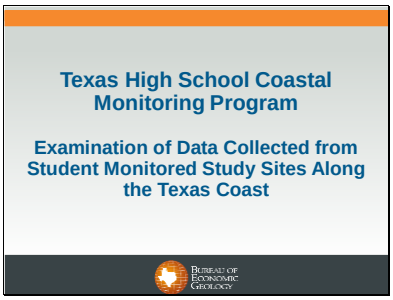
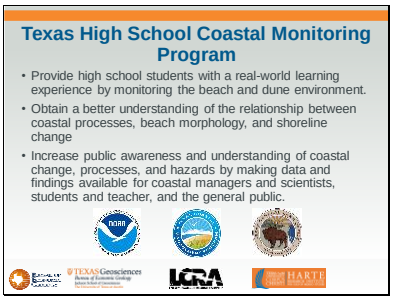
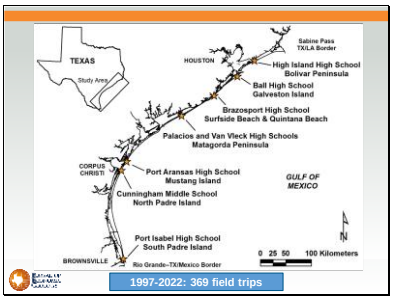


The Texas High School Coastal Monitoring Program is a research and outreach program at the Bureau of Economic Geology, part of the Jackson School of Geosciences at The University of Texas at Austin, where we partner with students and teachers in the study of the Texas coastal environment. This project has the dual benefit of enhancing the science education of the student participants while providing valuable data on the dynamic Texas coastline. This presentation examines data from every THSCMP study site to highlight the variability in geomorphology and coastal issues found along the Texas coast.

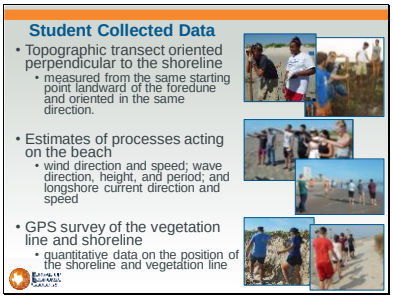


THSCMP was started in 1997 with three stated goals. The first to provide high school students with a real-world learning experience studying the Texas beach and dune environment. Eight schools along the Texas coast participate in 3 field trips each academic year collecting beach and dune monitoring data. Our second goal is to help scientists and decision makers gain a better understanding of the relationship between coastal processes, beach morphology and shoreline change along the Texas coast trough this long-term data collection program. A lot of scientific studies are short term. We have 15-20 years of data from the majority of our collection sites. And third goals is to increase public awareness and understanding about the ever changing coast. All data collected by the students and analysis made by Bureau scientists are publicly available for use by coastal managers, scientists, decision makers and the general public through our website, presentations, reports, and journal articles.

Support for THSCMP is made possible by NOAA and the Texas Coastal Management Program. Additional funding has been provided by the Jackson School of Geosciences. Staff from the Lower Colorado River Authority's Matagorda Bay Nature Park and graduate students and staff from the Harte Research Institute at Texas A&M University Corpus Christi provide field trip support.



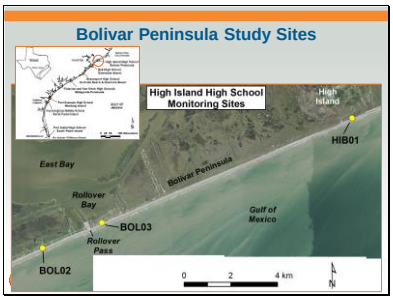
The eight schools currently participating in THSCMP collect data along the easily accessible, developed sections of the Texas coast. The program began with Ball HS on Galveston Island during the 1997-98 academic year. The schools joined in the following order.
1997: Ball High
1999: Port Isabel and Port Aransas High Schools
2004: Van Vleck High School
2006: Palacios High School
2009: Cunningham Middle School
2015: High Island High School
2018: Brazosport High School.
During the 2018-19 academic year we had 24 field trips (all 8 schools went on 3 field trips) and approximately 340 students participated. During the 2019-20 academic year over 200 students participated in 16 field trips. During the 2020-21 academic year we did not have field trips due to the pandemic. We were able to conduct 21 field trips during the 2021-22 academic year over 200 students participating. A total of 369 field trips have been completed since the program began in 1997.



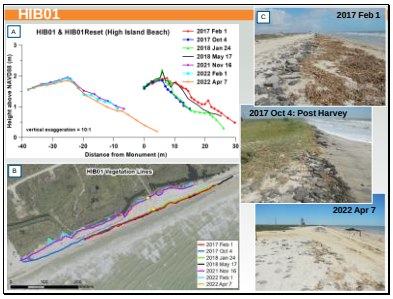
Each school collects 3 datasets at their monitoring sites.

- A topographic transect oriented perpendicular to the shoreline. Students use the Emory method to collect this data set. Students either use the horizon or a sighting level to determine the elevation or vertical offset between two pole and then measure the horizontal distance between the poles with a tape measure.
- Observations about the current weather and wave conditions effecting the site. We use compasses to determine wind and wave direction, simple wind meters to measure wind speed, and make estimates of wave height, wave period, and surf zone width. Oranges are thrown into the surf to determine how fast the longshore current is moving and which direction it is going.
- Hand-held GPS units are used to map the current position of the shoreline (or wet/dry line) and the line of continuous vegetation.

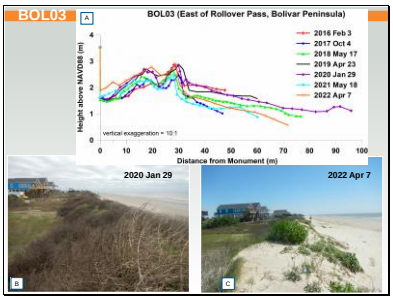
If time allows on the field trips, students participate in additional citizen science coastal studies such as Nurdle Patrol, which involves searching for plastic nurdles on the beaches.



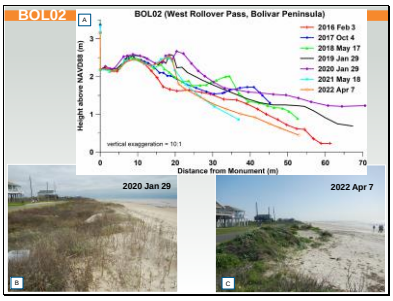
These slides examine data collected by THSCMP students from all of their monitoring sites along the Texas coast organized from the northeastern-most site at High Island Beach to the southern-most site adjacent to the Brazos Santiago Pass on South Padre Island. High Island High School science students collect data from three sites on Bolivar Peninsula. Two of the monitoring sites are adjacent to Rollover Pass, BOL02 to the west and BOL03 to the east of the Pass. The third site (HIB01) is seaward of High Island just past the eastern end of Highway 87. During the 2018-19 and 2019-20 academic years, HIHS was not able to collect data at the HIB01 site due to highway construction at the curve where Highway 87 and TX 124 intersect.



The beach at HIB01 has seen significant changes including a reset of the datum point. 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 moved landward 25 meters (just landward of the original profile datum location) and the vegetation line moved 45 meters landward, due in part to the impacts of the 2020 hurricane season. (A) Beach profiles showing movement of shoreline landward between 2017 and 2022. The original profile datum was lost between 2018 and 2021 and was reset during the November 2021 field trip. (B) GPS mapped vegetation line positions between 2017 and 2022. (C) Photography documenting the status of the shoreline and vegetation line on February 1, 2017; October 4, 2017 (post-Harvey); and April 7, 2022. Notice the pavement debris that was at the berm crest in early 2017 was deposited at the vegetation line by Harvey. The pump jack just visible on the left edge of the October 2017 photo is in the middle of the backbeach in April 2022 indicating how far the vegetation line moved landward.

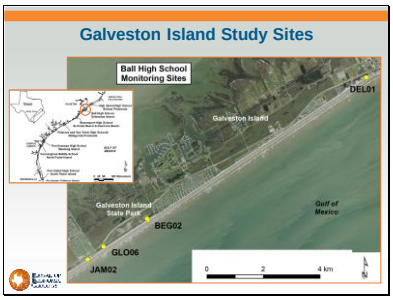


HIHS students monitor sites adjacent to Rollover Pass, BOL02 to the west and BOL03 to east. Rollover Pass was cut across Bolivar Peninsula in 1955 with the intention of improving water quality in Rollover Bay and Galveston East Bay. The opening of the pass caused significant erosion to the adjacent beaches and sand and sediment to be deposited in the Gulf Intracoastal Waterway (ICW). The U.S. Army Corps of Engineers was required to annually dredge and remove sediment from the ICW adjacent to Rollover Bay at significant cost. Due to these issues, the Texas Legislature authorized the General Land Office to close the pass. Construction began at the end of September 2019 and completed in spring 2020. High Island students collected baseline data from BOL02 and BOL03 and will be monitoring how the closure of Rollover Pass impacts these beaches in the future. HIHS beach monitoring at BOL03 east of Rollover Pass. (A) Beach profiles showing the changes in topography at the site between February 2016 and April 2022. (B) Photograph looking east along the dune crest during the field trip on January 29, 2020. C) BOL03 photograph looking east along the dune crest on April 7, 2022.

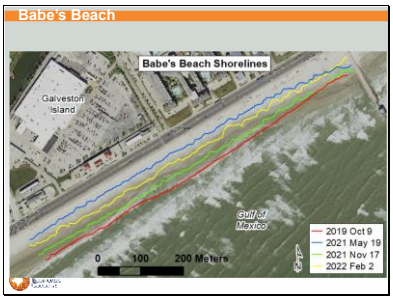


HIHS beach monitoring at BOL02 west of Rollover Pass. (A) Beach profiles showing the changes in topography at the site between February 2016 and April 2022. (B) Photograph looking east along the vegetation line and low foredune present during the field trip on January 29, 2020. (C) BOL02 photograph looking east along the discontinuous vegetation line on April 7, 2022.

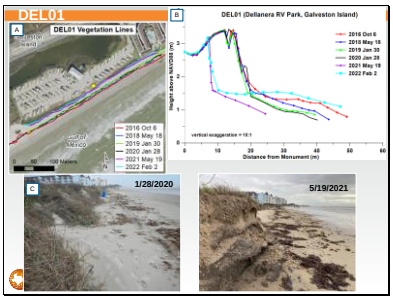
In addition, students started mapping the shoreline across the mouth of former Rollover Pass during the 2021—22 academic year. The top photo is an aerial image of Rollover Pass taken in 2018 before closure of the pass. The bottom is an aerial image of Rollover Pass taken in 2020 after closure of the pass had been completed with GPS mapped shoreline positions from the 2021—22 academic year.



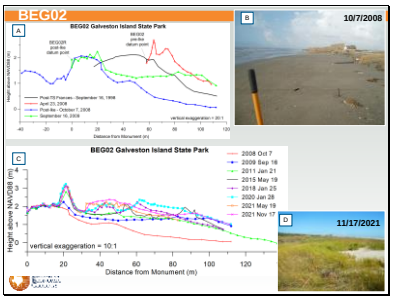
Ball High School students have three monitoring sites on Galveston Island.
Students conduct surveys at Galveston Island State Park, BEG02—a profile that the Bureau has been measuring since the 1980's. Ball High School students also collected data at JAM02 in Jamaica Beach and DEL01 at the Dellanera RV Park. Both of these sites monitor beach nourishment and Coastal Erosion Planning and Response Act (CEPRA) beach and dune restoration activities.



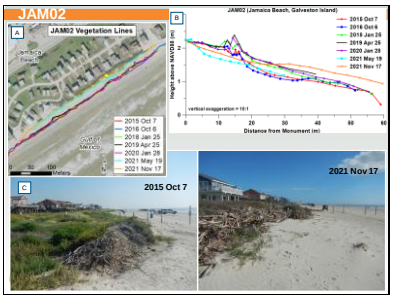
Students collect GPS mapped shoreline positions from a section of Babe's Beach (between 61st and 69th Streets) that is periodically nourished.



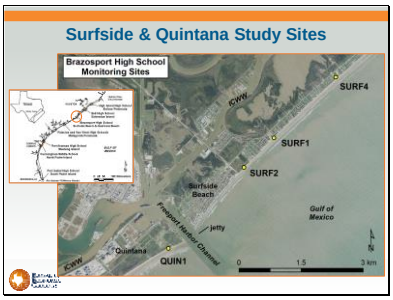
Hurricane Harvey in 2017 had minimal impacts to the beach and dune system on Galveston Island but the 2020 hurricane season did cause beach and dune erosion. The dune at the Dellanera RV Park that was created as part of a large nourishment and dune restoration project that took place in 2015, experienced significant erosion between January 2020 and May 2021. Over half the volume of sand in the beach/dune system was removed. (A) Vegetation line positions and (B) beach profile data between October 2016 and February 2022. (C) Photos looking northeast along the vegetation line from January 28, 2020 and May 19, 2021. The 2020 hurricane season caused significant erosion of the beach and dune. Note the scarped dune and narrow beach in the second picture.



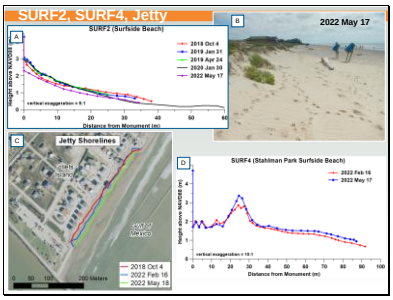
Students from Ball High School on Galveston Island have been collecting critical data since 1997 that are used by scientists to increase understanding of beach and dune impacts and recovery stages following major storms. During the 23-years Ball students have participated in THSCMP, numerous storms with varying intensities have caused impacts to the beaches of Galveston Island. Data from BEG02 in Galveston Island State Park documented how much the beach and dunes changed after Hurricane Ike in 2008 and the recovery of the beach and dune system. (A) Beach-profile plots from BEG02 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. (B) Photo of Galveston Island State Park after landfall of Hurricane Ike showing beach and dune erosion and damage to park infrastructure. (C) Beach profile plots from October 2007 through November 2021 showing the recovery of the beach and dune system following Hurricane Ike. A foredune established quickly, 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. After the 2020 hurricane season, the beach was eroded landward and a washover feature was deposited in the coppice dune area. (D) Photo from November 17, 2021 looking northeast of the vegetated coppice dunes at the park. Notice the toe of the washover feature.



Ball student monitoring documented changes to a dune and vegetation restoration project at site JAM02 in Jamaica Beach. Monitoring of changes at JAM02 in Jamaica Beach, community adjacent to Galveston Island State Park. (A) Vegetation line positions and (B) beach profile data between October 2015 and November 2021. (C) Photos looking northeast along the vegetation line from October 7, 2015 and November 17, 2021. The 2020 hurricane season caused erosion of the small reconstructed dune and landward movement of the vegetation line. Palm fronds have been placed along the vegetation line in the second photo to trap windblown sand to promote dune growth.

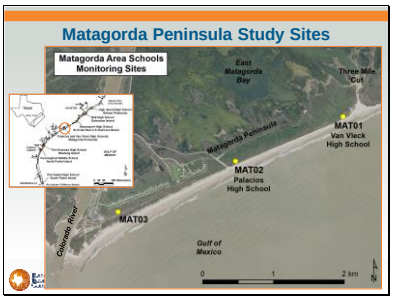


Brazosport High School in Freeport, Texas, joined THSCMP during the 2018–2019 academic year. Senior AP Environmental Science students collect data from sites at Surfside Beach and Quintana Beach. Three of the monitoring sites (SURF2, SURF4, and jetty park) are located in Surfside Beach on the southern end of Follets Island. A fourth site (QUIN1) is located in Brazoria County's Quintana Beach County Park.

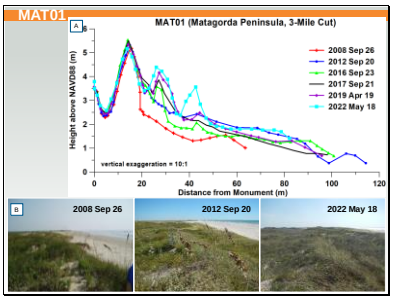


(A) Beach profile data at SURF2 showing changes in the topography between October 2018 and May 2022. Notice that the profile elevation is lower at the datum poin in May 2022. (B) SURF2 vegetation line looking northeast on May 17, 2022. The vegetation line moved landward due to the 2020 and 2021 hurricane seasons. (C) GPS mapped shoreline positions from October 2018 through May 2022 in a segment of beach between Surfside Jetty County Park and a rock revetment protecting Beach Drive. At times, the shoreline position (wet/dry line) is beneath or behind structures that are located on the beach. (D) Baseline monitoring beach profile data at SURF4 in Stahlman Park which was established in early 2022 to replace the beach profile lost due to erosion at SURF1. Initial measurements at this new profile location created a baseline dataset to monitor changes in the beach and dune system into the future.

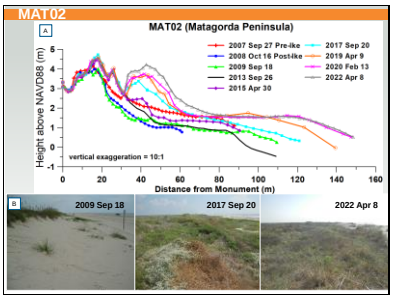
Significant changes to the beach and small dune system on Follets Island and Quintana Beach have been documented over the Brazosport's short monitoring. At the QUIN1 monitoring location, the small foredune that was present was destroyed and the vegetation line moved 15 meters landward between January 2020 and May 2021. (A) Beach profile data showing changes in the topography between April 2019 and January 2020. (B) GPS mapped vegetation line positions from April 2019 through May 2022. The vegetation line position had been stable prior to the 2020 hurricane season. By May 2021 the line had moved 15 meters landward the datum point was lost due to erosion. (C) Photos of theQUIN1 vegetation line looking southwest on January 30, 2020 and May 18, 2022. Notice the landward movement in the vegetation line position (distance between beach palapas and vegetation) between the 2 photographs.



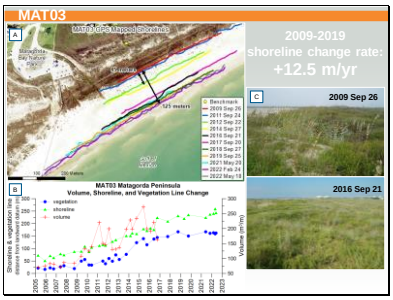
Van Vleck High School students collect data at MAT01 which is adjacent to a washover channel called Three Mile Cut. The washover channel is a low lying area of the peninsula that is periodically opened between the Gulf of Mexico and East Matagorda Bay during major storms such as hurricanes. Three Mile Cut was opened briefly by Hurricane Ike in 2008. Palacios High School students collect data at MAT02 which is northeast of the vehicular beach access point. Van Vleck and Palacios High School students also collect GPS vegetation line and shoreline data at MAT03 (Fig. 1), a site adjacent to the Matagorda Bay Nature Park fishing pier and on the updrift side of the jetty at the mouth of the Colorado River.



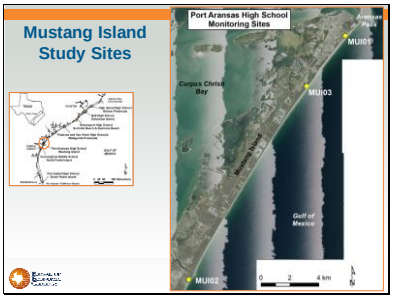
Hurricane Ike made landfall on Galveston Island on September 13, 2008, as a Category 2 hurricane. The storm surge from Hurricane Ike briefly opened Three Mile Cut and caused vegetation line retreat and dune erosion at MAT01. Since Ike's landfall, students from Van Vleck High School have been monitoring the recovery and seaward expansion of the dunes and the seaward movement of the vegetation line at this site. (A) Beach profile showing the seaward expansion of the dunes between September 2008 (Post-Hurricane Ike) and May 2022. (B) Series of photos from September 26, 2008; September 20, 2012; and May 18, 2022 showing the seaward movement of the vegetation line and shoreline and expansion of the dunes. All three photos were taken from the primary dune crest looking northeast (same orientation as the beach profile).



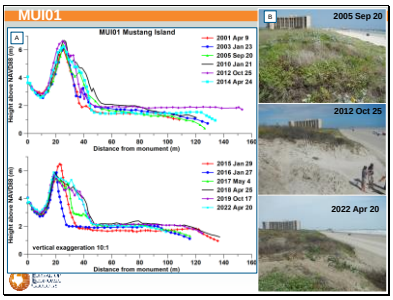
Students from Palacios High School have been monitoring the recovery and growth of the dunes and the seaward movement of the vegetation line at MAT02 on Matagorda Peninsula. (A) Beach profile showing the impacts of Hurricane Ike between September 2007 and October 2008 and seaward expansion of the dunes. (B) Series of photos taken from a point approximately 30 meters from the datum monument looking northeast (same orientation as the beach profile) showing the seaward movement of the vegetation line and shoreline and expansion of the dunes. On September 18, 2009 that point was the vegetation line. The September 20, 2017 and April 8, 2022 were taken from the crest of the secondary dune.



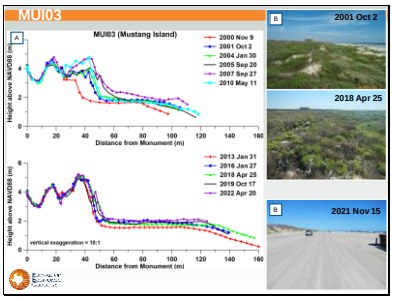
Understanding the impacts of coastal structures are critical to coastal management. After the U.S. Army Corps of Engineers constructed a new north jetty at the mouth of the Colorado River in 2010, GPS-mapping indicated that the shoreline position at MAT03 moved 125-m seaward over a decade. The combination of the new jetty impounding sand on the updrift side and decreased vehicular traffic at MAT03 has allowed for coppice dune formation to occur on the expanded backbeach area and for new vegetation to develop without being disturbed. Beach profile data collected at this site by Tidehaven ISD students from 2005 until 2016 when it was no longer safe for students to be landward of the vegetation line. Palacios and Van Vleck High Schools continue to collect GPS mapped shoreline and vegetation lines at this site. A) GPS mapped shorelines from September 2009 through May 2022. The shoreline moved seaward at an average rate of 12.5 m/yr until 2019 when the position stabilized. B) Shoreline, vegetation line, and beach profile volume change. Notice that the shoreline and vegetation lines have stabilized after a decade of advancement. C) September 26, 2009 and September 21, 2016 photographs looking southwest toward the Colorado River along the dune crest at MAT03. Note the increase in the coppice dune area seaward of the dune crest in the 2016 photograph.



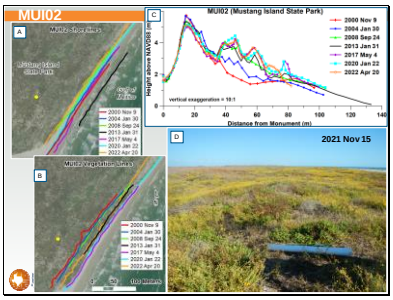
Port Aransas students have three monitoring sites on Mustang Island.
MUI01 is located near Horace Caldwell Pier.
MUI02 is located in Mustang Island State Park just southwest of Fish Pass
MUI03 is located near Beach Access Road 1 (Palmilla Beach Golf Club).
The beach-monitoring activities of Port Aransas High School students have provided beneficial information about the beach and dune system on Mustang Island. 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 all three of their profiling sites.



Beach maintenance practices vary along the island and have changed over time, which the students have documented through their data. Several beaches on Mustang Island, particularly within the City of Port Aransas boundaries, are regularly scraped to remove seaweed (Sargassum) from the forebeach. The MUI01 site was dune notched in 2012 and 2015, a beach beach-maintenance practice where sand is removed from the dune and replaced with sargassum and sand scraped from the beach over time. MUI01 also has shore-parallel bollards that have been installed 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. (A) Beach profile data from April 2001 through April 2022 showing expansion of the dune width until dune notching in 2012 and more severely in 2016. The dune system has been filled in but is no longer moving seaward due to the location of the Beach Road. (B) Photos showing the changes to the dune at MUI01 on September 20, 2005, October 25, 2012, and April 20, 2022. The 2012 photo shows the notch in the dune where sand was removed.

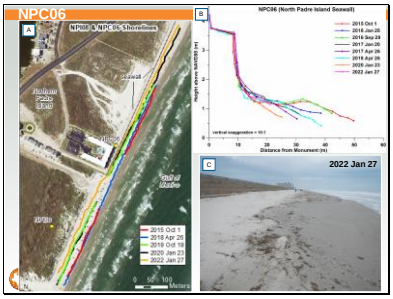


The beach road has also impacted the seaward extent of dune growth and vegetation line movement at MUI03. The beach maintenance practices and the impacts of the fixed position of the Mustang Island Beach Road will continue to be monitored by Port Aransas students at MUI01 and MUI03 and compared with the natural processes that occur in Mustang Island State Park. (A) Beach profile data from November 2000 through April 2022. The upper plot shows the steady seaward expansion of the dune system and movement through 2010. The bottom plot shows how the Beach Road on the backbeach has stopped the expansion of the dunes creating a fixed position of the dune toe with minimal change between 2013 and 2022. (B). Photos from October 2, 2001 and April 25, 2018 looking north along the landward most dune crest on the beach profile. (C) Photo from November 15, 2021 looking north along the Beach Road.

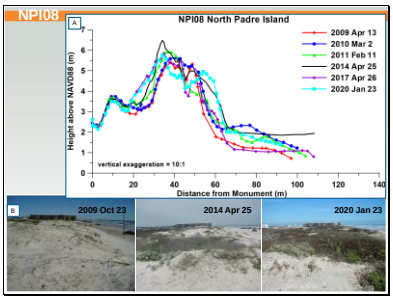


Minimal beach maintenance is performed within the Mustang Island State Park boundaries, only to keep the beach access points open. Student monitoring data at MUI02 in Mustang Island State Park. GPS-mapped (A) shoreline positions and (B) vegetation line positions, and (C) beach profile data between November 2000 and April 2022. The students have been documenting the seaward migration of the shore and vegetation lines as well as the growth of the dune system through 2020. The seaward most coppice dunes had been eroded and both the vegetation line had moved landward during the April 2022 field trip. Water levels were very high on the beach which would account for the landward position of the shoreline. (D) Photo looking north along the landward most dune crest on the beach profile on November 15, 2021.

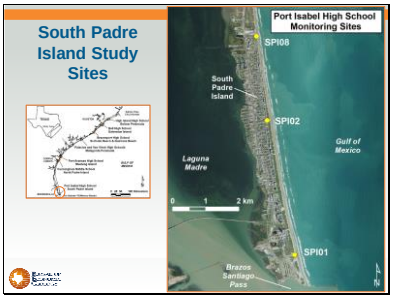
Cunningham eighth grade students collect data at two sites on northern Padre Island, NPI08 and NPC06. NPI08 monitors a very active foredune crest and maintained beach. NPC06, on the North Padre Island seawall, monitors beach restoration and maintenance activities seaward of the seawall.



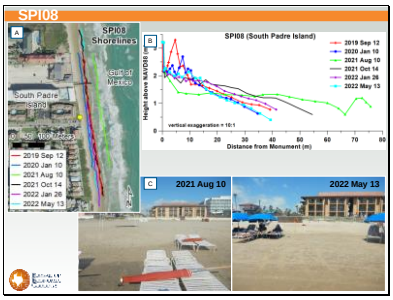
The site NPC06, near the southern end of the North Padre Island seawall, was added in 2015 to track the effects of nourishment projects and maintenance activities on the beach in front of the seawall and the adjacent natural area (NPI08). The beach in front of the seawall is periodically nourished with beneficial use material from maintenance dredging of Packery Channel. 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. 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. (A) GPS mapped shoreline position for NPI08 and NPC06 between October 2015 and January 2022. (B) Beach profile data showing changes in the shoreline position between October 2015 and January 2022. (C) Photo looking north along the shoreline in front of the seawall on January 27, 2022. Notice the narrow beach and how close the wet/dry line is to the base of the seawall.



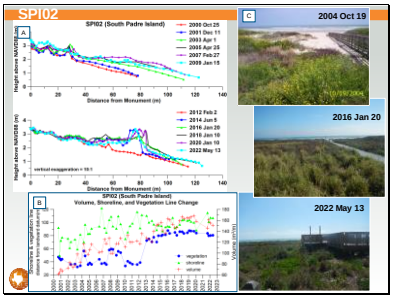
The sites monitored by CMS students are interesting to compare with the well-vegetated foredunes on Mustang Island to the north. The students have documented many changes at the NPI08 profile location, which is located just south of the North Padre Island seawall. The dune crest at this site is sparsely vegetated which creates an opportunity for prevailing winds to constantly rearrange and alter the shape and height of the dune crest. Until vegetation is established that completely covers the crest of this dune, it will remain a highly dynamic site. (A) Beach profile data collected between April 2009 and January 2020 illustrating the changes to the sparsely vegetated dune crest at NPI08. (B) Series of photos taken from the NPI08 dune crest showing the changes in vegetative cover and the topography of the crest at this location.



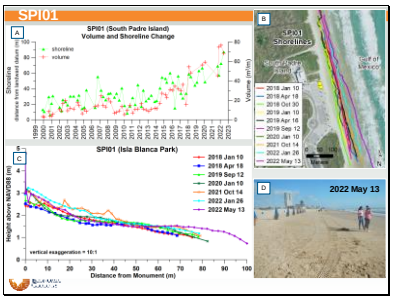
Port Isabel students have three monitoring sites on South Padre Island. SPI01 is located on the southern tip of the island within the boundaries of Isla Blanca County Park near Brazos Santiago Pass. SPI02 is located at Moonlight Circle, beach access number 13. SPI08 is located in front of the Tiki Condominiums near the north end of the City.
Port Isabel High School has been measuring SPI01 and SPI02 since 1999, and SPI08 since 2007. Brazos Santiago Pass, the southern border of South Padre Island, serves as the southern Gulf of Mexico access to the Gulf Intracoastal Waterway and the Port of Brownsville. Sediment dredged from the pass is 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.



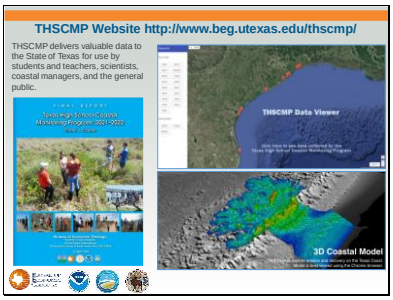
SPI08 is a chronically eroding location in front of the Tiki Condominiums near the north end of the city. This site has a narrow beach backed by a retaining wall and regularly receives nourishment sand from road maintenance north of the City of South Padre Island and from the dredging of Brazos Santiago Pass. The 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. (A) GPS mapped shoreline and (B) beach profiles from before and after the latest nourishment project at SPI08. The August 2021 shoreline and profile were measured shortly after the project took place. (C) Photos from the waterline looking landward toward the retaining wall taken on August 10, 2021 and May 13, 2022. Notice the decreased width of the beach between the 2 photos. Sand fencing and vegetation planting had taken place over the winter 2021-2022.



The SPI02 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. Since that time, student collected data has been quantifying the effects of the installation of sand fences, planting of vegetation, beach maintenance practices, and numerous BUDM nourishment projects. (A) Beach profile data and (B)volume, shoreline and vegetation line change plot documenting an overall trend of shoreline advancement and sediment-volume increase throughout the study period. (C) Photos looking seaward from the retaining wall from October 19, 2004; January 20, 2016; and May 13, 2022.



SPI01 is located in Isla Blanca Park at the southern end of the island. Beach profile data, sediment volume, and shoreline position documented a stable beach between 1999 and 2014. Since that time, the shoreline has gradually moved seaward and the volume of sediment in the beach profile has increased. (A) Volume and shoreline change plot documenting a stable beach system between 1999 and 2014. Starting in 2014, the shoreline has slowly been moving seaward and volume increasing in the beach profile. (B) Beach profile and (C) GPS mapped shoreline positions from Jan 2018 through May 2022. (D) Photo taken on May 13, 2022 looking north along the wet/dry line (GPS mapped shoreline).



The THSCMP website and the project final report are valuable sources of information for students and teachers, scientists, coastal managers, and the general public. At the end of each academic year we produce a report that includes the following components: presentation of field sites and field trip dates, graphs of data, scientific interpretation of the data by Bureau scientists, and select photos of the students conducting field measurements. We have a data viewer where you can see the profile, shoreline, and vegetation line data collected at each site. Each school in the program has a webpage dedicated to data, observations, and photos related to their study area, similar to the data presented in these slides. 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.