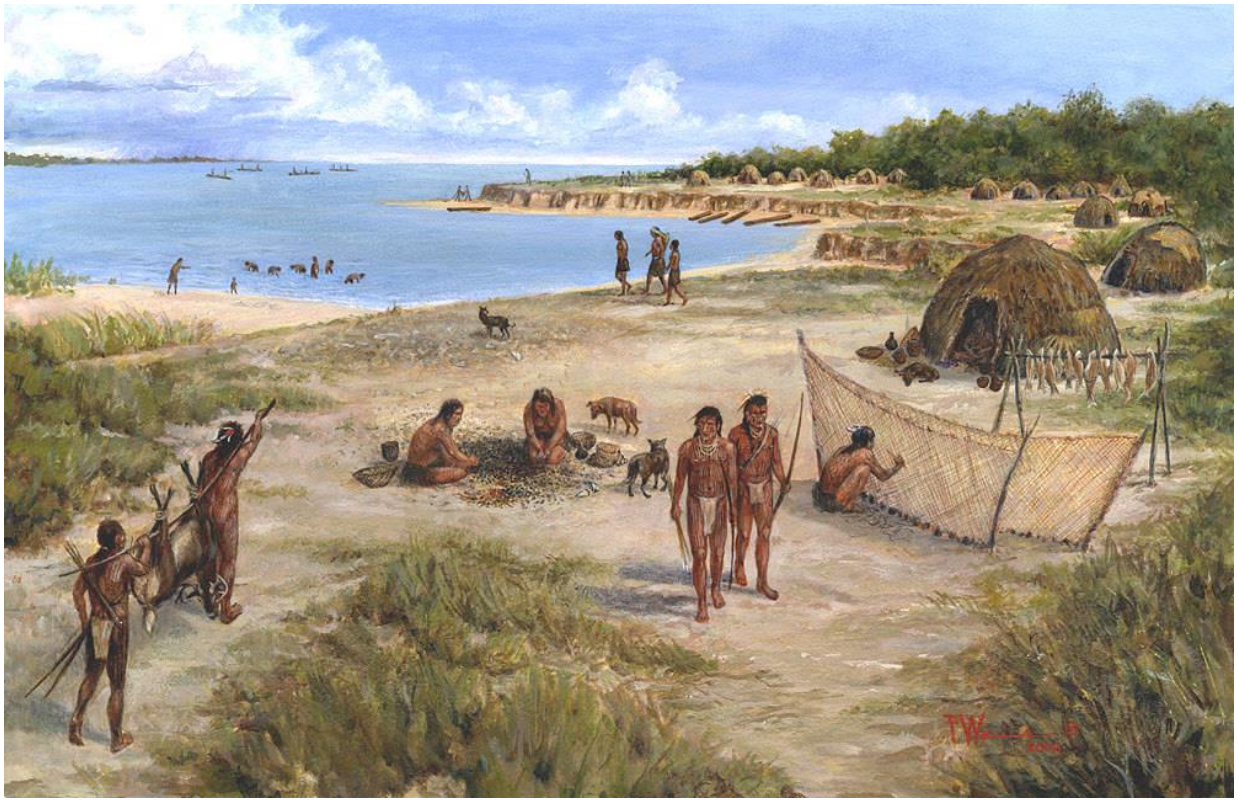
At the Osprey Overlook elevated trail, the relationship between the Flour Bluff Pleistocene barrier island and the ancestral lagoon behind it is easily observed. The cyclicity of coastal landforms becomes clear comparing the Pleistocene Isla Abuelo (Grandfather Island) and Laguna Abuela (Grandmother Lagoon) with the modern Padre Island (Father Island) and Laguna Madre (Mother Lagoon) that we will see later in the day. Along the Texas Coast, the relic Laguna Abuela expresses itself as Alazan Bay, Laguna Larga wetland, Oso Bay, Port Bay, Copano Bay, St. Charles Bay, and Powderhorn Lake all nestled behind the remnants of the Sangamon/Eemian "Ingleside" Barrier Island Trend that runs from the King Ranch through Flour Bluff, Ingleside, Rockport, Fulton, Goose Island State Park, Aransas National Wildlife Refuge, to Indianola and Port O'Connor.



The Ingleside Trend represents the late Pleistocene Barrier Island trend. The "Grandfather" island. Relics of the coincident "Grandmother" lagoon are the bays and waterways west of the Trend. (Bissell TMN Figure).

Ecology: The Oso Bay Preserve is a small example of Tamaulipan Thorn Scrub, or the northern extension of an arid coastal ecological region trending deep into Mexico. The thorn scrub habitat is notable for its name, indicating thorns of all sizes! The dense thorny thicket provides excellent shelter for a variety of locally nesting and migratory birds including beautiful northern cardinals, mockingbirds, orioles, tanagers, indigo and painted buntings, along with our summer visitors, the raucous Purple Martins. The 135-acre preserve also hosts small mammals, including raccoons, skunks, bobcats, and opossums. Rattlesnakes, coral snakes, lizards, and tortoises are common finds along trails. The Oso Bay wetlands that front the preserve are a brackish estuarine wetland environment where egrets, herons, and other shorebirds graze the flats for mollusks and small fish.

History: This shoreline along the Oso Bay was certainly the home of the Karankawa, a coastal native people who thrived in South Texas from Baffin Bay to Galveston. They are commonly misrepresented in Texas history books as nomadic, aggressive, and even wantonly cannibalistic. A factual description of this hunter-gatherer group should acknowledge their language, religion, technology, and amazing capacity to succeed in this harsh landscape for centuries before the settlement of Texas. Due to displacement (and extermination), the last few Karankawa were driven to Mexico by the 1850s. Today, the self-identified ancestors of the Karankawa are working to reestablish their language, customs, and traditions.



Karankawa - "Life on Guadalupe Bay" by artist, Frank Weir. Lipscomb and Seiter (2020).

<u>Further reading:</u> Brown, L.F., et al. 1976. Environmental Geologic Atlas of the Texas Coastal Zone - Corpus Christi Area. Austin, Texas: Bureau of Economic Geology, University of Texas., 123 p., 9 maps.

Lipscomb, Carol A., and Tim Seiter. "Karankawa Indians." TSHA Online. Texas State Historical Association, November 13, 2020. https://www.tshaonline.org/handbook/entries/karankawa-indians.

Stop 6: Padre Island Causeway – 2:00 pm
Quick on and off the bus, no restrooms.

Geology: The Laguna Madre is the shallow waterway formed between the Pleistocene mainland and the Holocene Mustang and Padre Barrier Island system. Sediments in the Laguna are a patchwork of seagrass vegetated and sometimes barren mud and hard sand bottom. The sediment source for the Laguna Madre is largely windblown – sand, silt, and clay from the barrier island with erosional drainage from the mainland. Another major source of sand influx comes with storms that surge sediment through cuts across the island into the lagoon. Lobes of coarse storm washovers can be seen along the backside of the barrier island. There are several examples of these "back barrier" or "strandline" traps in the subsurface Vicksburg of South Texas, most notably the prolific Tijerina-Canales-Blucher Field in Kleberg County.

Looking southward from this location along the John F. Kennedy Memorial Causeway, the low islands are all spoil from dredged channels when Humble Oil, and later Exxon, developed Miocene and Frio (Oligocene) gas reserves in Flour Bluff and under the Laguna Madre. The prolific Flour Bluff Field has produced over 600 BCFG and 30 million barrels of oil since its 1936 discovery. Only a handful of wells are still producing today. A large deadly blowout occurred in 1948 and the submarine crater is now a fishing spot.

Annotated GoogleEarth image showing the relative positions of the afternoon stops for the field day.

Ecology: The hypersaline Laguna Madre is one of the premier sport fishing locales in the world, notable for trophy-sized red drum, speckled trout, and flounder, all prized for the challenge of the catch and the delicious reward. Every weekend there are hundreds of anglers motoring about the waterway looking for their special "honey hole." Where there are fish and fishermen, there are also birds! The Laguna Madre hosts iconic pelicans, blue herons, sandhill cranes, osprey, gulls, black skimmers, various terns, egrets, and other fantastic shorebirds. Beyond the array of birds and fish, green turtles and porpoises can often be spotted in the shallow Laguna waters.

Further reading: *Weise, Bonnie R., and William A. White. 1980. Padre Island National Seashore - A Guide to the Geology, Natural Environments, and History of a Texas Barrier Island. Guidebook 17. Austin, Texas: Bureau of Economic Geology. University of Texas., 94 p., 1 map.*

Otvos, Ervin G., "Mississippi Coast: Stratigraphy and Quaternary Evolution in the Northern Gulf Coastal Plain Framework. Stratigraphic and Paleontologic Studies of the Neogene and Quaternary Sediments in Southern Jackson County, Mississippi." U. S. Geological Survey Open-file Report 01-415-H. (2001)

Taylor, Dennis A., and Zuhair Al-Shaieb. "Oligocene Vicksburg Sandstones of the Tijerina-Canales-Blucher Field: A South Texas Geologic Jambalaya." Presentation to the South Texas Geological Society, San Antonio, Texas, November 16, 1986.

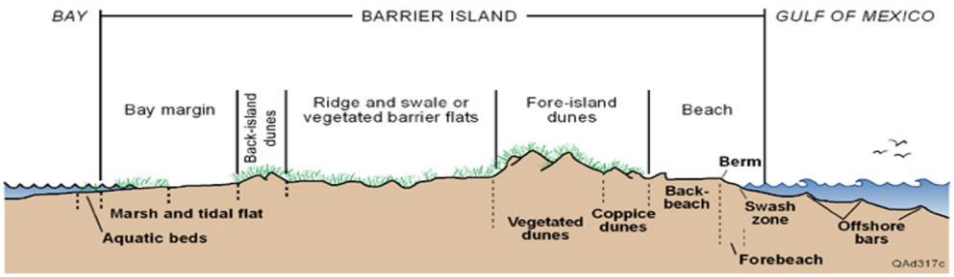
Stop 7: Mustang Island Newport Pass – 3 pm
Restroom facilities nearby at beach, no shade.
Moderate hike on beach (wind and heat).

Geology: Mustang and Padre Islands (together) are often referred to as the longest barrier island in the world, just over 125 miles from Boca Chica to the Aransas Pass. But history reveals that Mustang Island has almost always been separated from Padre Island by Corpus Christi Pass, albeit as a shallow and migratory network of channels. Remnants of the old 1852 and Corpus Christi passes remain, but the modern construction of the Packery Channel establishes a permanent distinction between the islands.

"High-Profile" or "Low-Profile" barrier island characterization refers to the comparative height and width of the island. High-profile islands have well-developed fore-island dunes with wide mid-island vegetated flats and often large back-island dunes. Low-profile islands are prone to recurrent washover during storms and seasonal tides. Although strictly not a low-profile island, this southern end of Mustang Island is prone to recurrent washovers, Newport Pass on Mustang Island was reopened in 2007 due to Hurricane Humberto.

Barrier islands occur under specific conditions, namely along passive margins of continents with wide shelves, low tidal range, and abundant longshore-current sourced sand – exactly our Gulf of Mexico. Texas barrier islands formed in the last 7500 to 3500 years with the slowing of Holocene sea level rise. Detectable changes in sea level rise today portend potential destabilization or migration of the barrier islands.

Mustang Island Barrier Island Profile



Idealized barrier island profile illustrating geomorphology and ecology subdivisions from Caudle (2017).

Ecology: Texas barrier islands host a variety of plants and animals with several ecological niches across the profile. Although the most popular part of the island, the "beach" is only a small portion of the island. The dunes, mid-island vegetated barrier flats, and back-island tidal flats each host a variety of plants, invertebrates, birds, fish, and mammals suited for the environment. The variety of species reflects the complexity of interrelated ecosystems defined by the availability of fresh water in island ponds versus salty water and the protection from severe heat, sunlight, wind, and wave energy.

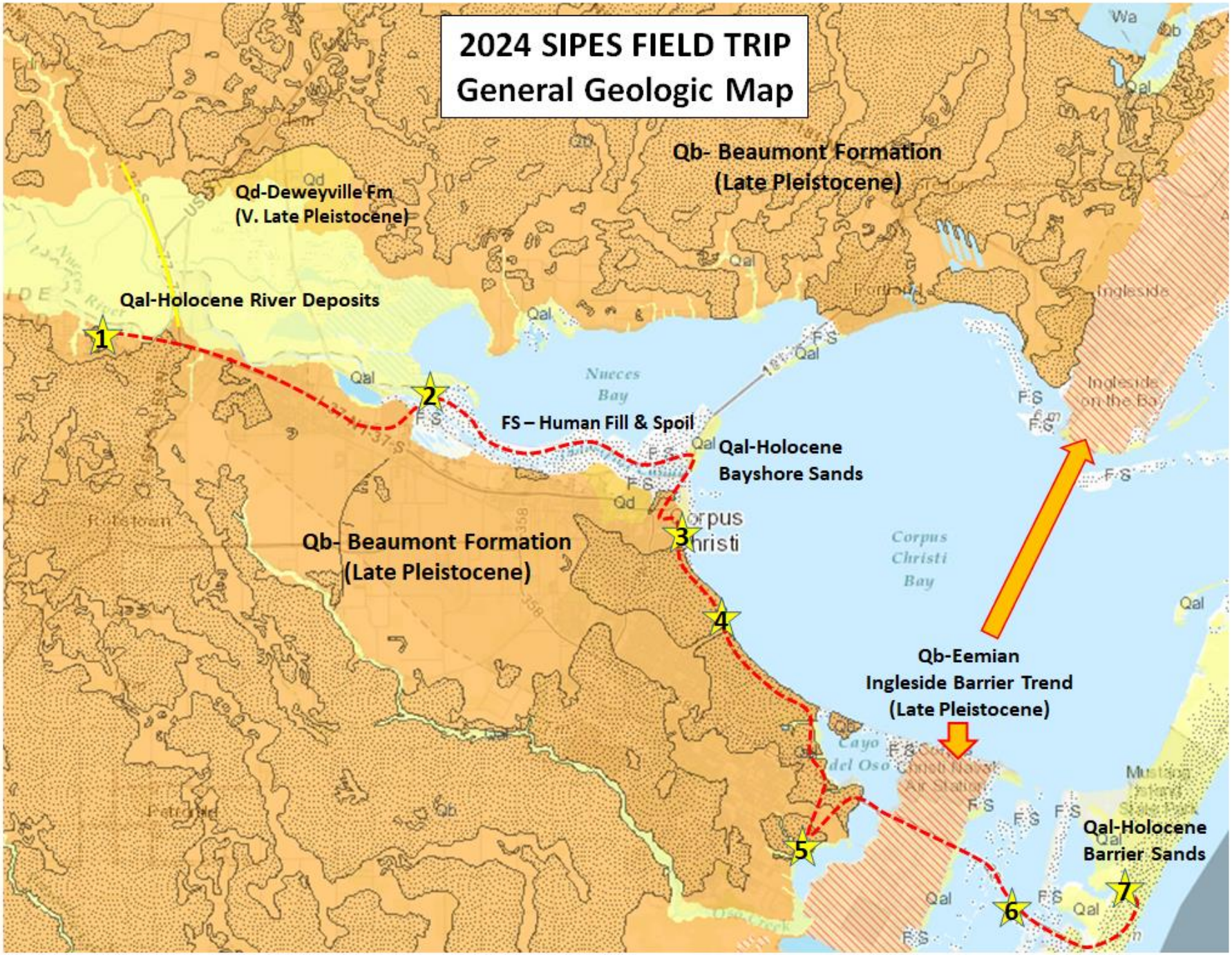
Mustang Island is named for the herds of wild Spanish horses observed here in the early 1800s. By the end of that century, all were removed, tamed, or eradicated to make way for cattle and tourism. Today, there are several other wild mammal species on the island including rats, squirrels, deer, coyotes, bobcats, and raccoons. Raptors, such as harriers and several types of hawk prey on small mammals, as do the rattlesnakes found in the dunes. South Texas barrier islands are famous for turtle nesting and great efforts are made to recover eggs and return the hatchlings in celebrated public releases.

Further reading: *Simms, Alexander R., John B. Anderson, and Michael Blum. "Barrier-island Aggradation via Inlet Migration: Mustang Island, Texas." Sedimentary Geology 187, (2006): 105-125.*

Caudle, Tiffany, Jay Raney, and Sigrid Clift. 2017. GeoForce Texas 9th Grade Academy: Guidebook for Geoscience Field Trip (Excerpt) - Lecture #7 Barrier Islands. 4th ed. Austin, Texas: Jackson School of Geosciences. University of Texas.

Ferguson, Shannon, Sophie Warney, John B. Anderson, Alexander R. Simms, and Crawford White. "Breaching of Mustang Island in Response to the 8.2 Ka Sea-level Event and Impact on Corpus Christi Bay, Gulf of Mexico: Implications for Future Coastal Change." The Holocene, no. Vol. 28 (2018): 166-172. https://doi.org/10.1177/0959683617715697.

Field Trip Concludes at 4:30 pm
Transport to Dinner Event at Doc's – 12 minutes.
Return to Corpus Christi – 30 minutes.


2024 SIPES FIELD TRIP
General Geologic Map
Qb- Beaumont Formation
(Late Pleistocene)
Qd-Deweyville Fm
(V. Late Pleistocene)
Qal-Holocene River Deposits
FS – Human Fill & Spoil
Qal-Holocene
Bayshore Sands
Qb- Beaumont Formation
(Late Pleistocene)
Qb-Eemian
Ingleside Barrier Trend
(Late Pleistocene)
Qal-Holocene
Barrier Sands
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Field Associates – Bradley Harris & Alan Innis, Texas A&M Corpus Christi

To access referenced files and other resources online
scan this QR Code with your smartphone or tablet.

www.txmn.org/st/coastal-geomorphology-field-trip