

FINAL REPORT

Texas High School Coastal Monitoring Program: 2024–2025

Tiffany L. Caudle



Bureau of Economic Geology

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Austin Texas 78758-4445

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INTRODUCTION

The Texas High School Coastal Monitoring Program (THSCMP) is designed to engage students living on the Texas coast in the study of their natural environment. Students, teachers, and scientists work together to gain a better understanding of dune and beach dynamics and coastal processes that shape their coastal communities. Scientists from The University of Texas at Austin's Bureau of Economic Geology (the Bureau) lead this research and outreach program by providing the tools and training needed for scientific investigation. Students and teachers learn how to measure topography, map vegetation lines and shorelines, and observe weather and wave conditions. The dynamic coastal environment provides an ideal setting for teaching middle school and high school students basic and applied science and for illustrating the roles that science and good data-collection practices play in coastal management decision-making.

By participating in an actual research project, the students obtain an enhanced science education and provide coastal decision-makers with valuable data about the Texas shoreline. The eight schools participating in THSCMP collect data along the easily accessible developed sections of the Texas coast. Students monitor changes in beaches, dunes, and vegetation-line position on Bolivar Peninsula, Galveston Island, Follet's Island, Matagorda Peninsula, Mustang Island, North Padre Island, and South Padre Island (**Fig. 1**). This report describes the program and our experiences at the eight participating schools through December 2025.

In support of coastal-management issues, data collected by students are useful in explaining beach cycles and defining short-term versus long-term trends. Defining these trends is important in decision-making regarding coastal development, beach nourishment, and dune restoration projects. The THSCMP observes beaches in several coastal parks: Mustang Island and Galveston Island State Parks, overseen by the Texas Parks & Wildlife Department (TPWD); the Lower Colorado River Authority's Matagorda Bay Nature Park; Cameron County's Isla Blanca Park; Brazoria County's Quintana Beach County Park, and the City of Galveston's

Dellanera RV Park. The data collected within these park systems help managers develop a better understanding of their local coastal environments, which allows managers to make wise decisions in long-term management and future park development.

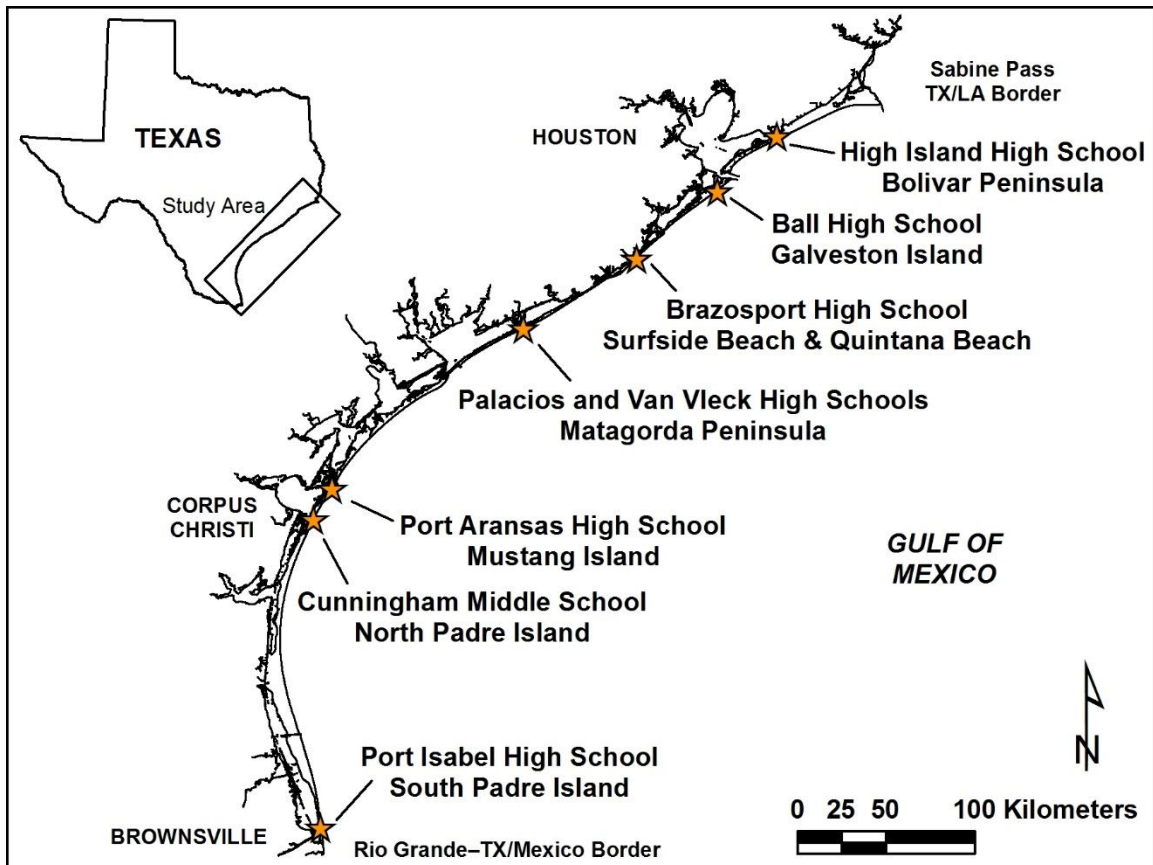


Figure 1. Location map of participating schools.

PROGRAM DESCRIPTION

Goals

The coastal monitoring program has three major goals:

(1) *Provide students with an inquiry-based learning experience.* Students make several field trips to their study sites during the school year. They conduct topographic surveys (beach profiles) of the foredune and beach, map the vegetation line and shoreline, and observe weather and wave conditions. Back in the

classroom, students analyze their data and look for relationships among the observed phenomena. Bureau scientists provide background information and guide inquiries about the data, but students are encouraged to form and test their own hypotheses. Through their collaboration with working scientists on an actual research project, the students gain an enhanced science education.

(2) Increase public awareness and understanding of coastal processes and hazards.

All data collected by the students and analyses made by Bureau scientists are publicly available for use by coastal managers, scientists, decision-makers, and the public. The THSCMP website (<http://www.beg.utexas.edu/thscmp/>) containing the latest data, analysis, photos, and educational resources is central to the project's community outreach aspect. Further aspects of the program conducted to improve public awareness include presentations at conferences by Bureau scientists, student presentations and data-collection demonstrations at community outreach events, annual reports, and scientific journal articles.

(3) Achieve a better understanding of the relationship between coastal processes, beach morphology, and shoreline change, and make data and findings available for solving coastal management problems. The Bureau conducts research to monitor shorelines and investigate the impact of coastal processes. An important part of this program is repeated shoreline mapping and beach profile measuring. Over time, these data are used to determine the rate of shoreline change. A problem we face is the limited temporal resolution of our shoreline data. The beach is a dynamic environment where significant changes in shape and sand volume can occur over periods of days or even hours. Tides, storms, and seasonal wind patterns cause large, periodic or quasiperiodic changes in the shape of the beach. If coastal data are not collected often enough, periodic variations in beach morphology could be misinterpreted as secular changes. The THSCMP helps to address this problem by providing scientific data at key locations along the Texas coast. These data are integrated into the ongoing coastal research program at the Bureau and are made available to other researchers and coastal managers.

Methods

The central element of the monitoring program is three class field trips during the academic year, weather permitting. During each trip, students visit several locations and apply scientific procedures to measure beach morphology and to make observations on beach, weather, and wave conditions. These procedures were developed during the program's pilot year (1997–1998). A general discussion of the field measurements follows.

Beach profile: Students use a pair of Emery rods, a metric tape measure, and a hand level to accurately survey a shore-normal beach profile (**Fig. 2**; Emery, 1961; Krause, 2004; O'Connell, 2001). The students begin the profile at a pre-surveyed datum stake so that they can compare each new profile with earlier profiles. Consistently oriented photographs are taken with a digital camera. The beach profiles provide detailed data on the volume of sand and the shape of the beach.

Shoreline and vegetation-line mapping: Using handheld Global Positioning System (GPS) units, students walk along the shoreline (wet/dry line) and vegetation line, mapping these features for display on aerial photography (**Fig. 3**). GPS mapping can be used to measure the rates of change to these features. By comparing positions determined through GPS mapping over time, students can visualize shoreline and vegetation-line changes.

Beach processes observations: Students measure wind speed and direction, estimate the width of the surf zone, and observe breaker type. They note wave direction, height, and period and they estimate longshore current speed and direction using a float, stopwatch, and tape measure (**Fig. 4**). From these measurements, they can infer relationships between physical processes and beach changes in time and space.



Figure 2. Students use (A) a sighting level to determine vertical offset between Emery rods and (B) a metric tape to measure horizontal distance.



Figure 3. Students mapping (A) the vegetation line and (B) the shoreline (wet/dry line) using handheld GPS units.

Bureau scientists provide teachers and students with all the training, information, field forms, and equipment needed to conduct the field measurements. The scientists and students discuss issues regarding scientific research, as well as coastal issues relevant to their community and the State of Texas. These visits also provide scientists with an opportunity to ensure the quality of the data.



Figure 4. Students (A) throw an orange into the surf to determine longshore current speed and direction, (B) using a sighting compass to determine wind and wave direction, and (C) measuring wind speed using a Dwyer hand-held wind meter.

Data Management, Data Analysis, and Dissemination of Information

All THSCMP data since the inception of the program have been analyzed and archived by Bureau scientists. The THSCMP produces several data products: topographic profiles representing the beach and dune system; GIS shapefiles mapping shorelines and vegetation lines; and photographs of shorelines, vegetation lines, and foredune crests from each data collection site. All scientific data, analyses, and results from the THSCMP are publicly available either through the THSCMP website or by request to Bureau staff.

The THSCMP website (<http://www.beg.utexas.edu/thscmp/>) is central to the dissemination of data collected by the program. It provides all the information needed to begin a beach-monitoring program and curriculum materials for high school teachers. Each school in the program has a page dedicated to data, observations, and photos related to their study area. Numerous educational resources are curated on the website that have been developed for use by students and teachers to enhance learning about coastal environments, processes, issues, and hazards. The website also hosts a 3D coastal visualization model to supplement in-class or at-home learning about coastal change.

STUDENT, TEACHER, AND SCIENTIST INTERACTIONS

In 1997, Bureau researchers developed a pilot beach-monitoring program with Ball High School on Galveston Island (Caudle and Paine, 2012; Hepner and Gibeaut, 2004). The THSCMP has since expanded several times to now include a total of eight schools (**Fig. 1, Table 1**). Students in the program are enrolled in classes such as physics, environmental science, biology, aquatic science, or general science. Since the program began in 1997, a total of 444 field trips have been completed.

High Island High School

High Island High School joined the THSCMP during the 2015–2016 academic year. Science teacher Alvin Yap and his students collected data from three Bolivar Peninsula sites on October 24, 2024; February 13, 2025; May 13, 2025; and November 5, 2025. Two of the monitoring sites are adjacent to Rollover Pass—BOL02 to the west of the pass and BOL03 to the east (**Fig. 5**). A third site (HIB01), seaward of High Island, is located just past the eastern end of Highway 87 (**Fig. 5**). Students also collected shoreline positions across the mouth of the now closed Rollover Pass. Access to this section of the beach is currently closed due to construction of a fishing pier. Once completed, students will resume mapping the shoreline position and establish a new beach profile site closer to the pier to replace BOL03.

Table 1. Schools involved in the THSCMP.

School	Location	Year Started
Ball HS	Galveston Island	1997
Brazosport HS	Surfside & Quintana	2018
Cunningham MS	North Padre Island	2009
High Island HS	Bolivar Peninsula	2016
Palacios HS	Matagorda Peninsula	2006
Port Aransas HS	Mustang Island	1999
Port Isabel HS	South Padre Island	1999
Tidehaven MS	Matagorda Peninsula	2005
Van Vleck HS	Matagorda Peninsula	2005

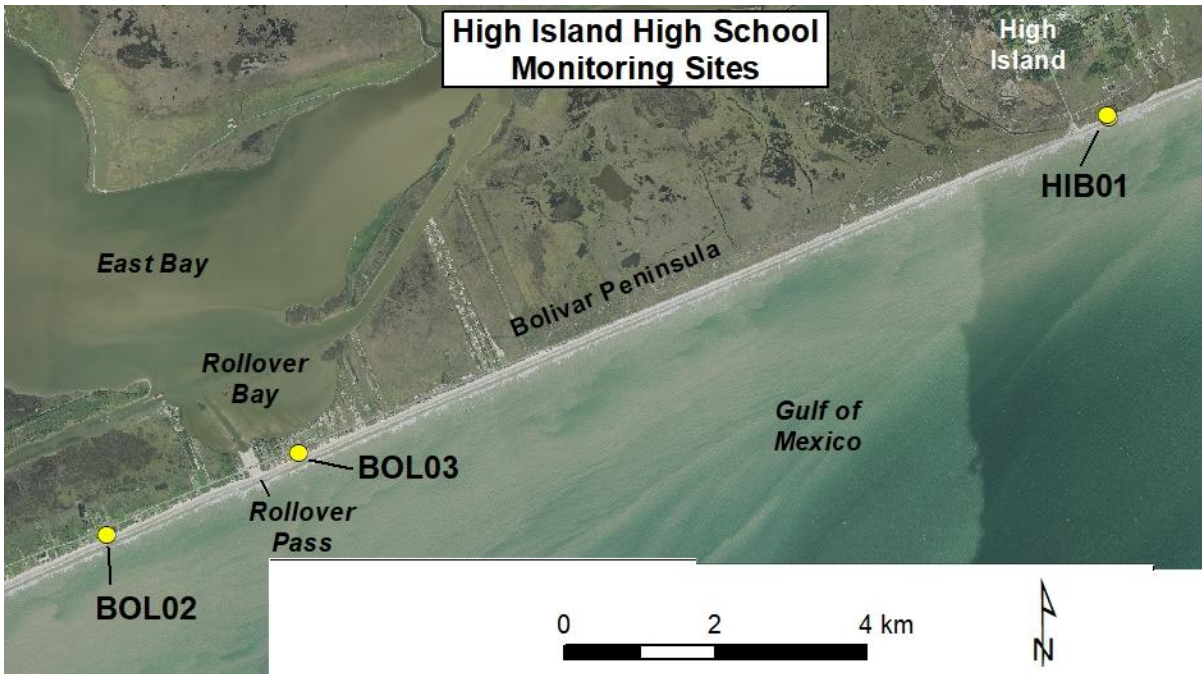


Figure 5. Location map of High Island High School monitoring sites.

Ball High School

Dr. Daniel Hochman's Advanced Placement (AP) Environmental Science classes at Ball High School conduct surveys at JAM02 in Jamaica Beach and DEL01 in the Dellanera RV Park (**Fig. 6**). Both sites monitor beach nourishment and Coastal Erosion Planning and Response Act (CEPRA) beach and dune restoration activities. A new monitoring site was established in Galveston Island State Park (GISP1) to replace BEG02, which is easier and safer for students to access. GPS mapped shoreline positions are collected along the Babe's Beach section of Galveston Island (west of 61st Street) as well. Ball High School students collected data on October 25, 2024; January 31, 2025; April 7, 2025; and October 2, 2025.

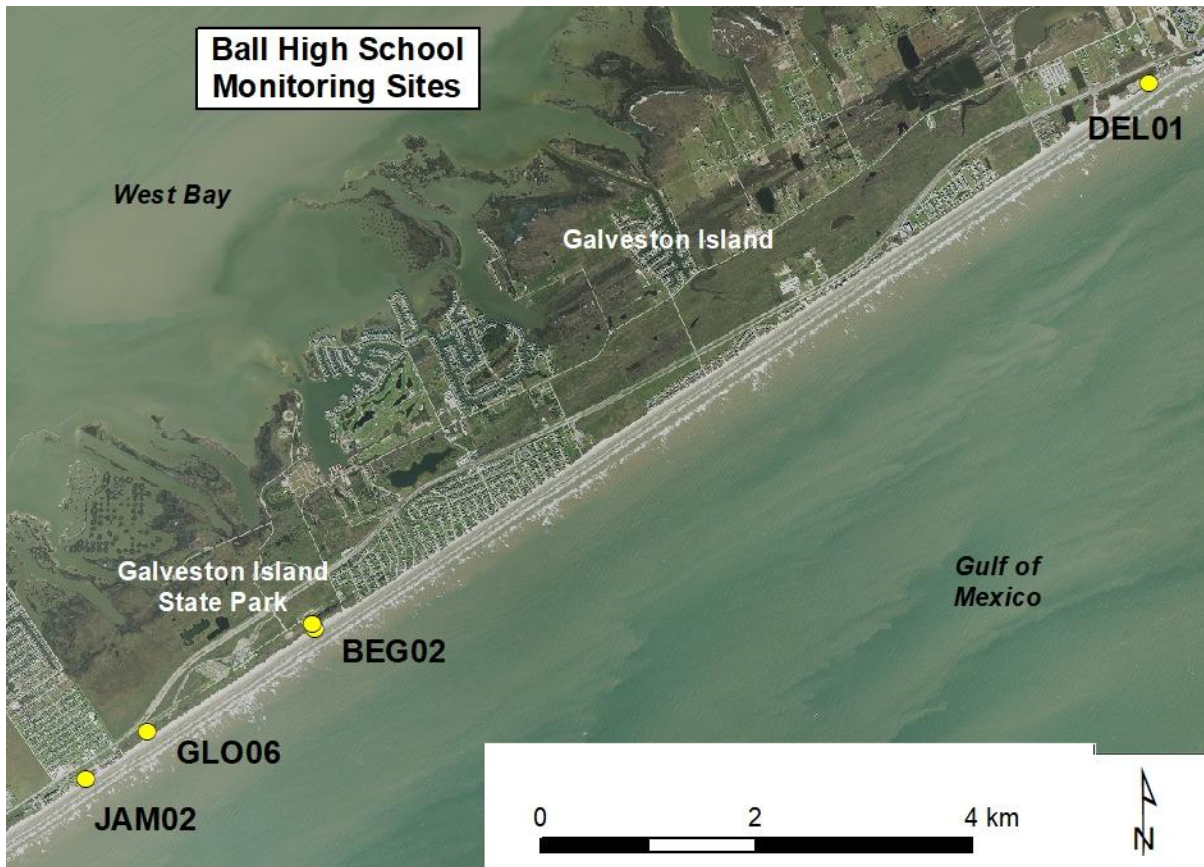


Figure 6. Location map of Ball High School monitoring sites.

Brazosport High School

Brazosport High School in Freeport, Texas, joined THSCMP during the 2018–2019 academic year. Teacher Tori Porter and senior AP Environmental Science students collect data from sites at Surfside Beach and Quintana Beach. Field trips took place on October 23, 2024; February 5, 2025; May 1, 2025; and October 8, 2025. Three of the monitoring sites (SURF2, SURF4, and jetty park) are in Surfside Beach on the southern end of Follet’s Island (**Fig. 7**). A fourth site (QUIN1) was established in Brazoria County’s Quintana Beach County Park (**Fig. 7**) where students map the vegetation line and shoreline. During the September 2023 field trip, the SURF4 datum point at Stahlman Park had been demoed and construction was taking a place. A new datum point will be established once construction is complete. Students collected GPS data and made observations of wind, waves, and currents but did not conduct a beach profile.

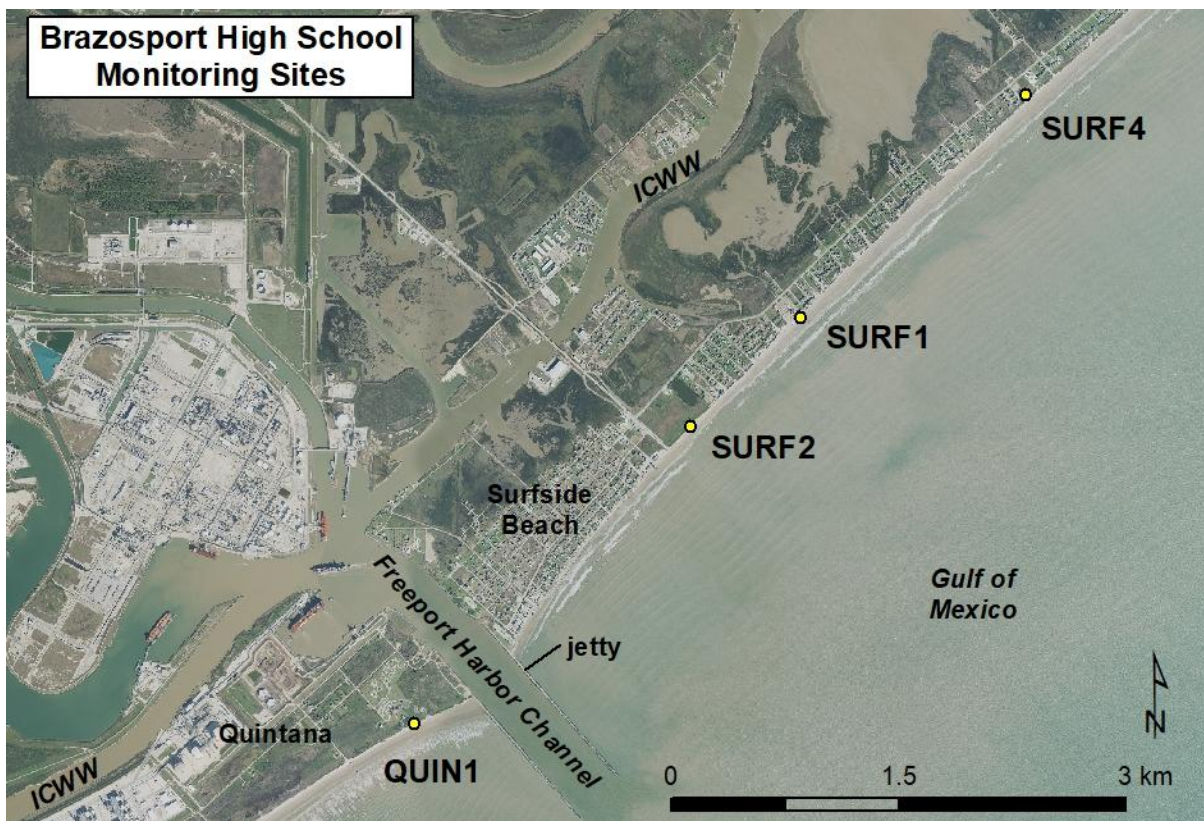


Figure 7. Location map of Brazosport High School monitoring sites.

Matagorda Area Schools

Van Vleck High School environmental science students participated in field trips on October 2, 2024; February 7, 2025; April 29, 2025; and October 7, 2025. Students from classes taught by Stacey Goodman and Jennifer Rodriguez collect data at MAT01 (**Fig. 8**). Palacios High School participated in field trips on October 8, 2024; February 6, 2025; April 30, 2025; and October 1, 2025. McKaylie Reamy and Hagen Land's students collect data at MAT02 (**Fig. 8**). The MAT03 profile location (**Fig. 8**) has seen a significant increase in beach width, including a coppice mound field with intermittent swales that usually contain water, marsh plants, and venomous snakes. It has become dangerous for students, teachers, and staff to collect profile data at this location without the proper protective gear. Van Vleck and Palacios High Schools map the shoreline and vegetation line positions with GPS at this site.

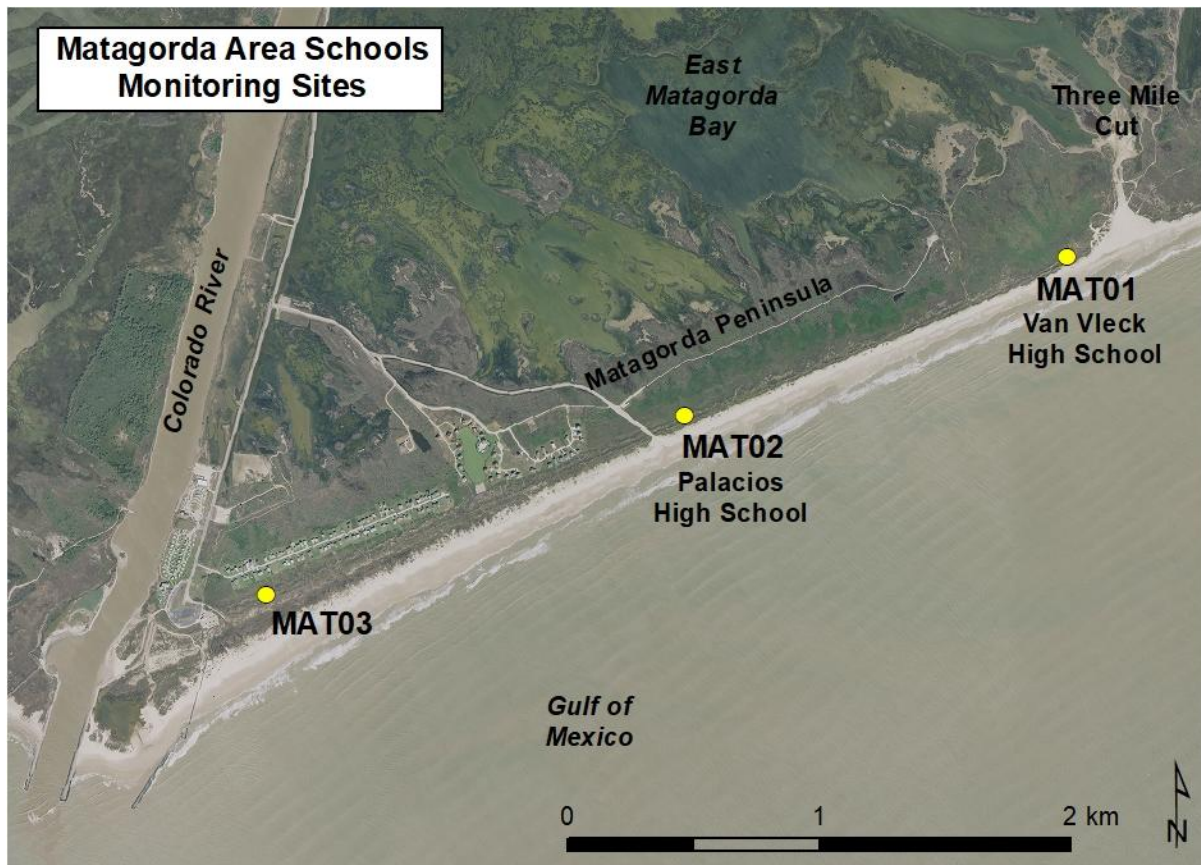


Figure 8. Location map of sites monitored by Matagorda-area schools.

Port Aransas High School

Port Aransas students participated in field trips on October 10, 2024; February 25, 2025; April 10, 2025; and October 23, 2025. Ryan Piwetz's students collect data at three profile locations on Mustang Island: MUI01 near Horace Caldwell Pier, MUI02 in Mustang Island State Park, and MUI03 at Beach Access Road 1 at the Palmilla Beach Golf Club (**Fig. 9**). Port Aransas High School has been measuring these profiles since 1999.

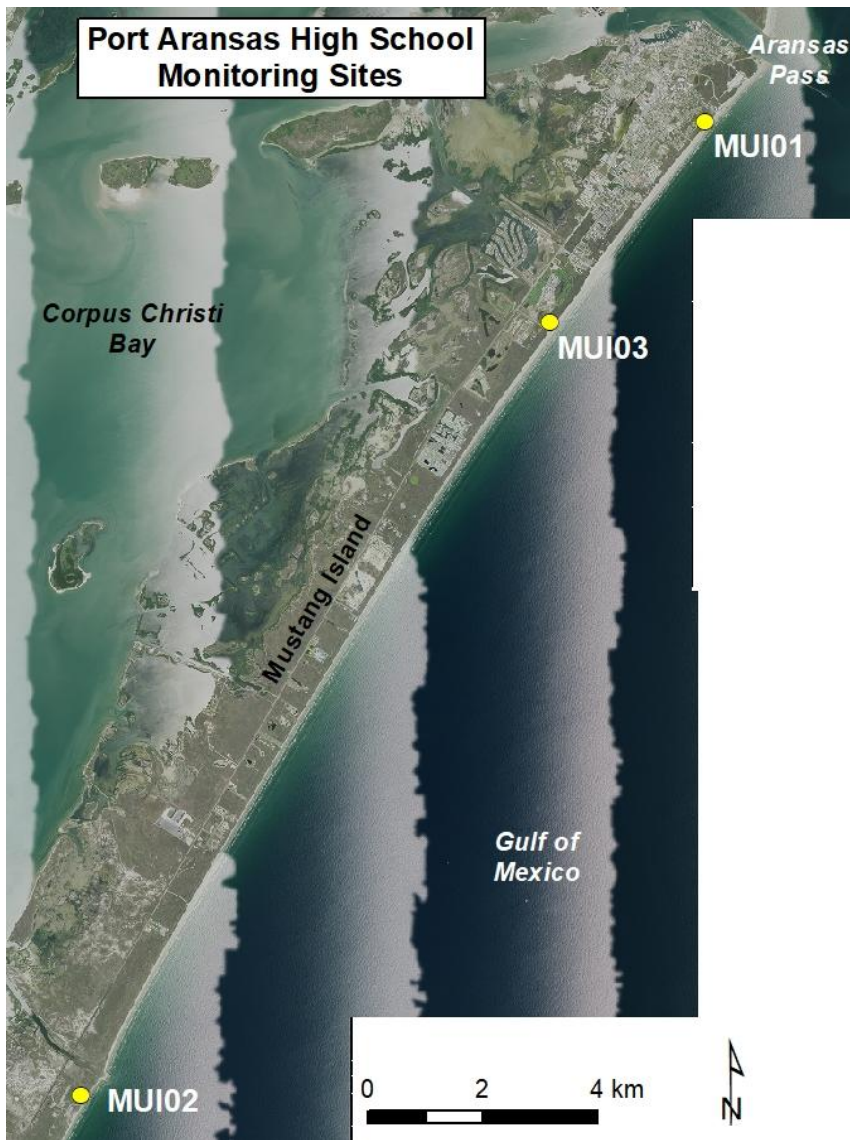


Figure 9. Location map of Port Aransas High School monitoring sites.

Cunningham Middle School

The Bureau worked with 7th and 8th grade students from Cunningham Middle School at South Park (Corpus Christi Independent School District) on October 9, 2024; April 11, 2025; and October 21, 2025. The winter 2025 field trip was canceled due to extreme cold temperatures and was unable to be rescheduled. Teacher Jennifer Juarez's students collect data at sites along and adjacent to the seawall on Northern Padre Island. (**Fig. 10**).

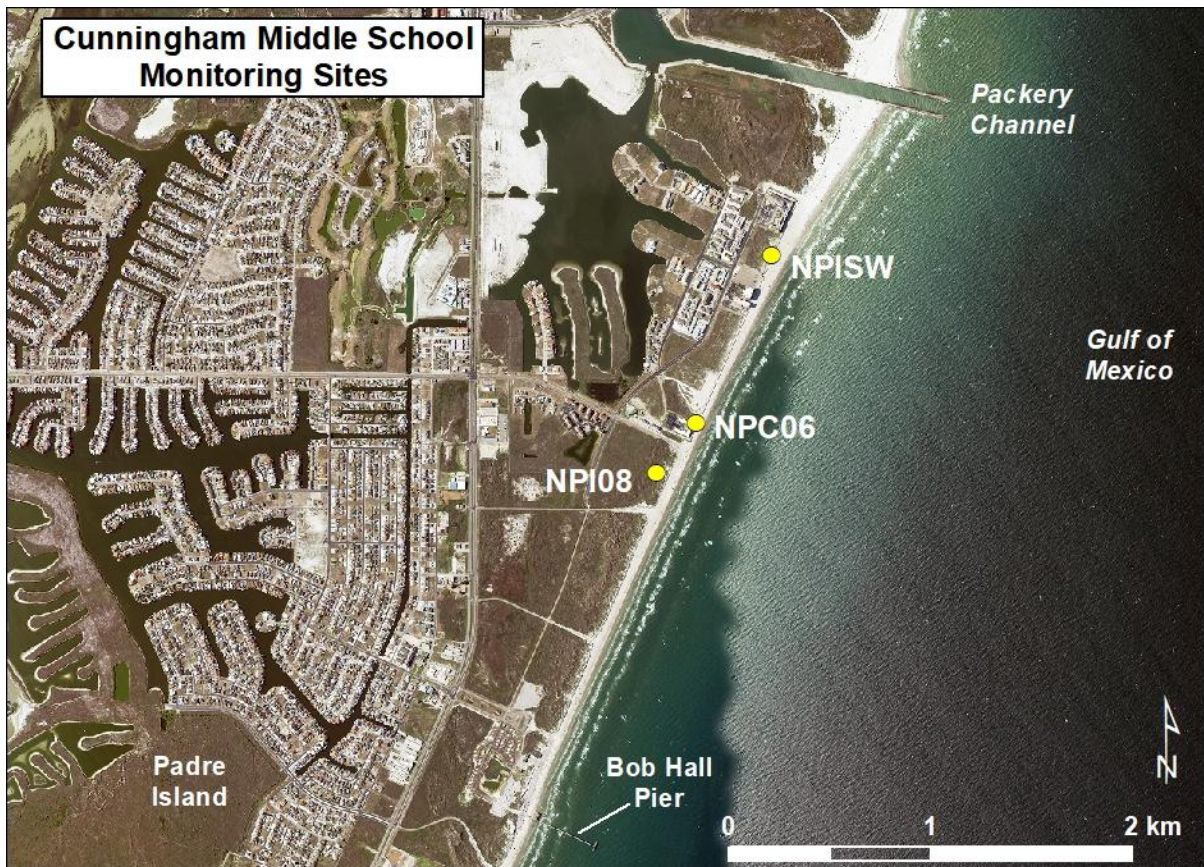


Figure 10. Location map of Cunningham Middle School monitoring sites.

Port Isabel High School

Port Isabel students participated in field trips on October 16, 2024; January 16, 2025; April 24, 2025; and September 24, 2025. Students from Dr. Michelle Zacher's science classes collect data at three profile locations on South Padre Island: SPI01

in Isla Blanca Park, SPI02 at Beach Access #13, and SPI08 at the Tiki Condominiums (E. White Sands Street) (**Fig. 11**). Port Isabel High School has been measuring SPI01 and SPI02 since 1999 and SPI08 since 2007. Port Isabel students participated in the Winter Wildlife Expo, held annually in South Padre Island, presenting the THSCMP project and data analysis to Island visitors.



Figure 11. Location map of Port Isabel High School monitoring sites.

EFFECTS ON SCIENTIFIC RESEARCH, COASTAL MANAGEMENT, AND PUBLIC AWARENESS

The first goal of the THSCMP is to provide high school students with an inquiry-based learning experience, which is achieved by involving students in real-world

research projects. We emphasize to students that they are collecting critical scientific data that will help scientists address coastal issues affecting their communities. The student-collected beach data can be and have been used by researchers at the Bureau to help respond to several beach-related issues. Data are available for coastal managers, decision-makers, scientists, students, and the public.

Long-term data collection is clearly useful in explaining beach cycles and defining short-term versus long-term trends. Defining these trends is important in decision-making regarding coastal development, beach nourishment, and dune restoration projects. The data collected within city, county, and state parks helps to develop a better understanding of the local coastal environment, which in turn allows managers to make wise decisions regarding long-term management and future park development. Coastal communities and managers throughout Texas—especially our partners at GLO, TPWD, and other coastal parks—benefit from having access to the beach monitoring data collected by this project for use in public-policy and coastal-management decision-making.

THSCMP-collected data has played a large role in important Bureau studies. In one study, site BEG02 has been used by Bureau scientists to investigate the effects of geotextile tubes installed along the upper Texas coast. BEG02, located in Galveston Island State Park (**Fig. 6**), is adjacent to a subdivision where these erosion-control devices have been installed. The study compared beach width (distance from the vegetation line or dune base to the waterline) in front of the geotextile tubes versus at a natural beach area in the adjacent state park. Beach width in the natural beach area was observed to be wider than in the subdivision—45.7 m on average compared to 20.4 m in the subdivision (Gibeaut and others, 2003). The natural area allowed for the landward migration of the dunes as the shoreline retreated, whereas the geotextile tube created a fixed dune line (Caudle and Paine, 2017).

Data collected by THSCMP students are invaluable in verifying shoreline positions for updates to Texas' long-term shoreline-change rates, which are widely used by public officials, corporations, and private citizens. These comparisons—in some

cases from ground-based GPS data acquired within a few days to weeks of the imagery or lidar survey date—generally show good agreement (within a few meters) between boundaries interpreted from ground-based data and imagery and those extracted from lidar data. Beach profiles and GPS-mapped shorelines (wet-beach/dry-beach boundaries) collected by THSCMP students were used to confirm the shoreline position digitized in 2007 aerial photography (Paine and others, 2011, 2012) and the shoreline positions extracted from aerial lidar data collected in 2012 (Paine and others, 2014), 2016 (Paine and Caudle, 2018), 2019 (Paine and others, 2021), and 2024 (Paine and others, 2025, **Fig. 12**).

The shoreline position extracted from 2024 lidar data was verified by visually comparing the shoreline proxy contour elevation with the wet-beach/dry-beach boundary as shown on georeferenced 2022 and 2024 NAIP aerial photographs and imagery acquired during the airborne survey. We used beach profiles and the GPS-mapped shorelines acquired by THSCMP students near the dates of the lidar survey to compare the observed wet- and dry-beach positions. Comparisons of lidar-extracted shoreline and wet-beach/dry-beach positions were conducted for THSCMP beach profile sites at Bolivar Peninsula, Galveston Island State Park, Follet's Island, Matagorda Peninsula, Mustang Island, and northern and southern Padre Island. The Galveston Island State Park profile site GISP1 and Mustang Island profile site MUI01 (**Fig. 12**; Paine and others, 2025) are representative of data comparisons along the Texas coast. At GISP1 there is excellent agreement between the 2024 lidar-derived shoreline and the GPS-based wet-beach/dry-beach boundary mapped on April 30, 2024 by Ball High School students (THSCMP) at profile site GISP1 (**Fig. 12A**). The lidar-derived shoreline proxy also coincides with the 2024 Bureau-acquired aerial imagery. Lidar, imagery, and GPS comparisons on Mustang Island (**Fig. 12B**) show excellent agreement between the lidar-extracted shoreline from the 2024 survey and the wet-beach/dry-beach boundary evident on the Bureau imagery. GPS surveys of the wet-beach/dry-beach boundary acquired by Port Aransas High School THSCMP students on February 22 and April 25, 2024 indicate shoreline positions that coincide with the lidar-extracted shoreline.

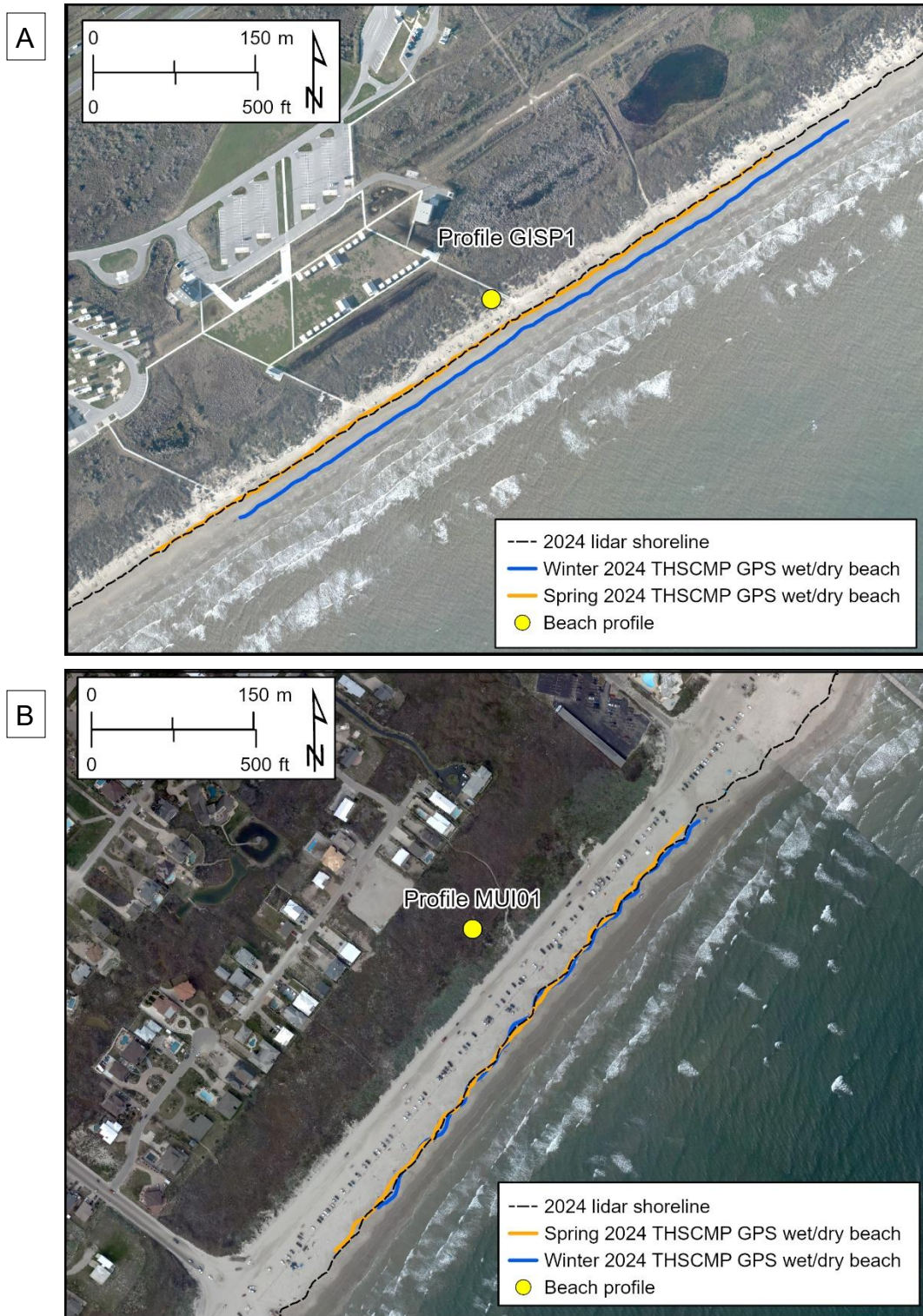


Figure 12. Shoreline position comparisons at (A) Galveston Island State Park site GISP1 (fig. 6) and (B) Mustang Island site MUI01 (fig. 9). Shorelines include the wet-beach/dry-beach boundaries mapped by THSCMP participants using ground GPS and the 1.16 m (3.8 ft) NAVD88 shoreline proxy extracted from the lidar data superimposed on the 2024 Bureau imagery. From Paine and others, 2025.

The THSCMP has increased public awareness of coastal issues through numerous media reports, presentations at conferences, journal articles, and learning tools.

THSCMP has been featured in:

- Paper in the fall 2004 issue of ASBPA's *Shore & Beach* (Hepner and Gibeaut, 2004)
- 2006 and 2009 issues of TGLO's *On the Coast* newsletter
- Paper and presentation at 2012 Gulf Coast Association of Geological Societies annual meeting (Caudle and Paine, 2012)
- 2013 American Shore and Beach Preservation Association national coastal conference in South Padre Island
- 2015 Texas Chapter of the American Shore and Beach Preservation Association Symposium in Corpus Christi
- 2015 Texas Beach and Dune Forum in Corpus Christi in a panel discussion on coastal outreach activities
- 2017 Texas Chapter of the American Shore and Beach Preservation Association Symposium in Port Aransas
- Technical communication paper in May 2017 *Journal of Coastal Research* (Caudle and Paine, 2017)
- November 2019 Coastal States Organization meeting held in South Padre Island (Bureau scientist and Port Isabel students co-presented)
- December 2019 Bureau's Research Program Profile (<http://www.beg.utexas.edu/node/5664>)
- July 2021 Bureau's Summer Seminar Series (https://www.youtube.com/watch?v=2SLLVBfX_n0)
- January 2023 Texas Coastal Management Program Coastal Resources Newsletter
- October 2023 presentation for The University of Texas at Austin On-Ramps geoscience course Earth, Wind, and Fire
- 2024 American Shore and Beach Preservation Association national coastal conference in Galveston

The students themselves have also increased public awareness of coastal issues and the program. Port Isabel High School students have presented THSCMP to coastal visitors at the Winter Wildlife Expo (WWE) sponsored by the South Padre Island Birding Center since 2017. The 2025 presentation occurred on February 9. Port Isabel students also presented at the Texas Master Naturalist Program annual meeting on October 13, 2023. High Island High School gave presentations on THSCMP in the spring of 2022. Student Jordan Grubbs presented the study to the Children’s Environmental Literacy Foundation (CELF) Student Symposium on March 11, 2022 (<https://www.youtube.com/watch?v=r21uMDcGkM4>) and to the High Island School Board on March 28, 2022. CELF was a virtual event where students participating in citizen science research across the country shared their projects with their peers, communities, and decision makers.

The THSCMP website (<https://www.beg.utexas.edu/thscmp/>) is instrumental in extending the reach of the program and increasing public awareness. The website provides direct access to data, analysis of coastal changes organized by school, field trip photos, and educational resources. A web-based 3D model was developed for visualizing beach and dune impacts and recovery from Hurricane Ike in 2008 and Hurricane Harvey in 2017. It can be accessed from the THSCMP front page of the or the model’s website (<https://www.beg.utexas.edu/visualizations/3d-coastal-model/>). This visualization project focuses on the geomorphological impacts of the hurricanes on their respective regions of the Texas Gulf Coast.

SCIENTIFIC RESULTS AND TEXAS COASTAL CHANGES: 1997–2025

Profile data collected by the students are entered into CEDAS v. 4.0 (Coastal Engineering Design and Analysis System) module BMAP (Beach Morphology and Analysis Package). Beach-volume calculations are then made using BMAP, and shoreline and vegetation-line positions are determined from field notes made by students and scientists or from GPS mapping. The shoreline is designated by the wet-beach/dry-beach boundary or a berm crest (a prominent break in slope between the forebeach and backbeach) for consistency with historical measurements

(Gibeaut and Caudle, 2009). Volume, shoreline, and vegetation-line plots; profile plots; and GPS-mapped shore and vegetation lines for each monitoring site are available upon request. Appendix A includes photographs from field trips during the 2024—25 academic year.

Since THSCMP began in 1997, data collected by students have been applied by scientists to investigate beach, dune, and vegetation-line recovery following several tropical cyclones, including Hurricanes Ike in 2008 and Harvey in 2017. Student-collected data are also used to monitor the effects of beach nourishment projects on South Padre, North Padre, and Galveston Islands; foredune changes on Mustang Island due to beach-maintenance practices; and jetty construction and vehicular traffic on Matagorda Peninsula. Through these real-world examples of scientific observation, students gain a better understanding of environmental issues affecting their communities.

Measurements by the schools involved in the THSCMP show the change through time at each location and highlight the spatial variation found along the Texas coast. The scientific observations documented by THSCMP students help scientists, decision-makers, coastal managers, and the students themselves gain a better understanding of relationships between coastal processes, beach morphology, and shoreline change affecting their local coastal communities. Key research results and coastal issues are presented within this report by region.

Bolivar Peninsula

The beach at HIB01 (**Fig. 5**) has seen significant changes since High Island High School joined THSCMP (**Fig. 13**). On the first field trip, the beach had a steep forebeach, high berm, and a backbeach wide enough for vehicles to travel up and down the beach. Large pieces of pavement, remnants of Highway 87, were at the upper reach of the swash zone. The October 2017 field trip took place about a month after Hurricane Harvey impacted the Texas Gulf coast. The beach had experienced significant erosion, pavement debris was deposited at the vegetation

line, and the elevated berm and backbeach that had once allowed vehicular access to the north were gone. The beach width had recovered by spring 2018.

Between the fall of 2018 and spring of 2021, HIHS students were unable to access the site at High Island Beach because of roadway construction at the intersection of Highway 87 and Texas 124. During that time, the shoreline and vegetation line positions moved landward due to the impacts of the 2020 hurricane season. The original profile site datum was lost due to the erosion of the beach at High Island and reset during the fall 2021 field trip. Between May 2018 and April 2022, the shoreline position moved landward 25 meters (landward of the original profile datum location) and the vegetation line moved 45 meters landward (**Figs. 13 and 14**). Data collection at this site has documented a continually steepening beach profile, landward retreating vegetation line, and evidence of beach washover.

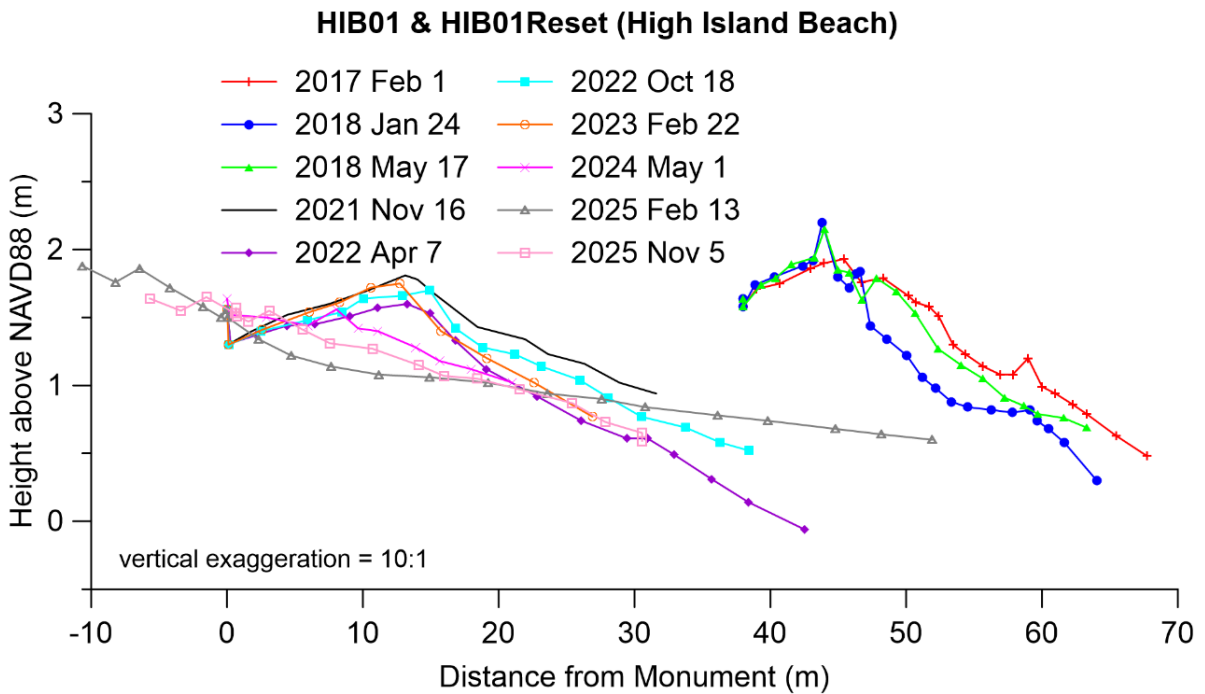


Figure 13. Changes at HIB01 and HIB01 Reset monitored by High Island High School students.

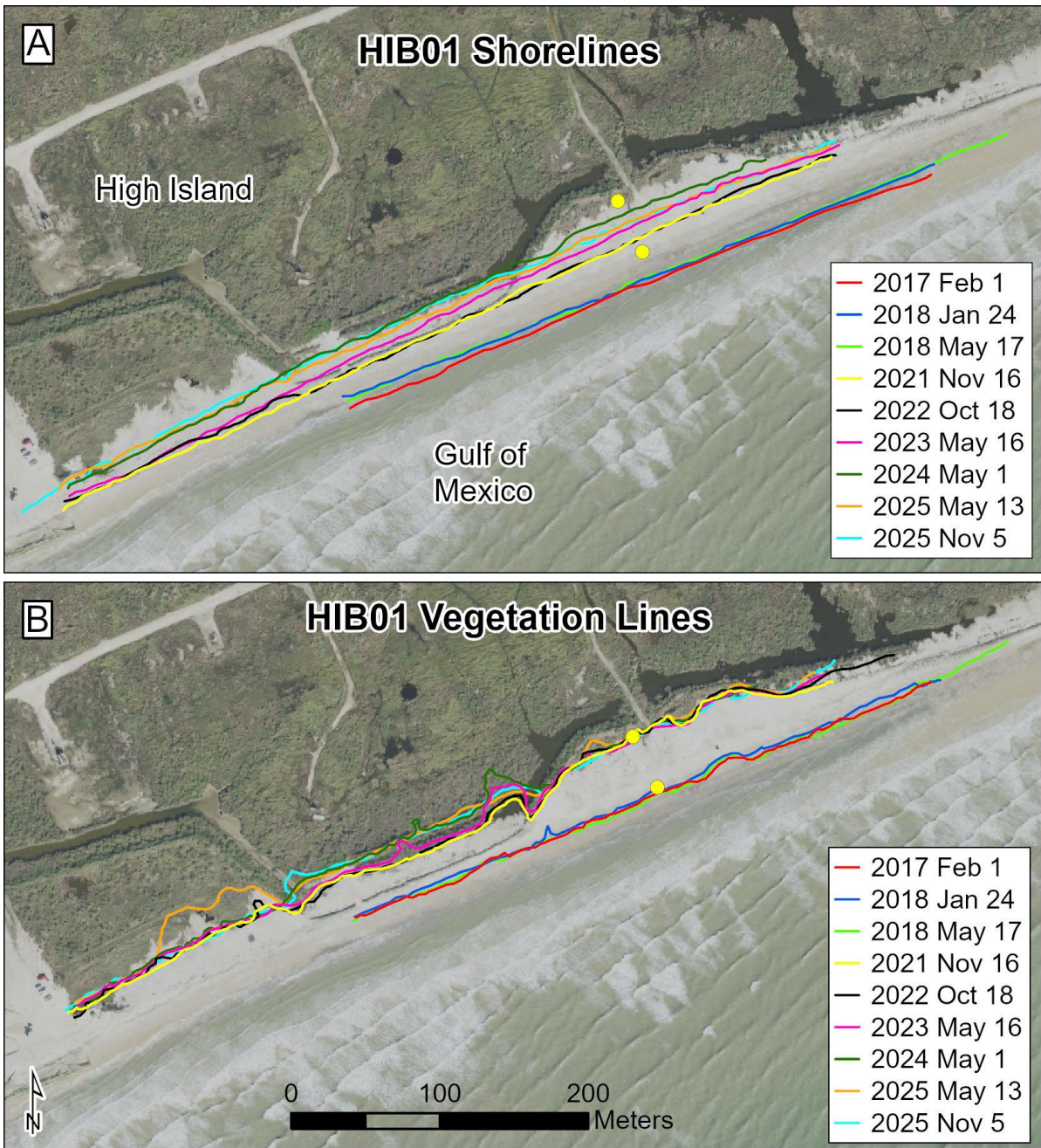


Figure 14. Changes to the position of the (A) shoreline and (B) vegetation line at HIB01 between February 2017 and November 2025.

High Island High School students also monitor sites adjacent to Rollover Pass (**Fig. 5**). Students have been monitoring the changes in the incipient dune at BOL02 on the west side of Rollover Pass. A small, vegetated dune was developing at this site between when the program began at High Island HS and the spring of 2024 (**Fig.**

15). During the October 2024 field trip, it was documented that a new, narrower push-up dune had been created adjacent to Keith Avenue (the profile crosses the road), the vegetation line had moved landward (new vegetation on the dune), and that the shape of the beach profile was significantly different with a narrower beach but higher berm elevation (Fig. 15).

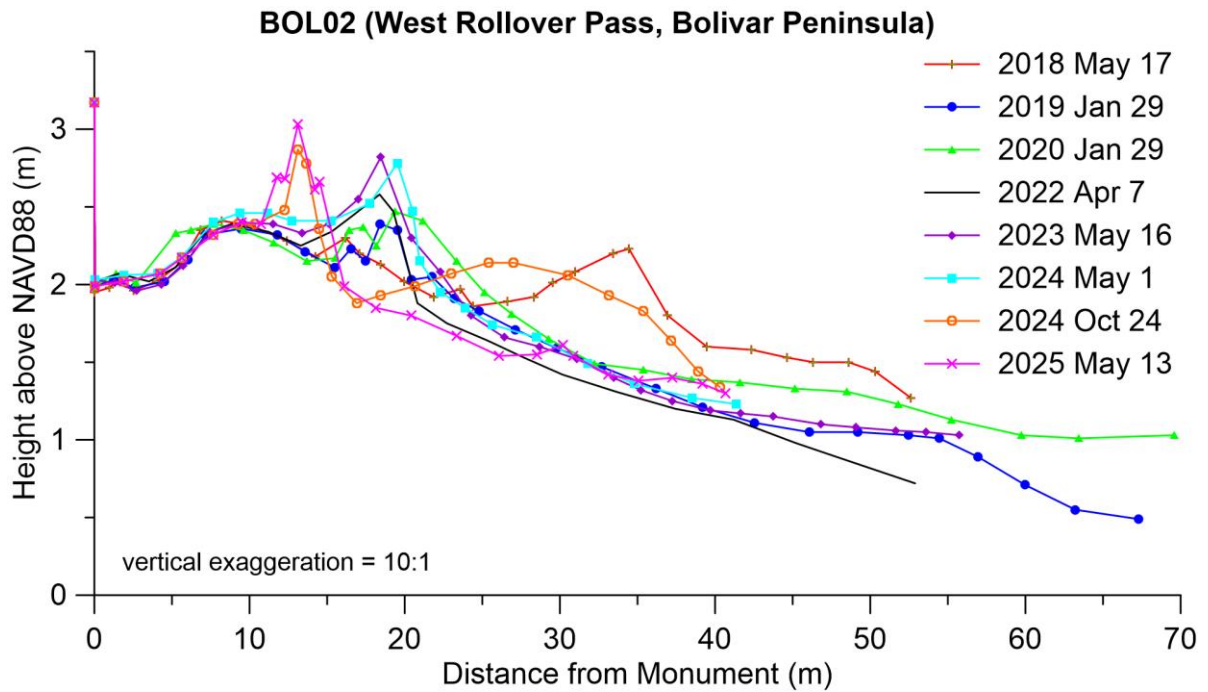


Figure 15. Changes to the beach profile at BOL02 west of Rollover Pass on Bolivar Peninsula.

Rollover Pass was cut across Bolivar Peninsula in 1955 with the intention of improving water quality in Rollover Bay and Galveston East Bay. The opening of the pass caused significant erosion to the adjacent beaches and caused sand and sediment to be deposited in the Gulf Intracoastal Waterway (ICW). For years, the U.S. Army Corps of Engineers were required to dredge and remove sediment from the ICW adjacent to Rollover Bay annually at significant cost. Due to the issues caused by Rollover Pass, the Texas Legislature authorized the General Land Office to close the pass. Construction began at the end of September 2019 and was completed in the spring of 2020. High Island students are monitoring how the closure of Rollover Pass impacts the beaches adjacent to the site as well as

mapping the position of the shoreline where the pass has been closed. Access to the beach at former Rollover Pass is currently closed due to construction of a fishing pier. Students will resume mapping the shoreline across the former mouth of the pass once construction is complete. A new beach profile site will also be established closer to pier replacing BOL03. The new site will have better beach access and a safer parking option for the school bus.

Galveston Island

Since 1997, Ball High School students participating in the THSCMP have been collecting critical data that is used by scientists at the Bureau to increase understanding of beach and dune recovery stages following major storms. Tropical Storm Frances (September 1998) played a major role in reshaping the beaches on the upper Texas coast. Data collected by Ball High School students on Galveston and Follet's Islands documented that Frances caused significant damage to beaches along the southeast coast of Texas. Several other severe storms have also impacted the Galveston study area. Tropical Storms Allison (June 2001) and Fay (September 2002) and Hurricanes Claudette (July 2003) and Rita (September 2005) have each caused varying degrees of damage to beaches and dunes along the Texas coast that Ball High students have been documenting through their data collection.

The upper Texas coast was severely affected by the landfall of Hurricane Ike in September 2008. Galveston Island experienced significant beach and dune erosion, as well as extensive damage to property and infrastructure. Ball High School students from the 2007–2008 academic year provided extremely valuable pre-storm profile data that have been used to determine how much the beach and dunes changed after Hurricane Ike. **Figure 16** is a profile plot at BEG02 comparing the Ball High School pre-storm profile (April 2008) with the post–Hurricane Ike profile measured on October 7, 2008. The post–Tropical Storm Frances profile from September 16, 1998, is also plotted for comparison. At Galveston Island State Park, the dune system was destroyed; the shoreline (wet-beach/dry-beach boundary) moved 53 m landward between April 23, 2008, and October 7, 2008; the vegetation

line moved 56 m landward; and the old datum point was 1.14 m above the post-storm surface of the beach (**Fig. 16**; Caudle and Paine, 2017). Data from 1-year post-storm is also included. This profile shows that the elevation of the beach has been restored, the beach width (dunes to waterline) has increased, and incipient dunes are beginning to form (**Fig. 16**).

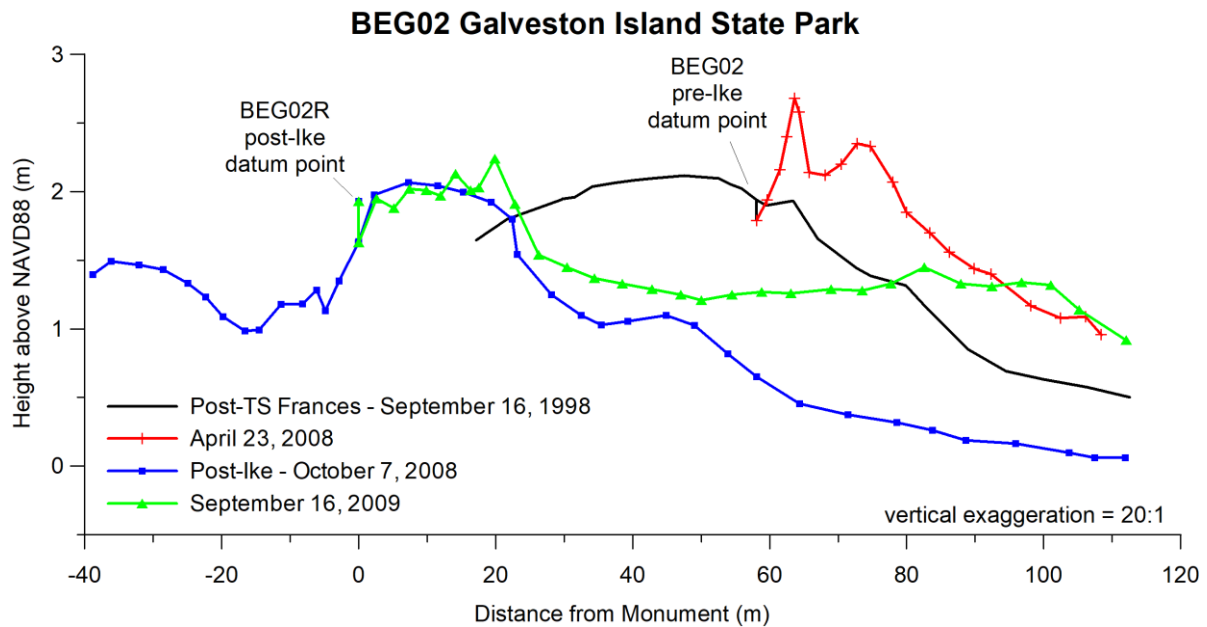


Figure 16. Beach-profile plots from BEG02 in Galveston Island State Park comparing the post-Hurricane Ike profile with a pre-storm profile from early 2008 and the post-Tropical Storm Frances profile from September 1998. Data from September 2009 (1-year post-storm) is also included.

Ball High School students resumed monitoring beaches at the start of the 2009–2010 academic year. Their data collection from BEG02 has documented the recovery of the beach and dune system (**Fig. 17**). Between September 2009 and January 2011, the foredunes at BEG02 had begun to grow. Whether initial growth of the foredunes is due to natural recovery processes or human intervention is unclear. The foredune ridge grew in the intervening years, stabilizing around 2015, and a wide, vegetated zone with expanding coppice dunes developed between the seaward base of the foredunes and the landward extent of wave run-up (**Fig. 17**). Impacts from the 2020 hurricane season were documented by landward erosion of the beach and a washover feature was deposited in the coppice dune area (**Fig. 17**).

A new profile location (GISP1) was established in 2023 due to a redesign of the state park's Gulf-facing facilities that closed the beach access to BEG02.

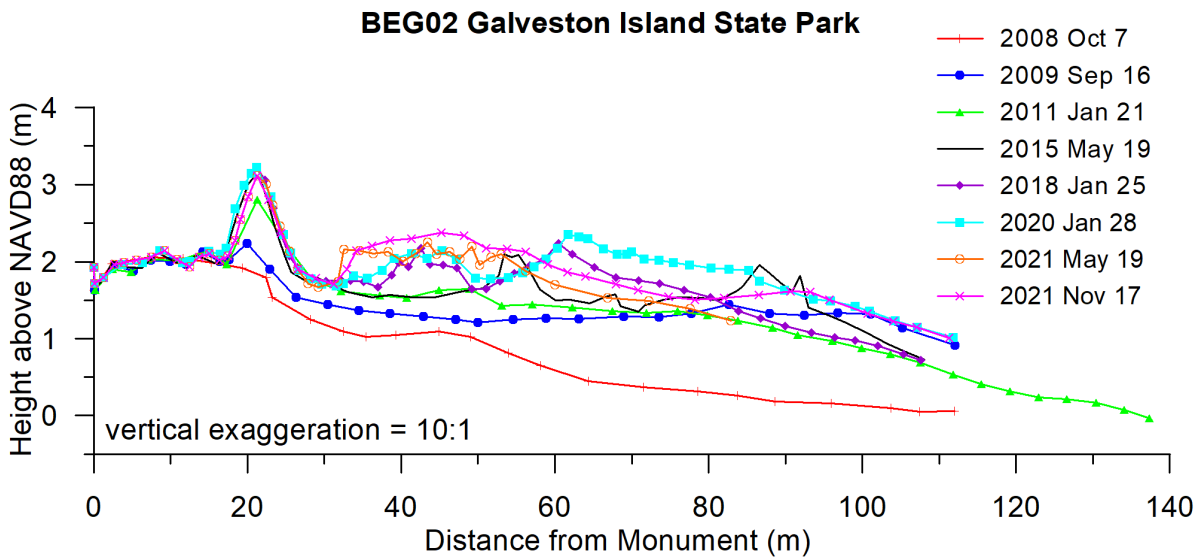


Figure 17. BEG02 profile data collected by Ball High School students. Students are monitoring recovery of the beaches and dunes at this site.

The 2020 hurricane season caused beach and dune erosion at all the sites Ball High School students monitor. At the site JAM02 in Jamaica Beach (**Fig. 6**), a community just to the south of Galveston Island State Park, the reconstructed dune was noticeably eroded and the vegetation line moved landward (**Fig. 18**). Sand fencing was installed seaward of the vegetation line in 2022 (removed in 2024) to trap windblown sand and promote dune growth (**Fig. 19A**). The dune at the Dellanera RV Park (DEL01, **Fig. 6**) that was created as part of a large nourishment and dune restoration project that took place in 2015, experienced significant erosion between January 2020 and May 2021 (**Fig. 20**). Over half the volume of sand in the beach/dune system was removed. Recent data collected at both JAM02 and DEL01 is monitoring the performance of beach nourishment projects (**Figs. 18** and **20**). The project in Dellanera RV Park was completed in 2023 and in Jamaica Beach in summer 2025. The data collected by Ball High School students in October 2025 at Jamaica Beach, documented a prominent scarp near the shoreline (**Figs. 18** and

19B). These features are often present after beach nourishment placement as the beach sand is redistributed to reach equilibrium.

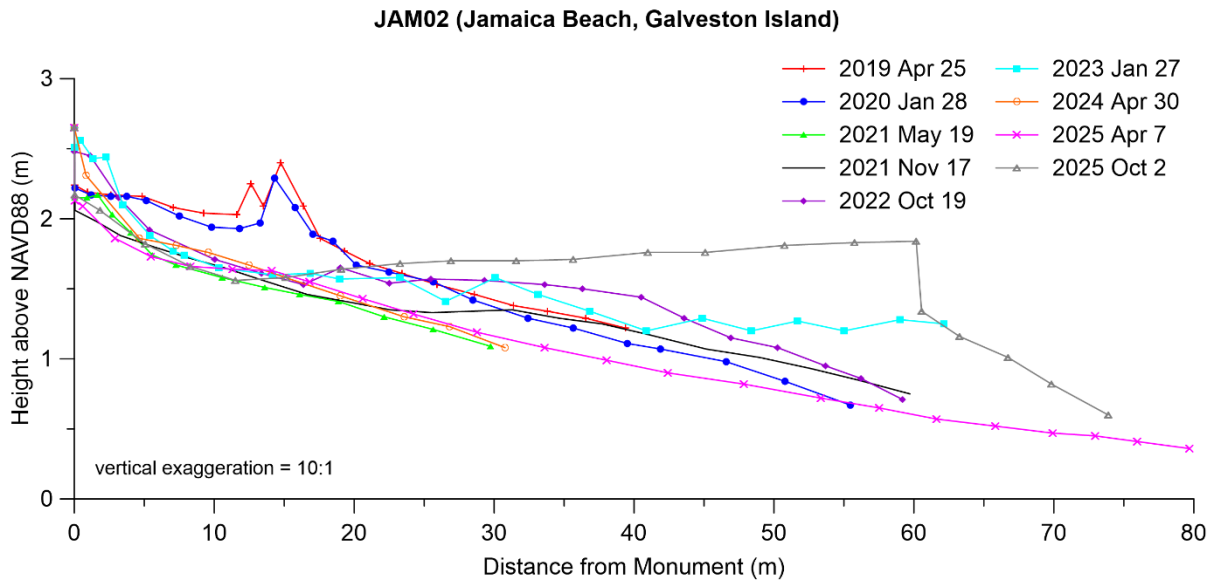


Figure 18. Erosion of the dune at JAM02 in Jamaica Beach due to the 2020 hurricane season. Student data is currently monitoring the performance sand fencing that was installed in 2022 and a beach nourishment project that was completed in summer 2025. Notice the prominent scarp present in the October 2, 2025 dataset.



Figure 19. (A) Photo looking north along the vegetation line in Jamaica Beach on October 19, 2022 showing the newly installed sand fencing. (B) Photo looking north along the wet/dry line on October 2, 2025. The arrow points to the scarp in the beach face.

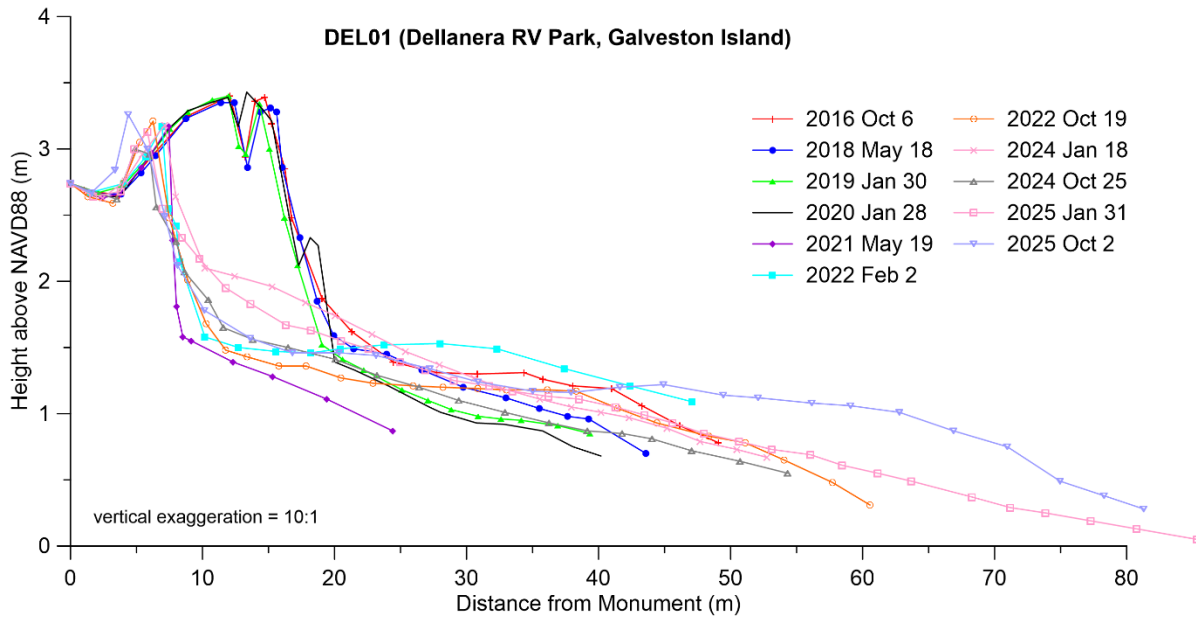


Figure 20. Erosion of the dune at DEL01 in the Dellanera RV Park due to the 2020 hurricane season and performance of the 2023 beach nourishment project.

Surfside Beach and Quintana Beach

Brazosport High School in Freeport, Texas, joined the THSCMP during the 2018–2019 academic year, allowing the program to expand to a section of the developed coast that was previously not monitored (**Fig. 7**). Significant changes to the beach and small dune system on Follet’s Island and Quintana Beach have been documented during Brazosport’s short monitoring period. At the QUIN1 location in Quintana Beach County Park, the small foredune that was present when the profile was established had been destroyed and the vegetation line moved 15 meters landward between January 2020 and May 2021 (**Fig. 21**). The park sustained further damage from Hurricane Beryl in July 2024. Student mapping of the vegetation line at this site shows it moved up to 15 m landward following the storm. Additionally, a large amount of debris was washed ashore and deposited at the edge of the vegetation line in the park (**Fig. 22**).

At SURF2, the vegetation line also moved landward and the elevation of the profile was lowered at the datum point following the 2020, 2021, and 2024 hurricane seasons (**Fig. 23A**). Students map the shoreline position of a segment between

Surfside Jetty County Park and a rock revetment protecting Beach Drive. The shoreline position (wet/dry line) is mapped beneath or behind structures that are located on the beach (**Fig 23B**).

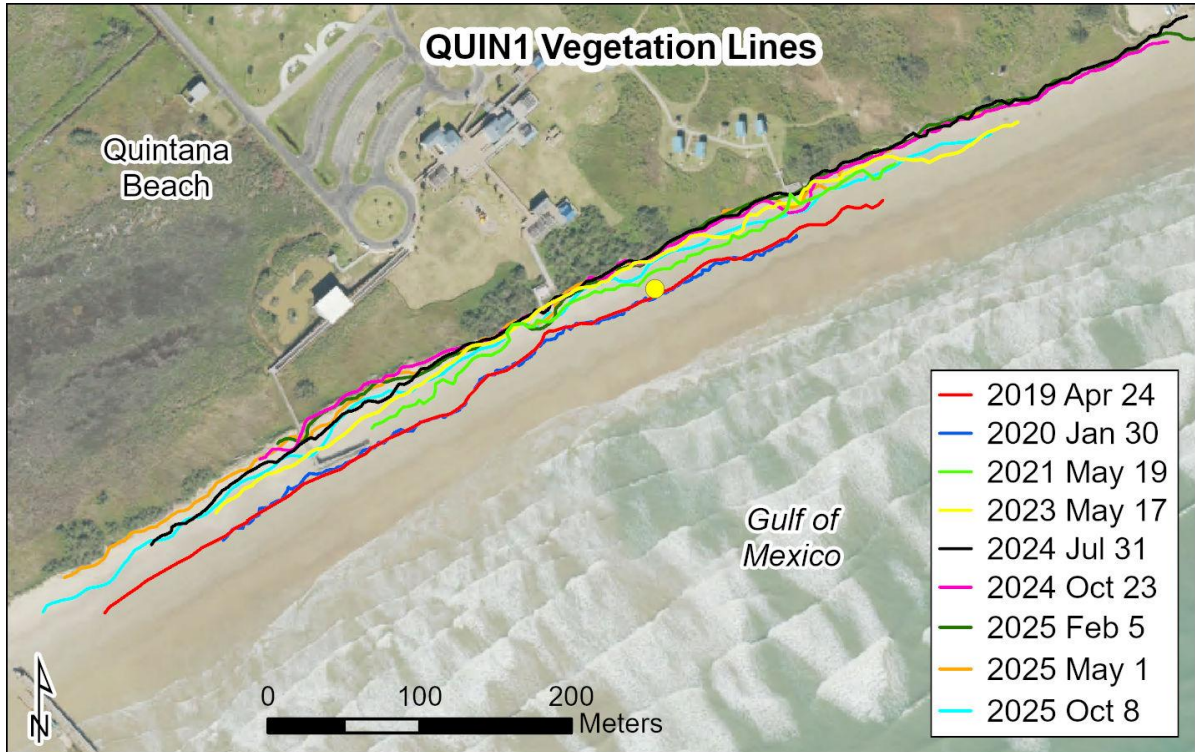


Figure 21. GPS mapping by Brazosport HS students of vegetation line positions at QUIN1 from April 2019 through October 2024.

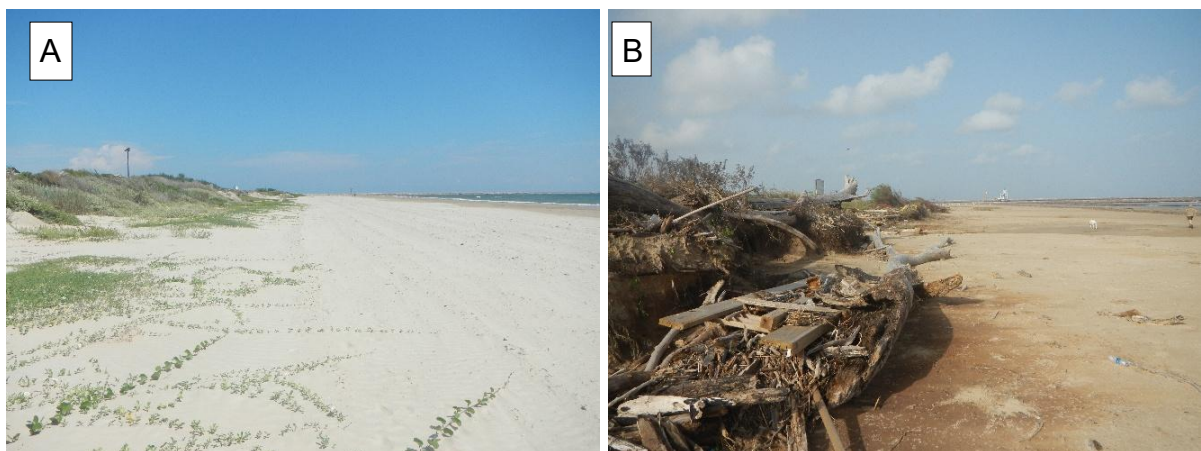


Figure 22. Photos looking north along the vegetation line in Quintana Beach County Park in (A) September 2023 and (B) after the landfall of Hurricane Beryl July 2024.



Figure 23. Photos of (A) the scarped dune at SURF2 after Hurricane Beryl and (B) students mapping the shoreline position near structures on the open beach by Jetty Park.

Matagorda Peninsula

Van Vleck High School students collect data at MAT01, which is adjacent to a washover channel—Three Mile Cut—that will occasionally open with the passage or landfall of a tropical storm or hurricane (**Fig. 8**). Students from Palacios High School collect data at MAT02, which is northeast of the vehicular beach access point on Matagorda Peninsula (**Fig. 8**). Hurricane Ike made landfall on Galveston Island on September 13, 2008, as a Category 2 hurricane. Owing to the size of the storm, impacts from this hurricane were seen along the entire Texas coast, including on Matagorda Peninsula. The storm surge from Hurricane Ike briefly opened Three Mile Cut and caused vegetation line retreat and dune erosion at MAT01 and MAT02. Over the years since Ike’s landfall, students from Van Vleck and Palacios have been monitoring the recovery and significant growth of the dunes (**Figs. 24 and 25**) and the seaward movement of the vegetation line. Hurricane Beryl made landfall on eastern Matagorda Peninsula on July 8 as a category 1 storm. The elevated water levels caused by the storm surge eroded the foredune at MAT01, the site closest to Three Mile Cut, but no indication of storm erosion at MAT02 (**Fig. 25**).



Figure 24. Photos looking toward the Gulf of Mexico from the primary foredune crest at MAT01 in (A) October 2015 and (B) February 2024. Between these two dates a secondary foredune and coppice dunes formed seaward of the primary foredune.

Palacios and Van Vleck students also measure the shoreline position adjacent to the fishing pier at Matagorda Bay Nature Park (MAT03, **Fig. 8**). The site is on the updrift side of the jetty at the mouth of the Colorado River. The monitoring of this location is important because understanding the impacts of coastal structures are critical to coastal management. In 2009—2010, the U.S. Army Corps of Engineers constructed a new east jetty at the mouth of the Colorado River. GPS-mapping of shorelines indicates that the shoreline position at MAT03 moved 125-m seaward over a decade, an average rate of 12.8 m per year (**Fig. 26**). The continued mapping has shown that the shoreline position continues to advance seaward between 2018 and 2024, but at a reduced rate (**Figs. 26 and 27**).

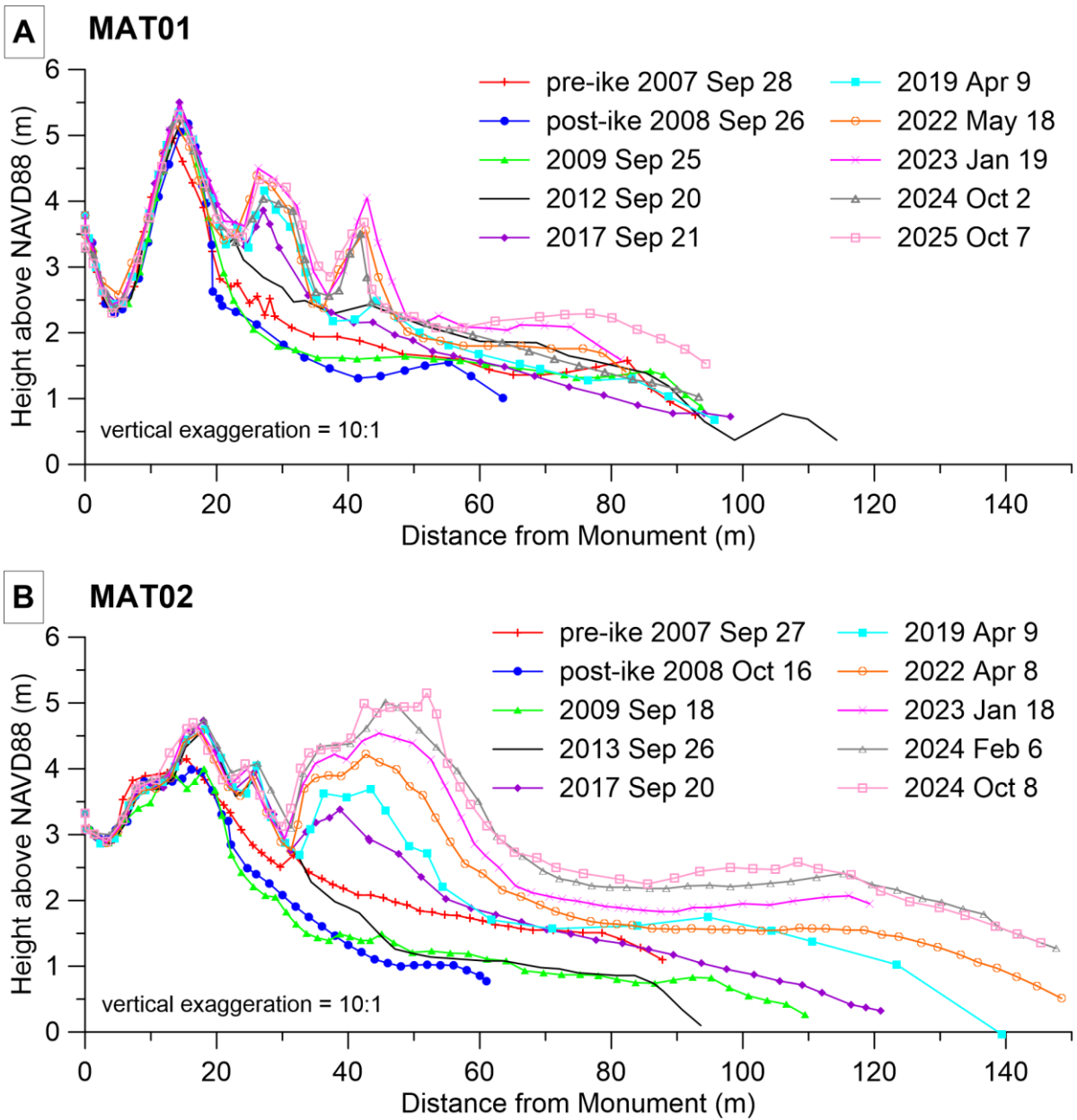


Figure 25. Profile data collected by Van Vleck High School students at (A) MAT01 and Palacios High School students at (B) MAT02. Students are monitoring post-Ike recovery and growth of the foredune at these sites.

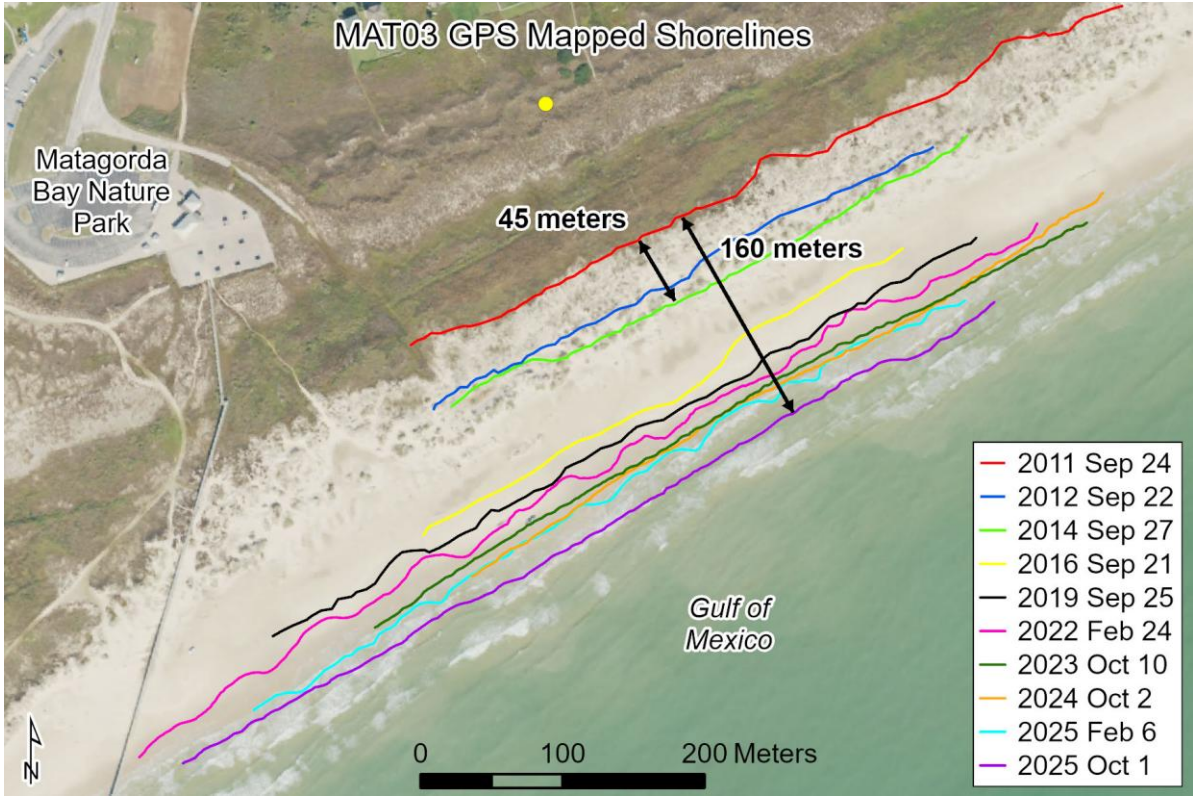


Figure 26. Shoreline position change at Matagorda Peninsula.

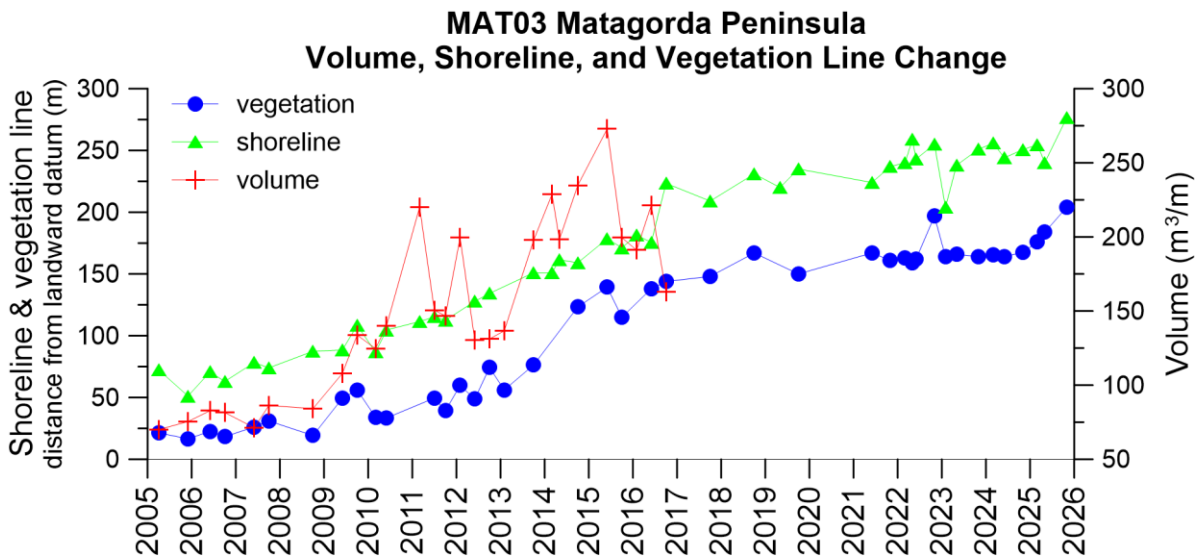


Figure 27. Changes in beach and dune volume, shoreline position, and vegetation-line position at MAT03 on Matagorda Peninsula.

Mustang Island

The beach-monitoring activities of Port Aransas High School students have provided beneficial information about the beach and dune system on Mustang Island (**Fig. 9**). The dune system on Mustang Island is healthy, with tall (> 3 m), wide foredunes along most of the island. The only breaks in the foredune system are at beach-access points and washover features. Since the beginning of the coastal monitoring program, Port Aransas students have been monitoring the growth of the foredune system at their profiling sites. **Figure 28A** is an example of foredune expansion at MUI01 near Horace Caldwell Pier in Port Aransas. Note that the width of the dunes increased between 2001 and early 2010, although the shoreline remained relatively stable.

Beach maintenance practices vary along the island and have changed over time, which the students have documented through their data collection. Several beaches on Mustang Island, particularly within the City of Port Aransas boundaries, are regularly scraped to remove seaweed (*Sargassum*) from the forebeach. At the MUI01 site students documented the cycles of a process called “dune notching” between 2012 and 2018. Dune notching is a beach-maintenance practice where a portion of the foredune is excavated and then refilled over time with the sand and seaweed debris removed from along the shoreline (**Figs. 28B** and **29A**). By the end of the 2018–19 academic year, the foredune at MUI01 was revegetated and stabilized. Between 2019 and 2024, beach profile volume, shoreline position, and vegetation line position have been stable (**Fig. 28B**) although the current width of the foredune is narrower with less sediment volume in the profile than when THSCMP began monitoring this site in 1999.

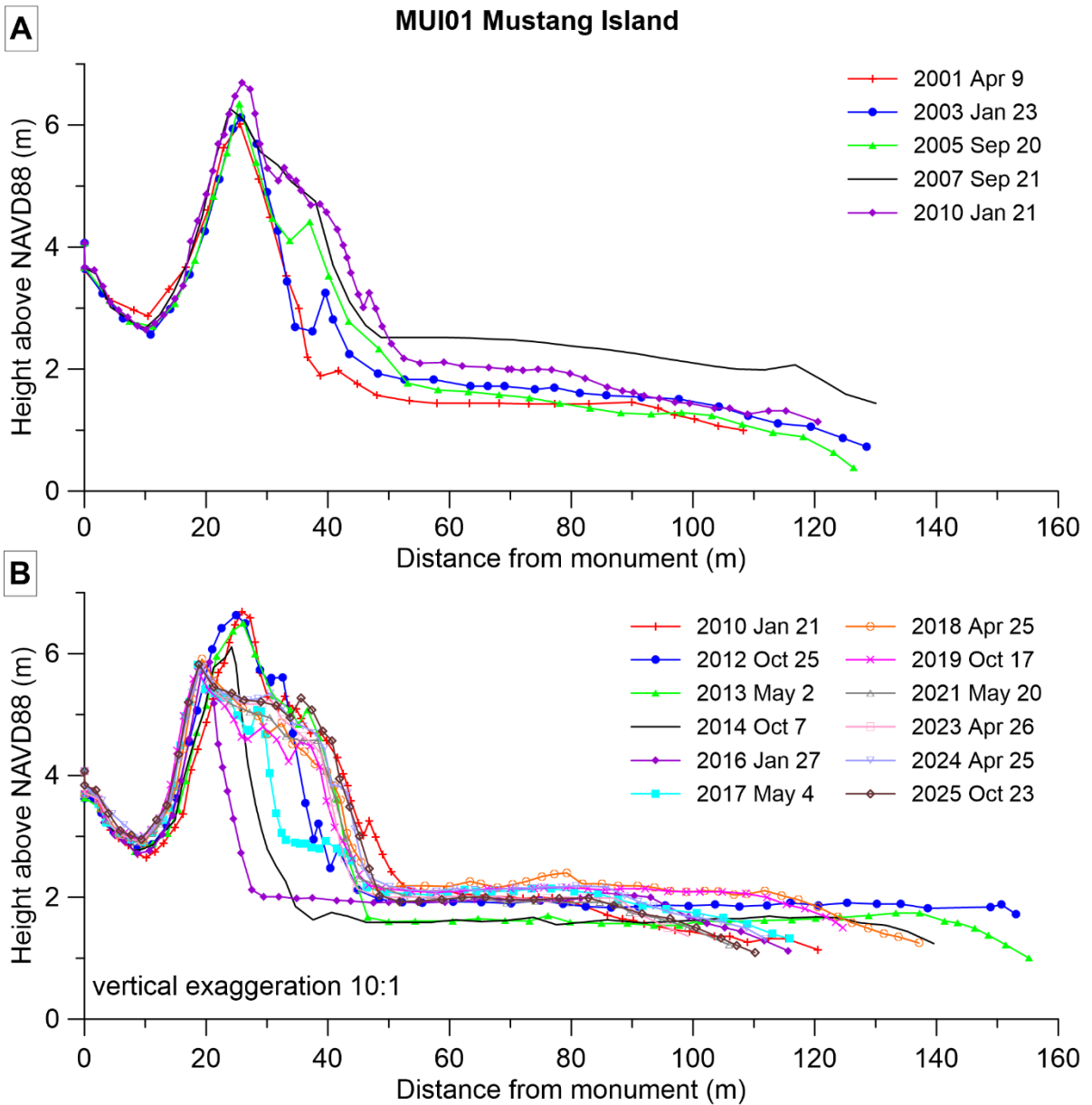


Figure 28. Changes at MUI01 on Mustang Island. (A) Expansion of the foredune between 2001 and 2009. (B) Changes in the foredune due to the beach-maintenance practice of dune notching between 2012 and 2017. Beach profile has been stable with minimum change since 2018.



Figure 29. (A) Photo from October 25, 2012 of the excavated dune at MUI01 on Mustang Island looking north toward Horace Caldwell Pier. (B) Beach road at MUI01 (view toward north) between the toe of the dune and bollards on October 23, 2025.

The MUI01 location also has shore-parallel bollards that have been installed on the backbeach to confine vehicles to the upper portion of the backbeach. The placement of these bollards has restricted further seaward advancement of the foredune complex and the vegetation line by maintaining a fixed location of the Mustang Island beach road starting at the toe of the dune (**Figs. 28B** and **29B**). Beach maintenance practices such as grading and dune notching and the impacts of the fixed position of the beach road will continue to be monitored by Port Aransas students at MUI01 and compared with the natural processes that occur elsewhere on Mustang Island.

The MUI02 monitoring site is located within Mustang Island State Park, just to the south of Fish Pass where minimal beach maintenance is performed. This site has seen significant changes since student monitoring began in 2000. Port Aransas students have documented several lines of coppice dunes forming and coalescing into continuous dune ridges (**Fig. 30**). The dune system and vegetation-line position have expanded seaward, and total profile volume increased at this location in 20 years. The seaward most coppice dunes that were measured in the beach profile starting in 2017 were eroded from the site between 2000 and 2022 (**Fig. 30**). Additional changes to the seaward most dunes were documented between 2022 through the end of 2025 including major scarping and extremely narrow beach

conditions in April 2023 (Figs. 30 and 31A) and increased dune height with the addition of overwash sediment in October 2024 (Figs. 30 and 31B). The over wash on the seaward-most dune was completely vegetated by October of 2025.

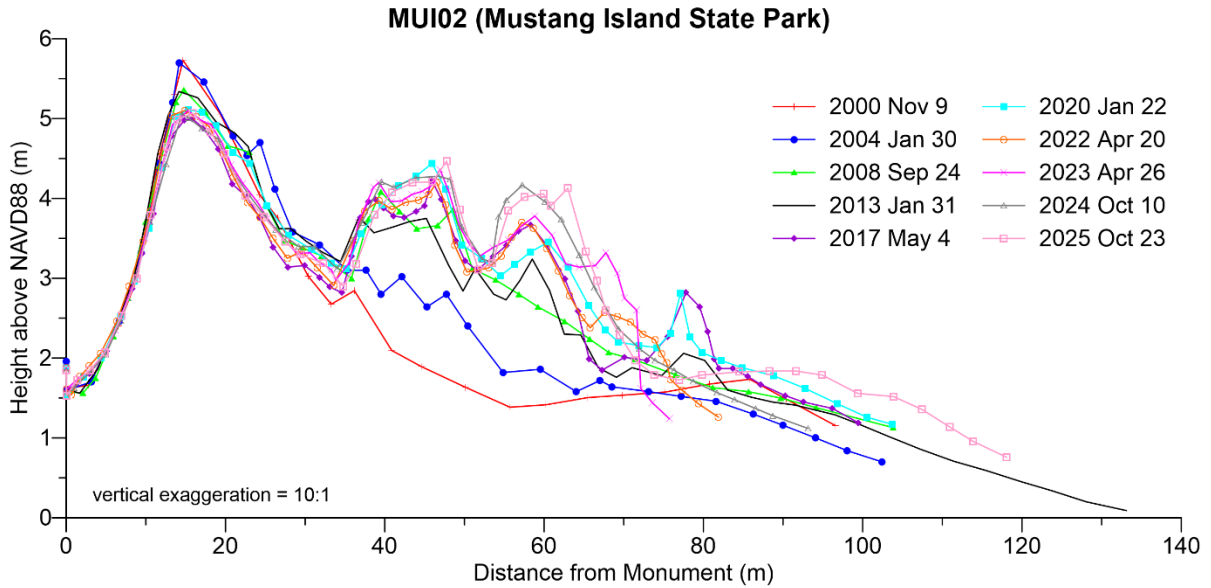


Figure 30. Student monitoring at MUI02 documents an increase in volume of the dune system and seaward migration of the vegetation line.

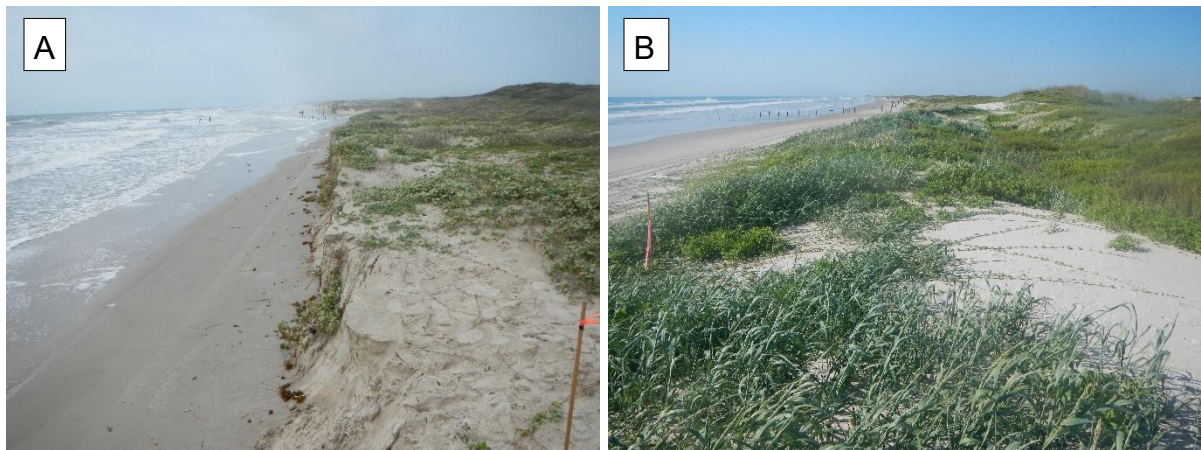


Figure 31. Changes to the seaward-most dune crest and beach width in (A) April 2023 and (B) October 2024.

North Padre Island

Cunningham Middle School at South Park students monitor sites on North Padre Island (**Fig. 10**) that are interesting to compare with the well-vegetated foredunes on Mustang Island to the north. The students have documented many changes at the NPI08 profile location, which is located adjacent to the northern Padre Island seawall. The dune crest at this site is sparsely vegetated (**Fig. 32**) which creates an opportunity for prevailing winds to constantly rearrange and alter the shape and height of the dune crest. When the program began at Cunningham in 2009, a new profile marker was established along the profile azimuth directly behind the foredune to shorten the profile for the middle school students. Within the first year of monitoring, sand was transported from the top of the foredune down the back slope of the dune so that the landward toe of the dune buried the new datum pipe. Until vegetation covers the crest of this dune, it will remain a dynamic site. Students used the original datum marker for several years until it was lost to corrosion of the pipe. Due to safety concerns of working with middle school students in knee to waist high vegetation landward of the large foredune, a new datum marker was not installed at NPI08. The students continue to collect GPS vegetation line and shoreline data at this location.



Figure 32. Changes in vegetation density and coverage on the foredune crest at NPI08 (A) October 2009 and (B) January 2023.

The site NPC06, near the southern end of the North Padre Island seawall (**Fig. 10**), was added in 2015 to track the effects of nourishment projects and maintenance activities on the beach in front of the seawall. During the spring 2022 field trip, students were unable to conduct a beach profile or map the shoreline at NPC06 due to elevated water levels which reached the base of the seawall. The beach in front of the seawall is periodically nourished with beneficial use material from maintenance dredging of Packery Channel (**Fig. 33**). Cunningham students have mapped the landward movement of the shoreline position in front of the seawall and the adjacent area with a natural dune system (NPI08) since the last beach nourishment (**Fig. 34**). A new profile location was added on the northern end of the sea wall that is easily accessible for the middle school students (NPISW, **Fig. 10**). The new site adds additional monitoring of the beach nourishment projects performance as well as a comparison with the typically narrow beach at the southern end of the seawall.



Figure 33. Change in beach width at NPC06 at the southern end of the North Padre Island seawall (A) in January 2022 before a beach nourishment project and (B) February 2024 after the project was completed.

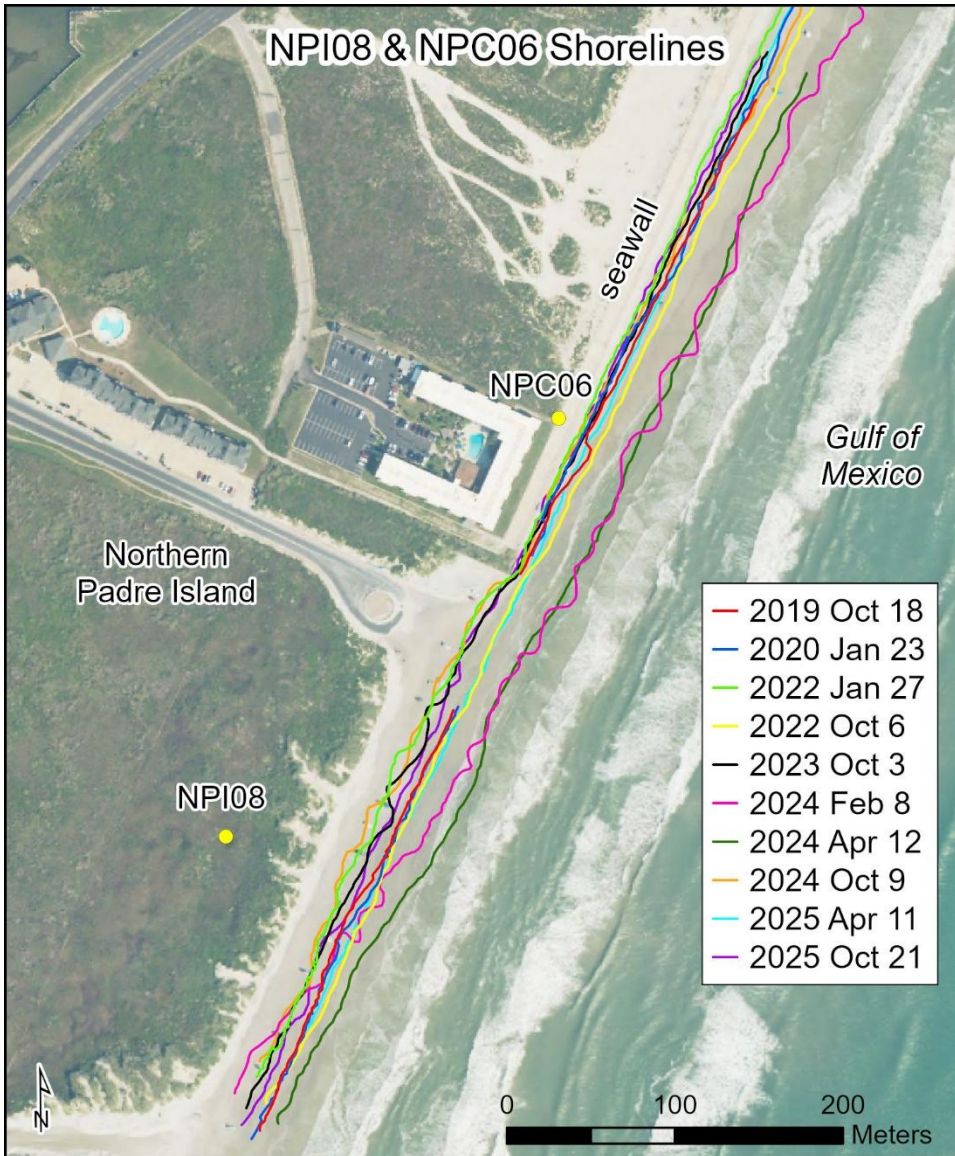


Figure 34. Shoreline position change between 2019 and 2025 along southern end of the North Padre Island seawall and adjacent beach.

South Padre Island

Brazos Santiago Pass, the southern border of South Padre Island, serves as access to the Gulf Intracoastal Waterway and the Port of Brownsville from the Gulf of Mexico. Sediment is dredged from the pass biannually and used to nourish the beaches of South Padre Island. The use of sediment dredged from the pass for beach nourishment or other restoration projects is called beneficial use of dredged

material or BUDM. The three sites monitored by Port Isabel High School students are typically within or adjacent to these nourishment areas.

The SPI02 (**Fig. 11**) monitoring site has been used by students and scientists to monitor the growth of dunes (sand volume) and shoreline movement. When SPI02 was established in August 2000, there were no dunes between the retaining wall and waterline at this location. Since that time, student-collected data has been quantifying the effects of sand fence installations, vegetation planting, beach maintenance practices, and numerous BUDM nourishment projects (**Fig. 35**). Port Isabel data have documented an overall trend of shoreline and vegetation line advancement and sediment-volume increase throughout the study period (Caudle and others, 2014, 2019). A dune crossover was constructed at this site in 2017. The construction project slightly flattened the profile and caused the loss of vegetation in the dunes (**Fig. 36A**). The vegetation quickly recovered at this site which quickly recovered. The position of the shoreline and vegetation line and the volume of sediment in the beach profile has remained stable for the past several years. Students monitoring is documenting the performance of a dune planting project that was completed before the April 2024 field trip (**Fig. 36B**).

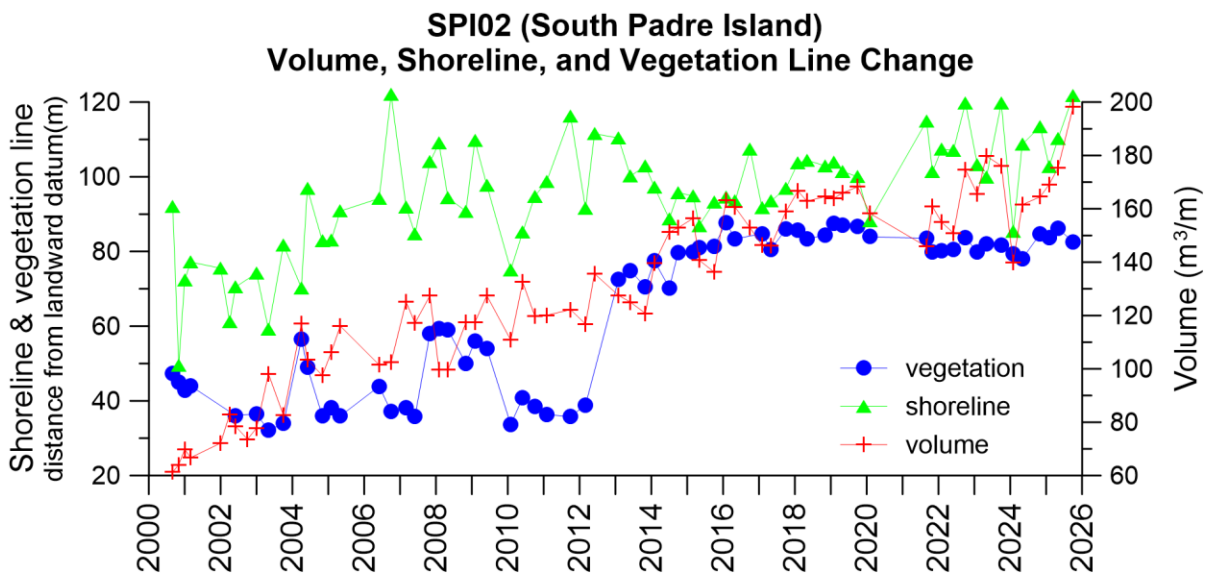


Figure 35. Changes in sand volume and in shoreline and vegetation-line positions at SPI02 on South Padre Island due to beach nourishment projects and the installation of sand fences.



Figure 36. (A) View toward the north at SPI01 from April 2024 showing newly planted vegetation and protective fencing. (B) Photo from September 2025 reveals that the vegetation has filled in the dune face. Wind-blown sand has accumulated adjacent to the fence and vegetation is spreading seaward.

SPI08 is a chronically eroding location in front of the Tiki Condominiums near the north end of the City of South Padre Island (**Fig. 11**). This site has a narrow beach backed by a retaining wall and regularly receives nourishment sand from road maintenance north of the City or from the dredging of Brazos Santiago Pass. Students from Port Isabel have been documenting cycles between beach nourishment, dune creation by beach maintenance practices, and the long-term shoreline erosion trend at this site (**Fig. 37**). The most recent nourishment took place between January 2020 and August 2021. The beach was much wider than had been previously documented. Fencing was installed and vegetation planted before the winter 2022 field trip. Students have documented that wind-blown sand is accumulating around the base of the sand fencing and vegetation is expanding to cover the coppice dune area.

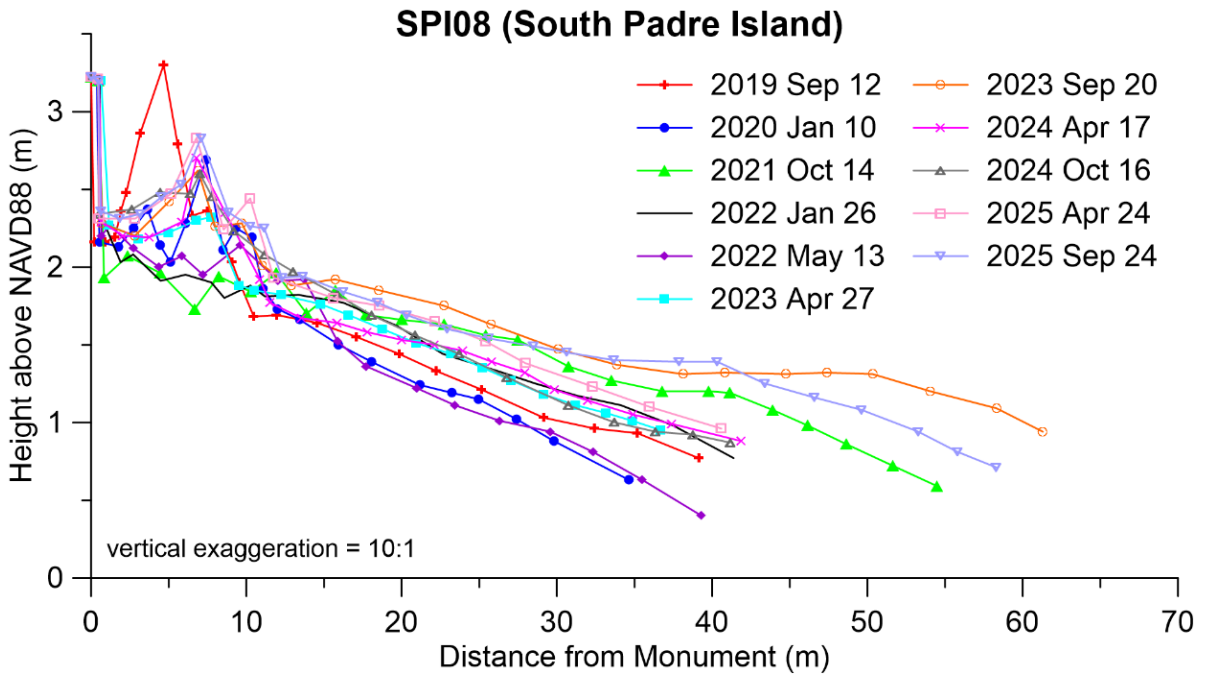


Figure 37. Beach profiles from before and after the latest nourishment project at SPI08.

CONCLUSIONS

The purpose of the Texas High School Coastal Monitoring Program is to provide middle and high school students with a real-world learning experience outside the everyday classroom. The program provides not only hands-on education for students but also valuable data for coastal researchers and decision-makers. During the 2024–2025 academic year, approximately 220 students from Ball, Brazosport, High Island, Palacios, Port Aransas, Port Isabel and Van Vleck High Schools and Cunningham Middle School at South Park collected data during 23 field trips. The fall field trips of the 2025—2026 academic year started the 28th year of data collection for THSCMP.

Since the inception of the program, work by students participating in the THSCMP has been beneficial to Bureau researchers and coastal managers in several research projects. Analysis of the data has been used to investigate storm effects and monitor recovery; to measure impacts to the beach and dune system from beach nourishment, construction of jetties, and beach maintenance practices; and to

verify shoreline positions for calculating change rates. Through this successful student research program, scientists, students, and the public continue to gain a better understanding of processes and shoreline change along the Texas coast. Historical and future measurements by the eight schools involved in the THSCMP show change through time at each location, but also highlights the geomorphic differences found along the Texas coast. Data collected from Bolivar Peninsula, Galveston Island, Follet's Island, Quintana Beach, Matagorda Peninsula, Mustang Island, and North and South Padre Islands helps scientists better understand the relationships between coastal processes, beach morphology, and shoreline change at these locations. Coastal communities and managers—especially our partners at the Texas General Land Office, Texas Parks and Wildlife Department, and other coastal parks—benefit from having access to the beach monitoring data and analysis for use in public-policy and coastal-management decision-making.

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APPENDIX A: PHOTOS FROM FIELD TRIPS

High Island High School



Ball High School



Brazosport High School



Van Vleck High School



Palacios High School



Port Aransas High School



Cunningham Middle School



Port Isabel High School

