FINAL REPORT

Texas High School Coastal Monitoring Program: 2023–2024

Tiffany L. Caudle

Bureau of Economic Geology
Mark W. Shuster, Interim Director
Jackson School of Geosciences
The University of Texas at Austin, Austin, Texas 78713-8924

February 2025

F I N A L R E P O R T

Texas High School Coastal Monitoring Program: 2023–2024

Tiffany L. Caudle

This report was funded by a Texas Coastal Management Program grant approved
by the Texas Land Commissioner, providing financial assistance under the
Coastal Zone Management Act of 1972, as amended, awarded by the
National Oceanic and Atmospheric Administration (NOAA), Office for Coastal Management,
pursuant to NOAA Award No. NA23NOS4190249. The views expressed herein are those
of the author(s) and do not necessarily reflect the views of NOAA, the U.S. Department
of Commerce, or any of their subagencies.

Bureau of Economic Geology
Mark W. Shuster, Interim Director
Jackson School of Geosciences
The University of Texas at Austin, Austin, Texas 78713-8924

February 2025

TABLE OF CONTENTS

TABLES

FIGURES

INTRODUCTION

The Texas High School Coastal Monitoring Program (THSCMP) is designed to help students and communities living on the Texas coast develop a better understanding of their natural environment. Students, teachers, and scientists work together to gain a better understanding of dune and beach dynamics in their regions. Scientists from The University of Texas at Austin’s Bureau of Economic Geology (the Bureau) lead the 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. Coastal processes, the beach and dune environment, and public access and private property rights provide 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 public policy 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, Follets 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 2024.

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.

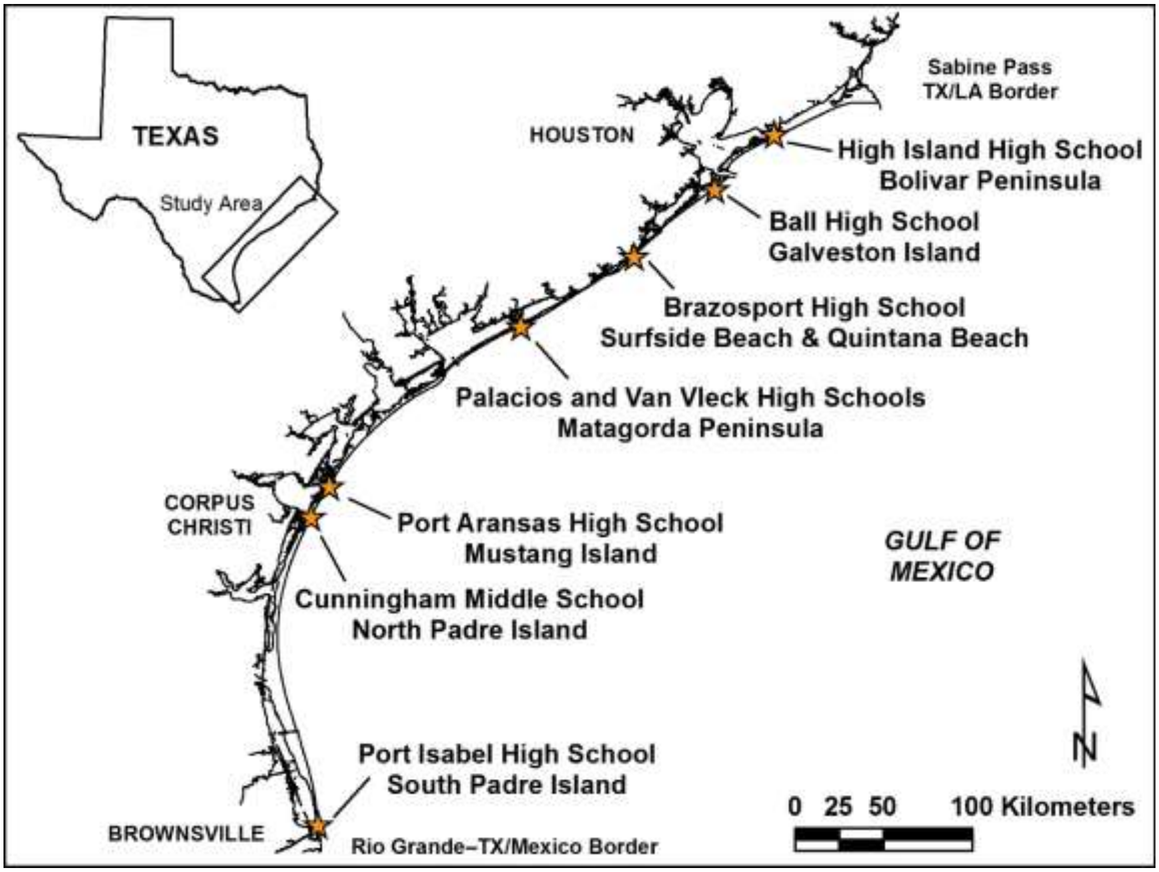


Figure 1. Location map of participating schools.

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. Working in teams, they conduct topographic surveys (beach profiles) of the foredune and beach, map the vegetation line and shoreline, collect sediment samples, 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 general 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, the annual report, 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 has conducted research to monitor shorelines and investigate 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, and a hand level to accurately survey a shore-normal beach profile from behind the foredunes to the waterline (**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.

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

Shoreline and vegetation-line mapping: Using handheld Global Positioning System (GPS) units, students walk along the shoreline and vegetation line, mapping these features for display on Geographic Information System (GIS) software (**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.

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

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. Students also learn to obtain weather and oceanographic data from online resources.

Bureau scientists provide teachers and students with all the training, information, field forms, and equipment needed to conduct the field measurements. During the academic year, Bureau scientists accompany students on at least one field trip. The scientists and students discuss general and theoretical 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 and (B) measuring wind speed.

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**). Expansion of the program has not only increased the number of schools in the THSCMP but also included middle school students. 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 421 field trips have been completed.

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

High Island High School

High Island High School joined the THSCMP during the 2015–2016 academic year. Ms. Caudle worked with High Island High School science teacher Alvin Yap. Science students at High Island collected data from three Bolivar Peninsula sites on February

1, 2024; May 1, 2024; and October 24, 2024. 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 collect shoreline positions across the mouth of the now closed Rollover Pass.

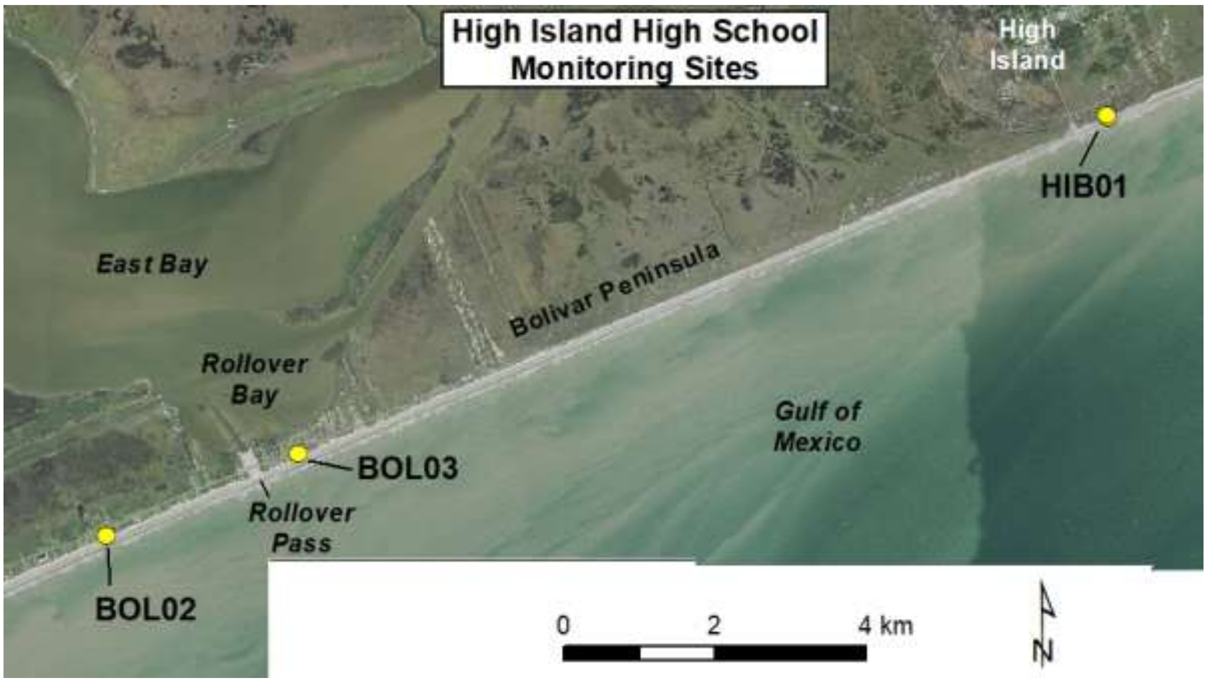


Figure 5. Location map of High Island High School monitoring sites.

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. The new site is easier and safer for students to access, especially with the new beachfront access points in the park. 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 11, 2023; January 18, 2024; April 30, 2024; and October 25, 2024.

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. Ms. Caudle works with teacher Tori Porter and senior AP Environmental Science students to collect data from sites at Surfside Beach and Quintana Beach. Field trips took place on September 28, 2023; January 19, 2024; May 3, 2024; and October 23, 2024. Three of the monitoring sites (SURF2, SURF4, and jetty park) are in Surfside Beach on the southern end of Follets 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.

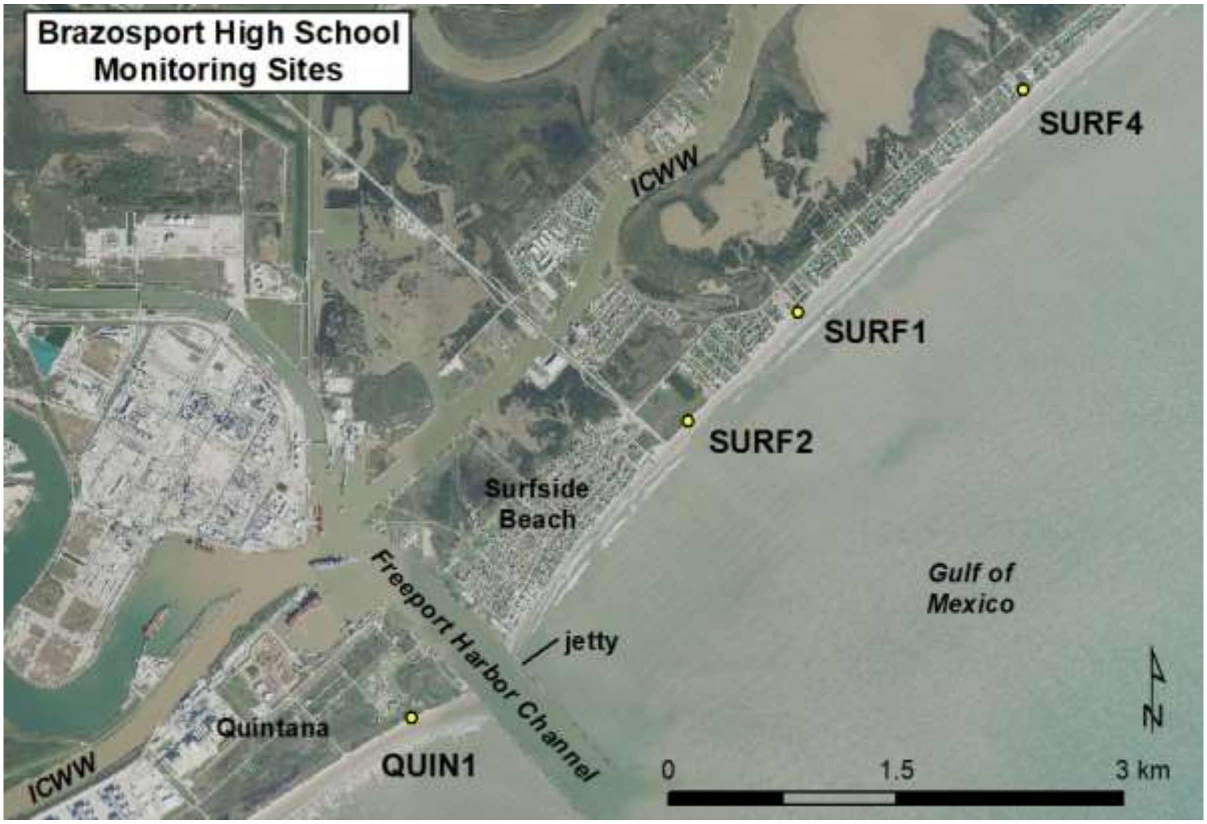


Figure 7. Location map of Brazosport High School monitoring sites.

Matagorda Area Schools

Van Vleck High School environmental science students participated in field trips on September 27, 2023; February 21, 2024; April 26, 2024; and October 2, 2024. Students from classes taught by Sherry Martinez and Jennifer Rodriquez collected data at MAT01 (**Fig. 8**). Physics students from Palacios High School participated in field trips on October 10, 2023; February 6, 2024; May 2, 2024; and October 8, 2024. McKaylie Reamy's students collected 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. Though beach profile data is no longer collected at MAT03, Van Vleck and Palacios High Schools map the shoreline and vegetation line positions with GPS at this site.

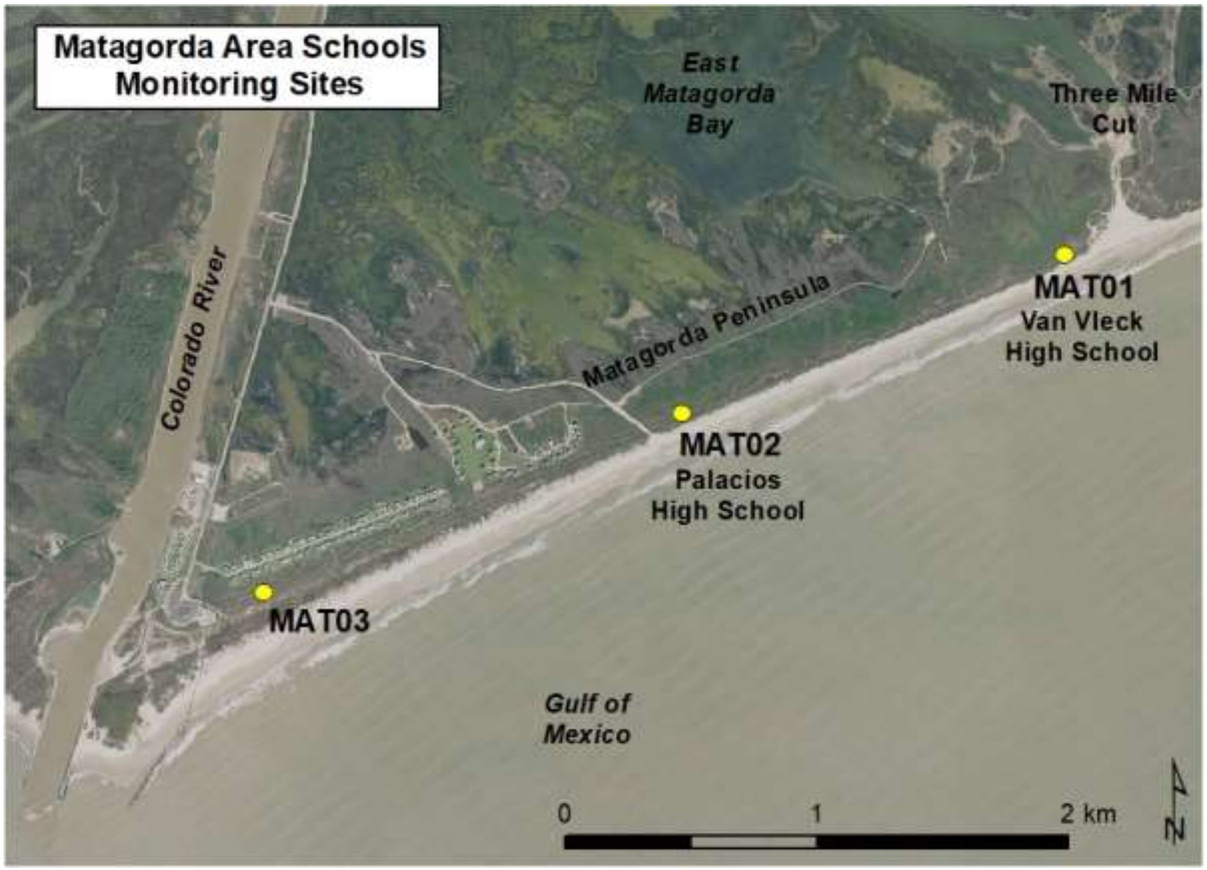


Figure 8. Location map of sites monitored by Matagorda-area schools.

Port Aransas High School

Port Aransas students participated in field trips on October 4, 2023; February 22, 20024; April 25, 2024; and October 10, 2024. Ryan Piwetz's students collected 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 8th grade students from Cunningham Middle School at South Park (Corpus Christi Independent School District) on October 3, 2023; February 8, 2024; April 12, 2024; and October 9, 2024. Teacher Jennifer Juarez's students collect data at sites along and adjacent to the seawall on Northern Padre Island. (**Fig. 10**). The sites monitor the impacts of beach restoration and maintenance activities. The datum for NPI08 has been lost due to thick vegetation and corrosion of the pipe therefore, students do not measure a beach profile. They will continue to collect GPS data for the shoreline and vegetation line positions seaward of NPI08. Beach profiles are measured at both ends of the seawall (NPISW and NPC06).

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

Port Isabel High School

Port Isabel students participated in field trips on September 20, 2023; January 24, 2024; April 17, 2024; and October 16, 2024. Students from Dr. Michelle Zacher's science classes collected 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 participate 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), and 2019 (Paine and others, 2021, **Fig. 12**).

The shoreline position extracted from 2019 lidar data was verified by visually comparing the shoreline proxy contour elevation with the wet-beach/dry-beach boundary as shown on georeferenced 2016 and 2018 NAIP aerial photographs and imagery acquired during the airborne survey. We used beach profiles and GPS-mapped shorelines acquired by the THSCMP near the dates of the lidar survey to compare the observed wet- and dry-beach positions. The Surfside Beach profile site SURF2 on Follets Island (**Fig. 12**; Paine and others, 2021) is representative of data comparison all along the Texas coast. At this site, there is excellent positional agreement between the 2019 lidar-derived shoreline proxy; the wet-beach/dry-beach boundary mapped on April 24, 2019, by THSCMP participants and Bureau staff; 2018 NAIP imagery, and 2019 aerial imagery. The next update of long-term rates of Gulf shoreline movement will utilize data collected during winter and spring 2024 field trips to verify the shoreline position extracted from 2024 lidar data.

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

Figure 12. Shoreline position comparison at Surfside Beach site SURF2. Shorelines include the wet-beach/dry-beach boundary mapped on April 24, 2019, by THSCMP students and Bureau staff using ground GPS and the 1 m (3.3 ft) above mean sea level shoreline proxy extracted from airborne lidar data acquired in spring 2019, superimposed on 2019 Bureau imagery. From Paine and others (2021).

- 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
- 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 2024 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 three 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. High Island teacher, Ms. Skewis, presented the program to the Bolivar Peninsula Special Utility District (BPSUD) on April 12, 2022.

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: 1997–2024

Profile data collected by the students are entered into CEDAS v. 4.0 (Coastal Engineering Design and Analysis System)—a system originally developed by the U.S. Army Corp of Engineers and commonly used by coastal engineers and scientists in beach-profile analysis—using the BMAP (Beach Morphology and Analysis Package) module. 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 for each monitoring site are found in Appendix A. Profile plots that contain all student-collected data for each monitoring site are found in Appendix B. Additional data, including the GPS-mapped shore and vegetation lines, can be found on the THSCMP website.

Since the 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's joined THSCMP. 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 that are remnants of Highway 87 were at the upper reach of the swash zone (**Fig. 13A**). 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 (**Fig. 13B**). The beach width had recovered by spring 2018 (**Fig. 14**).

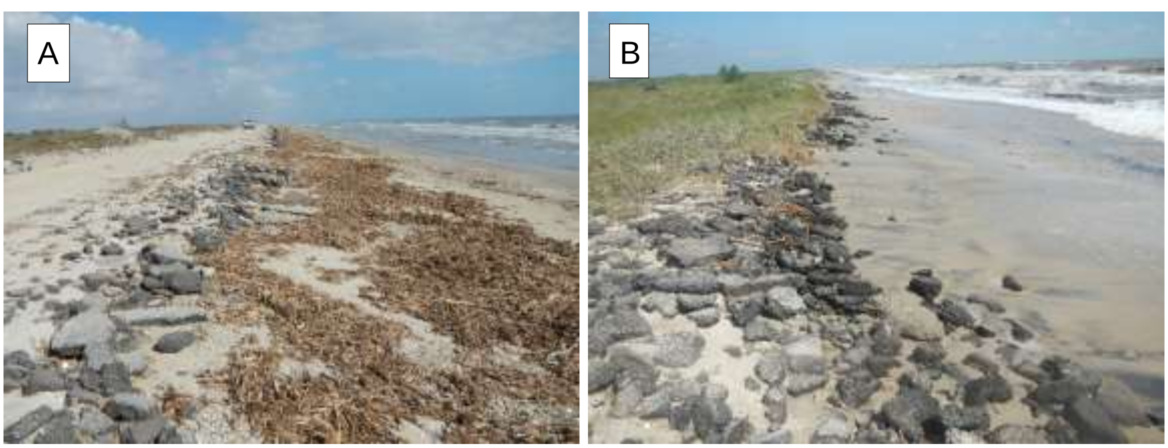


Figure 13. Photos looking northeast along High Island Beach from (A) February 2017 and (B) October 2017 showing the impacts to the beach due to Hurricane Harvey.

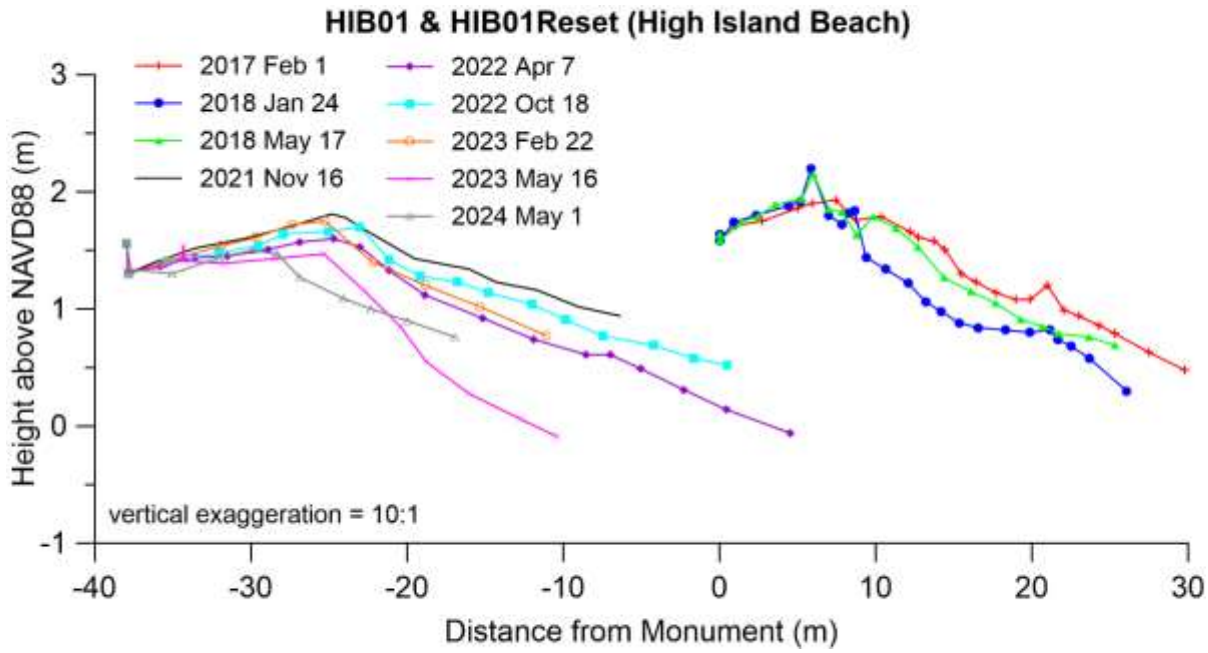


Figure 14. Changes at HIB01 and HIB01 Reset monitored by High Island High School students.

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. 14 & 15**). Data collection at this site has documented a continually steepening beach profile, landward retreating vegetation line, and evidence of beach washover.

High Island High School students also monitor sites BOL02 and BOL03 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 (**Figs. 16 & 17A**). 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 spring 2024 with a narrower beach but higher elevation berm (**Figs. 16 & 17B**).

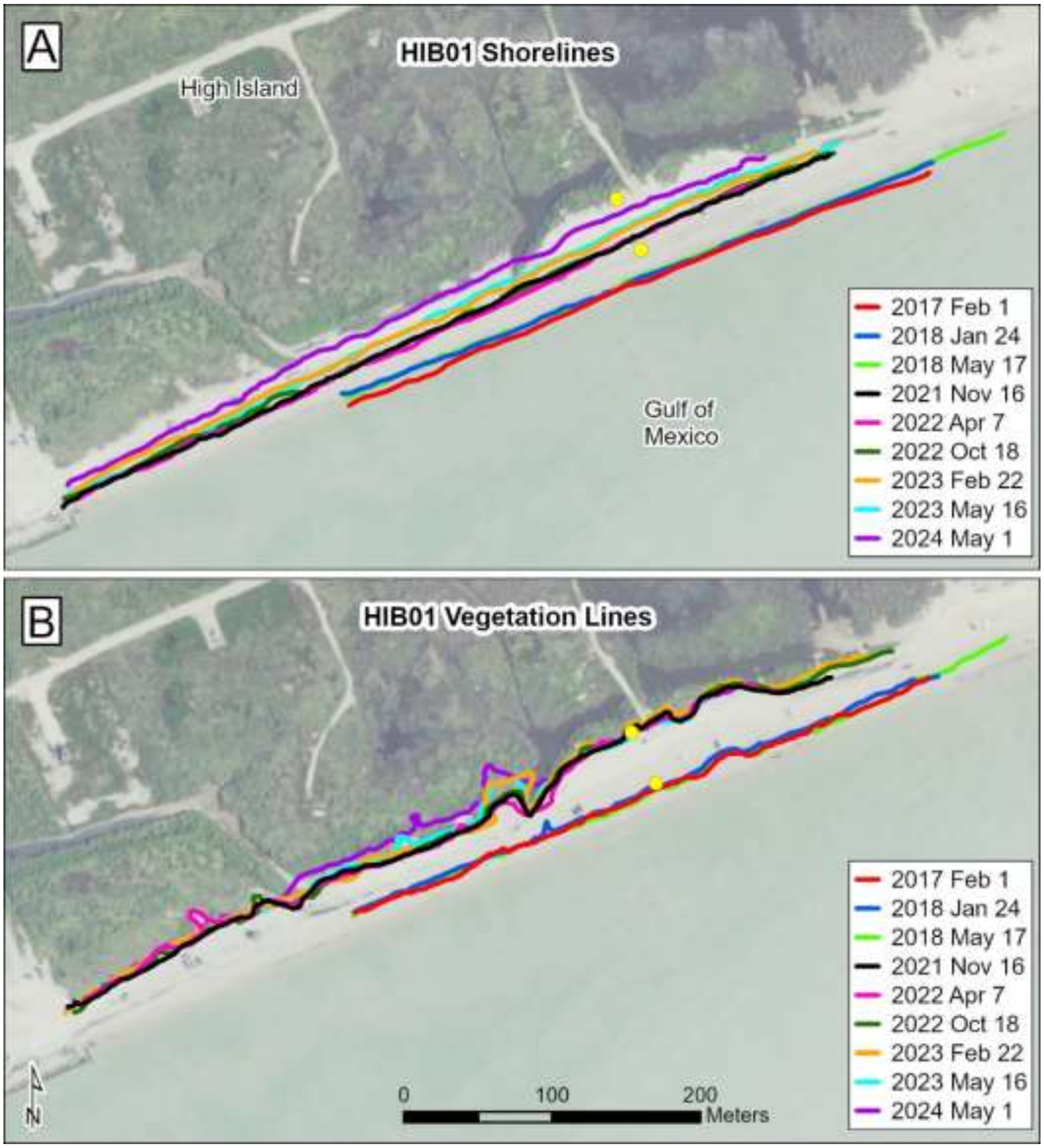


Figure 15. Changes to the position of the (A) shoreline and (B) vegetation line at HIB01 between February 2017 and May 2024.

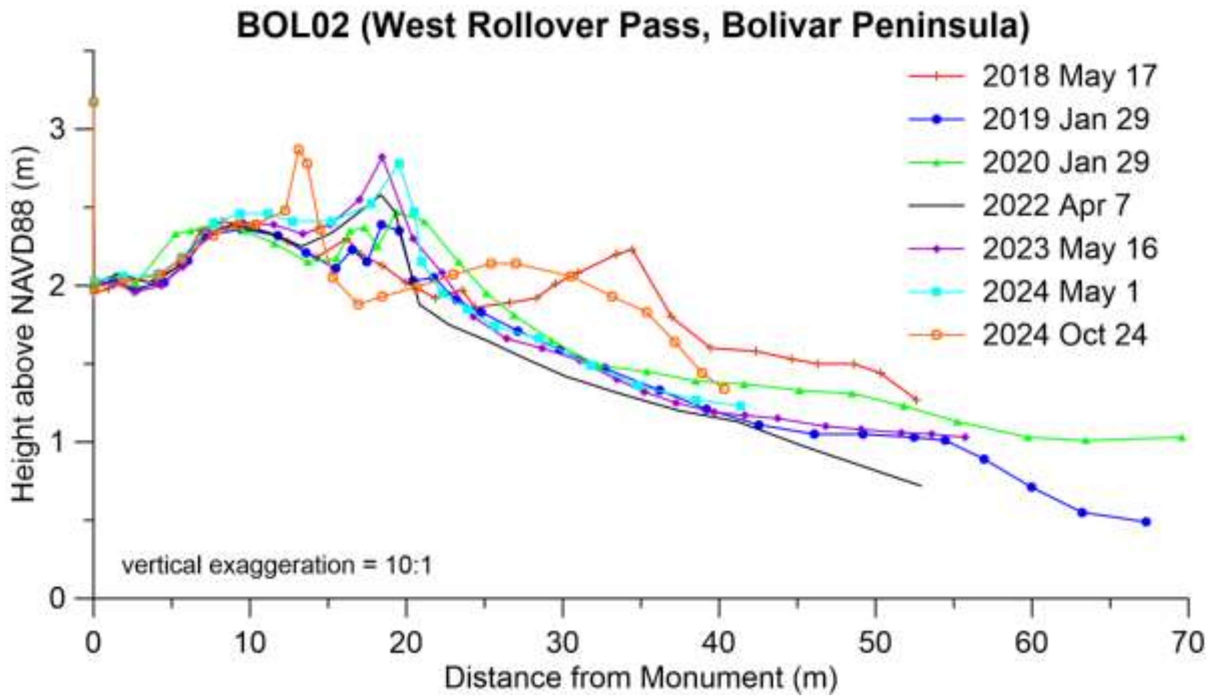


Figure 16. Changes to the beach profile at BOL02 west of Rollover Pass on Bolivar Peninsula.

Figure 17. Photos looking northeast along the small dune at BOL02 in (A) January 2020 and (B) October 2024.

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.

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 Follets 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 18** 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. 18**; 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. 18**).

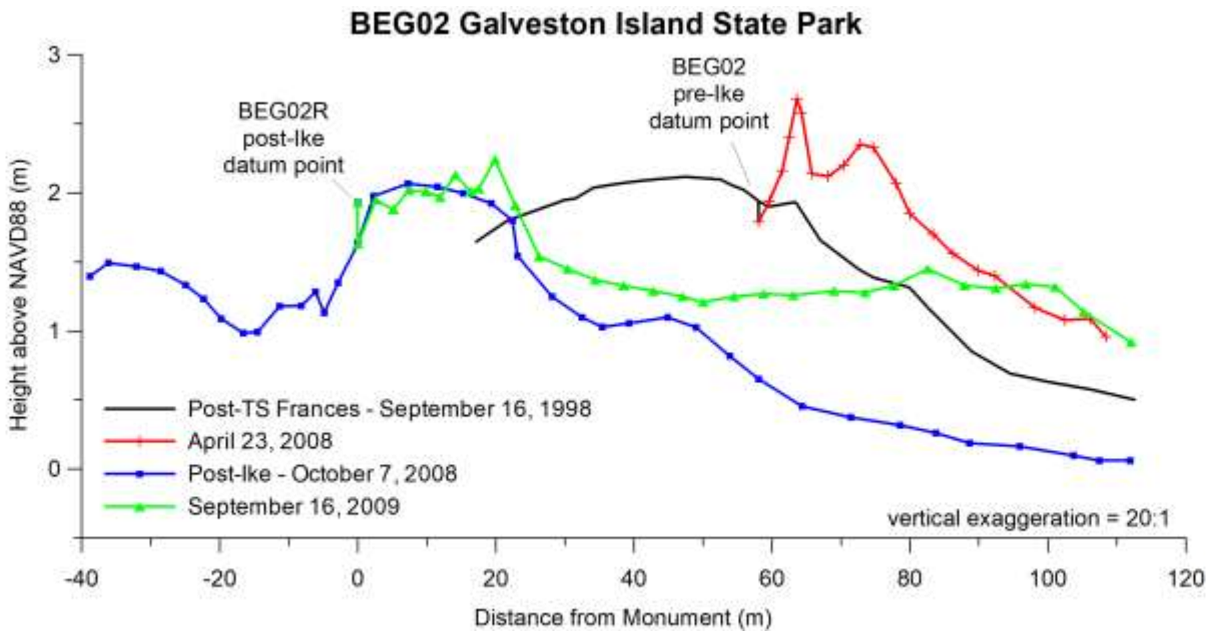


Figure 18. Beach-profile plots from BEG02 in Galveston Island State Park comparing the post–Hurricane Ike profile with a pre-storm profile from early 2008 and the post–Tropical Storm Frances profile from September 1998. Data from September 2009 (1-year post-storm) is also included.

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. 19**). 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. 19**). 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. 19**).

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. Data from the new site can be found in Appendix A and B and on the THSCMP website.

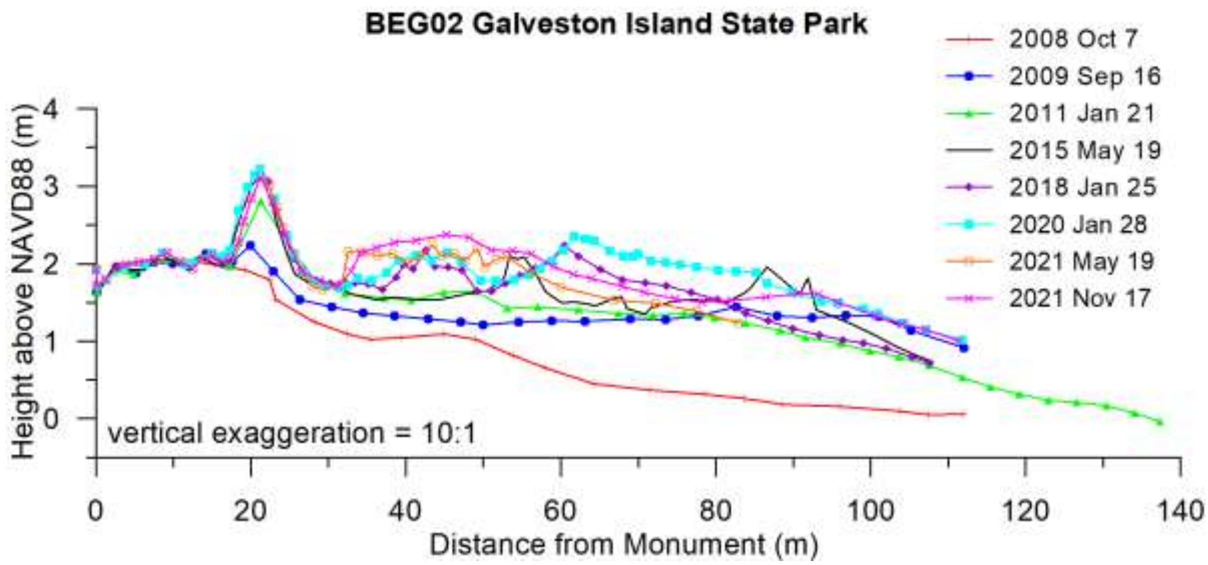


Figure 19. BEG02 profile data collected by Ball High School students. Students are monitoring recovery of the beaches and dunes at this site.

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. 20**). 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. 21 & Fig. 22**). Over half the volume of sand in the beach/dune system was removed. Data collected at DEL01 during 2024 are monitoring the performance of a beach nourishment project that was completed in 2023 (**Fig. 21**).

Figure 20. Photos looking northeast at JAM02 in Jamaica Beach on Galveston Island showing the changes to the dune and vegetation line between (A) October 2019 and (B) October 2024.

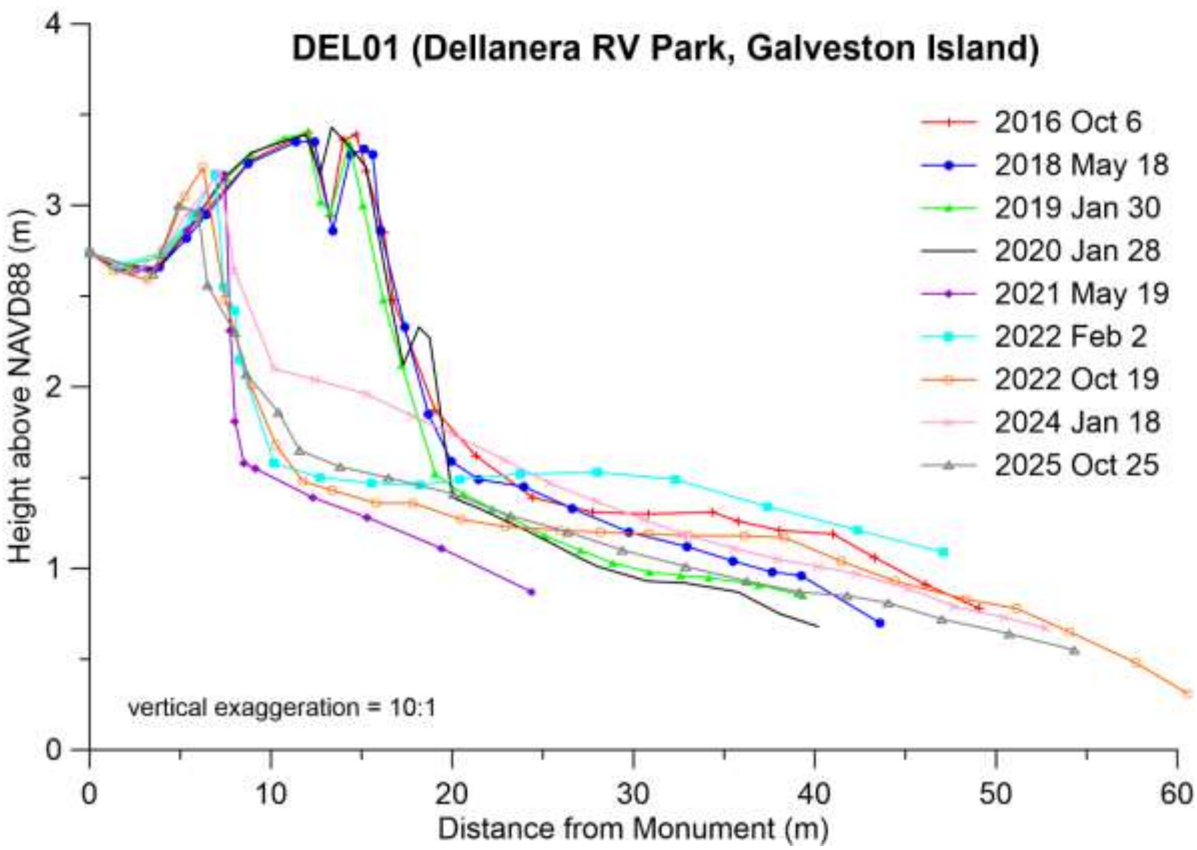


Figure 21. Erosion of the dune at DEL01 in the Dellanera RV Park due to the 2020 hurricane season and performance of 2023 beach nourishment project.

Figure 22. Photos looking northeast at the Dellanera RV Park adjacent the Galveston seawall from (A) January 2020 and (B) April 2024 showing erosion of the dune restoration 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 the small dune system on Follets 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. 23**). 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. 24**).

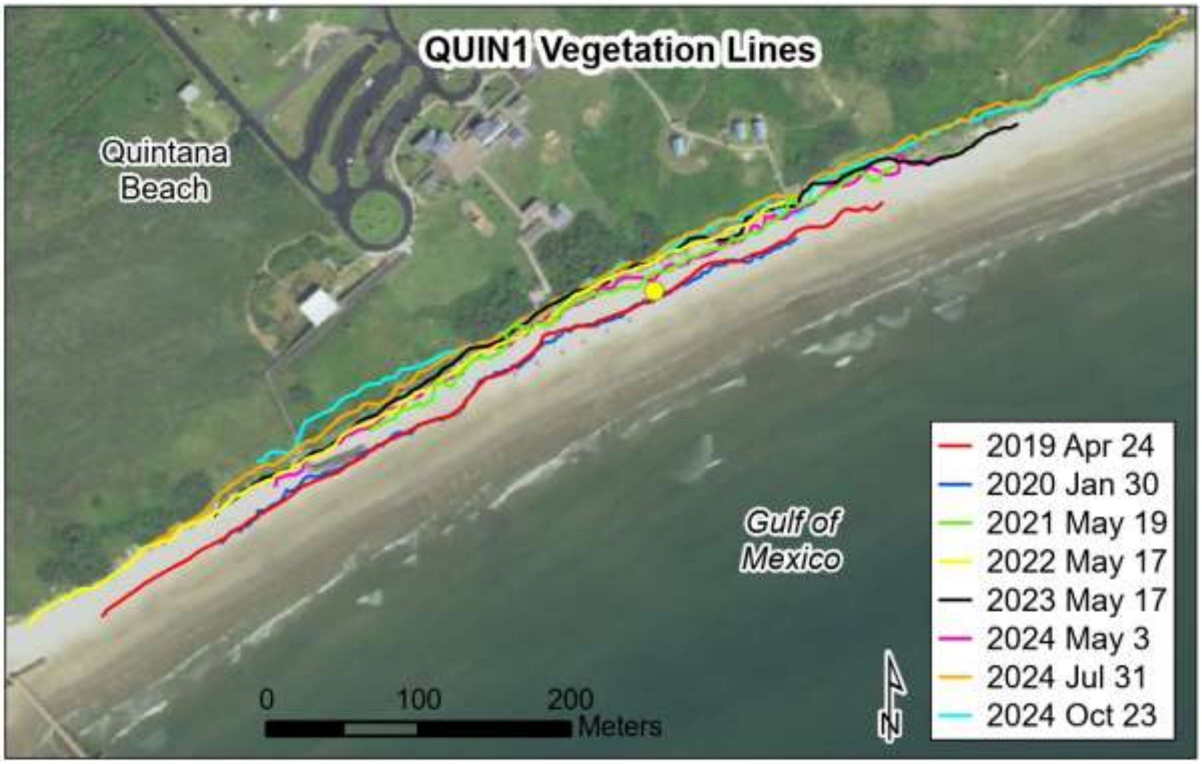


Figure 23. GPS mapping by Brazosport HS students of vegetation line positions at QUIN1 from April 2019 through October 2024.

Figure 24. 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.

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. 25A**). 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 25B**).

Figure 25. Photos of (A) the scarped dune at SURF2 October 2024 and (B) students mapping the shoreline position under a structure on the open beach.

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. 26 & 27**) and the seaward movement of the vegetation line (Appendix A). 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. 27**).

Figure 26. 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. 28**). The continued mapping has shown that the shoreline position continues to advance seaward between 2018 and 2024, but at a reduced rate (**Figs. 28 & 29**).

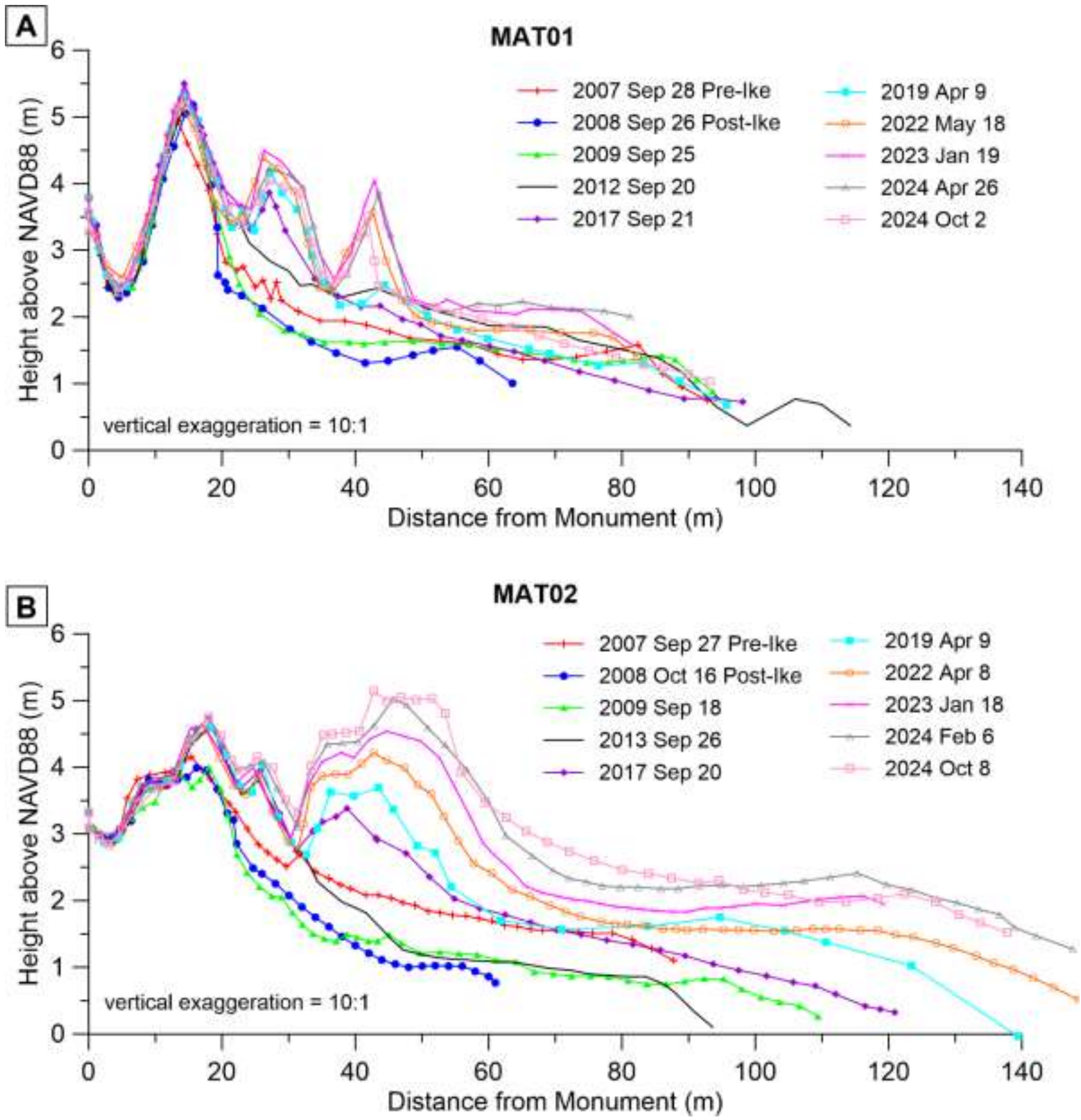


Figure 27. Profile data collected by Van Vleck High School students at (A) MAT01 and Palacios High School students at (B) MAT02. Students are monitoring post-Ike recovery and growth of the foredune at these sites.

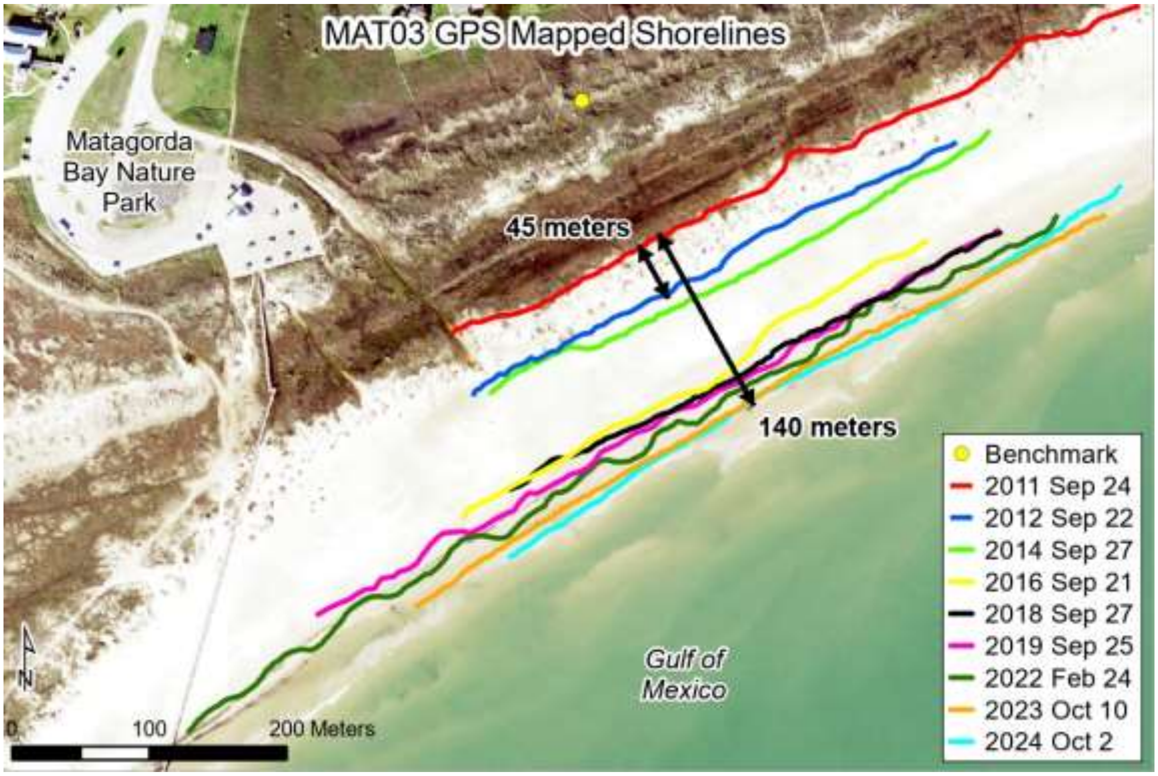


Figure 28. Shoreline position change at Matagorda Peninsula.

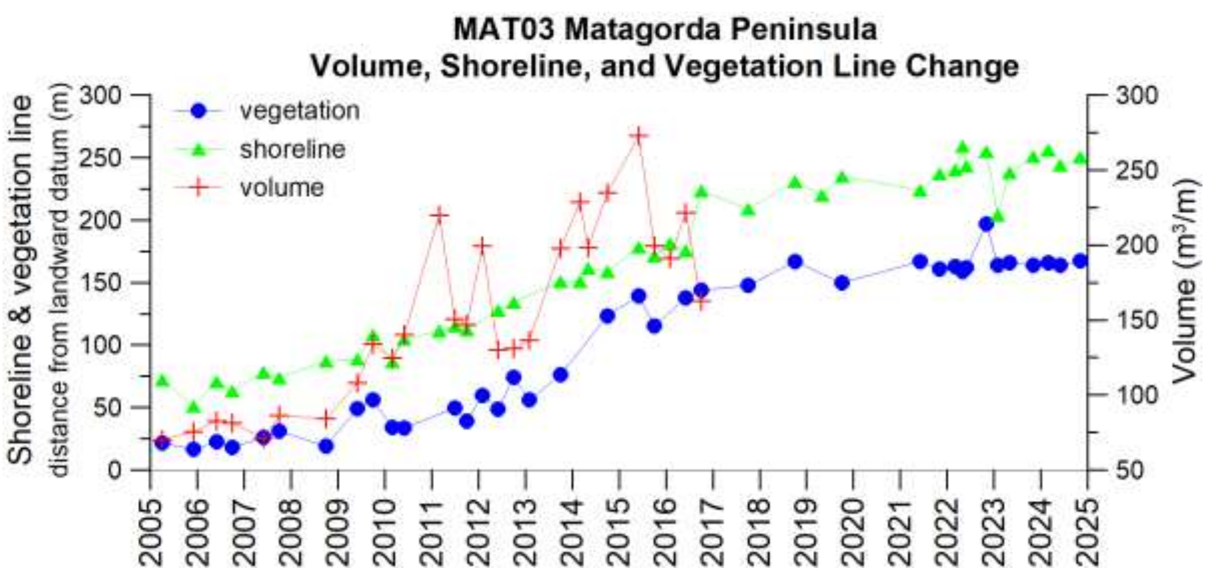


Figure 29. Changes in beach and dune volume, shoreline position, and vegetation-line position at MAT03 on Matagorda Peninsula.

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 30A** 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. 30B & 31**). By the end of the 2018–2019 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. 30B**) 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 (see change plot in Appendix A).

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 (**Fig. 30B** and Appendix A). 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.

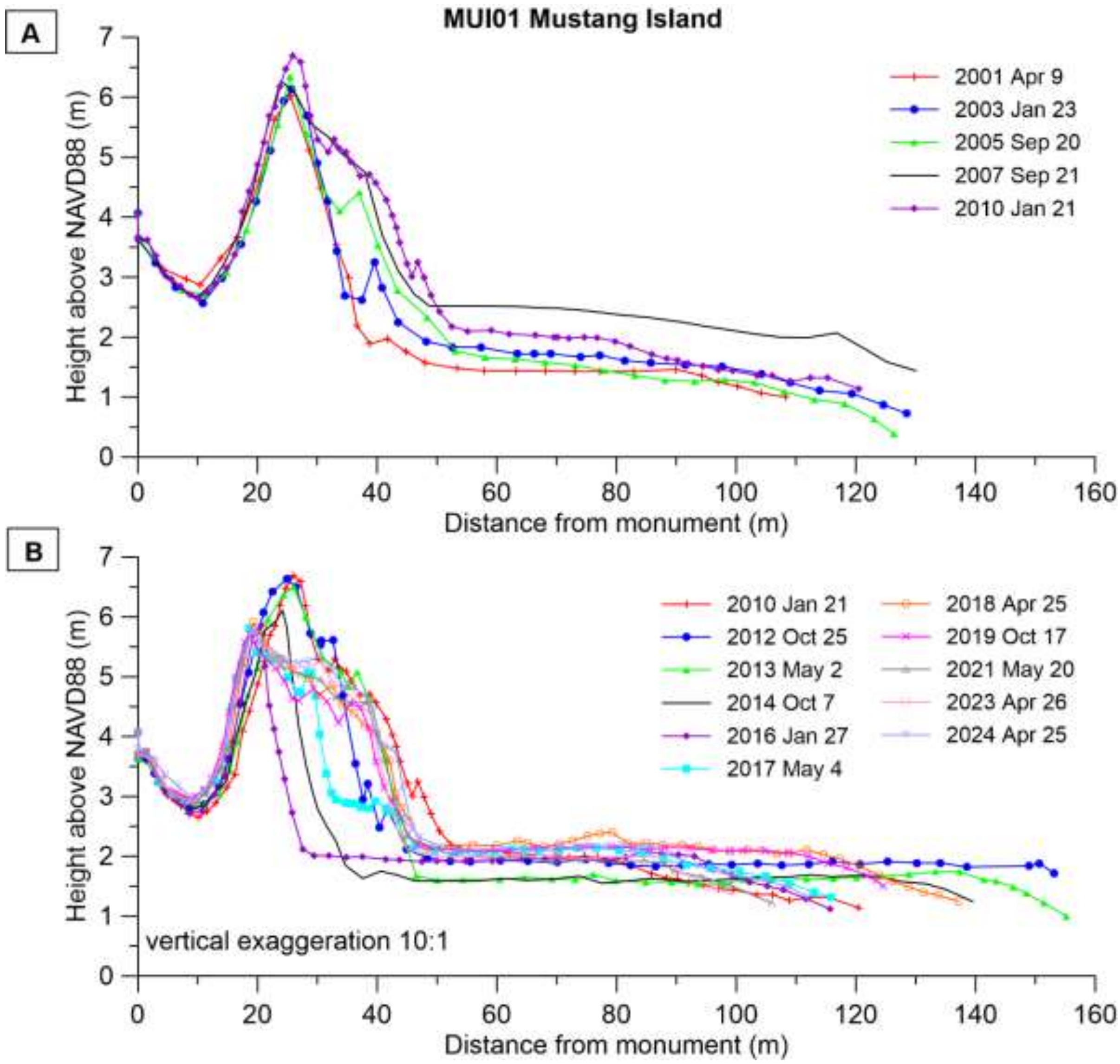


Figure 30. Changes at MUI01 on Mustang Island. (A) Expansion of the foredune between 2001 and 2009. (B) Changes in the foredune due to the beach-maintenance practice of dune notching between 2012 and 2017. Beach profile has been stable with minimum change since 2018

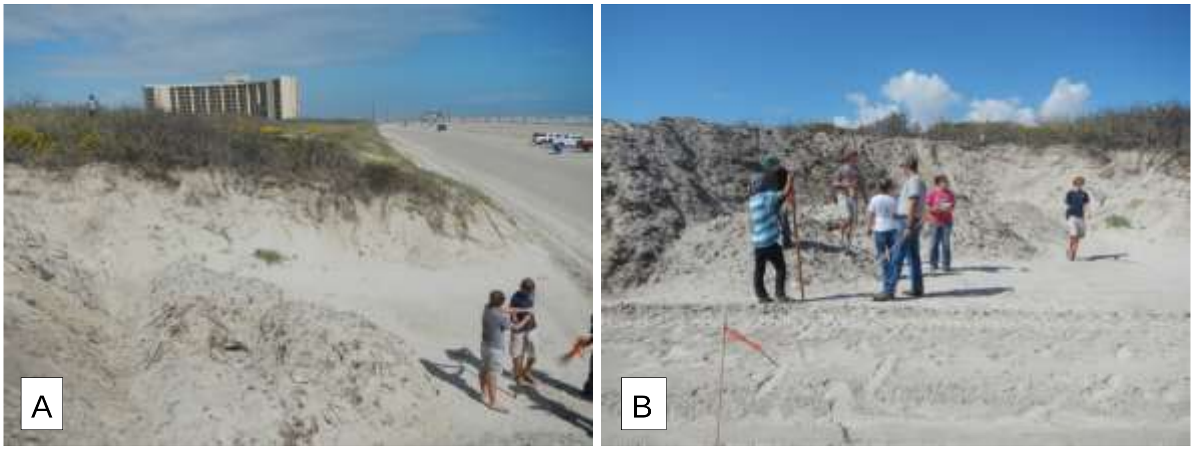


Figure 31. Excavated dune at MUI01 on Mustang Island looking (A) north toward Horace Caldwell Pier and (B) landward.

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. 32**). The dune system and vegetation-line position have expanded seaward, and total profile volume increased at this location in 20 years (Appendix A). 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. 32**). Additional changes to the seaward most dunes were documented between 2022 through the end of 2024 including major scarping and extremely narrow beach conditions in April 2023 (**Figs. 32** and **33A**) and increased dune height with the addition of overwash sediment in October 2024 (**Figs. 32** and **33B**).

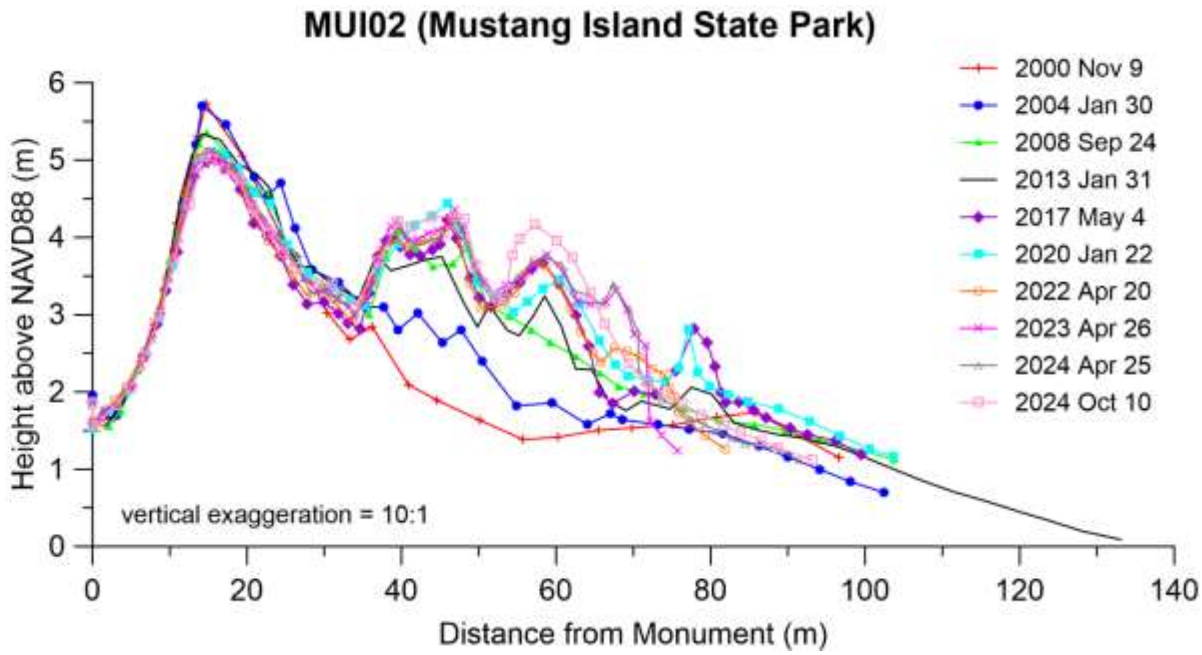


Figure 32. Student monitoring at MUI02 documents an increase in volume of the dune system and seaward migration of the vegetation line.

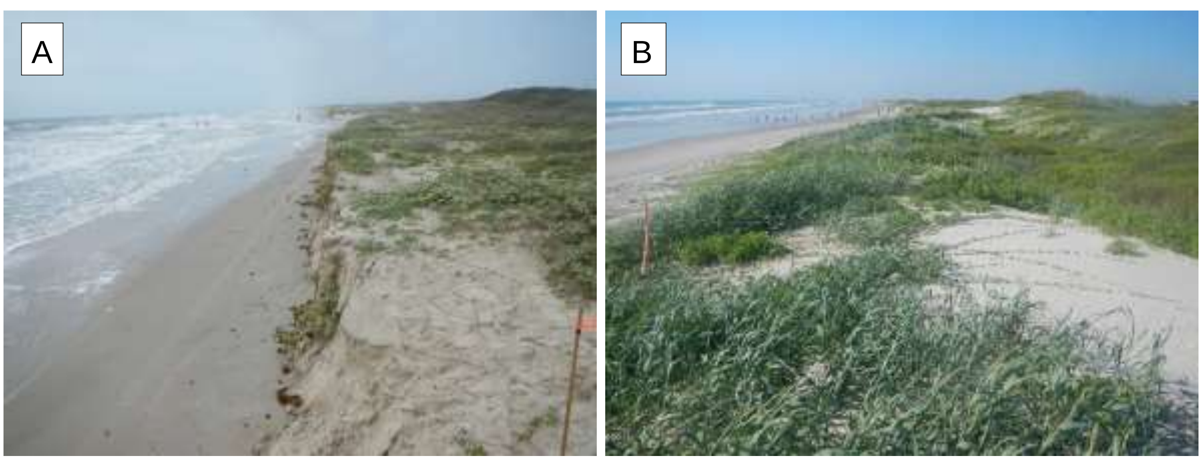


Figure 33. Changes to the seaward-most dune crest and beach width in (A) April 2023 and (B) October 2024.

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. 34**) 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 34. 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. 35**). 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. 36**). 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 35. 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.

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

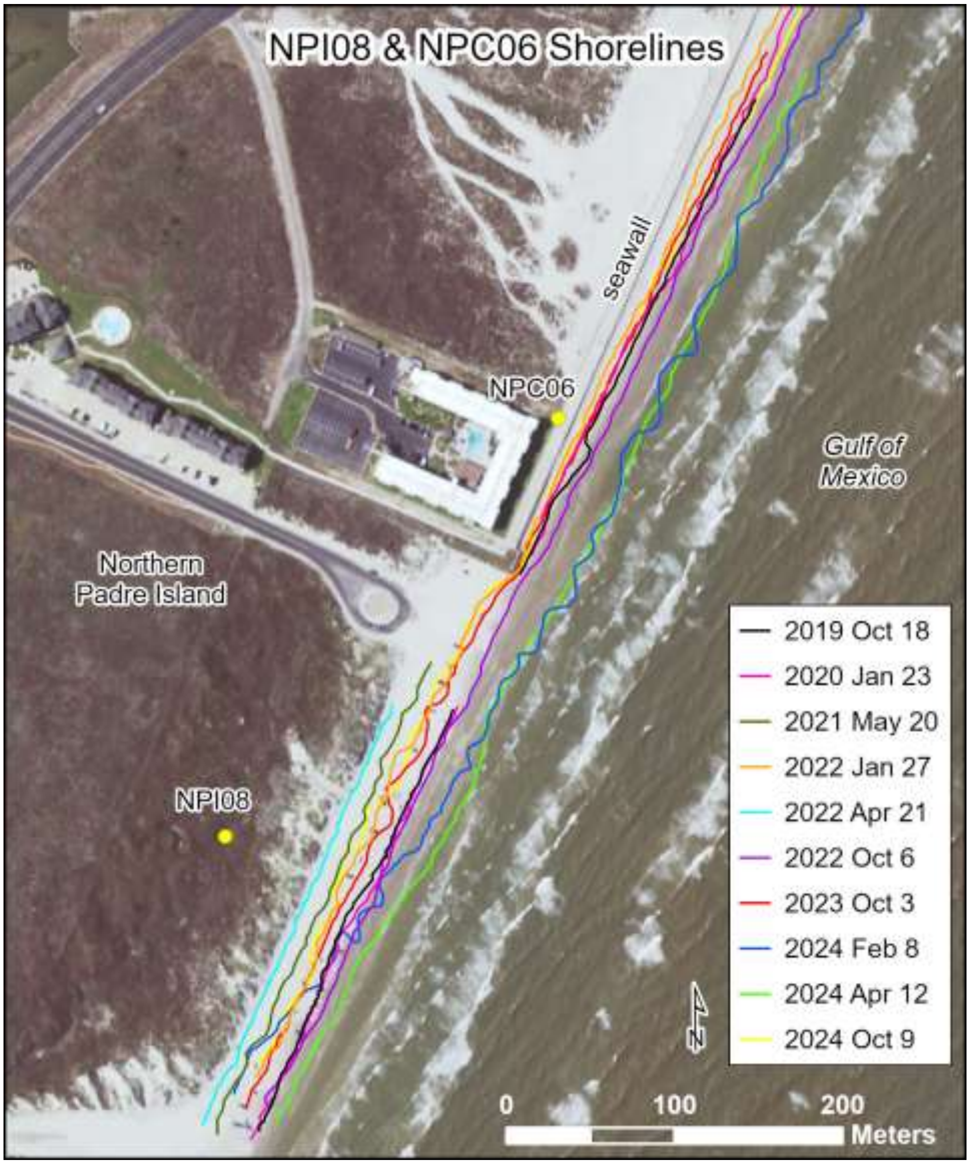


Figure 36. Changes in shoreline position between 2019 and 2024 along the southern end of the North Padre Island seawall and adjacent beach.

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. 37**). 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. 38A**). 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. 38B**).

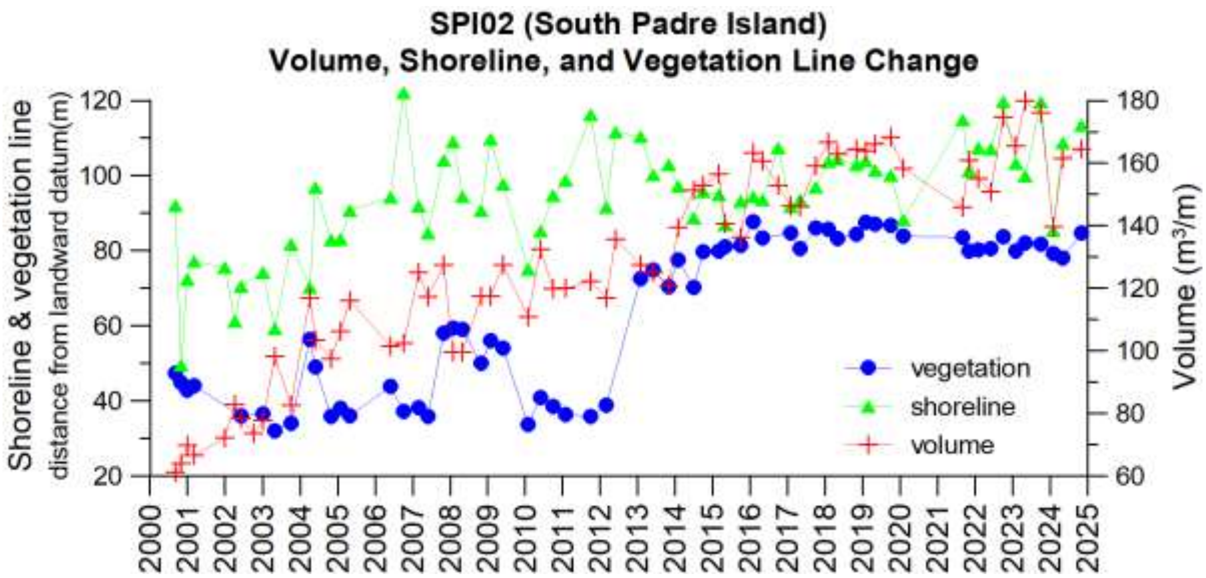


Figure 37. Changes in sand volume and in shoreline and vegetation-line positions at SPI02 on South Padre Island due to beach nourishment projects and the installation of sand fences.

Figure 38. (A) Photo from January 2018 looking seaward from the retaining wall of the impacts to the dune system at SPI02 after construction of the dune crossover. (B) Newly planted vegetation and protective fencing on the seaward dune face at SPI02 in April 2024.

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. 39**). 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. Port Isabel students will continue to monitor this rapidly changing and chronically eroding location.

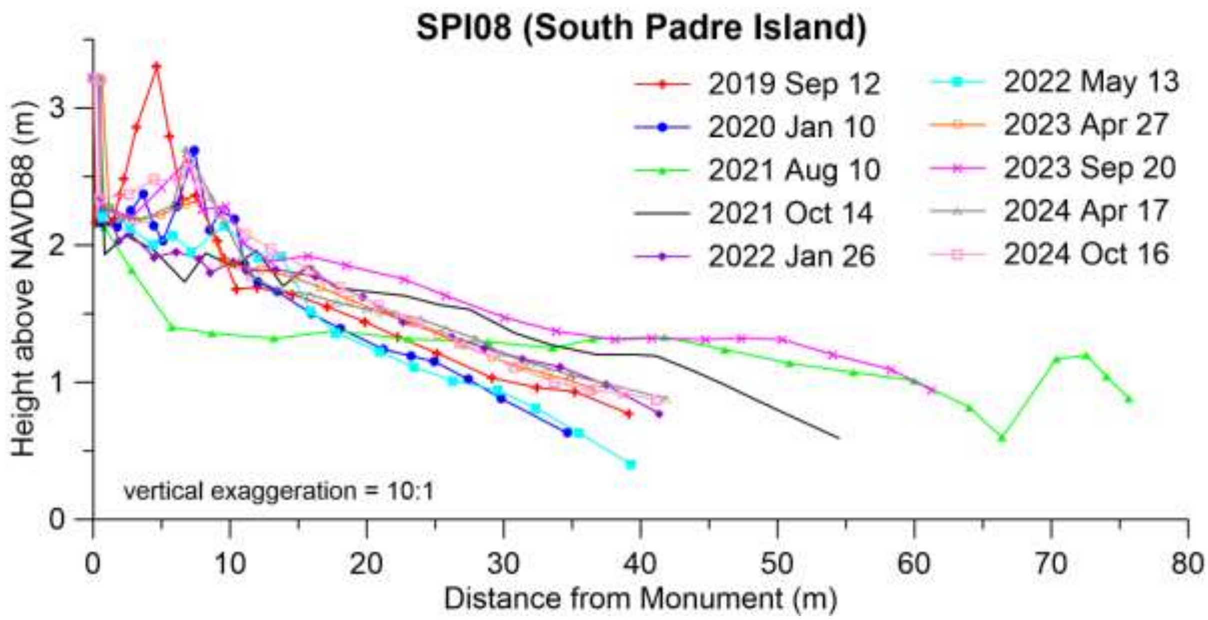


Figure 39. Beach profiles from before and after the latest nourishment project at SPI08.

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 2023–2024 academic year, approximately 230 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 2024—2025 academic year started the 27th 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. The data have 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 changes 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 highlight the geomorphic differences found along the Texas Gulf coast. Data collected from Bolivar Peninsula, Galveston Island, Follets Island, Quintana Beach, Matagorda Peninsula, Mustang Island, and North and South Padre Islands help 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.

ACKNOWLEDGMENTS

This project was funded in part by a Texas Coastal Management Program grant approved by the Texas Land Commissioner, providing financial assistance under the Coastal Zone Management Act of 1972, as amended, and awarded by the National Oceanic and Atmospheric Administration (NOAA), Office for Coastal Management, pursuant to NOAA Award No. NA23NOS4190249. The award was administered through grant no. 24-022-012-E021 from the General Land Office of Texas (GLO) to the Bureau of Economic Geology, The University of Texas at Austin. Jessica Chappell (GLO) served as project manager. Tiffany Caudle served as principal investigator. Field trip support was provided by staff at Matagorda Bay Nature Park, Lower Colorado River Authority. The views expressed herein are those of the author and do not necessarily reflect the views of NOAA, the U.S. Department of Commerce, or any of their sub agencies. Additional funds to support the project came from The Jackson School of Geosciences.

REFERENCES

Caudle, T. L., and Paine, J. G., 2012, Pre-college student involvement in Texas coastal research: Gulf Coast Association of Geological Societies Transactions, v. 62, p. 27–38.

Caudle, T. L., and Paine, J. G., 2017, Applications of Coastal Data Collected in the Texas High School Coastal Monitoring Program (THSCMP): Journal of Coastal Research, v. 33, no. 3, p. 738–746.

Caudle, T.L., Paine, J.G., Andrews, J.R., and Saylam, K., 2019, Beach, Dune, and Nearshore Analysis of Southern Texas Gulf Coast Using Chiroptera LIDAR and Imaging System: Journal of Coastal Research, v. 35, no. 2, p. 251–268.

Caudle, T.L., Tremblay, T.A., Paine, J.G., Andrews, J.R., and Saylam, K., 2014, Beach and Dune Analysis using Chiroptera Imaging System, South Padre and Brazos Islands, Texas Gulf Coast: The University of Texas at Austin, Bureau of

Economic Geology, report prepared for the Texas General Land Office under GLO contract number 13-030-000-6895, 68 p.

Emery, K. O., 1961, A simple method of measuring beach profiles: Limnology and Oceanography, v. 6, no. 1, p. 90–93.

Gibeaut, J. C., and Caudle, T. L., 2009, Defining and Mapping Foredunes, the Line of Vegetation, and Shorelines along the Texas Gulf Coast. The University of Texas at Austin, Bureau of Economic Geology, report prepared for the Texas General Land Office under GLO contract number 07-005-22, 14 p.

Gibeaut, J. C., Hepner, T. L., Waldinger, R. L., Andrews, J. R., Smyth, R. C., and Gutiérrez, R., 2003, Geotextile tubes along the Upper Texas Gulf coast: May 2000 to March 2003: The University of Texas at Austin, Bureau of Economic Geology, final report prepared for Texas Coastal Coordination Council pursuant to National Oceanic and Atmospheric Administration Award No. NA07OZ0134, under GLO contract number 02-493 R, 37 p. plus appendices.

Hepner, T. L., and Gibeaut, J. C., 2004, Tracking post-storm beach recovery using data collected by Texas high school students: Shore & Beach, v. 72, no. 4, p. 5–9.

Krause, G., 2004, The “Emery-Method” Revisited: Performance of an Inexpensive Method of Measuring Beach Profiles and Modifications: Journal of Coastal Research, v. 20, no. 1, p. 340–346.

O’Connell, J., 2001, Beach and Dune Profiles: An Educational Tool for Observing and Comparing Dynamic Coastal Environments: Marine Extension Bulletin, Woods Hole Oceanographic Institution Sea Grant Program, Massachusetts, 6 p.

Paine, J.G., and Caudle, T. L., 2018, Shoreline movement along the Texas Gulf Coast, 1930s to 2016: The University of Texas at Austin, Bureau of Economic

Geology, report prepared for the Texas General Land Office under GLO contract number 16-201-000, 59 p.

Paine, J. G., Caudle, T., and Andrews, J., 2014, Shoreline movement along the Texas Gulf Coast, 1930’s to 2012: The University of Texas at Austin, Bureau of Economic Geology, report prepared for the Texas General Land Office under GLO contract number 09-074-000, 52 p.

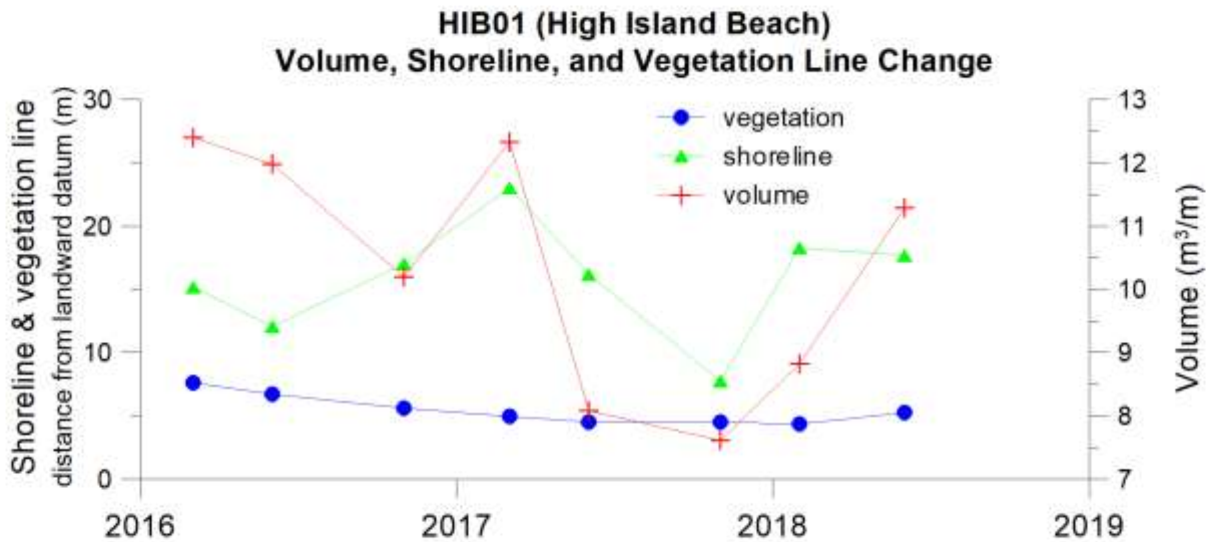
Paine, J.G., Caudle, T., and Andrews, J.R., 2021, Shoreline Movement and Beach and Dune Volumetrics along the Texas Gulf Coast, 1930s to 2019: The University of Texas at Austin, Bureau of Economic Geology, report prepared for the Texas General Land Office under GLO contract number 16-201-000, 101 p.

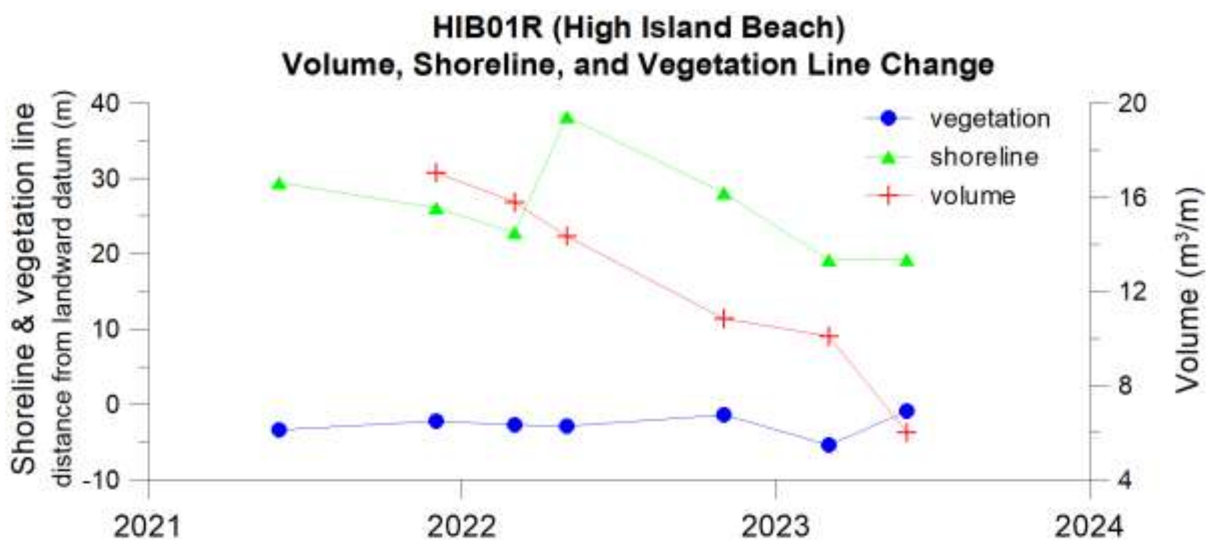
Paine, J. G., Mathew, S., and Caudle, T., 2011, Gulf shoreline change rates through 2007: The University of Texas at Austin, Bureau of Economic Geology, report prepared for the Texas General Land Office under GLO contract number 10-041-000-3737, 38 p.

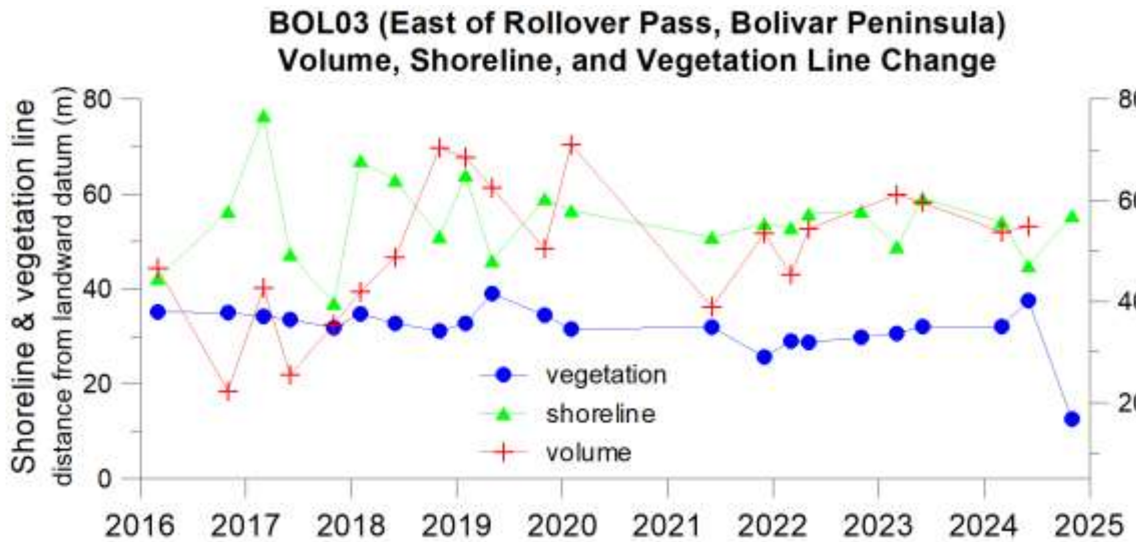
Paine, J. G., Mathew, S., and Caudle, T., 2012, Historical Shoreline Change Through 2007, Texas Gulf Coast: Rates, Contributing Causes, and Holocene Context, Gulf Coast Association of Geological Societies Journal, v. 1, p. 13–26.

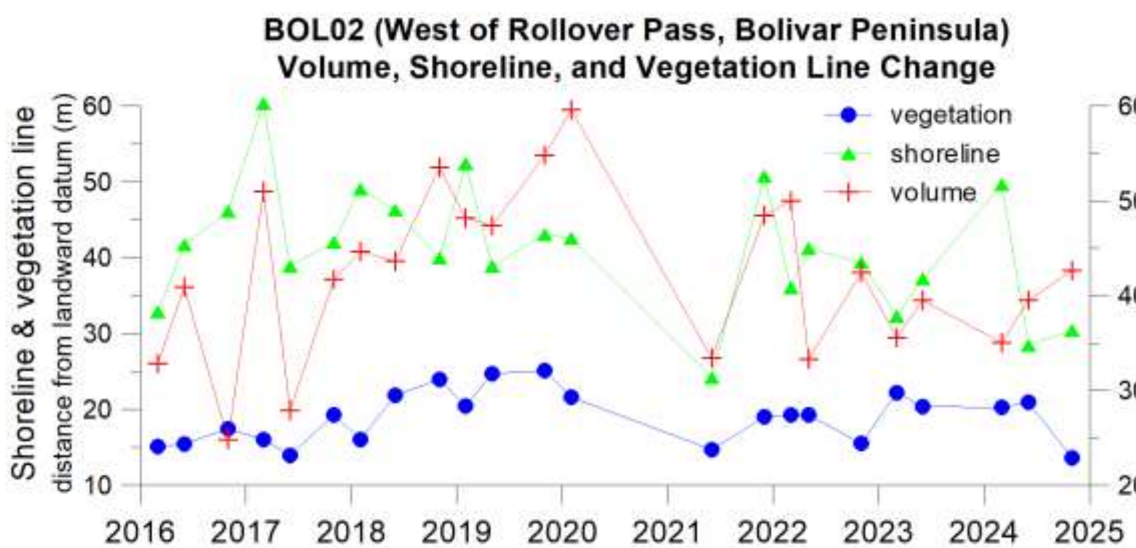
APPENDIX A: GRAPHS OF VOLUME, SHORELINE, AND VEGETATION-LINE CHANGE

Sediment volume was calculated above 1-meter NAVD88 for all profiles unless otherwise indicated.

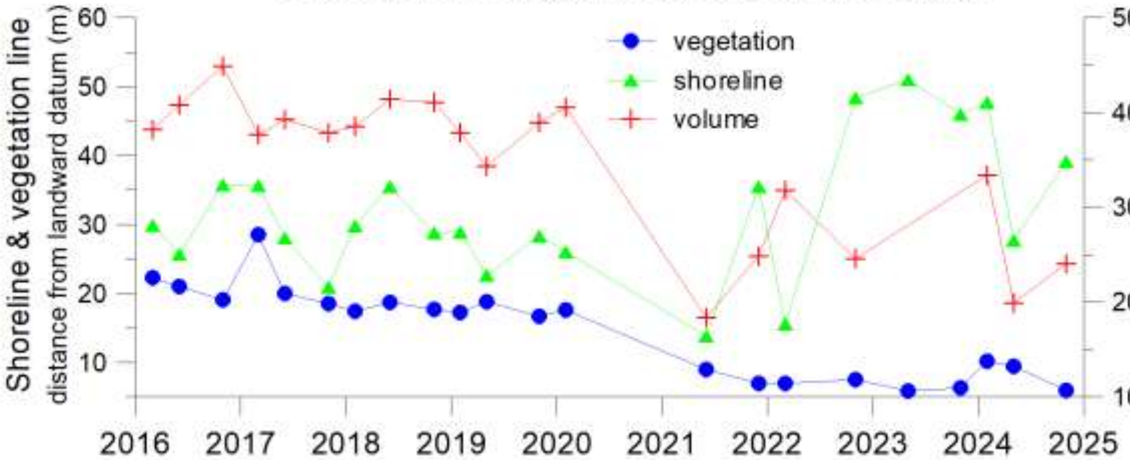




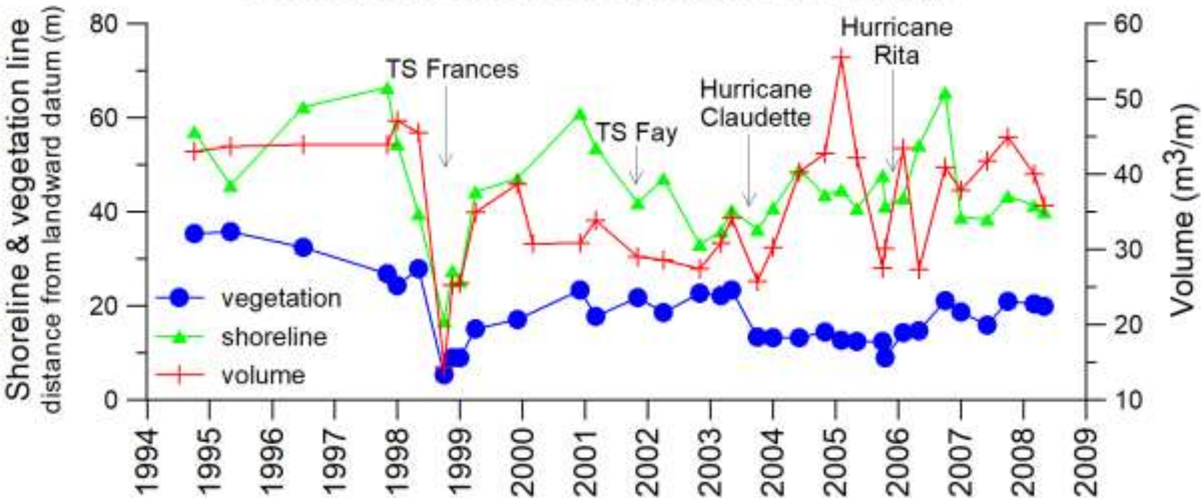

BOL03 (East of Rollover Pass, Bolivar Peninsula)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
0
20
40
60
80
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

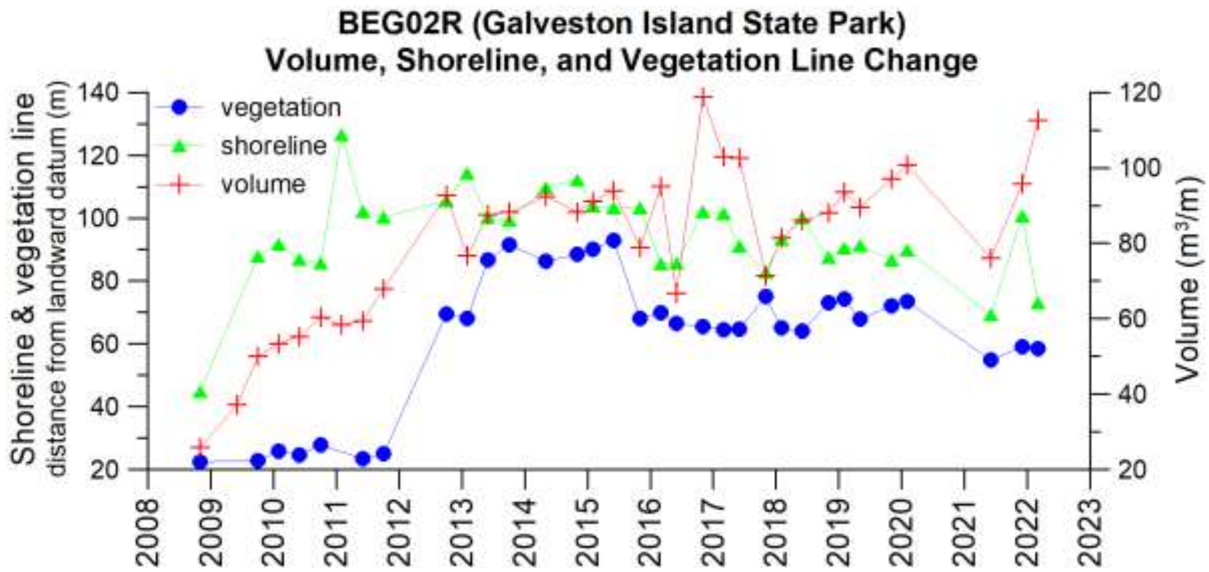

BOL02 (West of Rollover Pass, Bolivar Peninsula)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
10
20
30
40
50
60
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

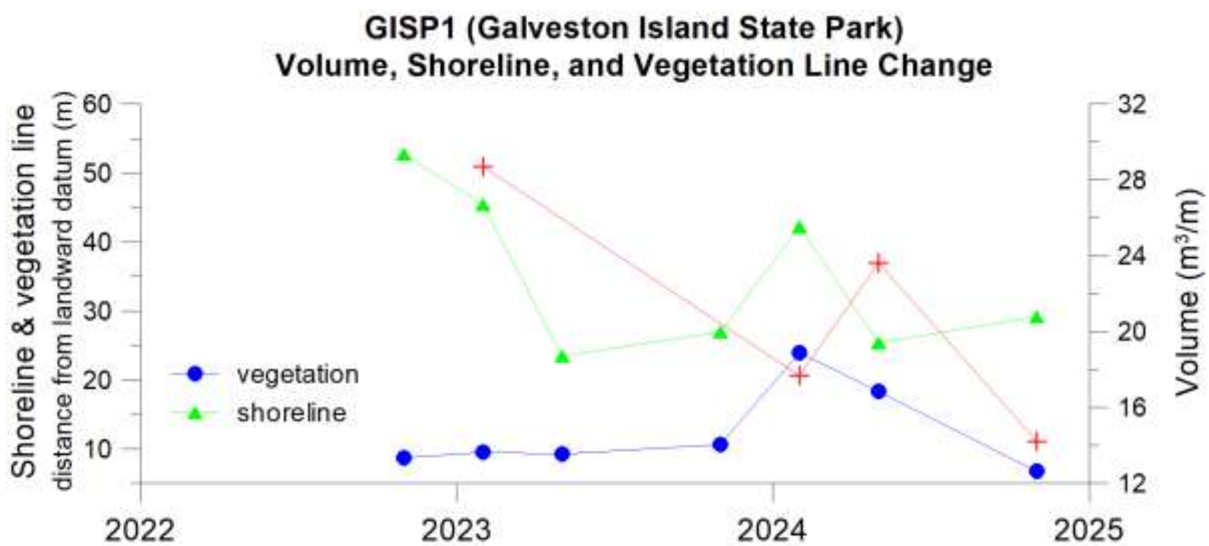
DEL01 (Dellanera RV Park, Galveston Island)
Volume, Shoreline, and Vegetation Line Change

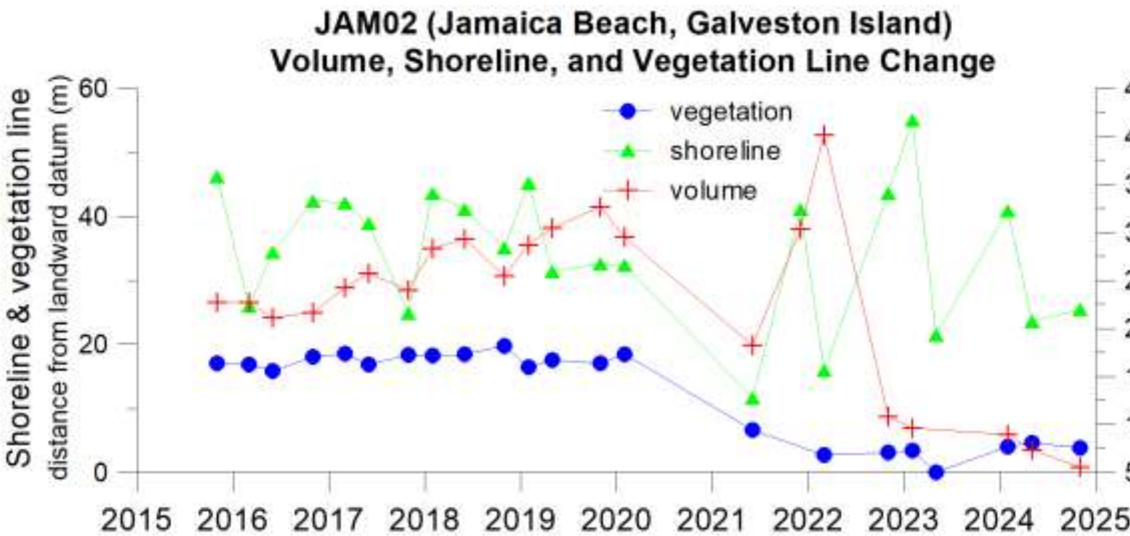


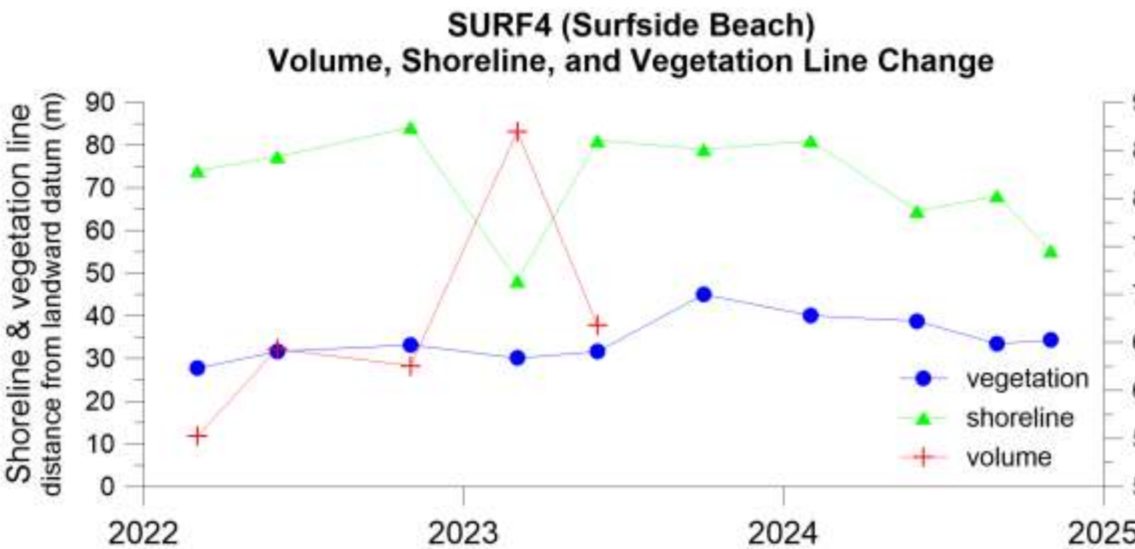
BEG02 (Galveston Island State Park)
Volume, Shoreline, and Vegetation Line Change

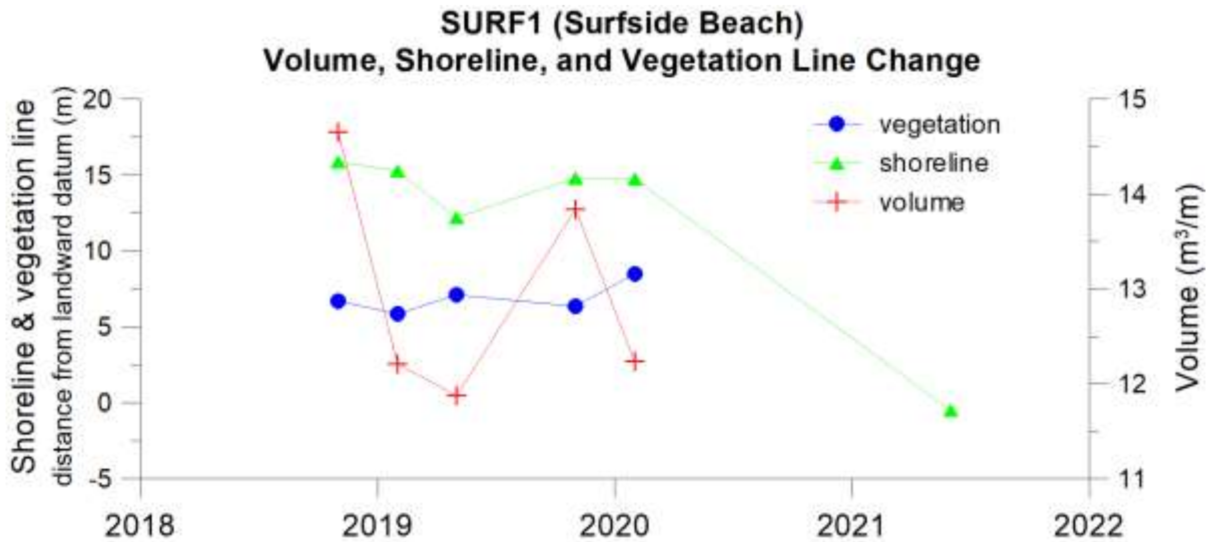


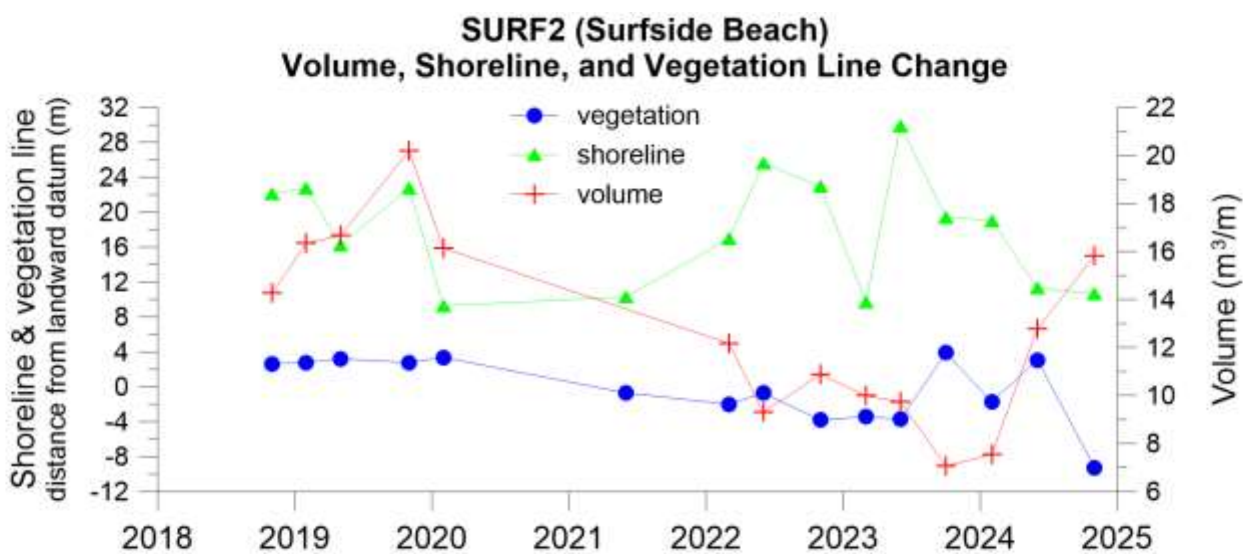

BEG02R (Galveston Island State Park)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
140
120
100
80
60
40
20
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

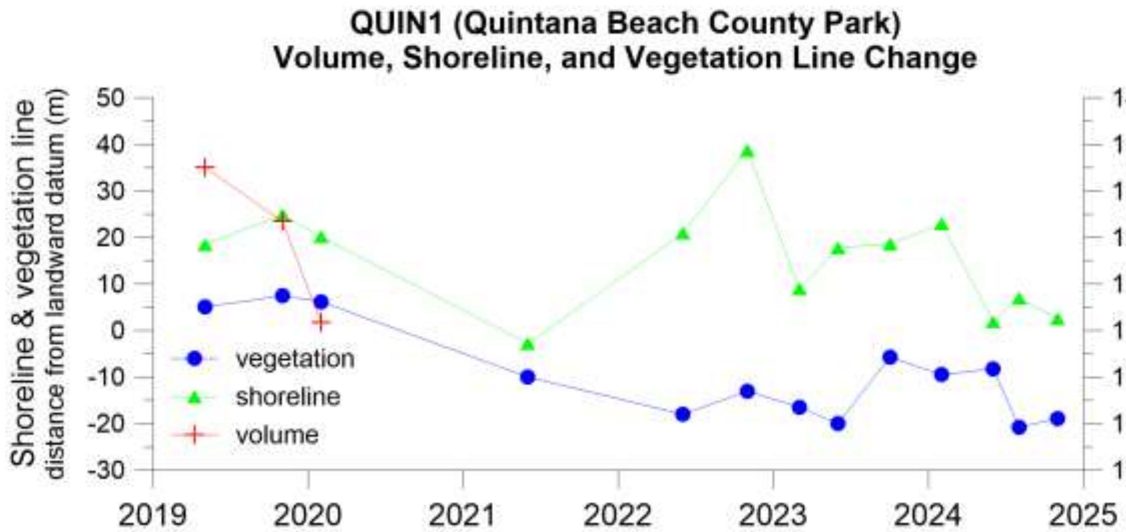

GISP1 (Galveston Island State Park)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
60
50
40
30
20
10
32
28
24
20
16
12
2022
2023
2024
2025

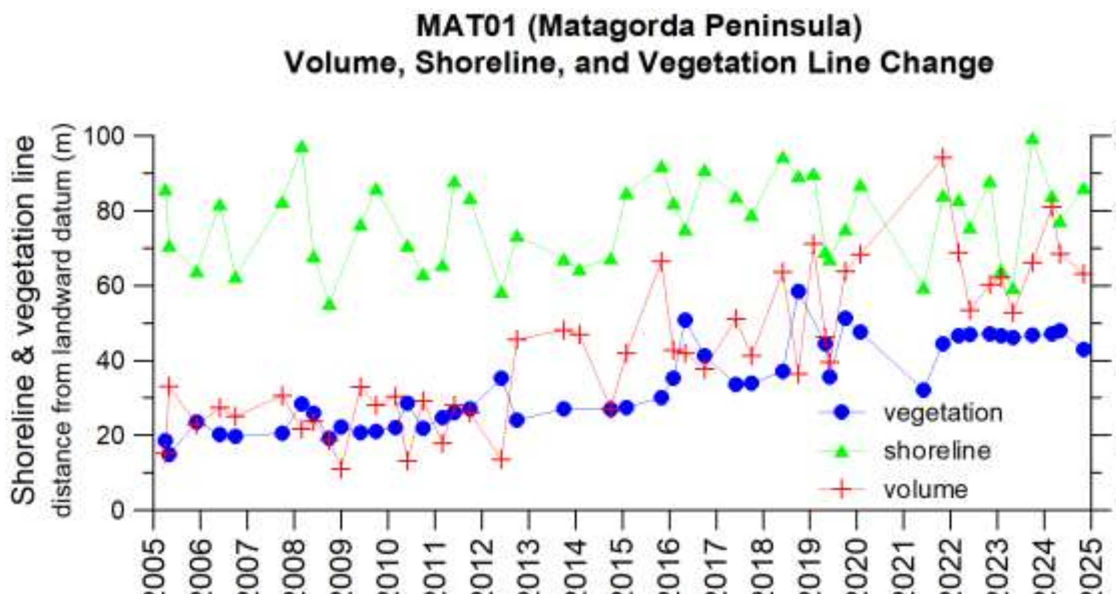

JAM02 (Jamaica Beach, Galveston Island)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
0
20
40
60
5
10
15
20
25
30
35
40
45
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

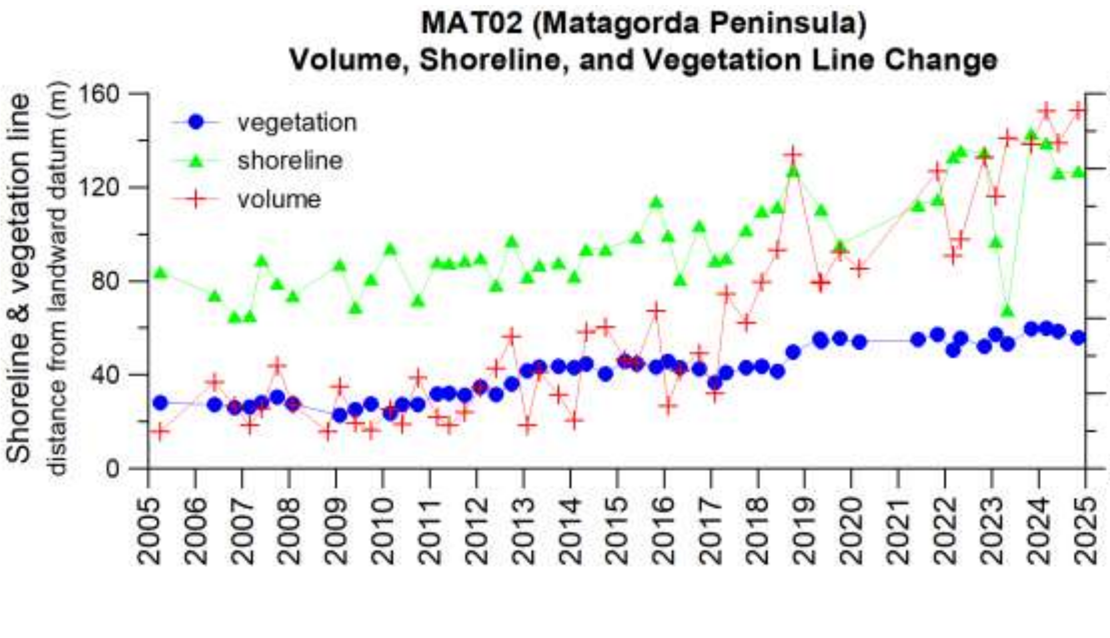

SURF4 (Surfside Beach)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
0
10
20
30
40
50
60
70
80
90
50
55
60
65
70
75
80
85
90
2022
2023
2024
2025

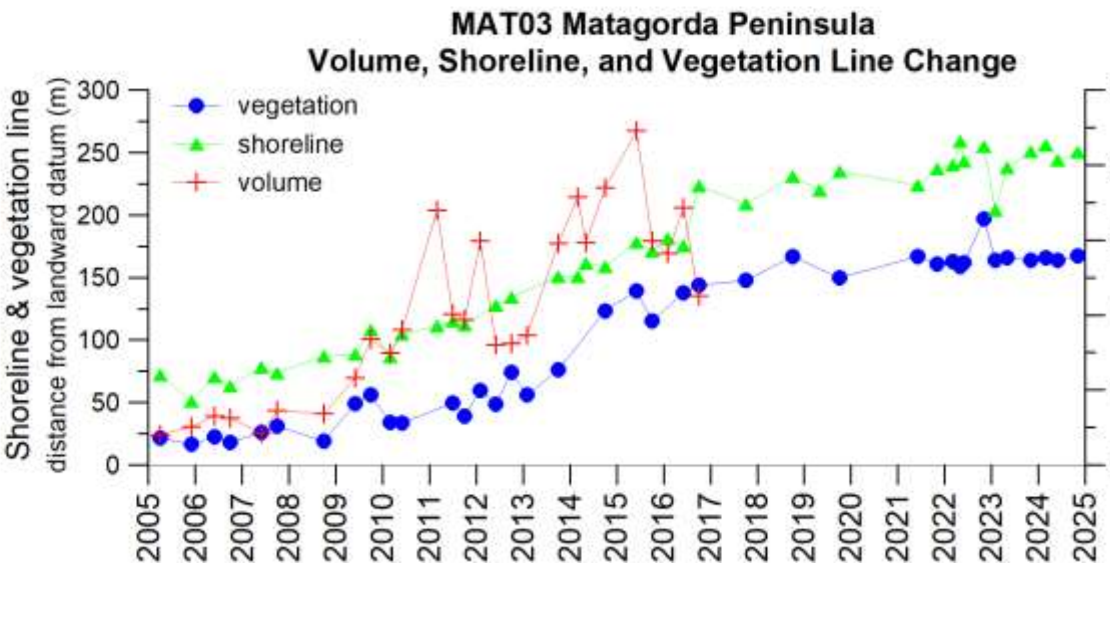

SURF1 (Surfside Beach)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
20
15
10
5
0
-5
15
14
13
12
11
2018
2019
2020
2021
2022


SURF2 (Surfside Beach)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
32
28
24
20
16
12
8
4
0
-4
-8
-12
22
20
18
16
14
12
10
8
6
2018
2019
2020
2021
2022
2023
2024
2025

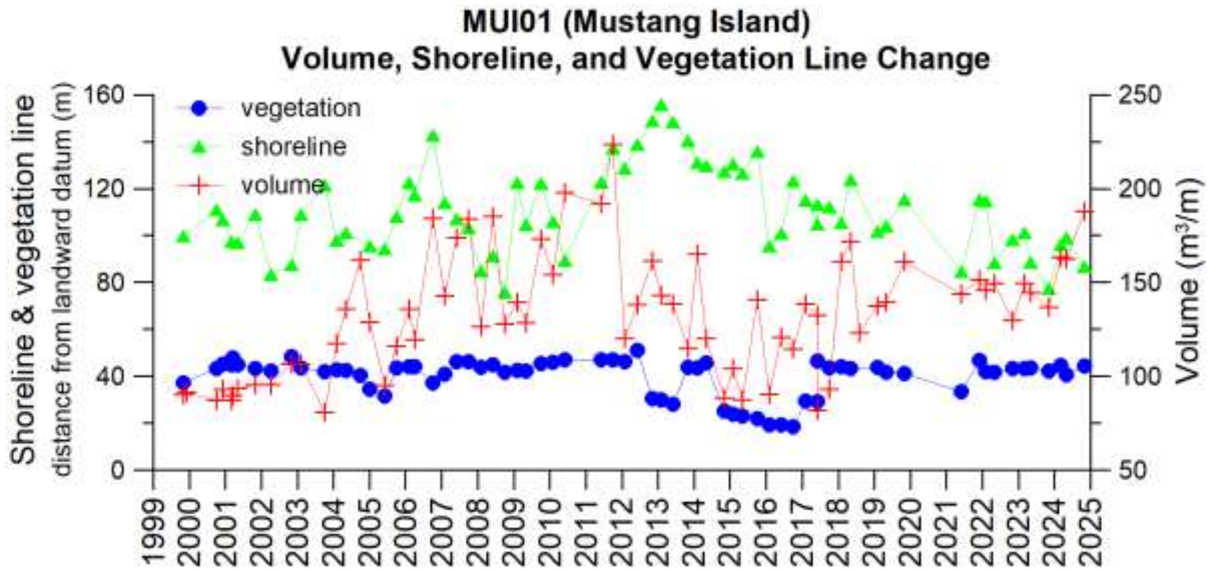

QUIN1 (Quintana Beach County Park)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
50
40
30
20
10
0
-10
-20
-30
14
13.5
13
12.5
12
11.5
11
10.5
10
2019
2020
2021
2022
2023
2024
2025


MAT01 (Matagorda Peninsula)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
100
80
60
40
20
0
240
200
160
120
80
40
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

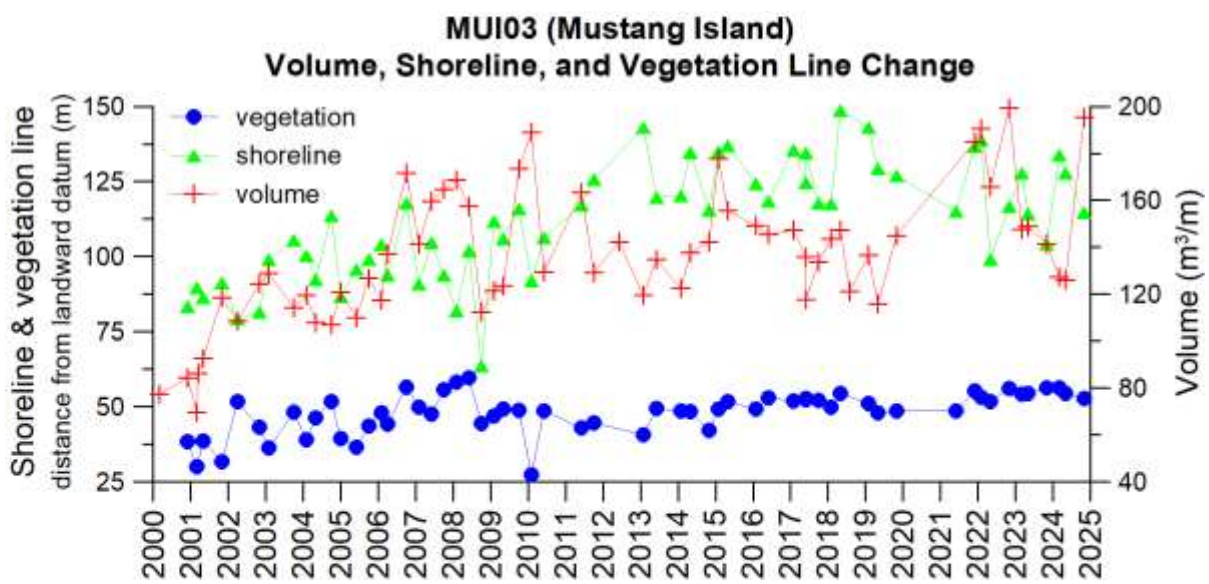

MAT02 (Matagorda Peninsula)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
0
40
80
120
160
50
100
150
200
250
300
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025


MAT03 Matagorda Peninsula
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
0
50
100
150
200
250
300
50
100
150
200
250
300
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

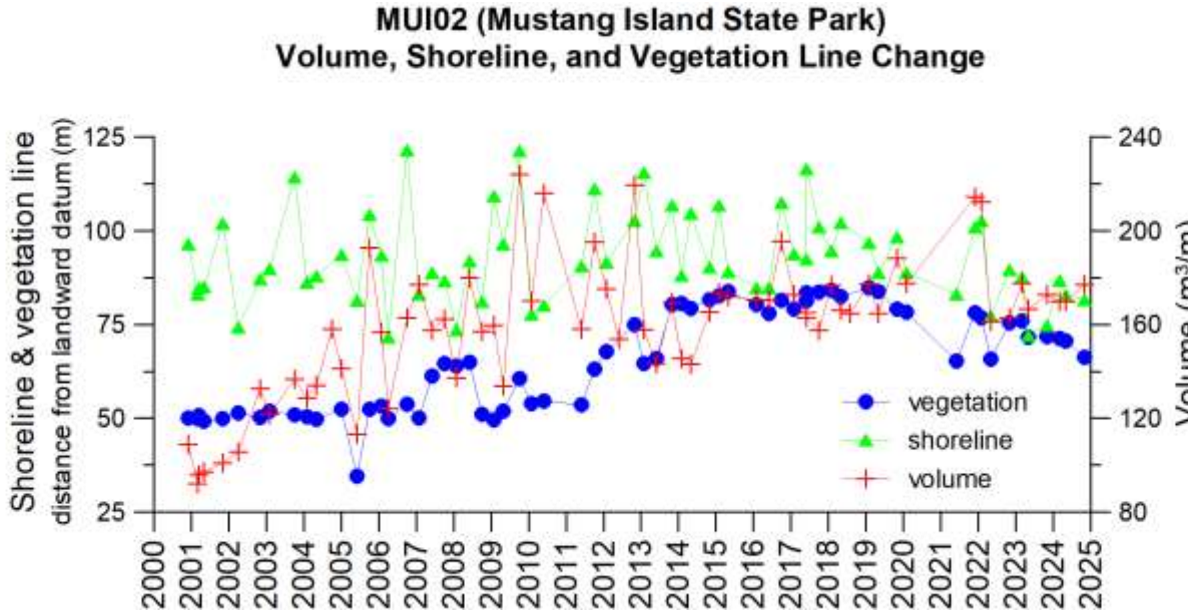
MUI01 volumes were calculated above 1.5 meters NAVD88.



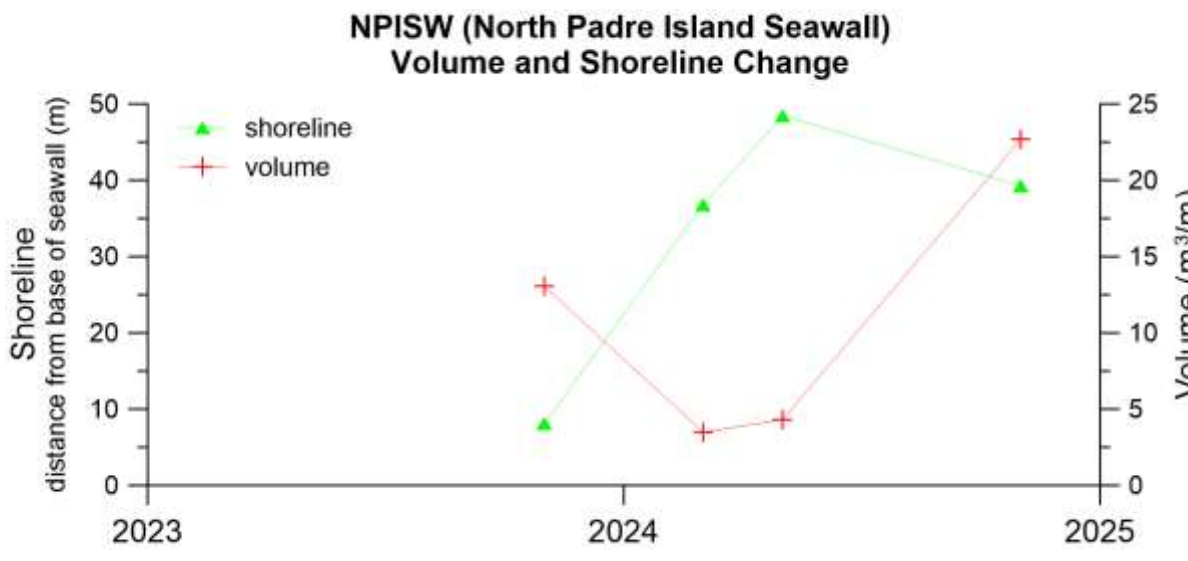
MUI03 volumes were calculated above 1.5 meters NAVD88.

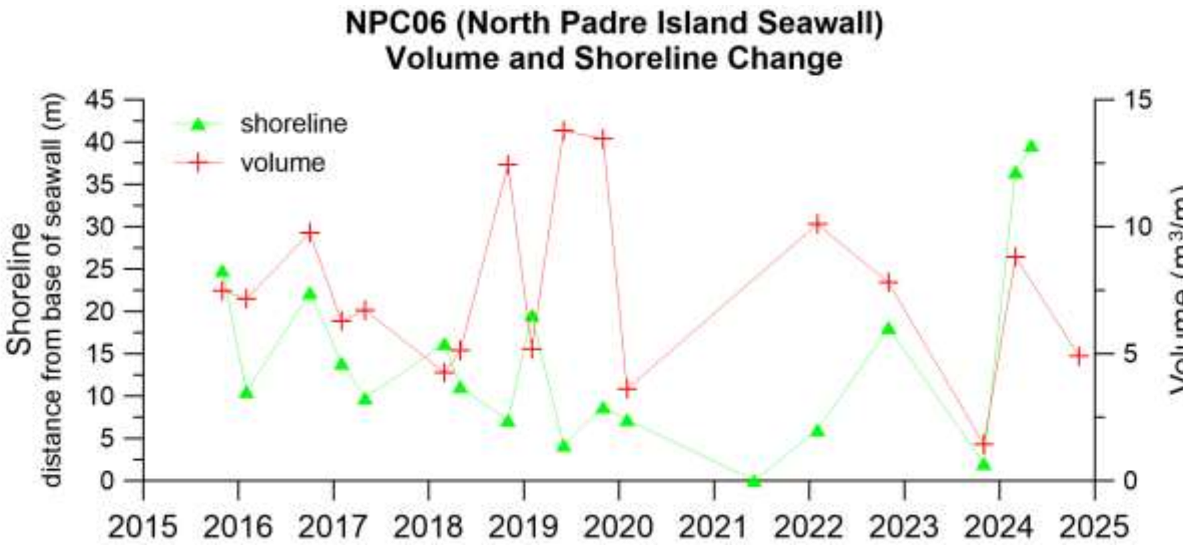


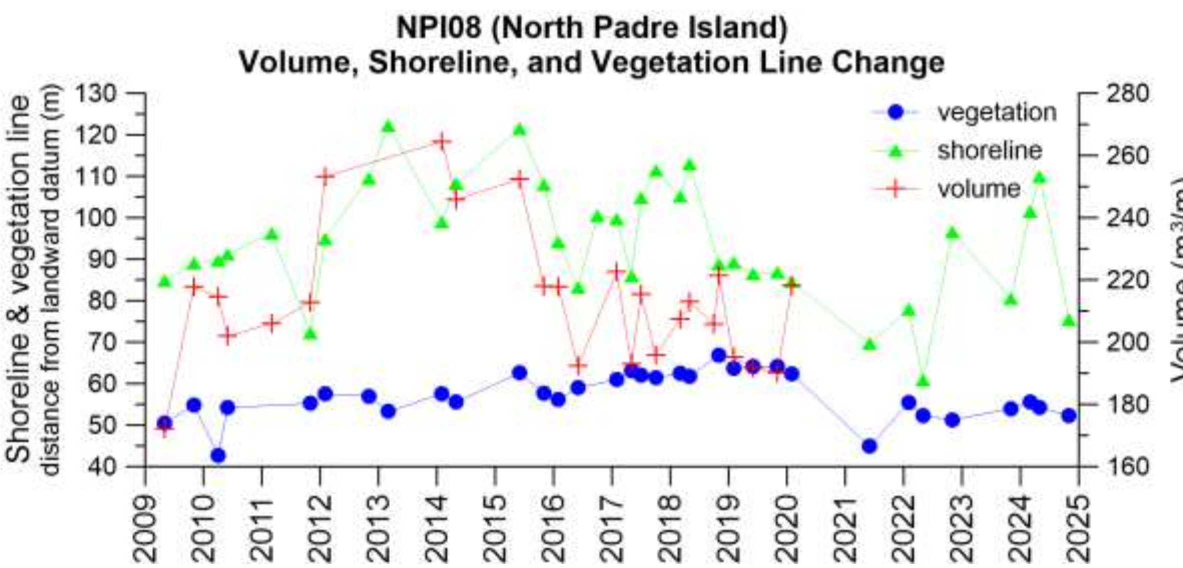
MUI02 volumes were calculated above 1.25 meters NAVD88.

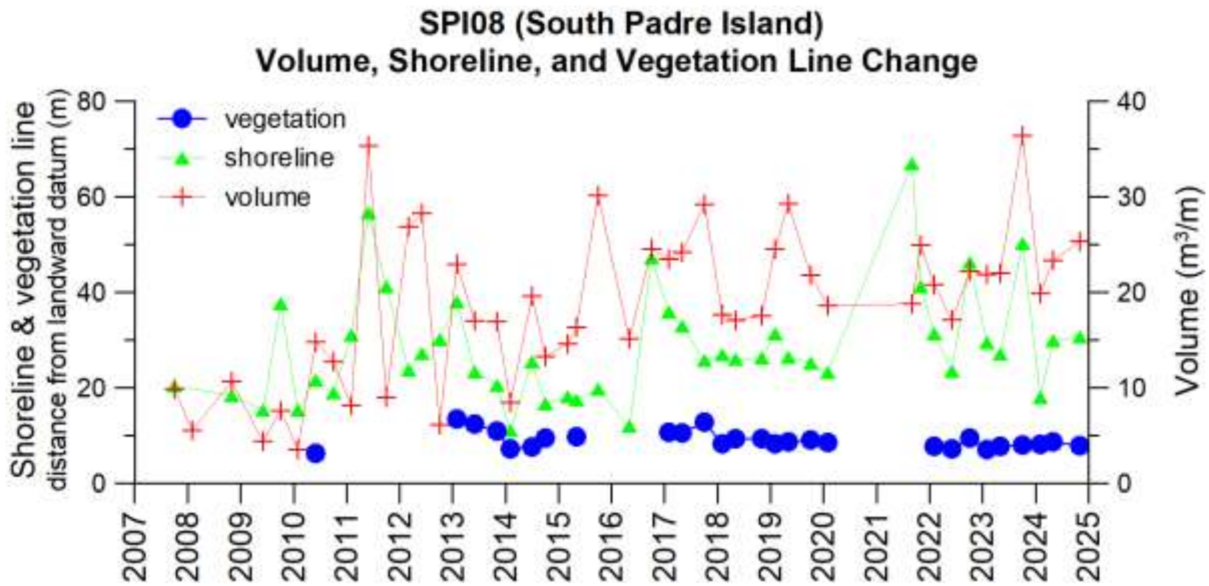


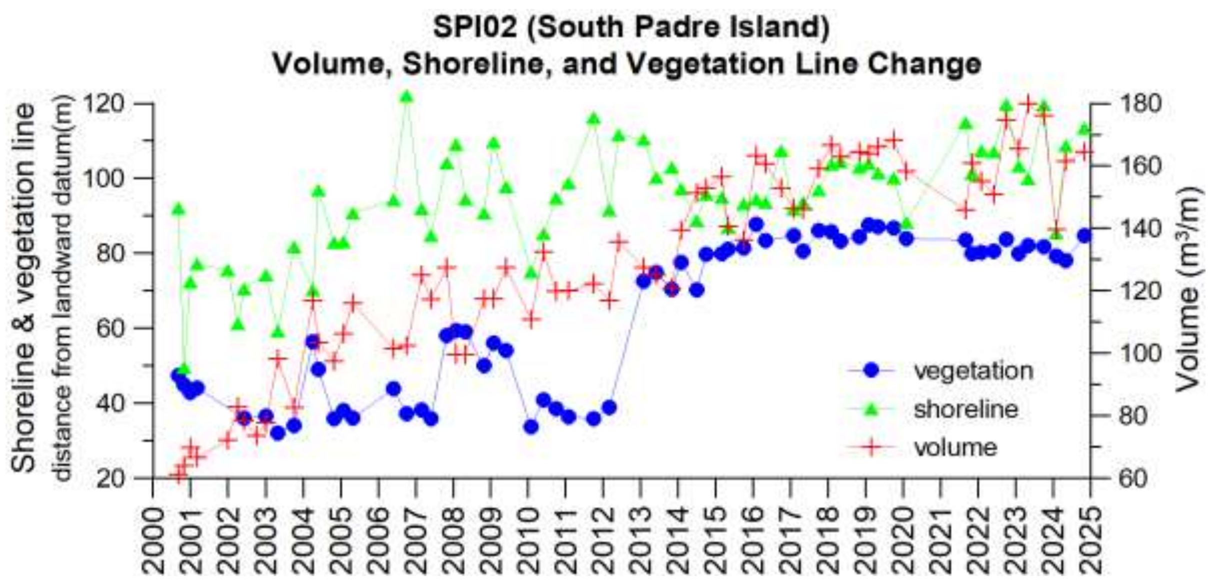
NPISW volumes were calculated above 0.5 meters NAVD88.

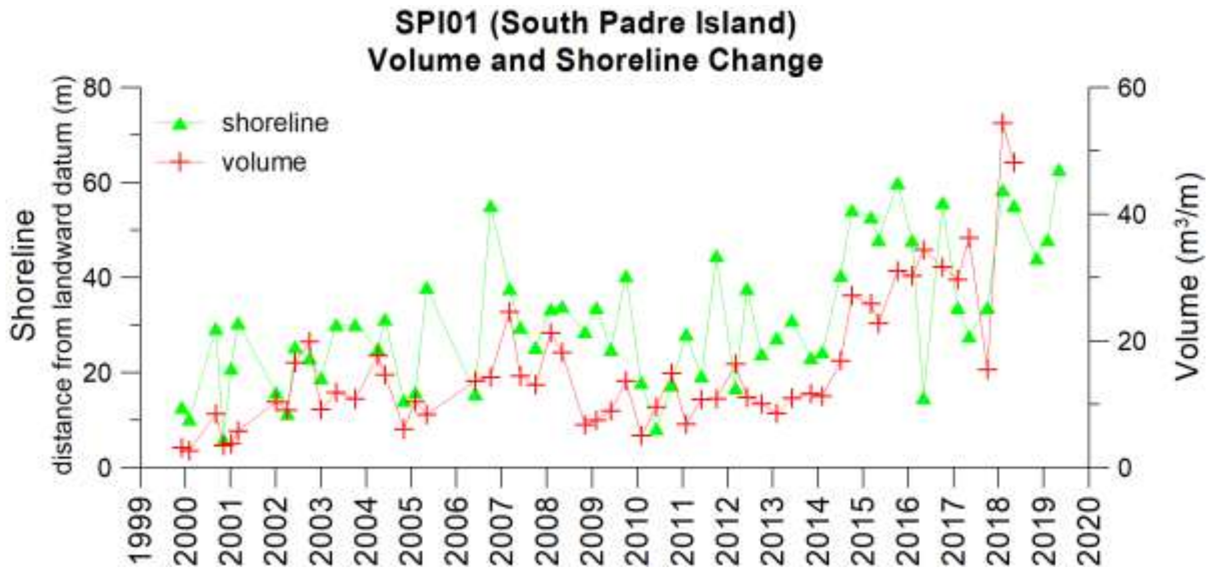


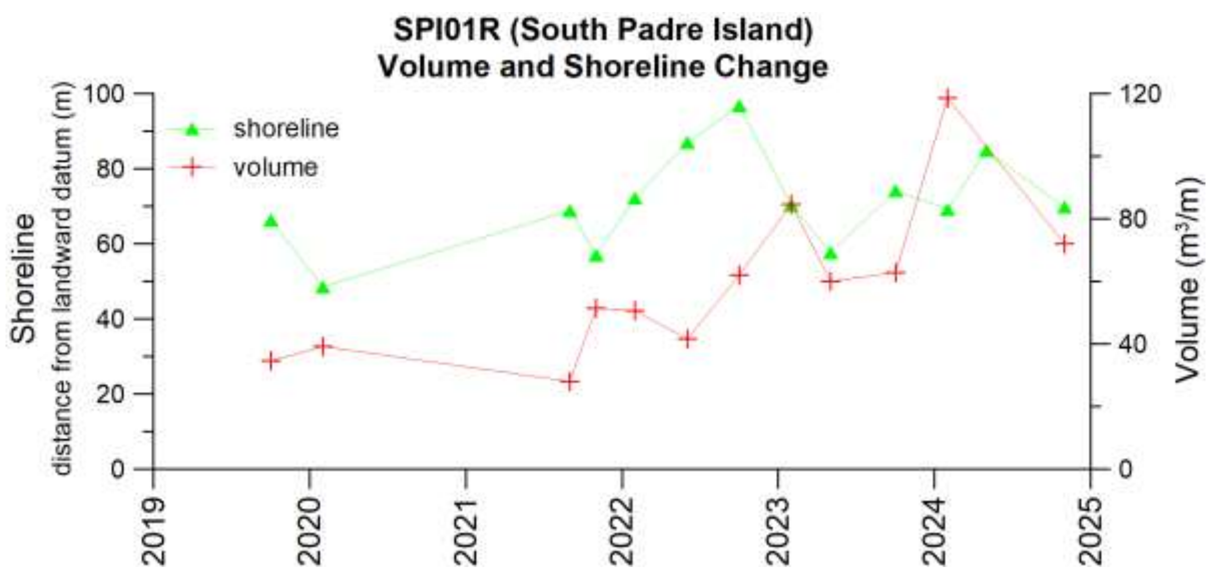

NPC06 (North Padre Island Seawall)
Volume and Shoreline Change
shoreline
volume
Shoreline
distance from base of seawall (m)
Volume (m3/m)
0
5
10
15
20
25
30
35
40
45
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025


NPI08 (North Padre Island)
Volume, Shoreline, and Vegetation Line Change
vegetation
shoreline
volume
Shoreline & vegetation line
distance from landward datum (m)
Volume (m3/m)
40
50
60
70
80
90
100
110
120
130
160
180
200
220
240
260
280
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025


SPI08 (South Padre Island)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum (m)
Volume (m³/m)
vegetation
shoreline
volume
0
20
40
60
80
10
30
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

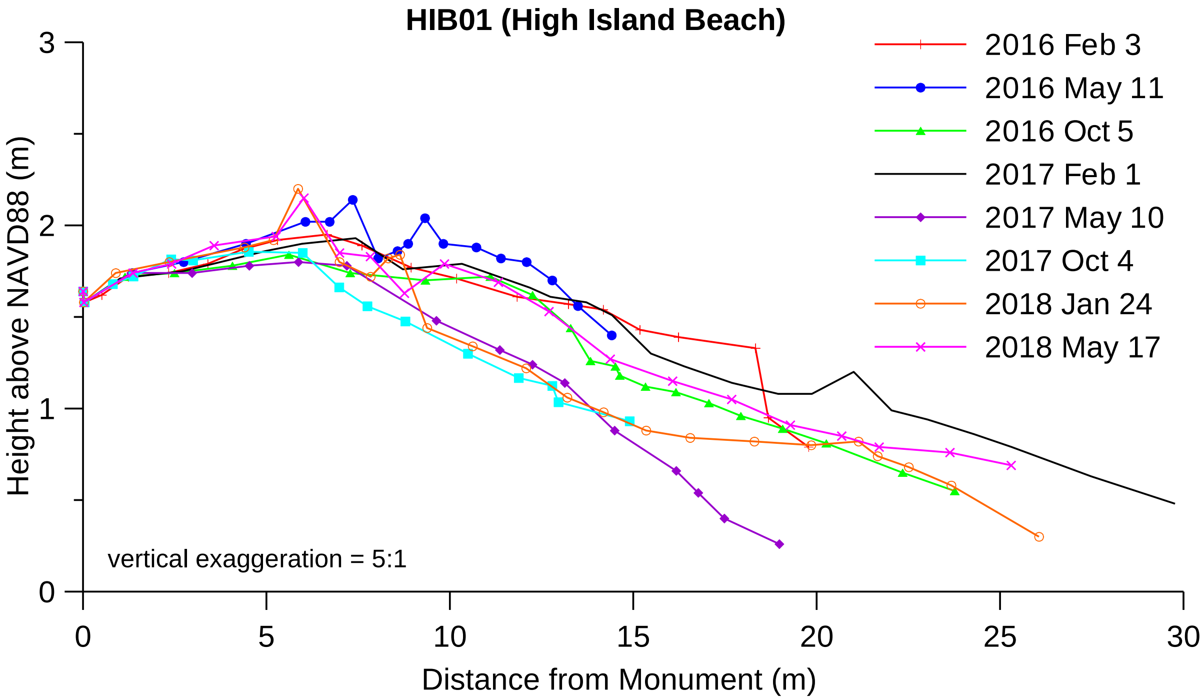

SPI02 (South Padre Island)
Volume, Shoreline, and Vegetation Line Change
Shoreline & vegetation line
distance from landward datum(m)
Volume (m³/m)
vegetation
shoreline
volume
20
40
60
80
100
120
140
160
180
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

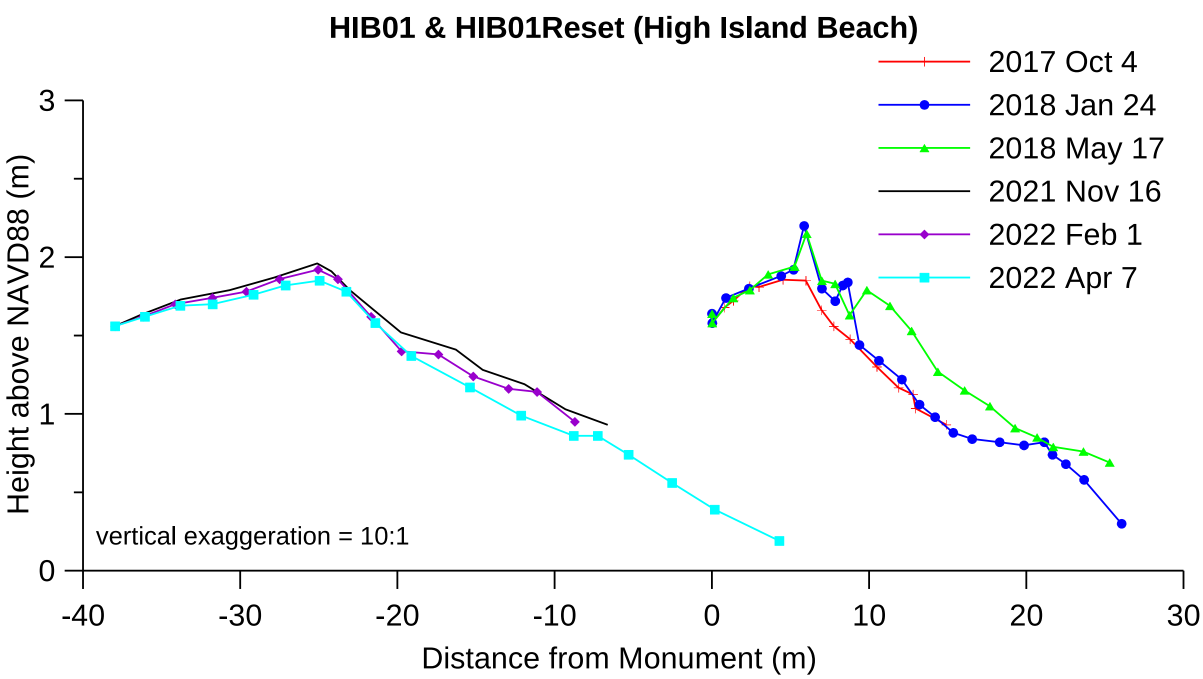

SPI01 (South Padre Island)
Volume and Shoreline Change
shoreline
volume
Shoreline
distance from landward datum (m)
Volume (m³/m)
0
20
40
60
80
0
20
40
60
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


SPI01R (South Padre Island)
Volume and Shoreline Change
shoreline
volume
Shoreline
distance from landward datum (m)
Volume (m³/m)
0
20
40
60
80
100
0
40
80
120
2019
2020
2021
2022
2023
2024
2025

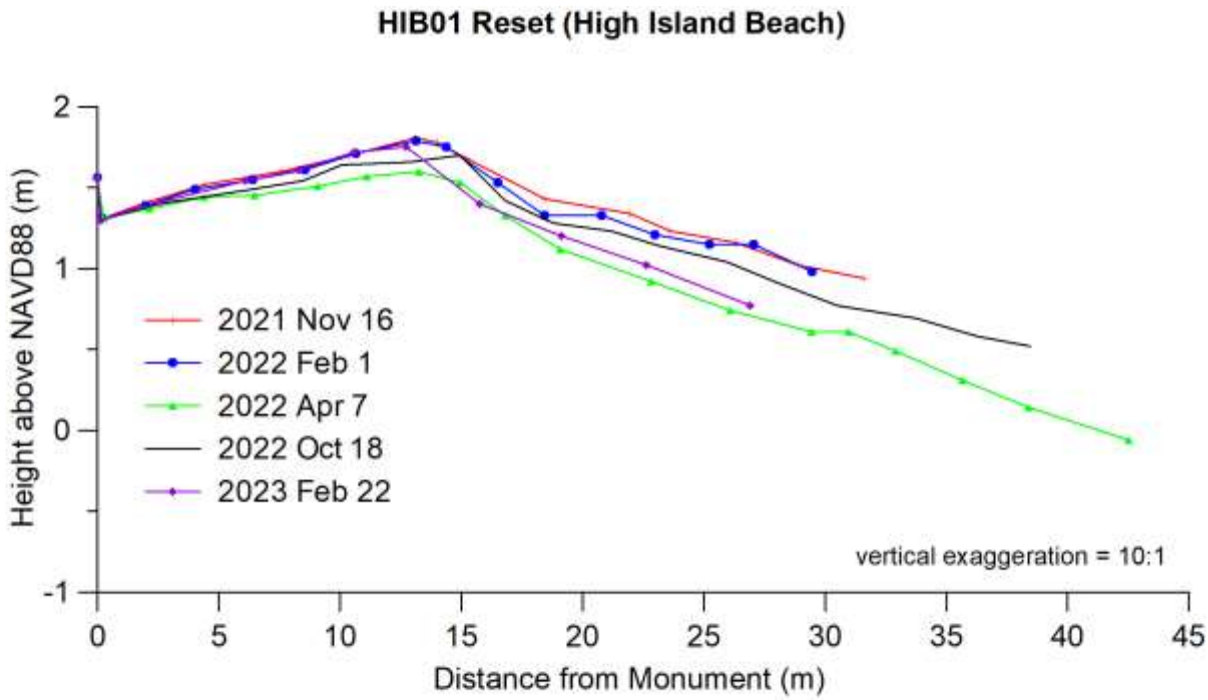
APPENDIX B: GRAPHS OF BEACH PROFILES

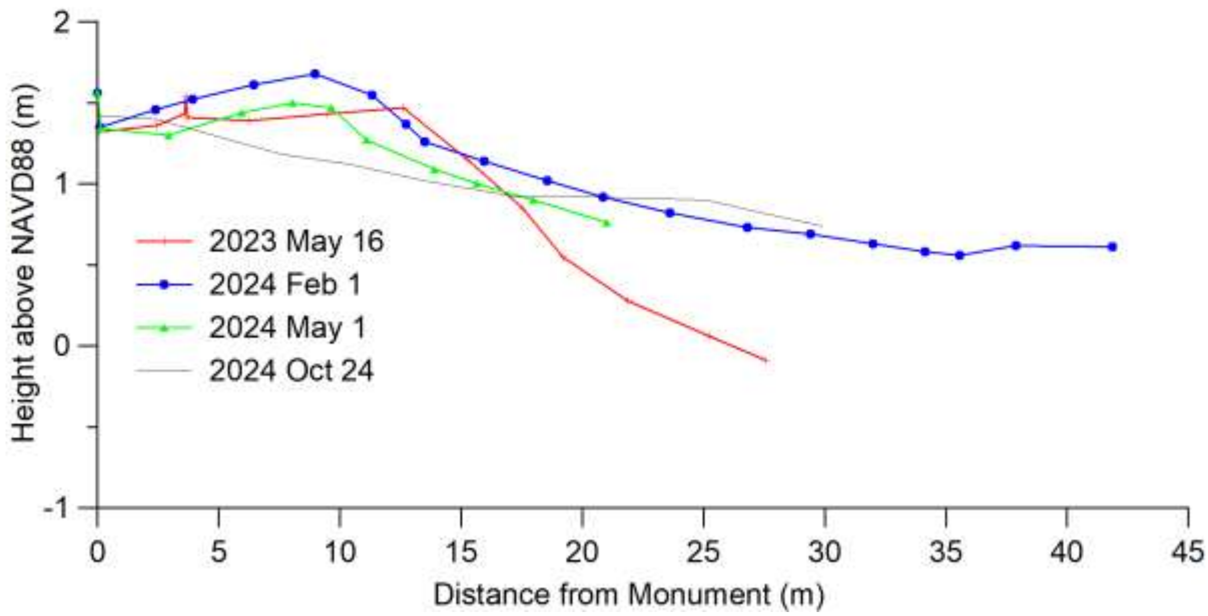
HIB01



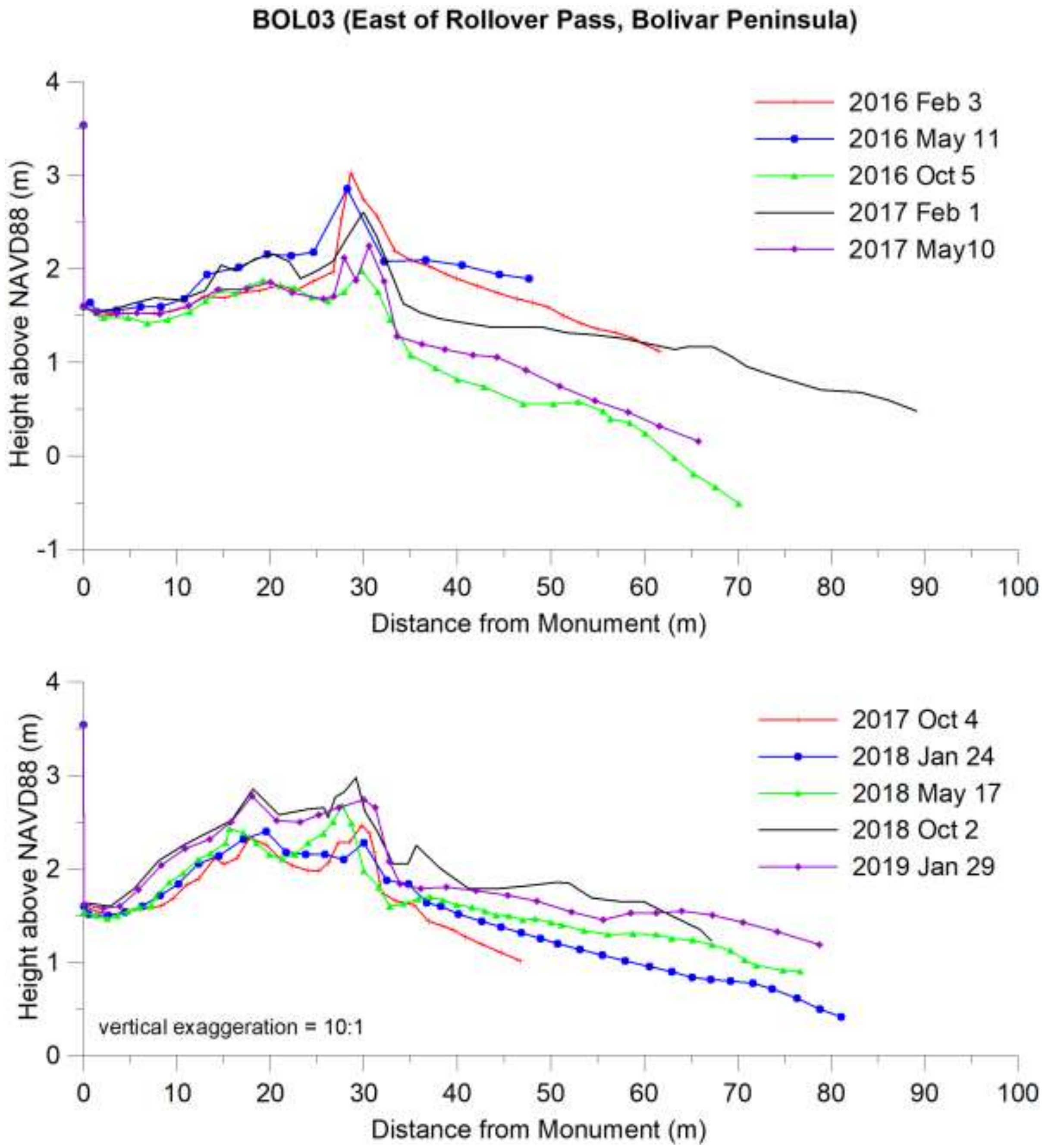


HIB01R

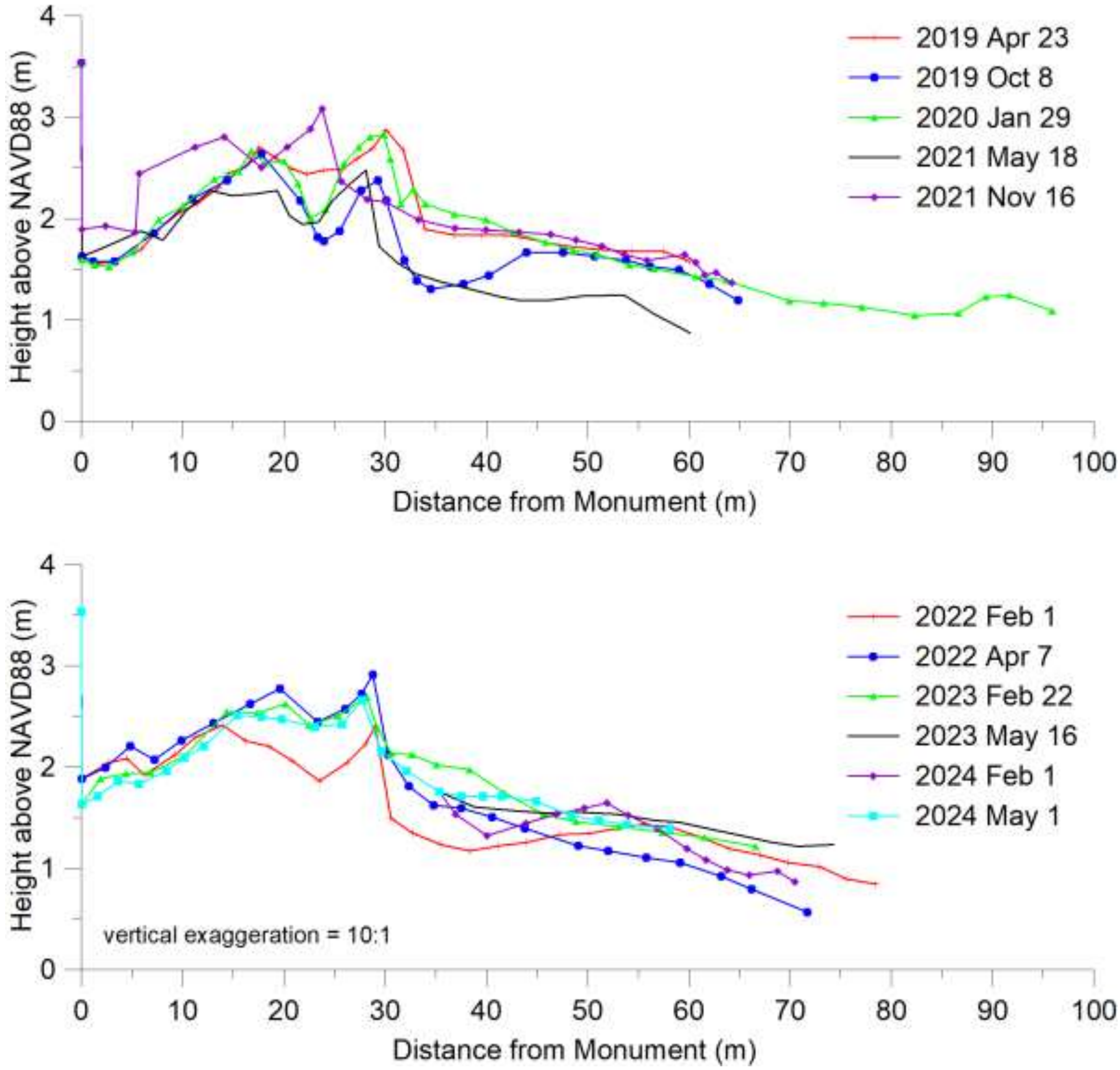

HIB01 Reset (High Island Beach)
Height above NAVD88 (m)
2
1
0
-1
0
5
10
15
20
25
30
35
40
45
Distance from Monument (m)
2021 Nov 16
2022 Feb 1
2022 Apr 7
2022 Oct 18
2023 Feb 22
vertical exaggeration = 10:1


Height above NAVD88 (m)
2
1
0
-1
0
5
10
15
20
25
30
35
40
45
Distance from Monument (m)
2023 May 16
2024 Feb 1
2024 May 1
2024 Oct 24

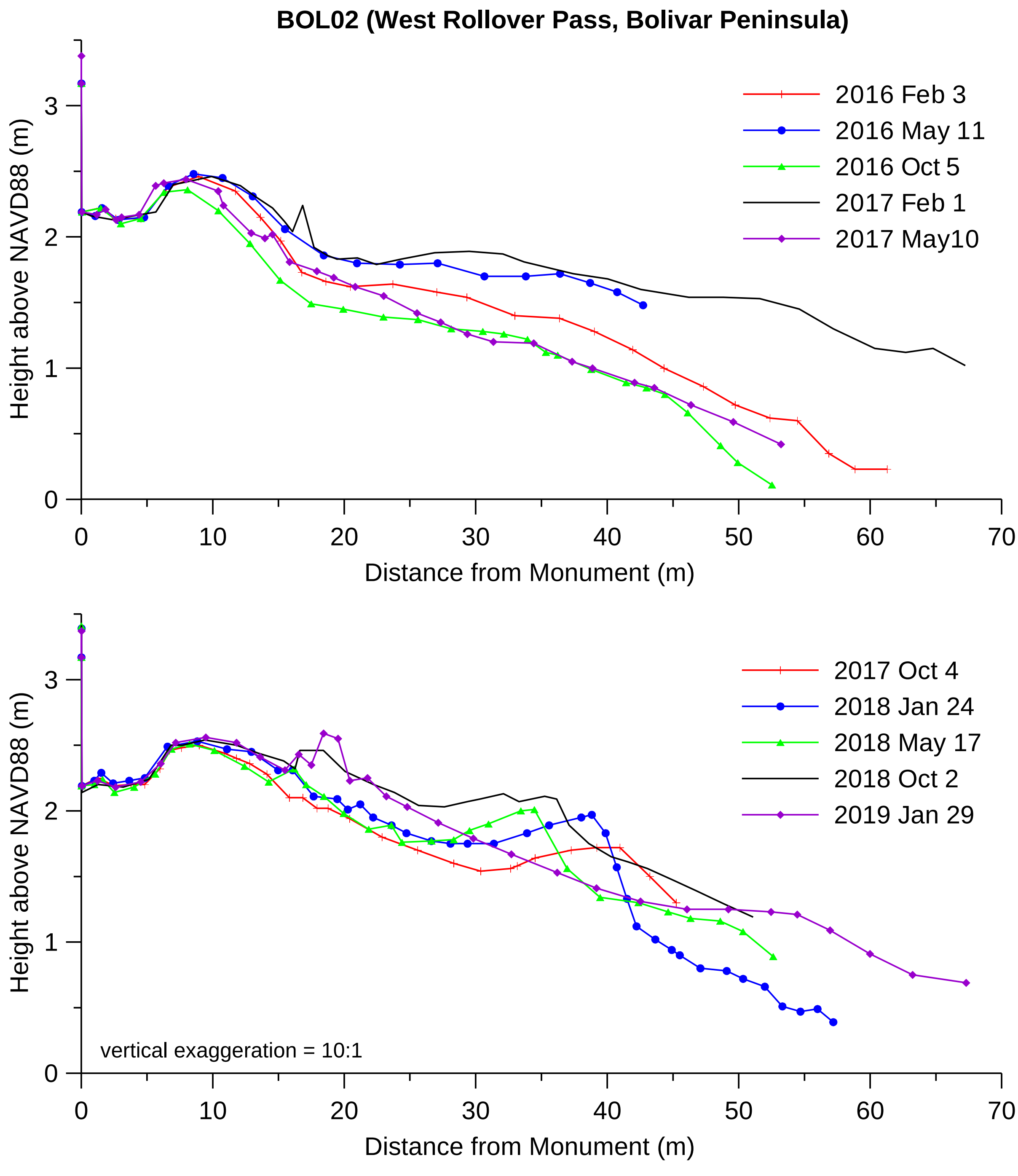
BOL03


BOL03 (East of Rollover Pass, Bolivar Peninsula)
Height above NAVD88 (m)
Distance from Monument (m)
2016 Feb 3
2016 May 11
2016 Oct 5
2017 Feb 1
2017 May10
2017 Oct 4
2018 Jan 24
2018 May 17
2018 Oct 2
2019 Jan 29
vertical exaggeration = 10:1

BOL03 (East of Rollover Pass, Bolivar Peninsula)

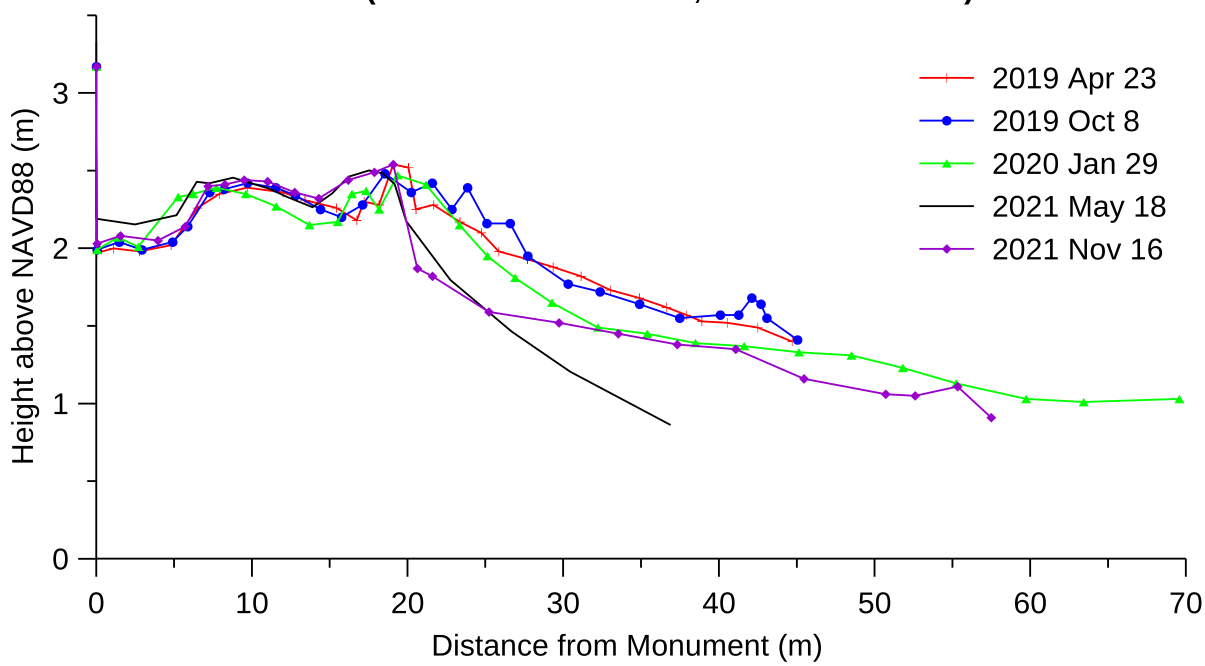


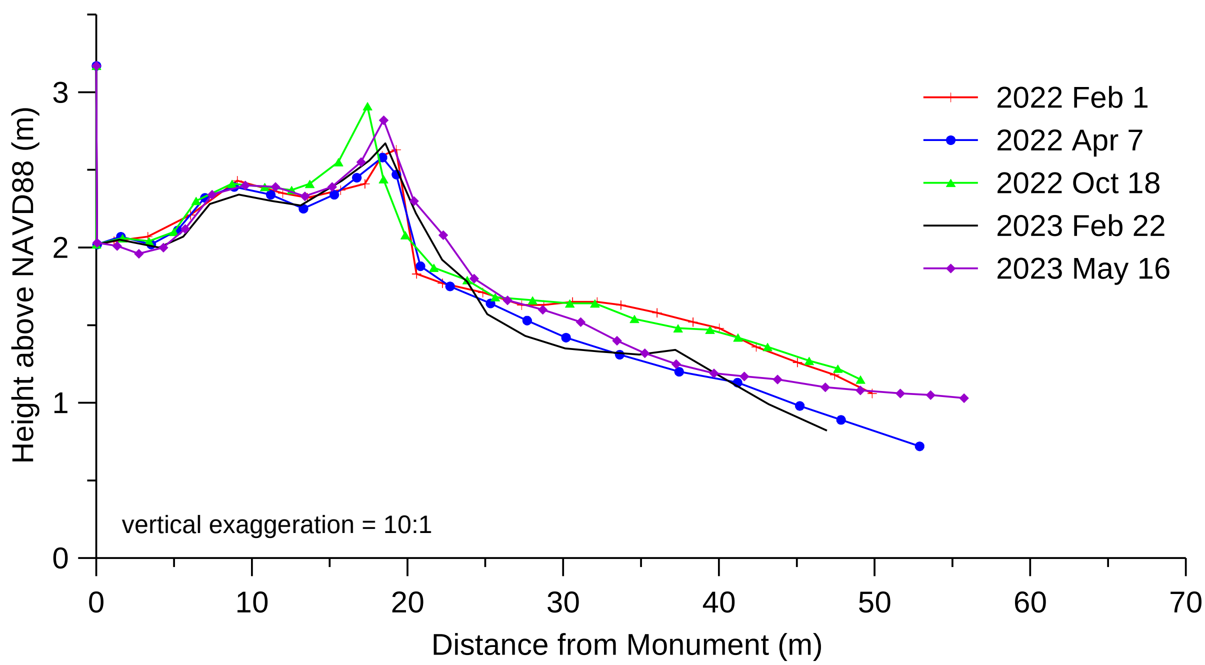
BOL02

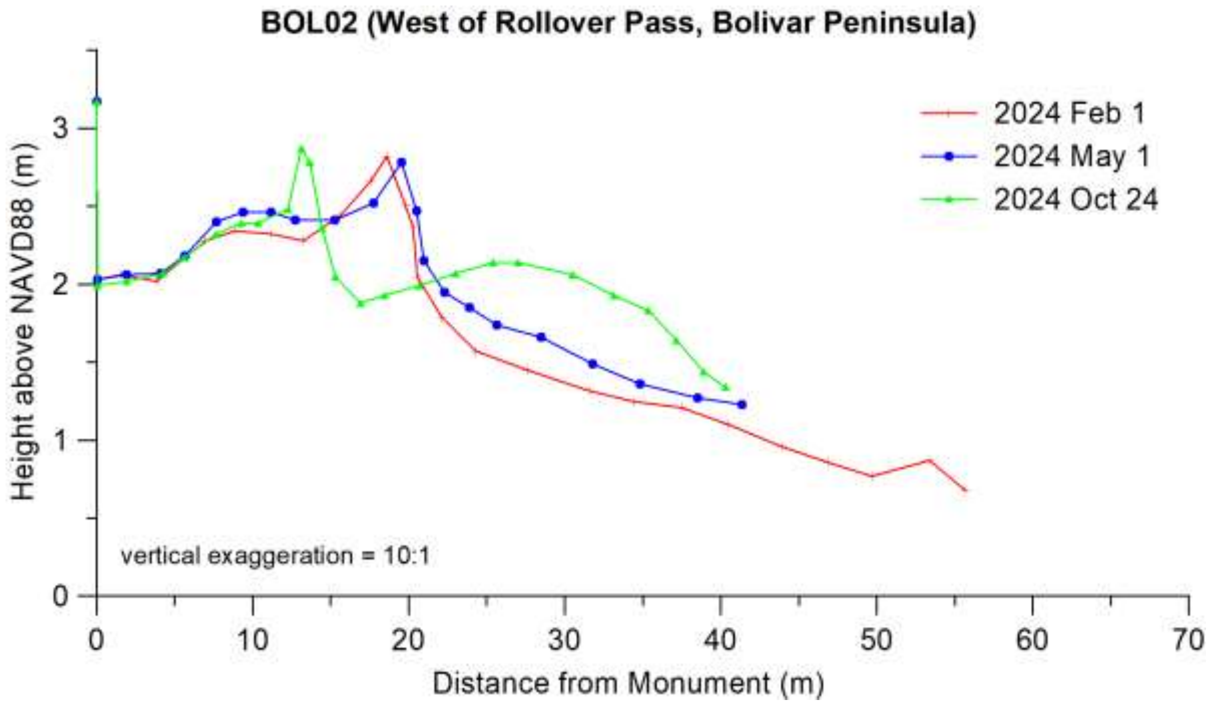


BOL02 (West Rollover Pass, Bolivar Peninsula)
Height above NAVD88 (m)
Distance from Monument (m)
2016 Feb 3
2016 May 11
2016 Oct 5
2017 Feb 1
2017 May10
2017 Oct 4
2018 Jan 24
2018 May 17
2018 Oct 2
2019 Jan 29
vertical exaggeration = 10:1
0
1
2
3
0
10
20
30
40
50
60
70

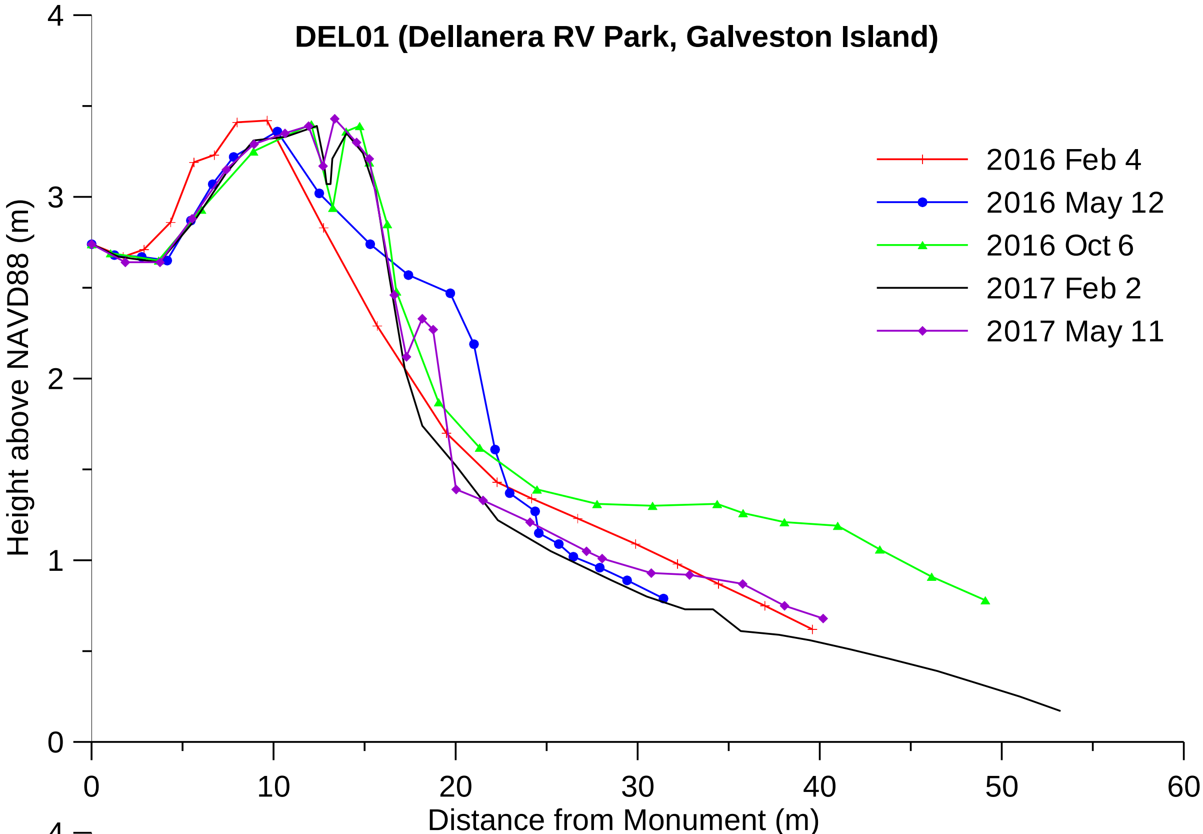
BOL02 (West of Rollover Pass, Bolivar Peninsula)

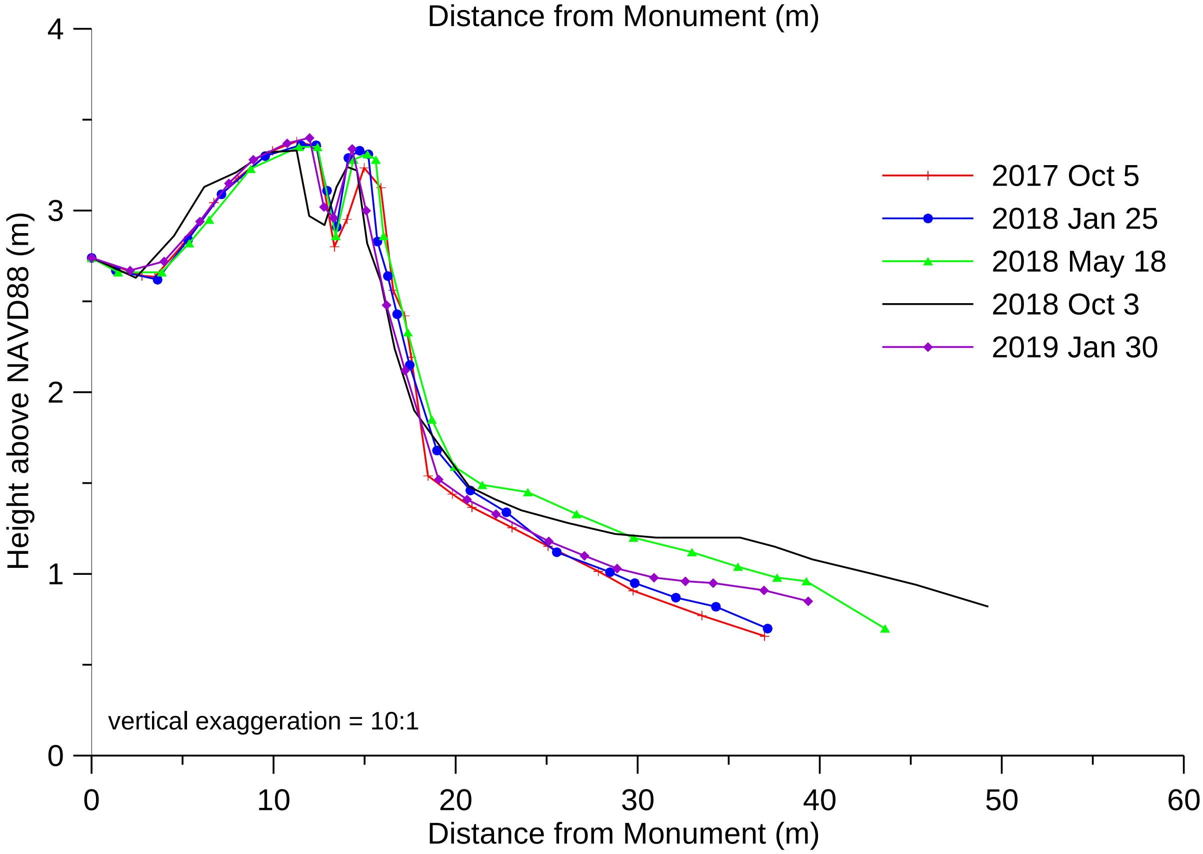


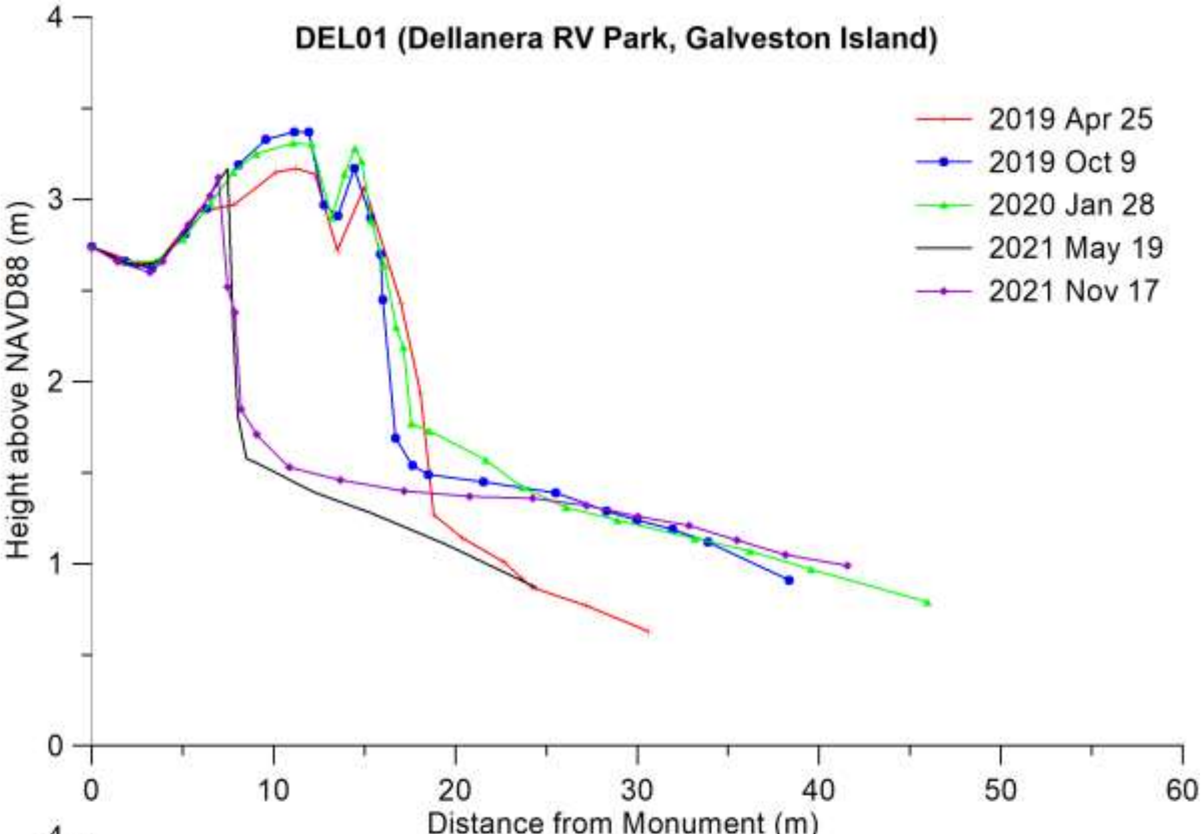


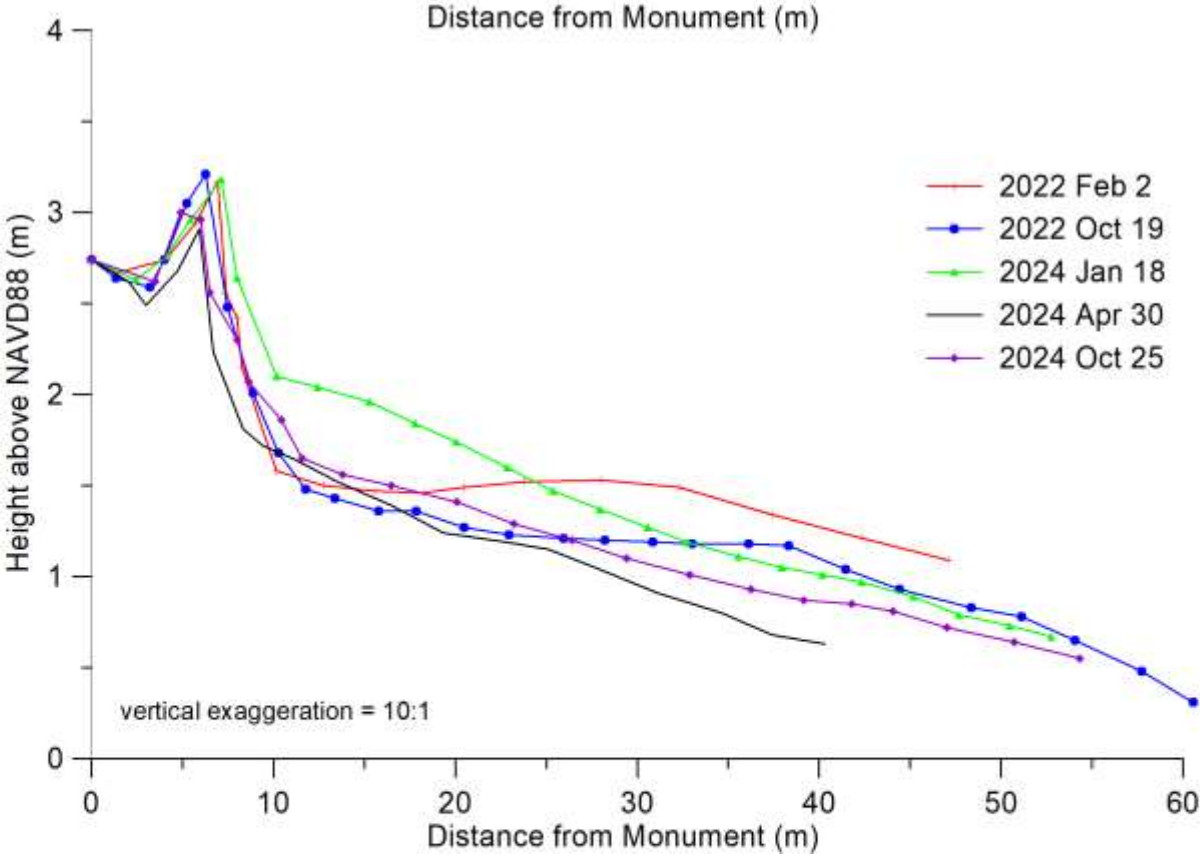

BOL02 (West of Rollover Pass, Bolivar Peninsula)
2024 Feb 1
2024 May 1
2024 Oct 24
Height above NAVD88 (m)
vertical exaggeration = 10:1
Distance from Monument (m)
0
1
2
3
0
10
20
30
40
50
60
70

DEL01

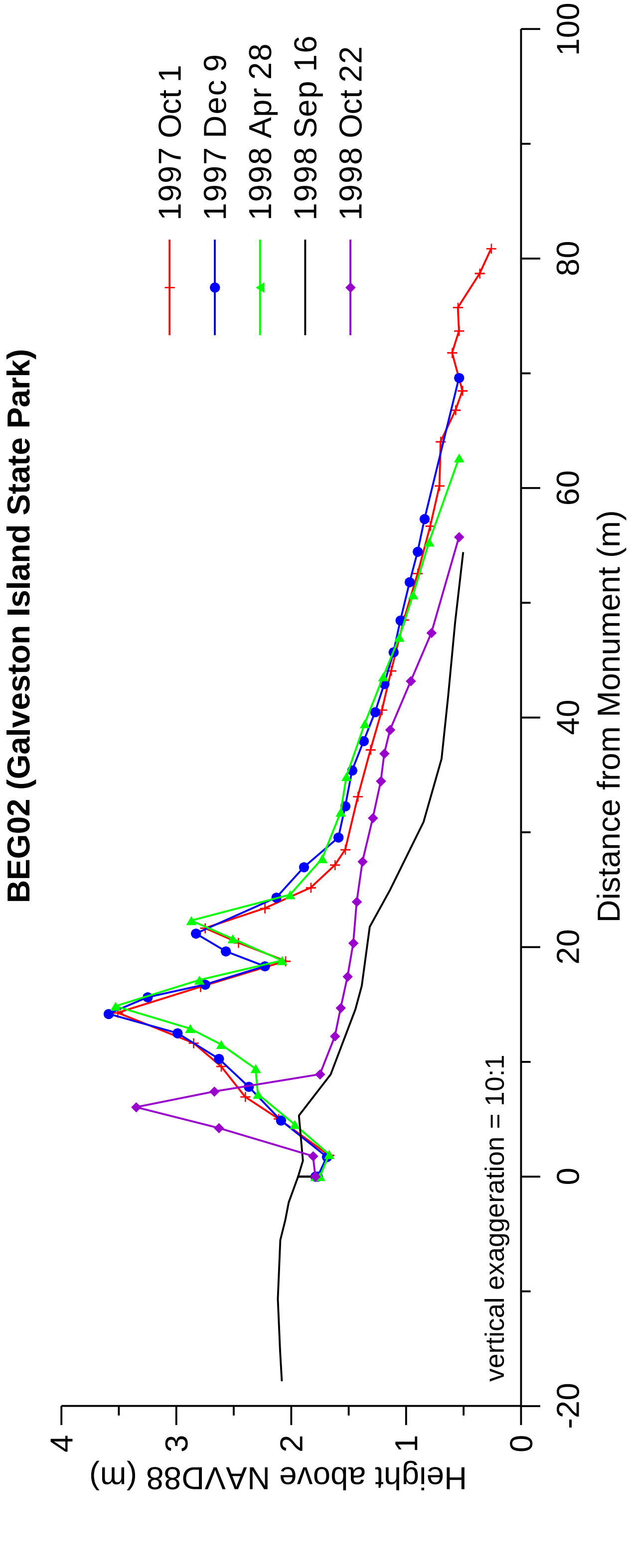

DEL01 (Dellanera RV Park, Galveston Island)
Height above NAVD88 (m)
Distance from Monument (m)
2016 Feb 4
2016 May 12
2016 Oct 6
2017 Feb 2
2017 May 11
0
1
2
3
4
0
10
20
30
40
50
60

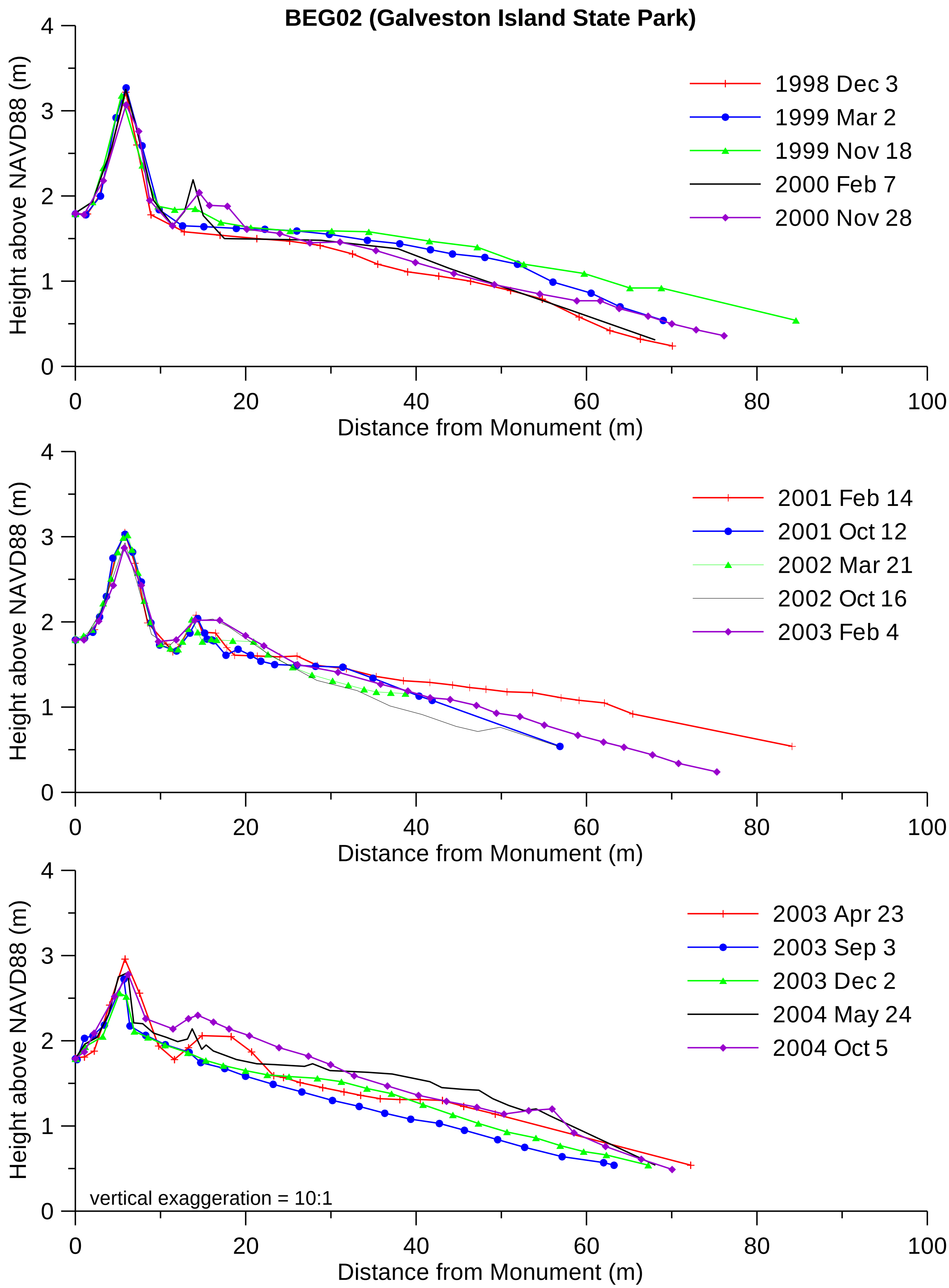

Height above NAVD88 (m)
Distance from Monument (m)
2017 Oct 5
2018 Jan 25
2018 May 18
2018 Oct 3
2019 Jan 30
vertical exaggeration = 10:1
0
1
2
3
4
0
10
20
30
40
50
60

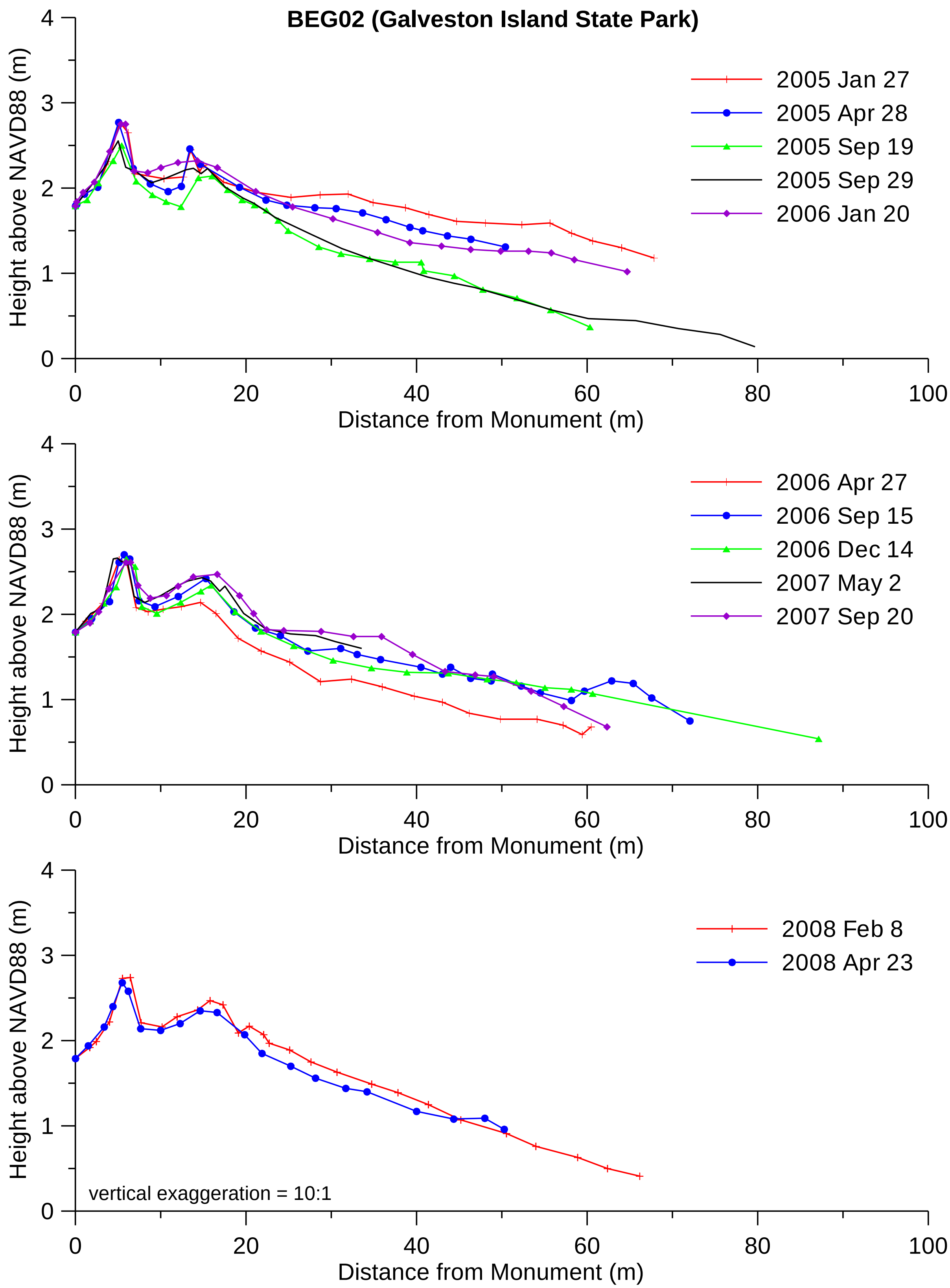

DEL01 (Dellanera RV Park, Galveston Island)
2019 Apr 25
2019 Oct 9
2020 Jan 28
2021 May 19
2021 Nov 17
Height above NAVD88 (m)
Distance from Monument (m)


2022 Feb 2
2022 Oct 19
2024 Jan 18
2024 Apr 30
2024 Oct 25
vertical exaggeration = 10:1
Height above NAVD88 (m)
Distance from Monument (m)

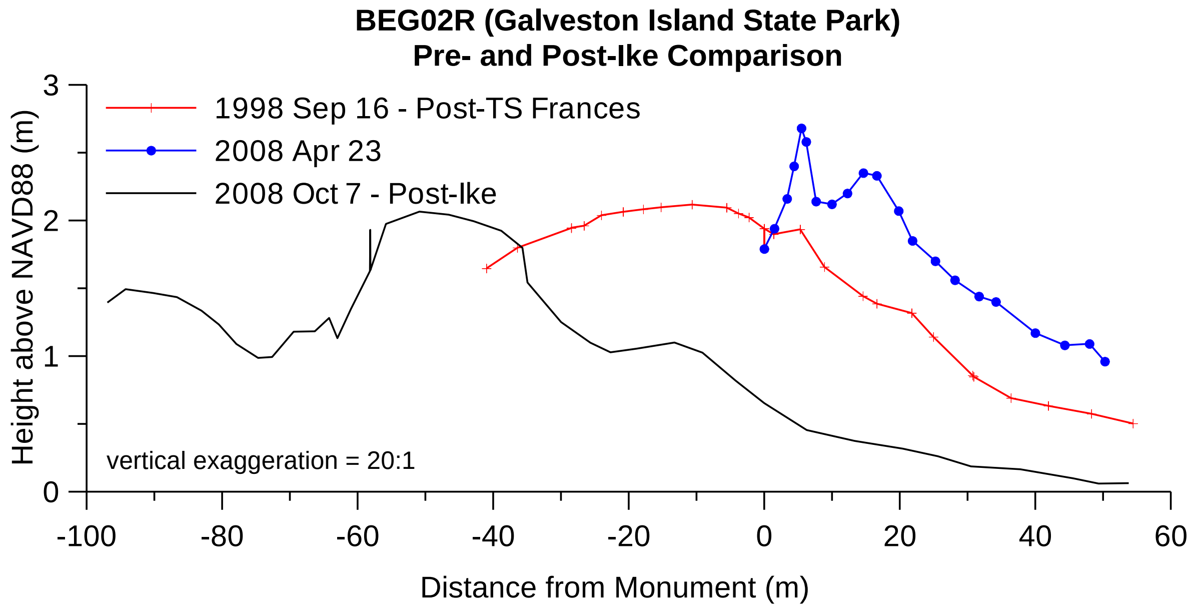
BEG02

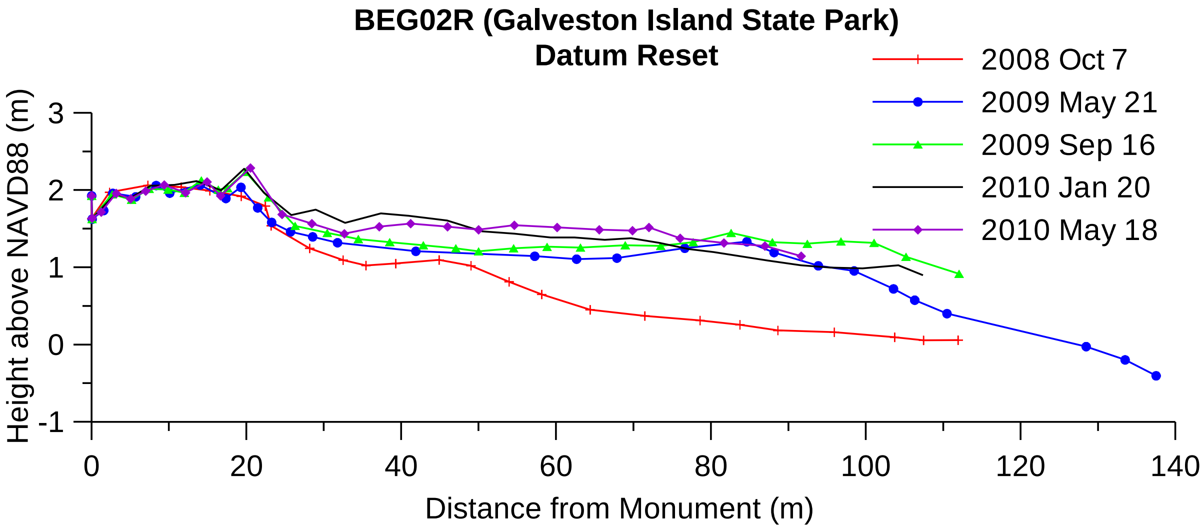

BEG02 (Galveston Island State Park)
1997 Oct 1
1997 Dec 9
1998 Apr 28
1998 Sep 16
1998 Oct 22
vertical exaggeration = 10:1
Height above NAVD88 (m)
Distance from Monument (m)
0
1
2
3
4
-20
0
20
40
60
80
100

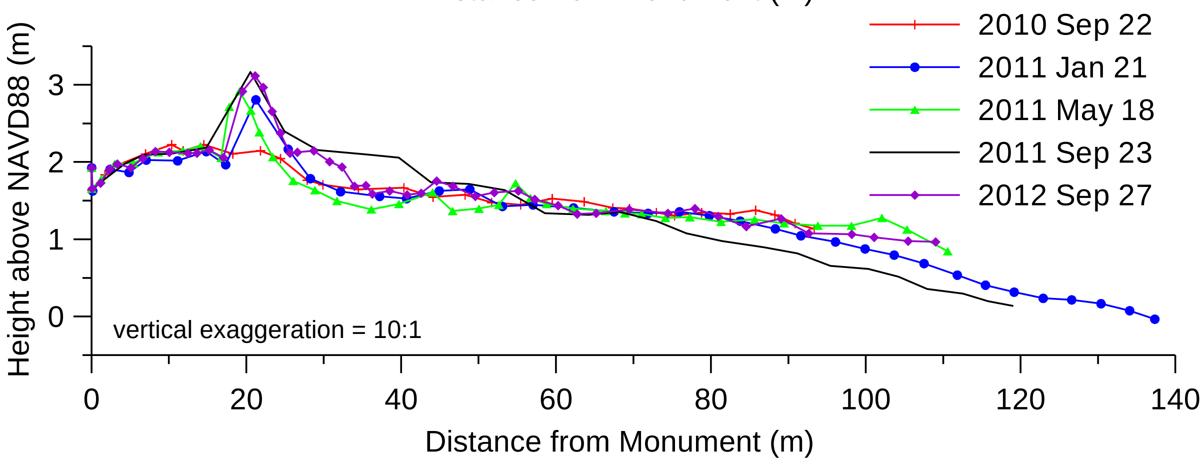

BEG02 (Galveston Island State Park)
Height above NAVD88 (m)
Distance from Monument (m)
1998 Dec 3
1999 Mar 2
1999 Nov 18
2000 Feb 7
2000 Nov 28
2001 Feb 14
2001 Oct 12
2002 Mar 21
2002 Oct 16
2003 Feb 4
2003 Apr 23
2003 Sep 3
2003 Dec 2
2004 May 24
2004 Oct 5
vertical exaggeration = 10:1


BEG02 (Galveston Island State Park)
Height above NAVD88 (m)
Distance from Monument (m)
2005 Jan 27
2005 Apr 28
2005 Sep 19
2005 Sep 29
2006 Jan 20
2006 Apr 27
2006 Sep 15
2006 Dec 14
2007 May 2
2007 Sep 20
2008 Feb 8
2008 Apr 23
vertical exaggeration = 10:1

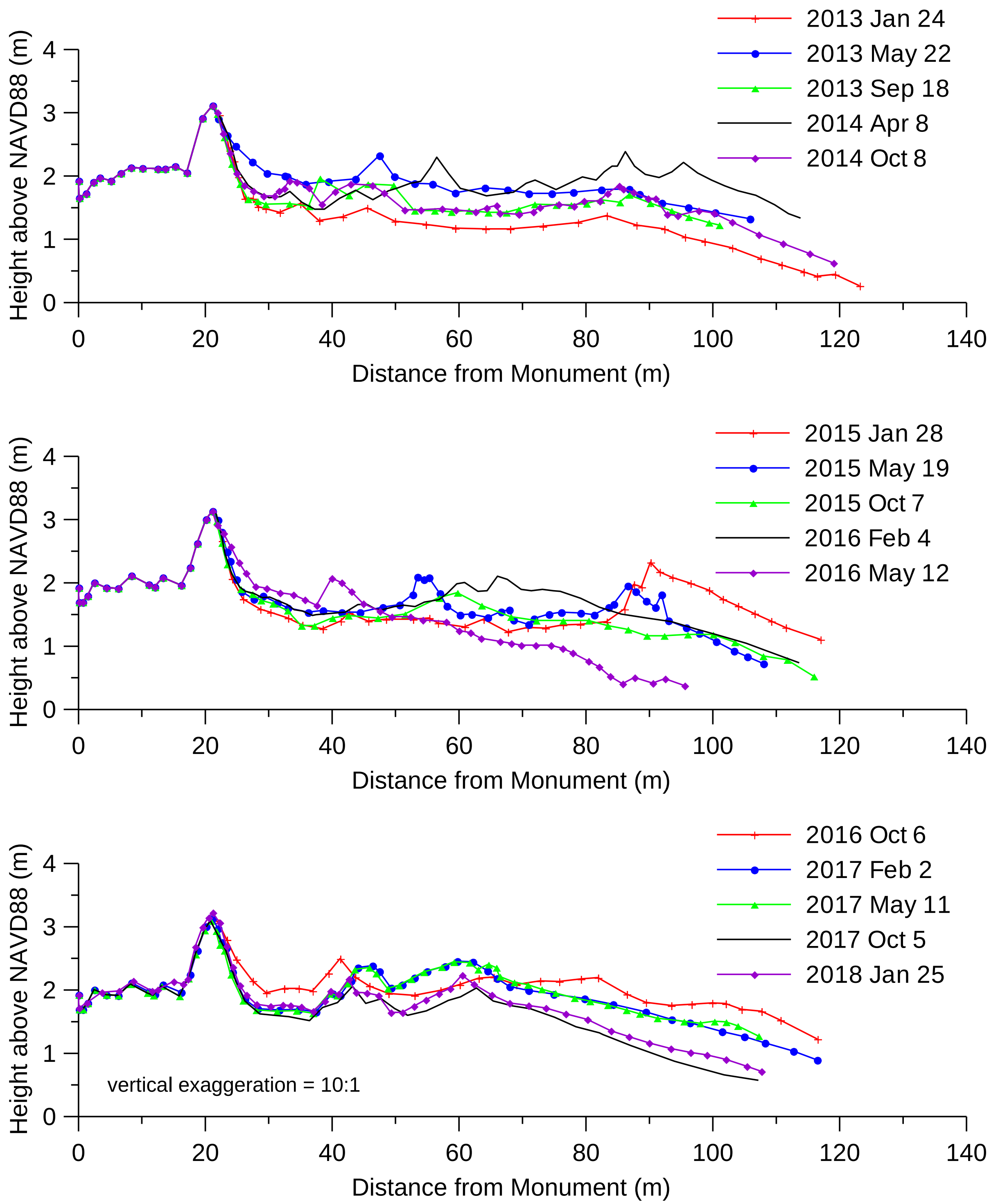
BEG02R

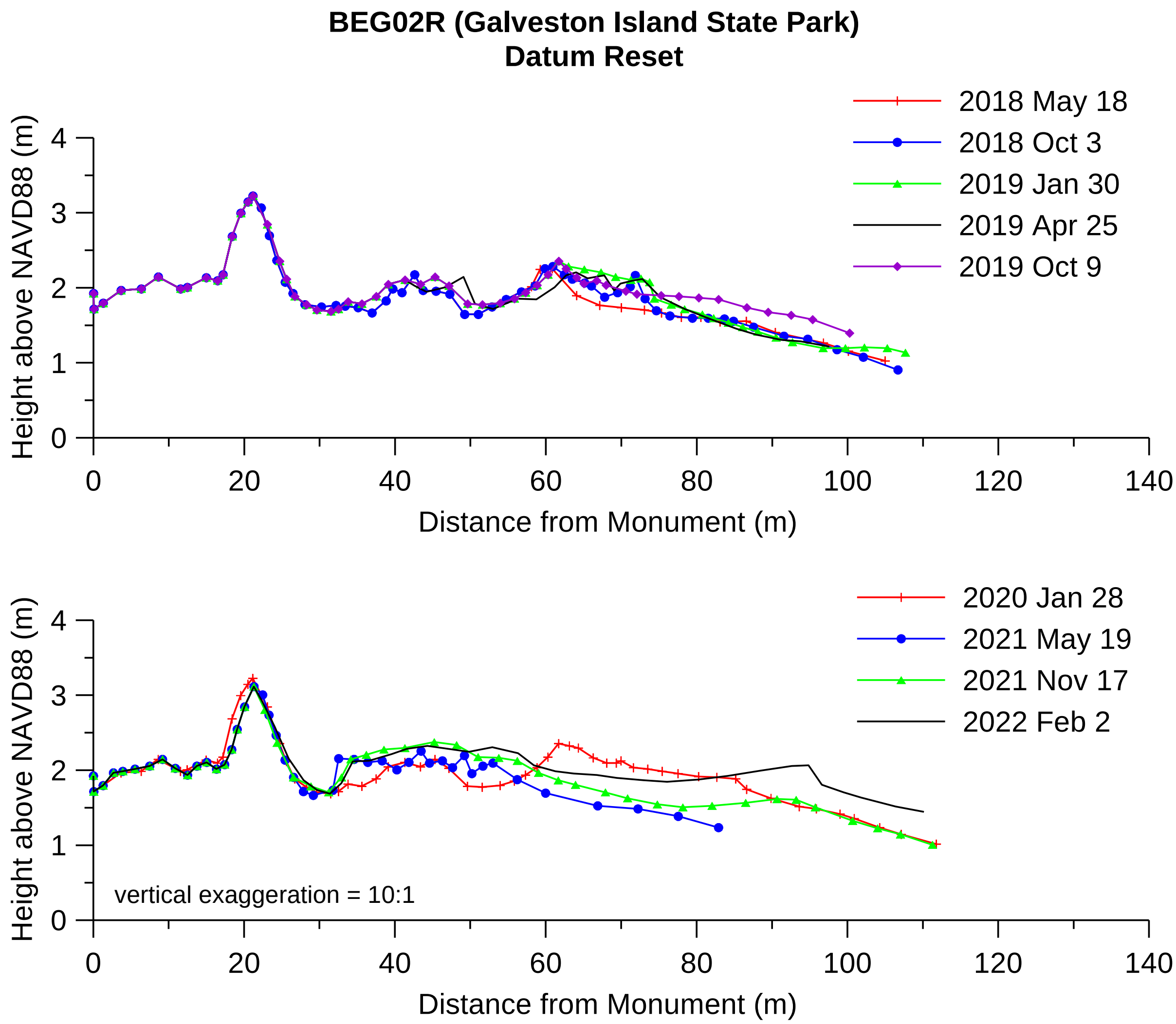

BEG02R (Galveston Island State Park)
Pre- and Post-Ike Comparison
1998 Sep 16 - Post-TS Frances
2008 Apr 23
2008 Oct 7 - Post-Ike
vertical exaggeration = 20:1
Height above NAVD88 (m)
Distance from Monument (m)


BEG02R (Galveston Island State Park)
Datum Reset
2008 Oct 7
2009 May 21
2009 Sep 16
2010 Jan 20
2010 May 18
Height above NAVD88 (m)
Distance from Monument (m)

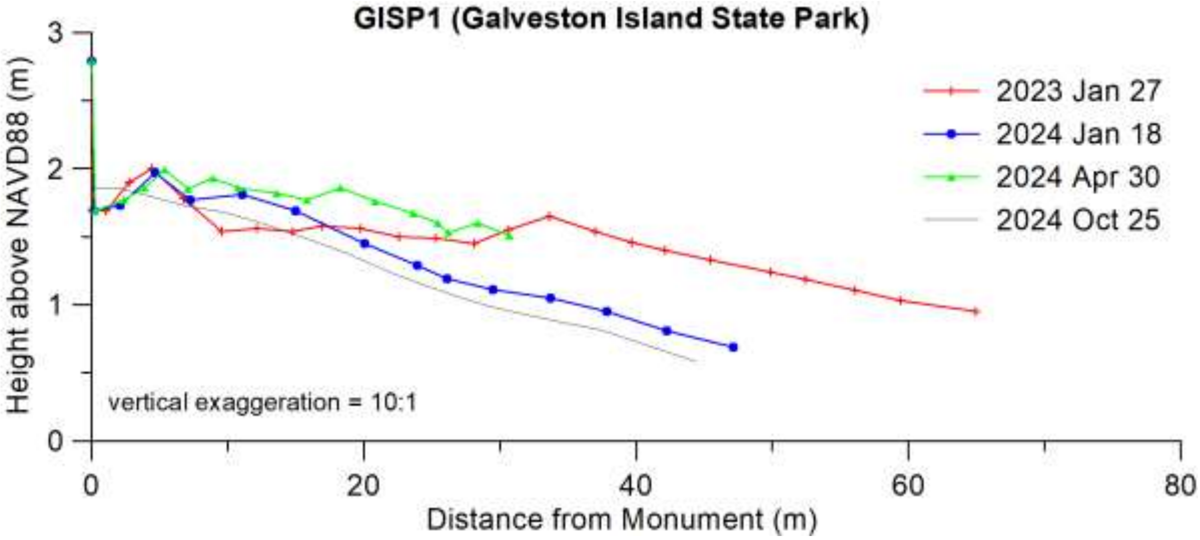

2010 Sep 22
2011 Jan 21
2011 May 18
2011 Sep 23
2012 Sep 27
vertical exaggeration = 10:1
Height above NAVD88 (m)
Distance from Monument (m)

BEG02R (Galveston Island State Park)
Datum Reset

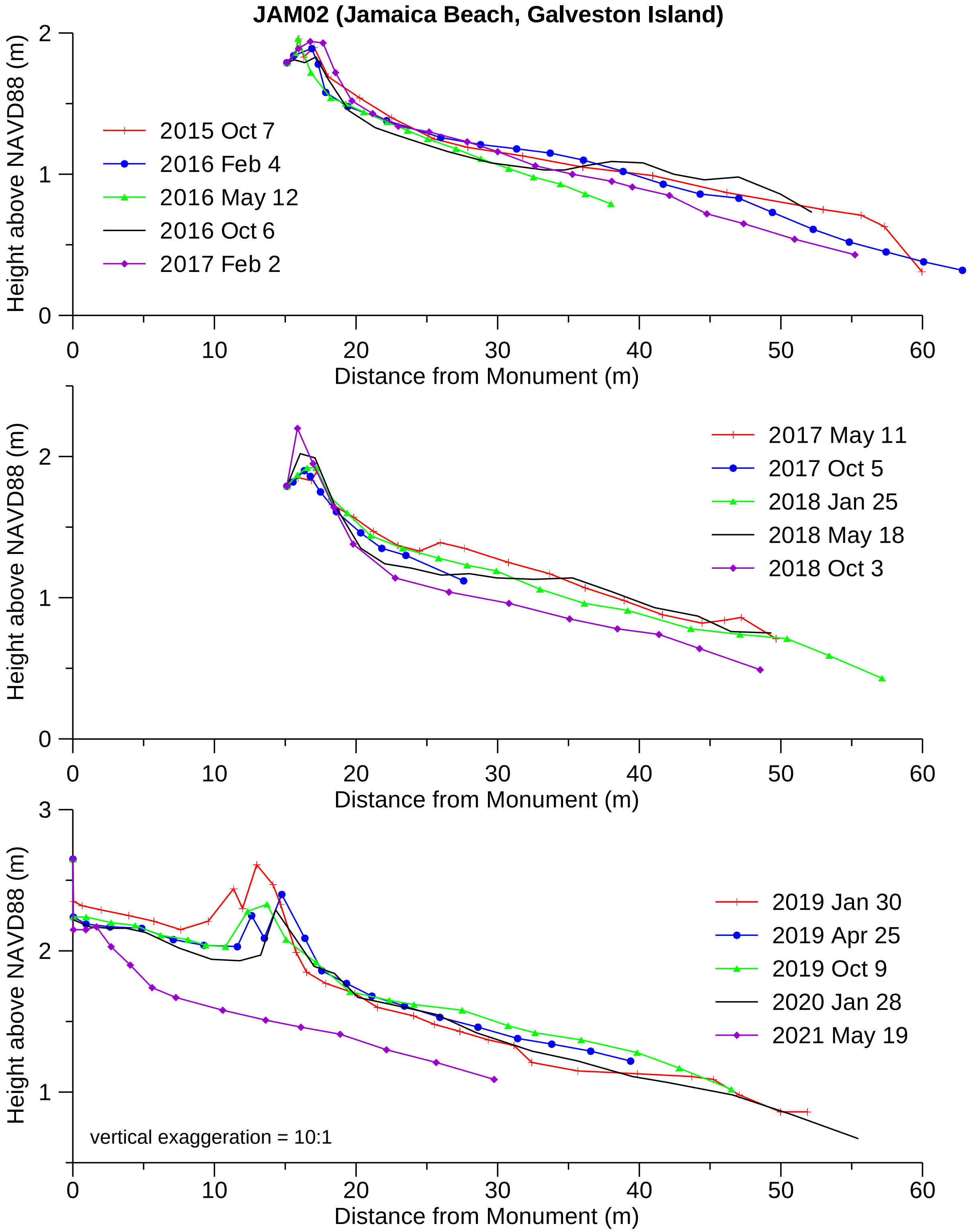



BEG02R (Galveston Island State Park)
Datum Reset
2018 May 18
2018 Oct 3
2019 Jan 30
2019 Apr 25
2019 Oct 9
Height above NAVD88 (m)
Distance from Monument (m)
2020 Jan 28
2021 May 19
2021 Nov 17
2022 Feb 2
vertical exaggeration = 10:1
Height above NAVD88 (m)
Distance from Monument (m)

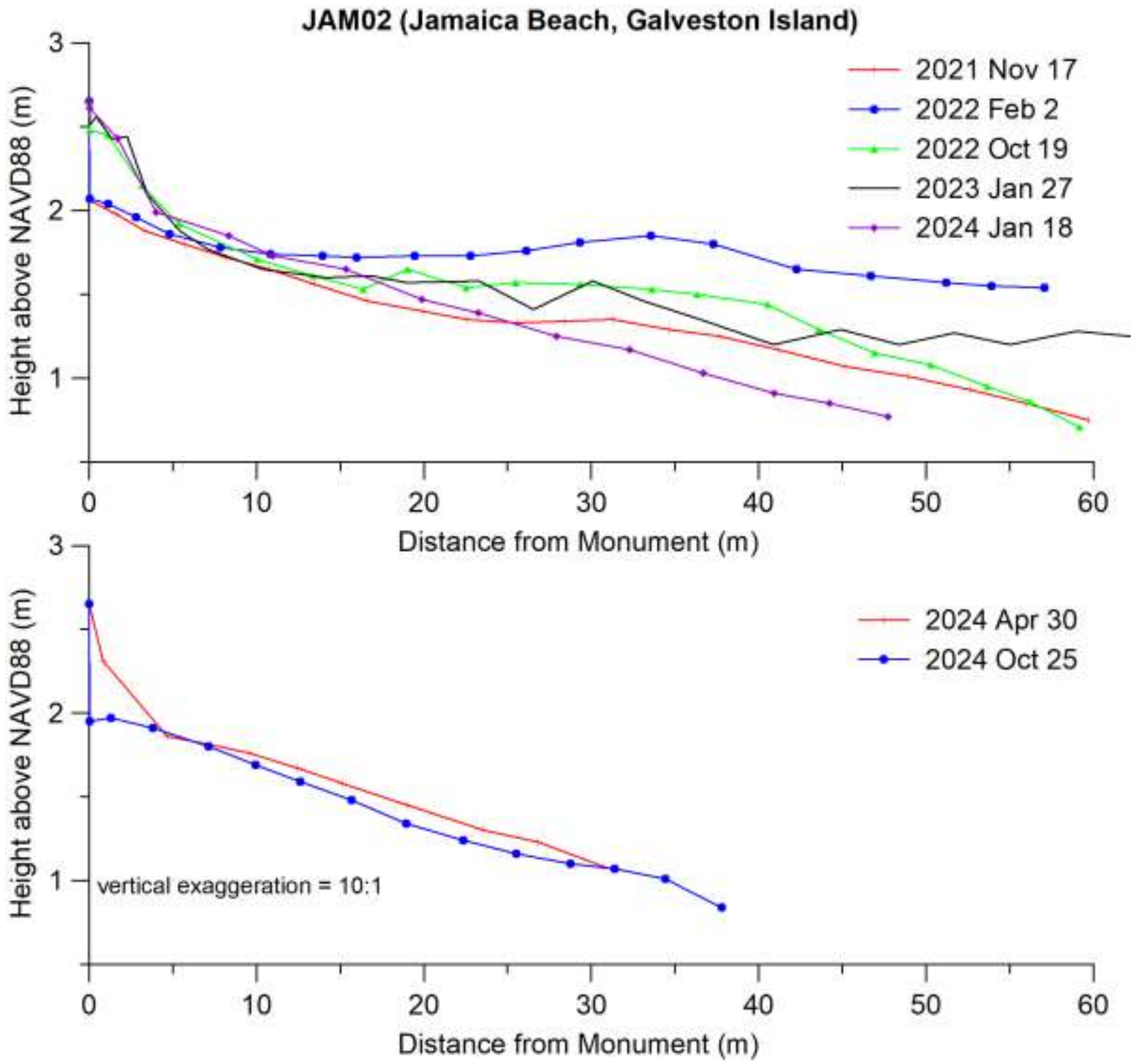
GISP1


GISP1 (Galveston Island State Park)
Height above NAVD88 (m)
3
2
1
0
0
20
40
60
80
Distance from Monument (m)
2023 Jan 27
2024 Jan 18
2024 Apr 30
2024 Oct 25
vertical exaggeration = 10:1

JAM02

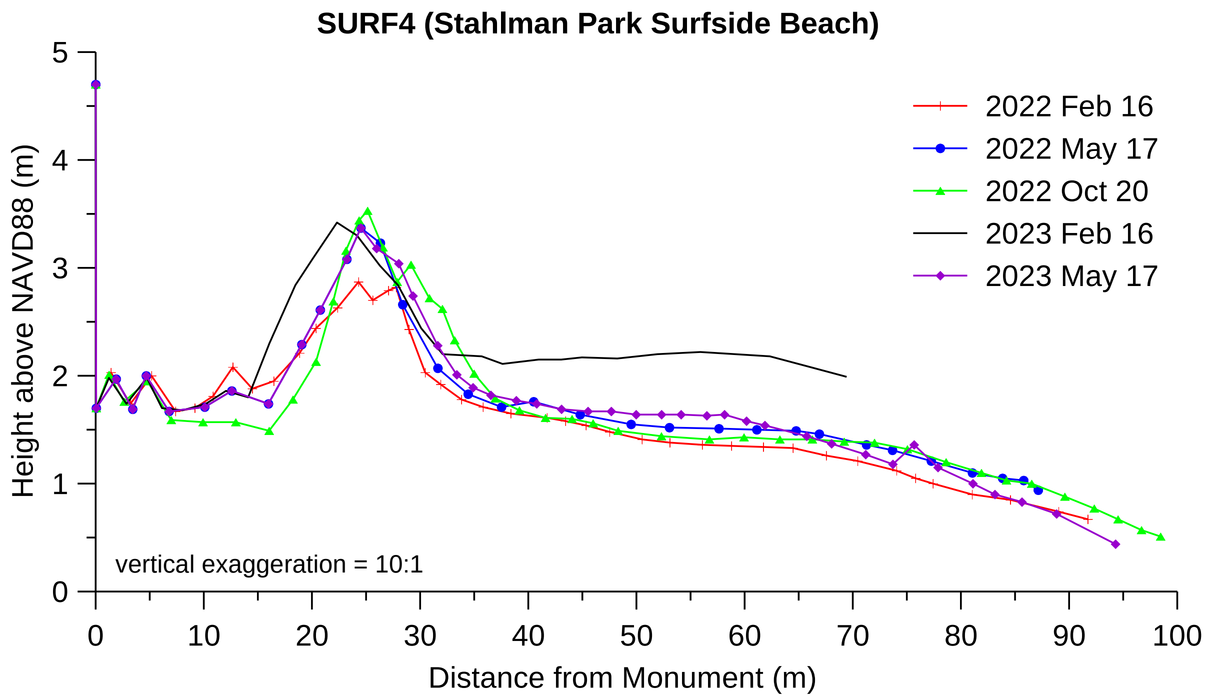


JAM02 (Jamaica Beach, Galveston Island)
Height above NAVD88 (m)
Distance from Monument (m)
2015 Oct 7
2016 Feb 4
2016 May 12
2016 Oct 6
2017 Feb 2
2017 May 11
2017 Oct 5
2018 Jan 25
2018 May 18
2018 Oct 3
2019 Jan 30
2019 Apr 25
2019 Oct 9
2020 Jan 28
2021 May 19
vertical exaggeration = 10:1

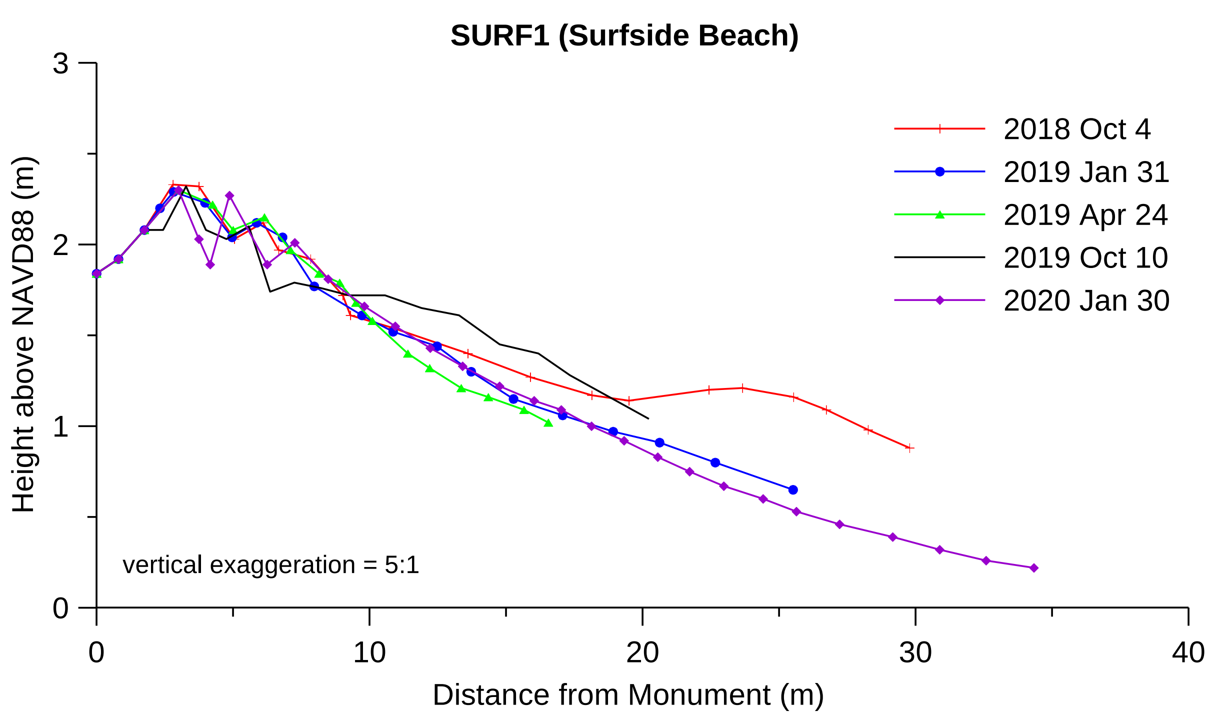


JAM02 (Jamaica Beach, Galveston Island)
2021 Nov 17
2022 Feb 2
2022 Oct 19
2023 Jan 27
2024 Jan 18
Height above NAVD88 (m)
Distance from Monument (m)
2024 Apr 30
2024 Oct 25
vertical exaggeration = 10:1
Height above NAVD88 (m)
Distance from Monument (m)

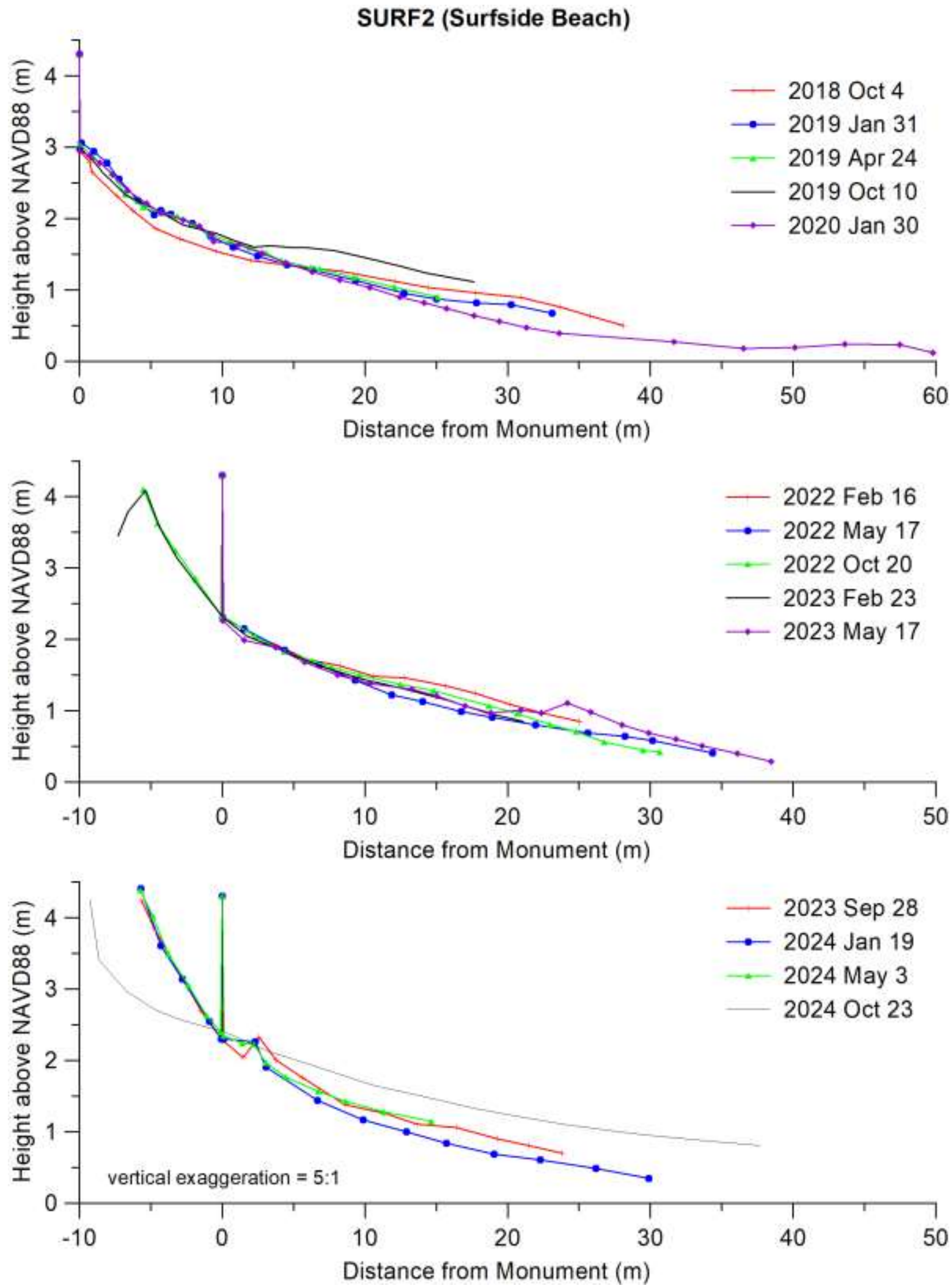
SURF4


SURF4 (Stahlman Park Surfside Beach)
Height above NAVD88 (m)
Distance from Monument (m)
2022 Feb 16
2022 May 17
2022 Oct 20
2023 Feb 16
2023 May 17
vertical exaggeration = 10:1
0
1
2
3
4
5
0
10
20
30
40
50
60
70
80
90
100

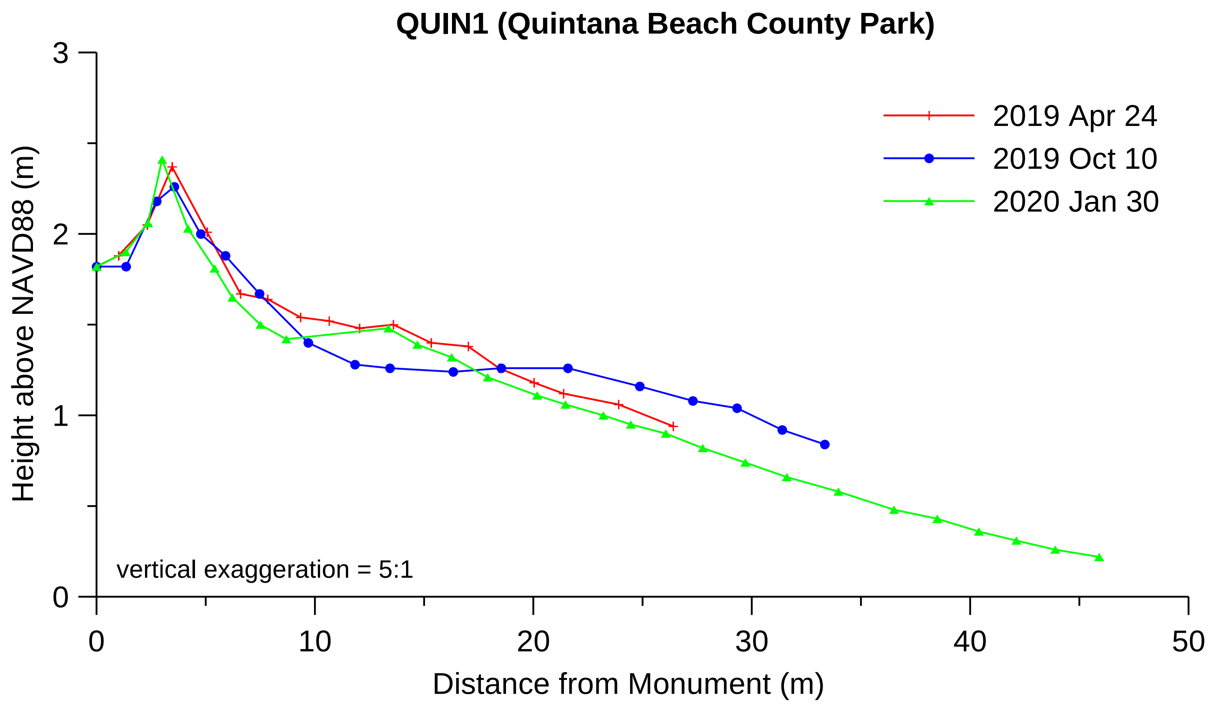
SURF1


SURF1 (Surfside Beach)
Height above NAVD88 (m)
Distance from Monument (m)
2018 Oct 4
2019 Jan 31
2019 Apr 24
2019 Oct 10
2020 Jan 30
vertical exaggeration = 5:1
0
1
2
3
0
10
20
30
40

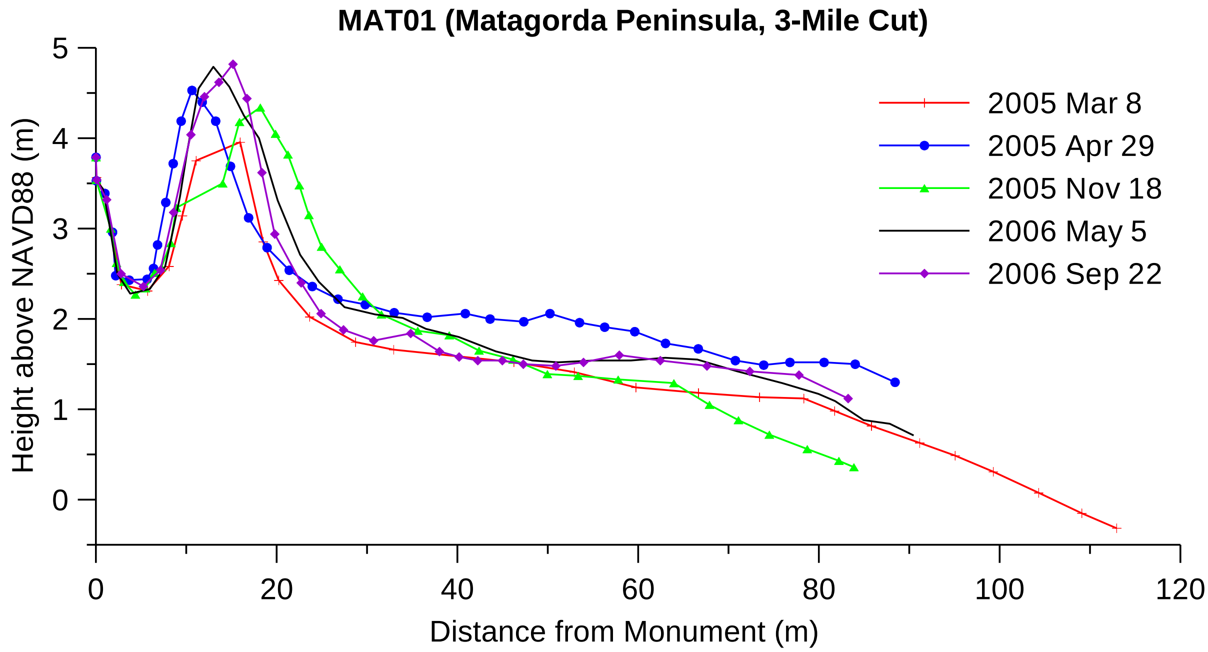
SURF2

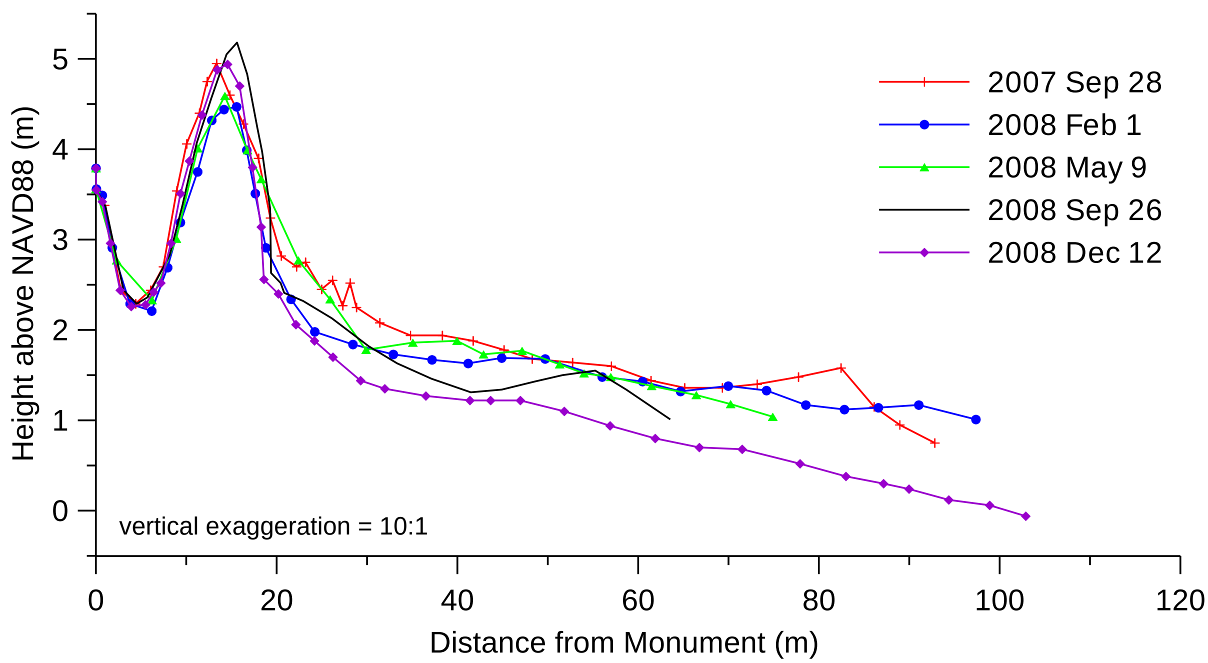

SURF2 (Surfside Beach)
Height above NAVD88 (m)
Distance from Monument (m)
2018 Oct 4
2019 Jan 31
2019 Apr 24
2019 Oct 10
2020 Jan 30
2022 Feb 16
2022 May 17
2022 Oct 20
2023 Feb 23
2023 May 17
2023 Sep 28
2024 Jan 19
2024 May 3
2024 Oct 23
vertical exaggeration = 5:1

QUIN1

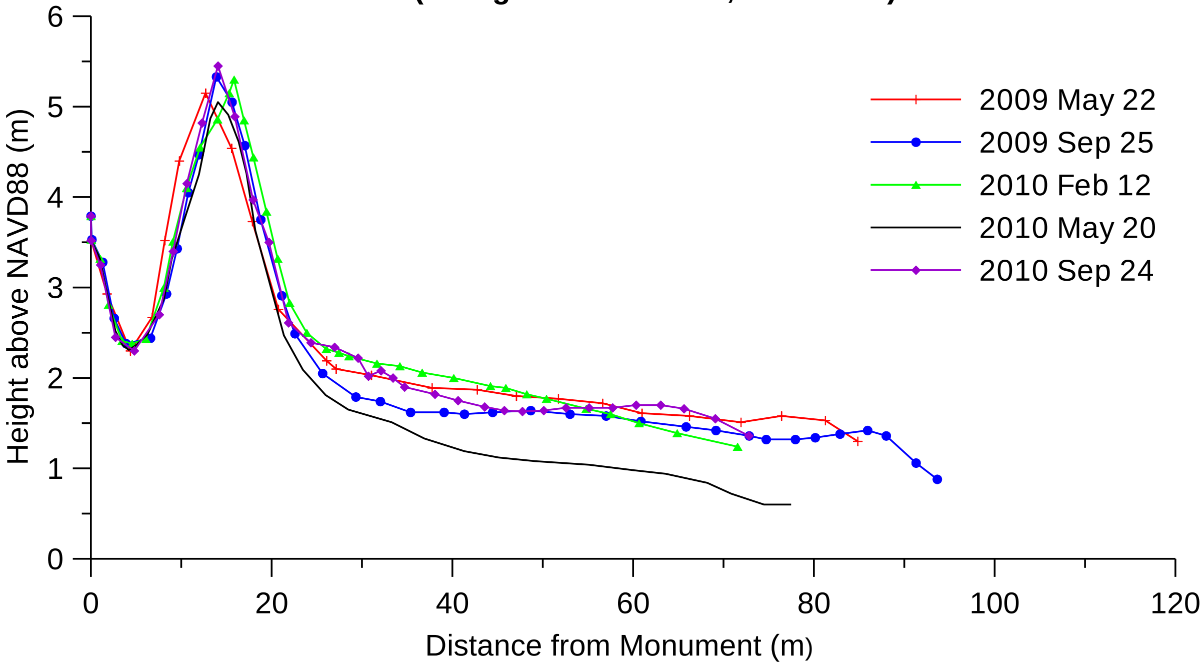

QUIN1 (Quintana Beach County Park)
Height above NAVD88 (m)
Distance from Monument (m)
2019 Apr 24
2019 Oct 10
2020 Jan 30
vertical exaggeration = 5:1
0
1
2
3
0
10
20
30
40
50

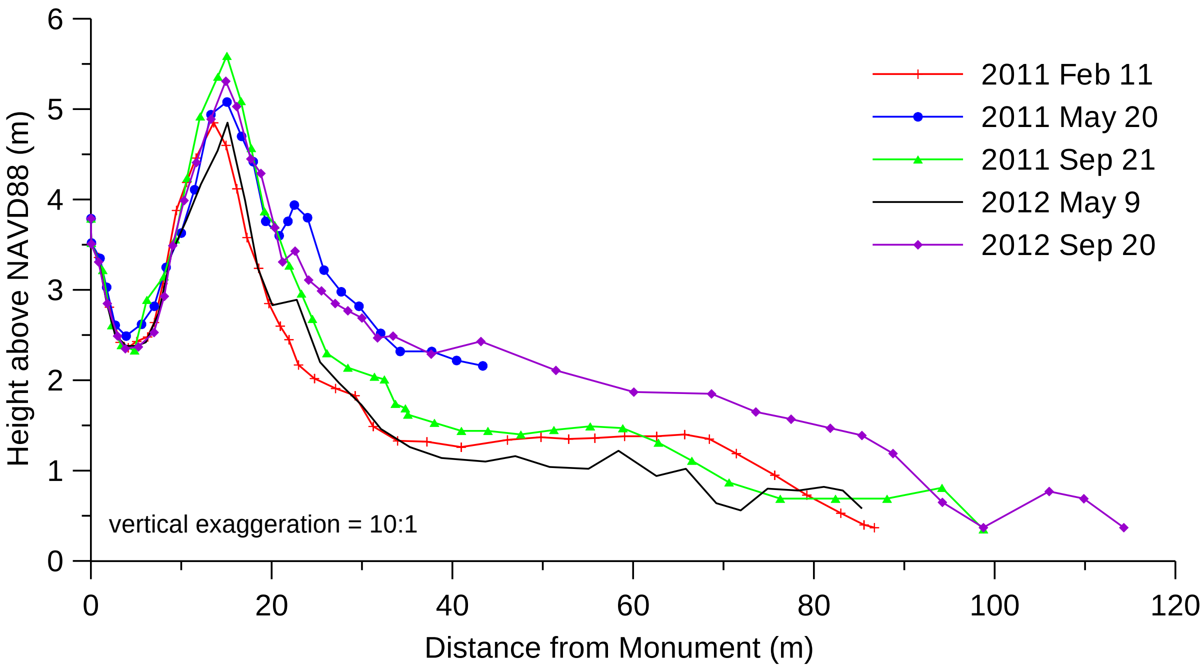
MAT01

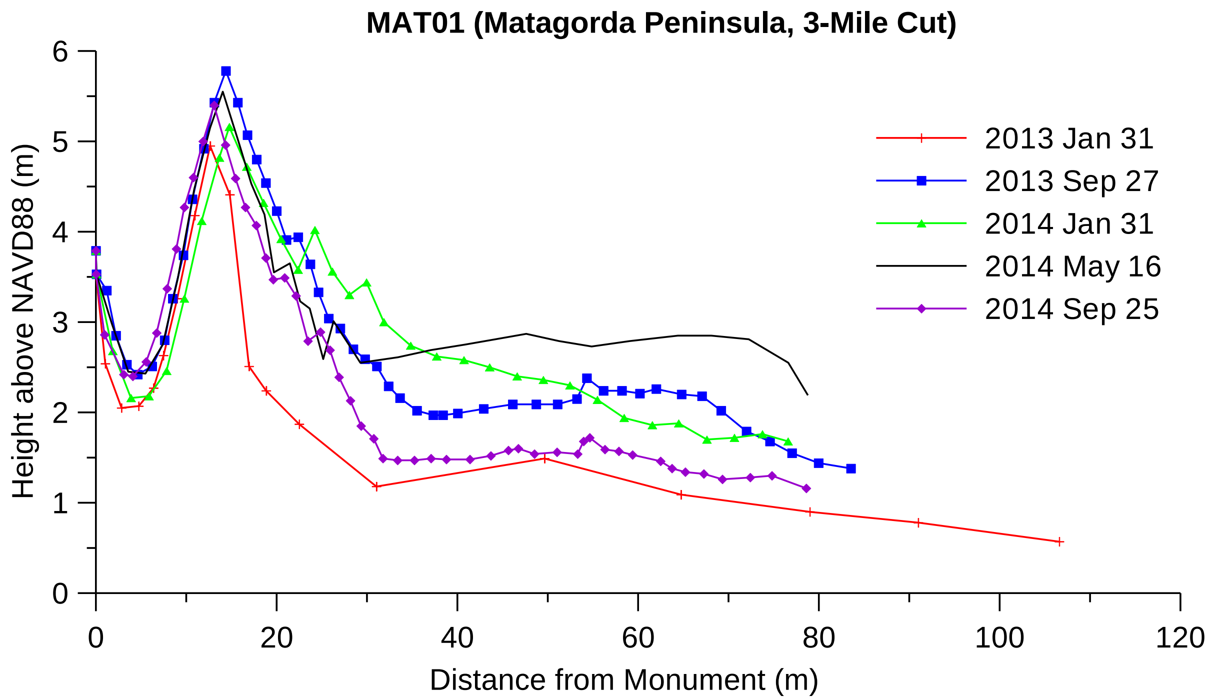

MAT01 (Matagorda Peninsula, 3-Mile Cut)
Height above NAVD88 (m)
Distance from Monument (m)
2005 Mar 8
2005 Apr 29
2005 Nov 18
2006 May 5
2006 Sep 22
0
1
2
3
4
5
0
20
40
60
80
100
120

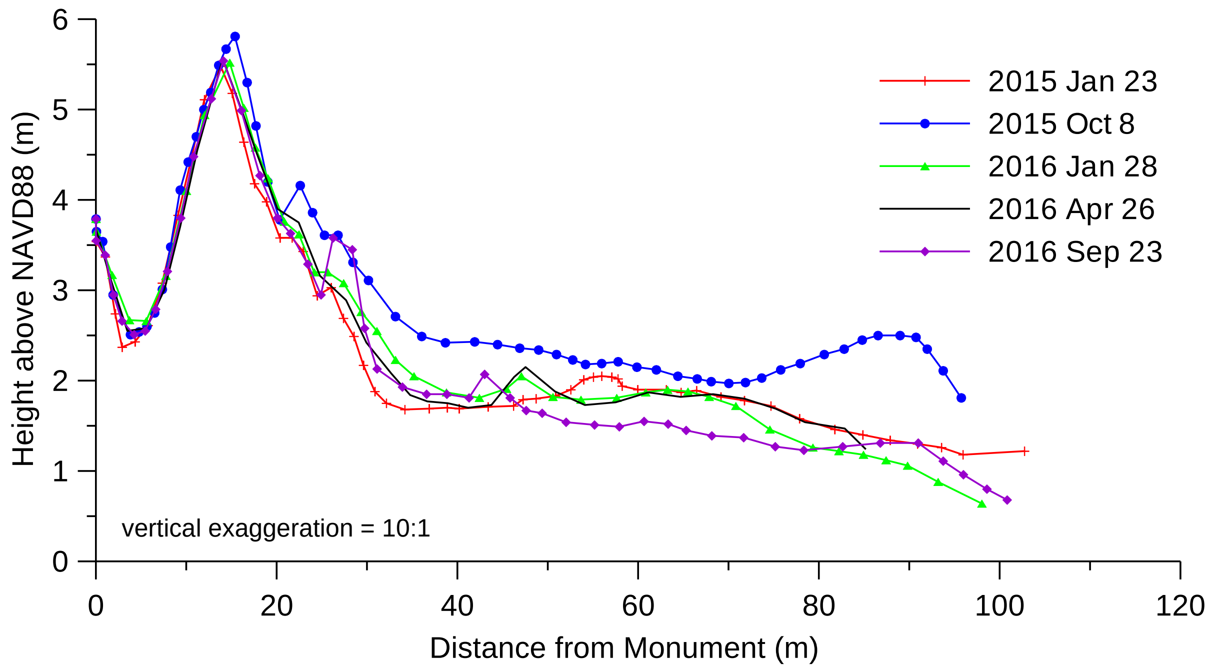

Height above NAVD88 (m)
Distance from Monument (m)
2007 Sep 28
2008 Feb 1
2008 May 9
2008 Sep 26
2008 Dec 12
vertical exaggeration = 10:1
0
1
2
3
4
5
0
20
40
60
80
100
120

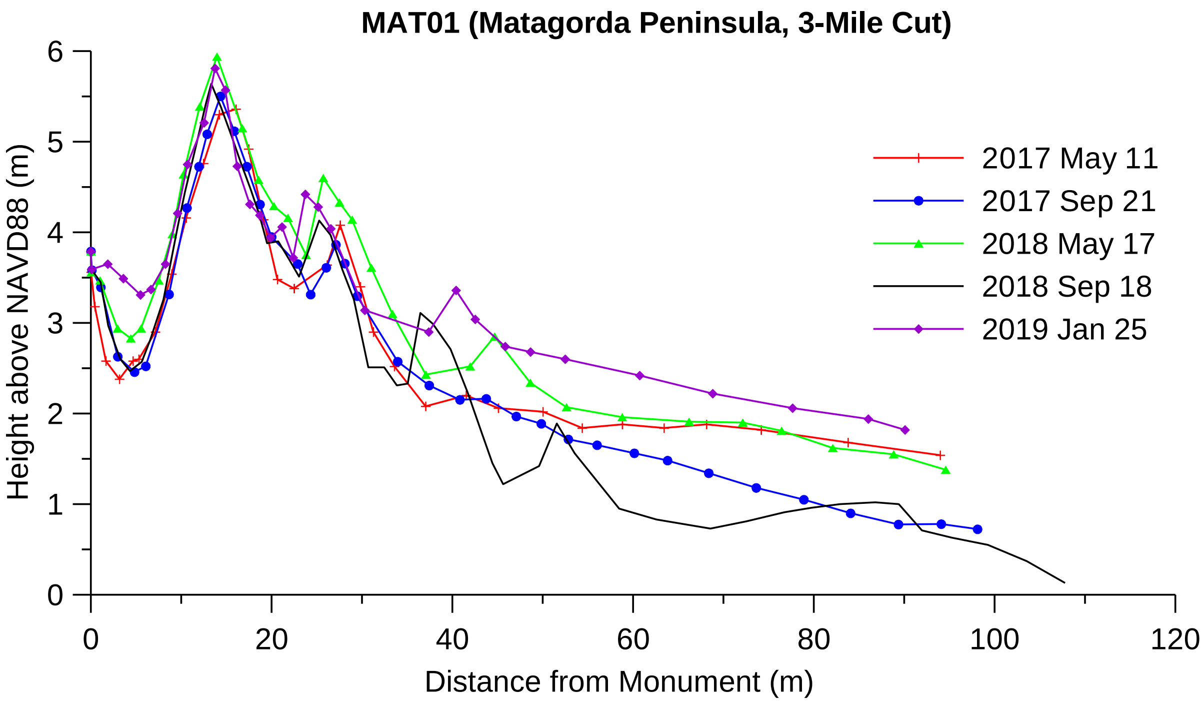
MAT01 (Matagorda Peninsula, 3-Mile Cut)

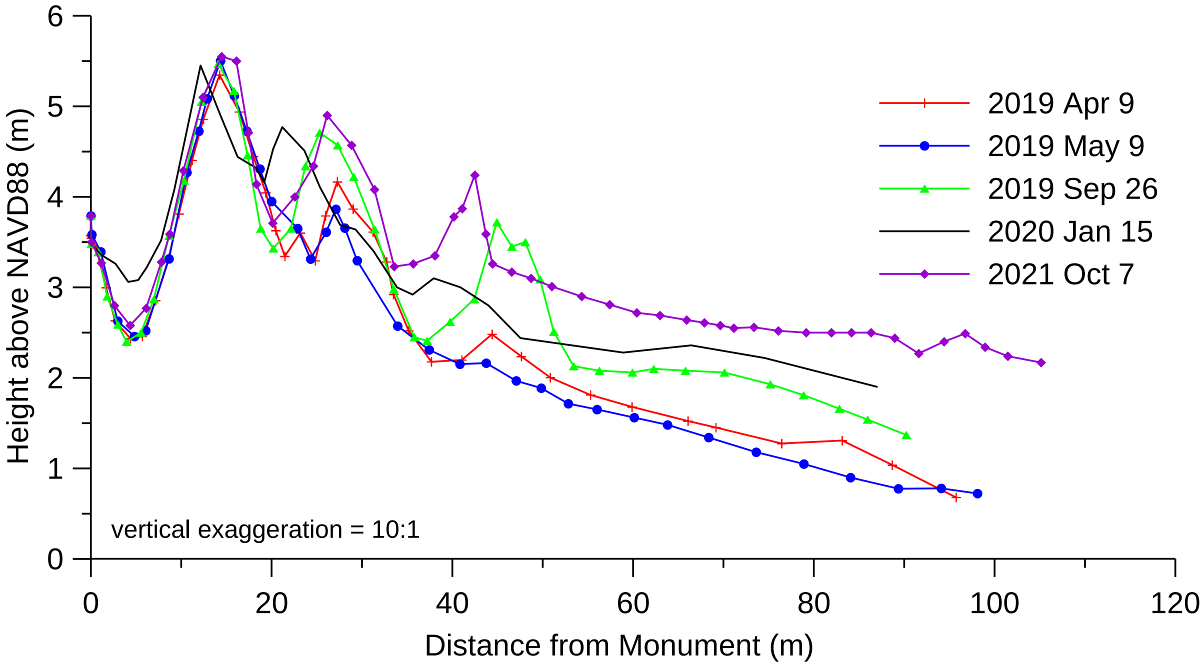


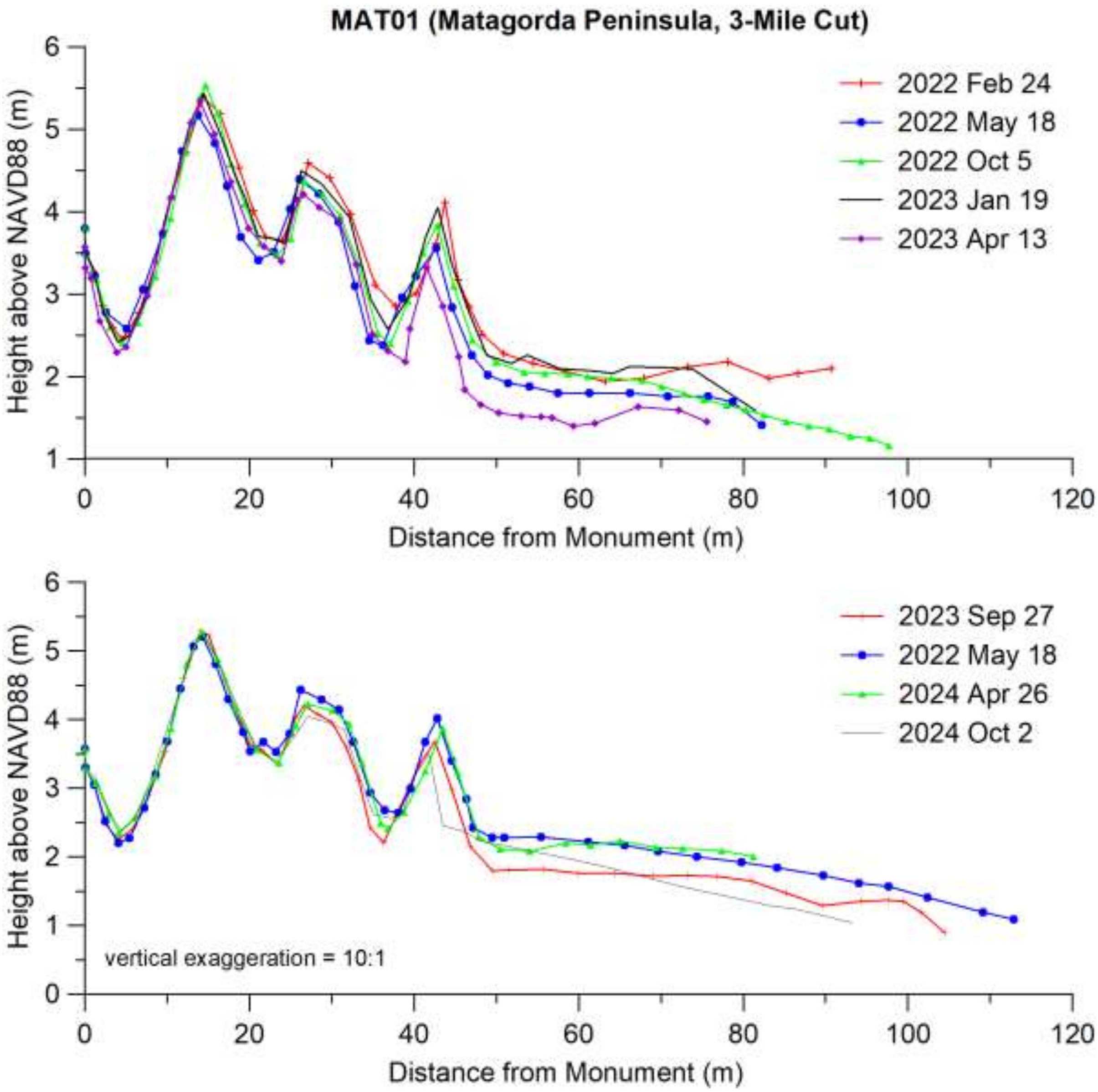



MAT01 (Matagorda Peninsula, 3-Mile Cut)
Height above NAVD88 (m)
Distance from Monument (m)
2013 Jan 31
2013 Sep 27
2014 Jan 31
2014 May 16
2014 Sep 25
0
1
2
3
4
5
6
0
20
40
60
80
100
120

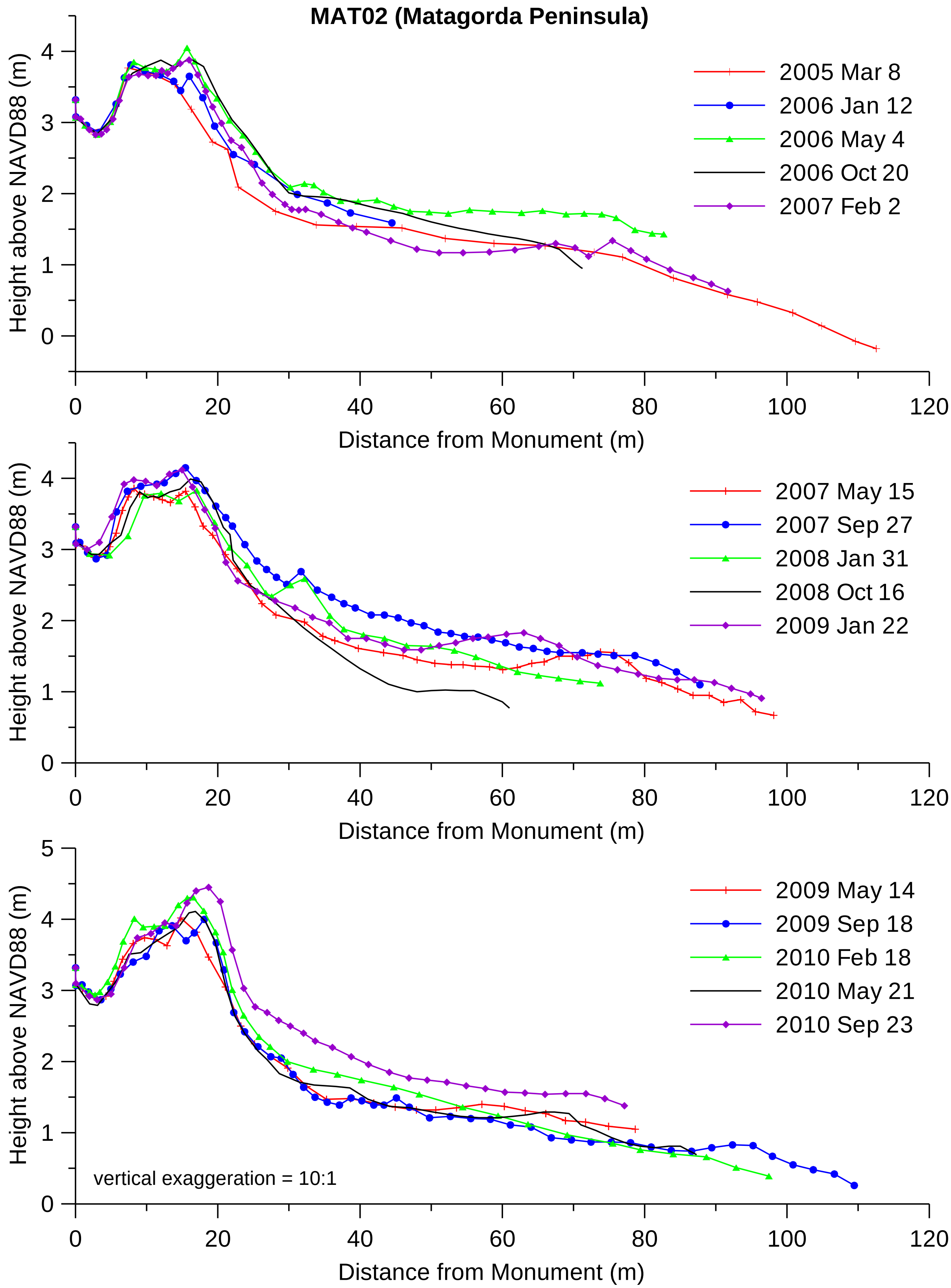

Height above NAVD88 (m)
Distance from Monument (m)
2015 Jan 23
2015 Oct 8
2016 Jan 28
2016 Apr 26
2016 Sep 23
vertical exaggeration = 10:1
0
1
2
3
4
5
6
0
20
40
60
80
100
120


MAT01 (Matagorda Peninsula, 3-Mile Cut)
Height above NAVD88 (m)
Distance from Monument (m)
2017 May 11
2017 Sep 21
2018 May 17
2018 Sep 18
2019 Jan 25
0
1
2
3
4
5
6
0
20
40
60
80
100
120

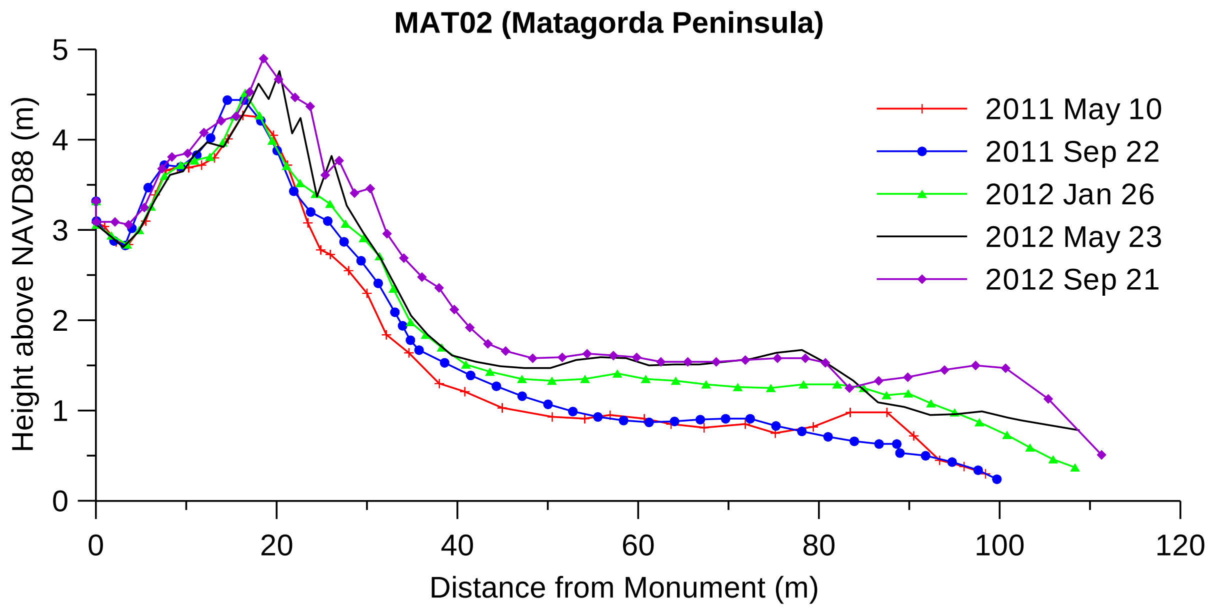

Height above NAVD88 (m)
Distance from Monument (m)
2019 Apr 9
2019 May 9
2019 Sep 26
2020 Jan 15
2021 Oct 7
vertical exaggeration = 10:1
0
1
2
3
4
5
6
0
20
40
60
80
100
120

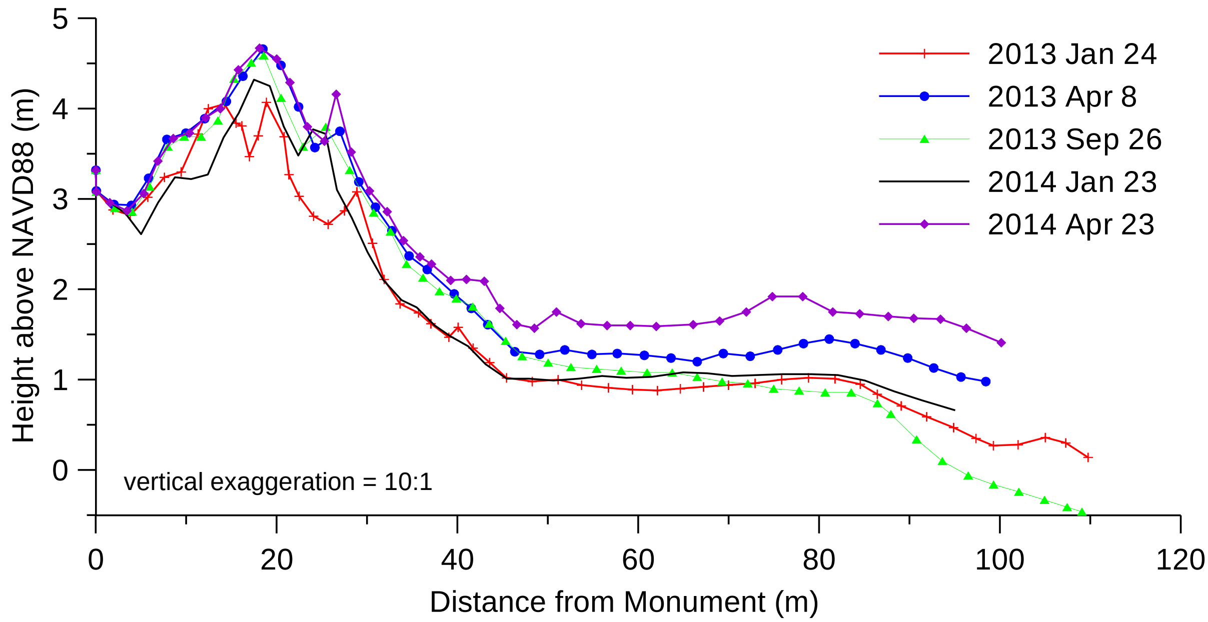

MAT01 (Matagorda Peninsula, 3-Mile Cut)
Height above NAVD88 (m)
Distance from Monument (m)
2022 Feb 24
2022 May 18
2022 Oct 5
2023 Jan 19
2023 Apr 13
2023 Sep 27
2022 May 18
2024 Apr 26
2024 Oct 2
vertical exaggeration = 10:1

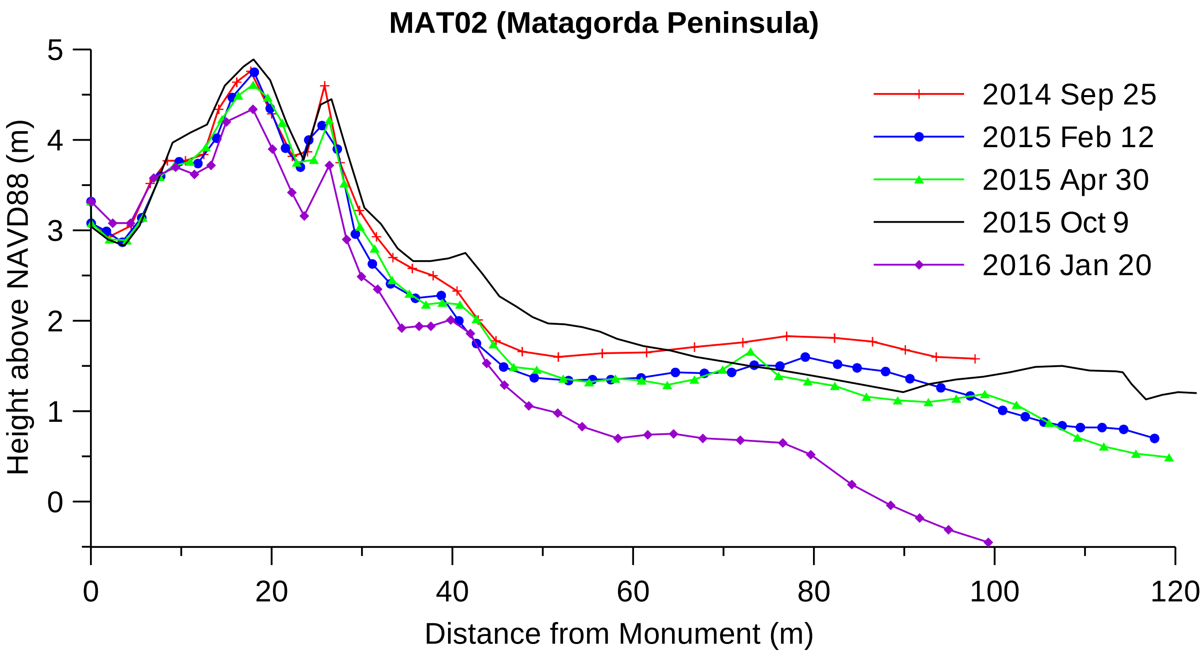
MAT02

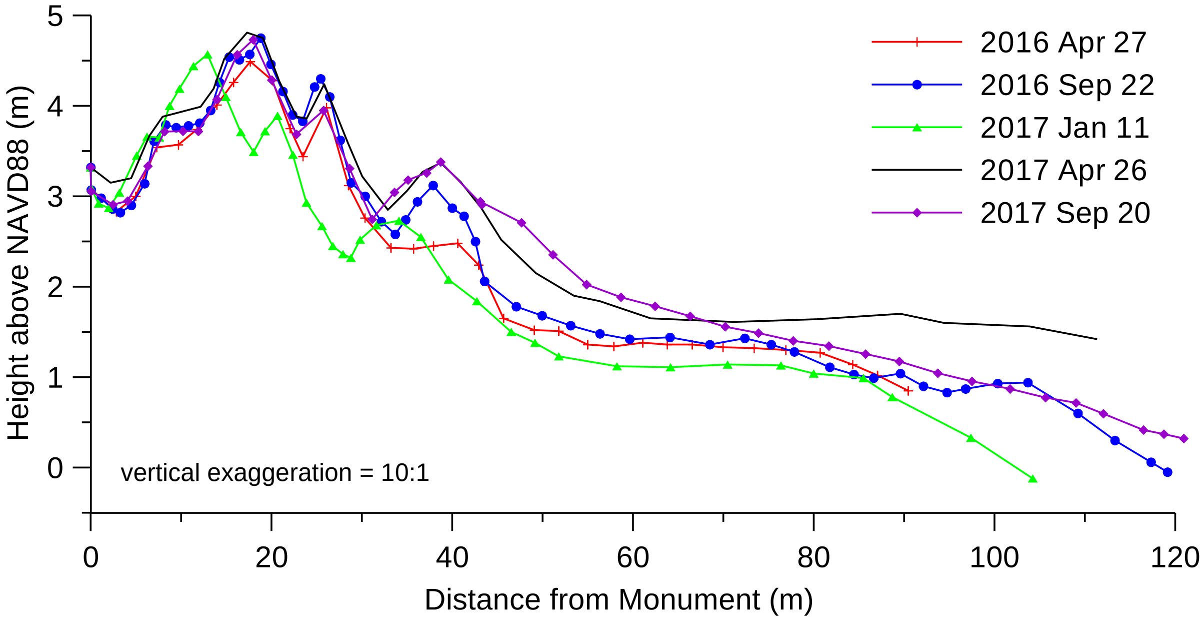


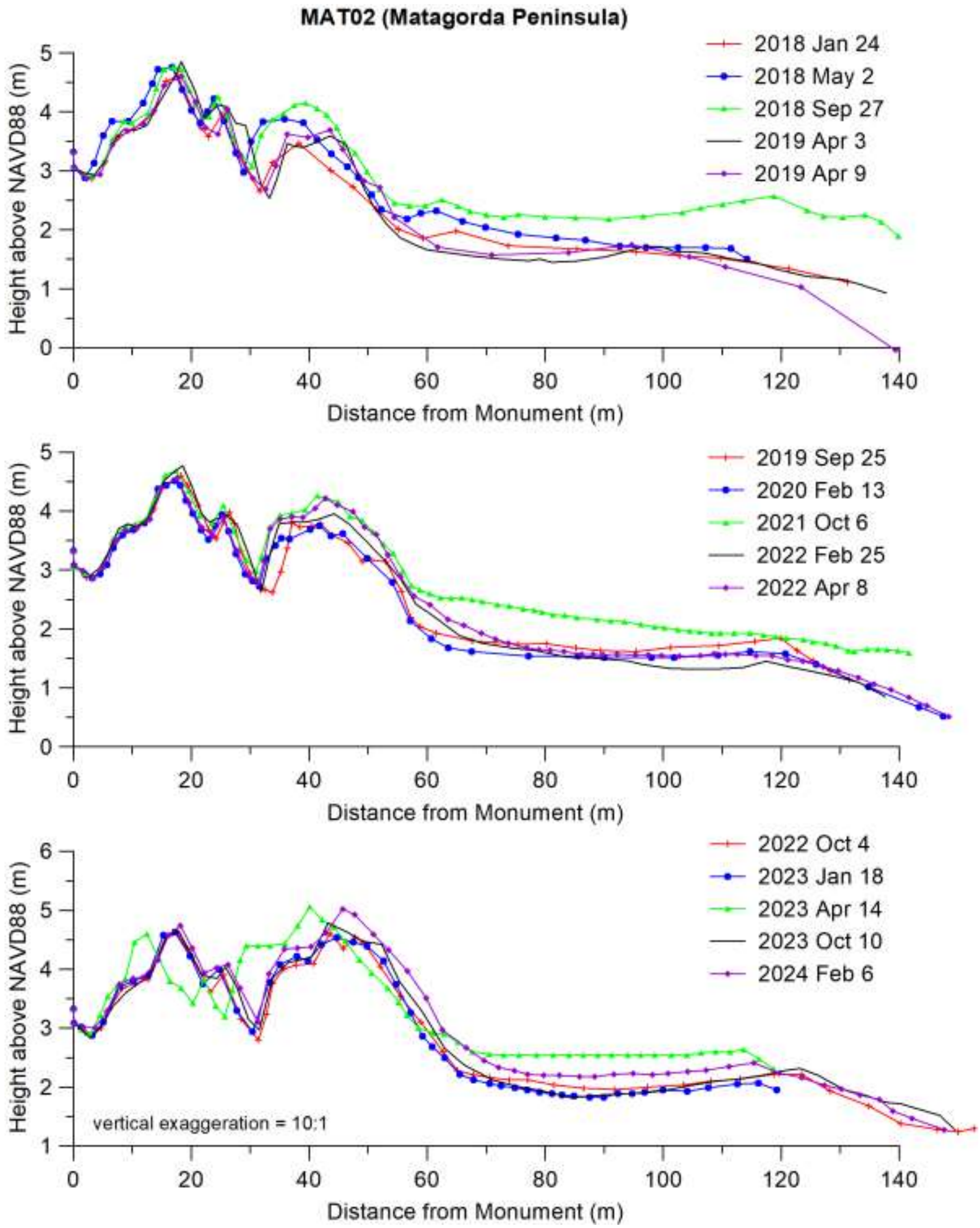
MAT02 (Matagorda Peninsula)
Height above NAVD88 (m)
Distance from Monument (m)
2005 Mar 8
2006 Jan 12
2006 May 4
2006 Oct 20
2007 Feb 2
2007 May 15
2007 Sep 27
2008 Jan 31
2008 Oct 16
2009 Jan 22
2009 May 14
2009 Sep 18
2010 Feb 18
2010 May 21
2010 Sep 23
vertical exaggeration = 10:1

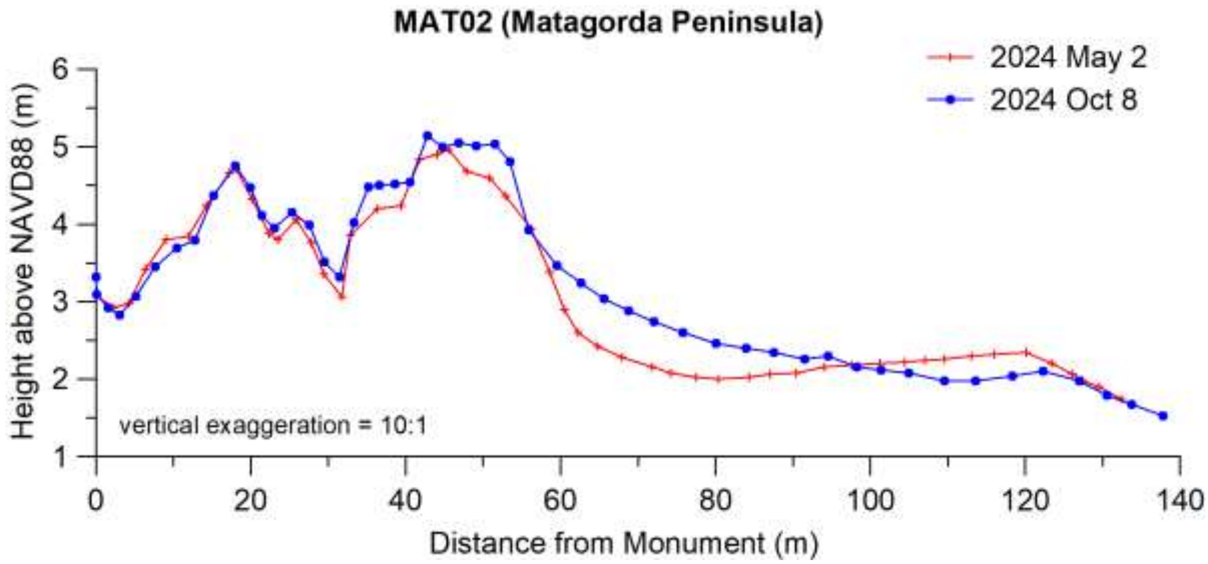

MAT02 (Matagorda Peninsula)
Height above NAVD88 (m)
Distance from Monument (m)
2011 May 10
2011 Sep 22
2012 Jan 26
2012 May 23
2012 Sep 21
0
1
2
3
4
5
0
20
40
60
80
100
120


Height above NAVD88 (m)
Distance from Monument (m)
2013 Jan 24
2013 Apr 8
2013 Sep 26
2014 Jan 23
2014 Apr 23
vertical exaggeration = 10:1
0
1
2
3
4
5
0
20
40
60
80
100
120

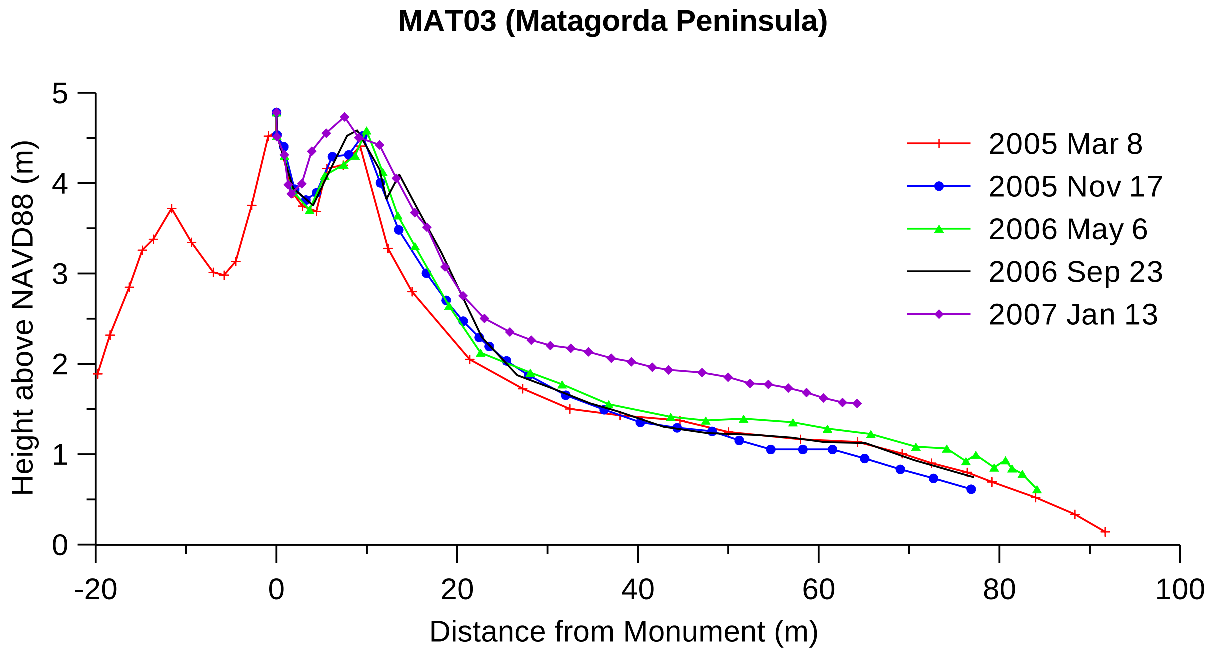

MAT02 (Matagorda Peninsula)
Height above NAVD88 (m)
Distance from Monument (m)
2014 Sep 25
2015 Feb 12
2015 Apr 30
2015 Oct 9
2016 Jan 20


Height above NAVD88 (m)
Distance from Monument (m)
2016 Apr 27
2016 Sep 22
2017 Jan 11
2017 Apr 26
2017 Sep 20
vertical exaggeration = 10:1

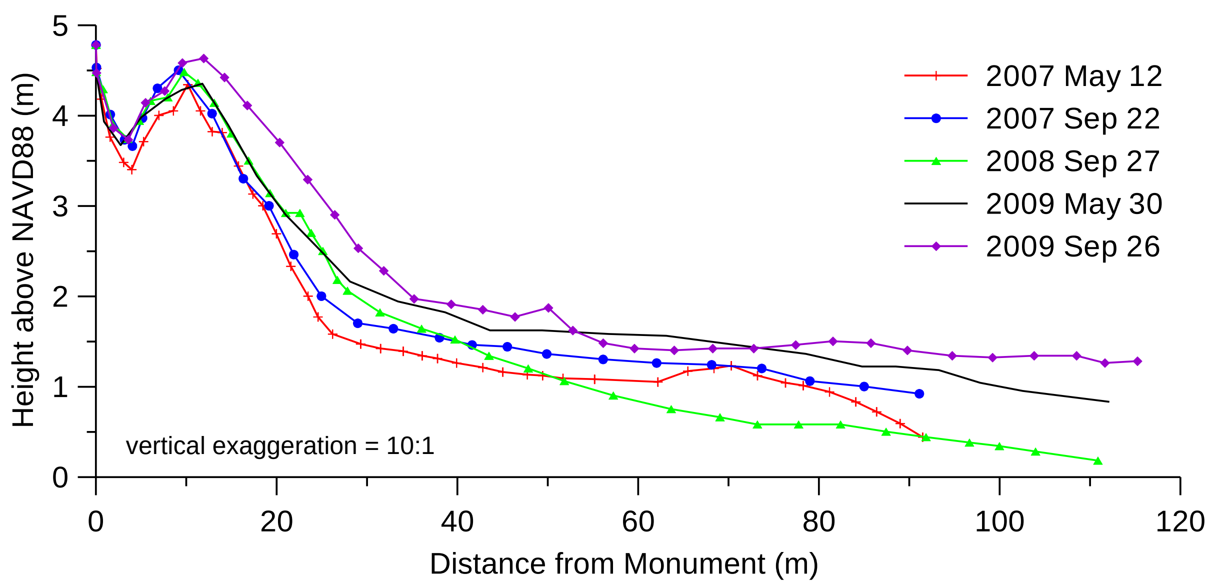

MAT02 (Matagorda Peninsula)
2018 Jan 24
2018 May 2
2018 Sep 27
2019 Apr 3
2019 Apr 9
Height above NAVD88 (m)
Distance from Monument (m)
2019 Sep 25
2020 Feb 13
2021 Oct 6
2022 Feb 25
2022 Apr 8
Height above NAVD88 (m)
Distance from Monument (m)
2022 Oct 4
2023 Jan 18
2023 Apr 14
2023 Oct 10
2024 Feb 6
vertical exaggeration = 10:1
Height above NAVD88 (m)
Distance from Monument (m)


MAT02 (Matagorda Peninsula)
2024 May 2
2024 Oct 8
Height above NAVD88 (m)
6
5
4
3
2
1
vertical exaggeration = 10:1
0
20
40
60
80
100
120
140
Distance from Monument (m)

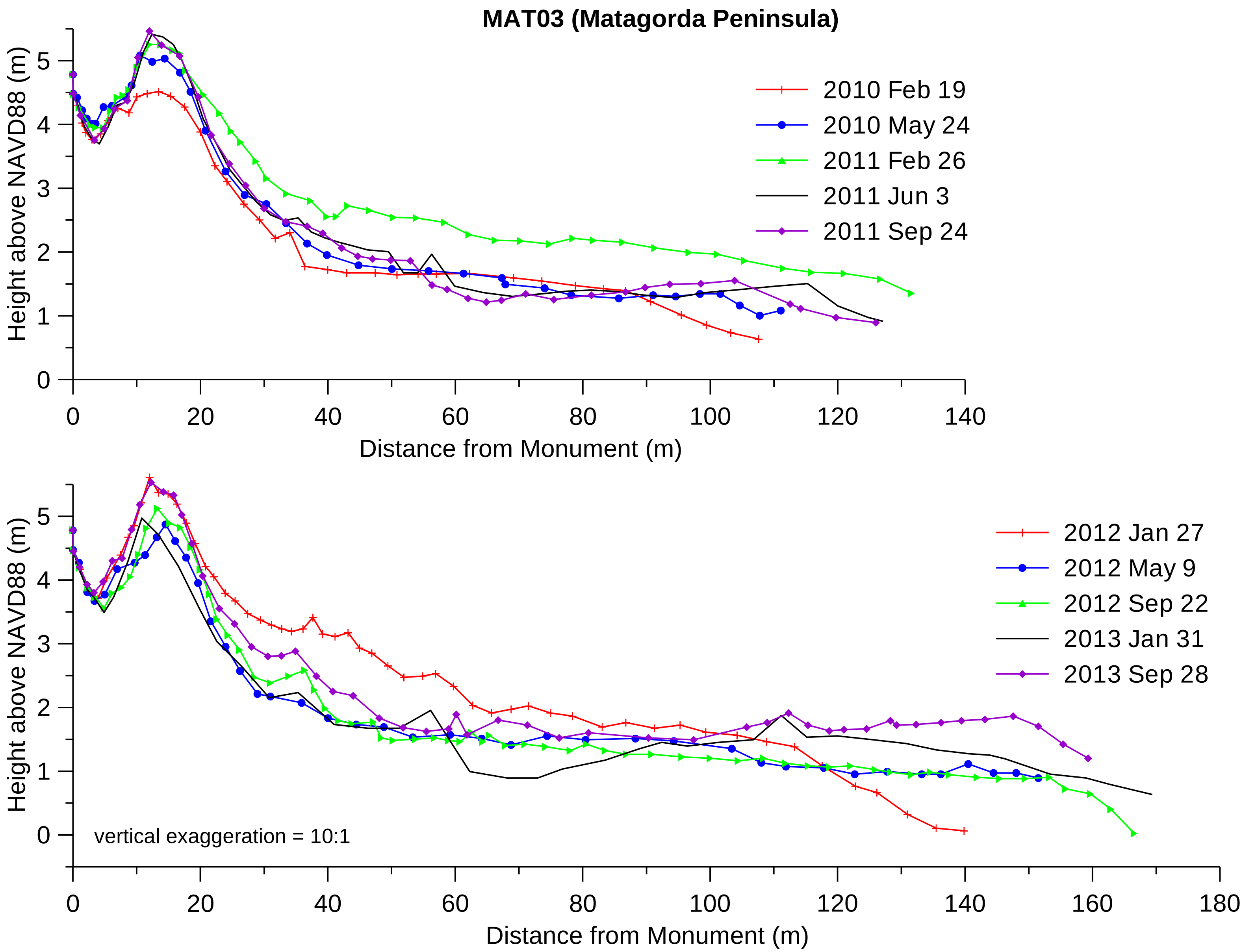
MAT03

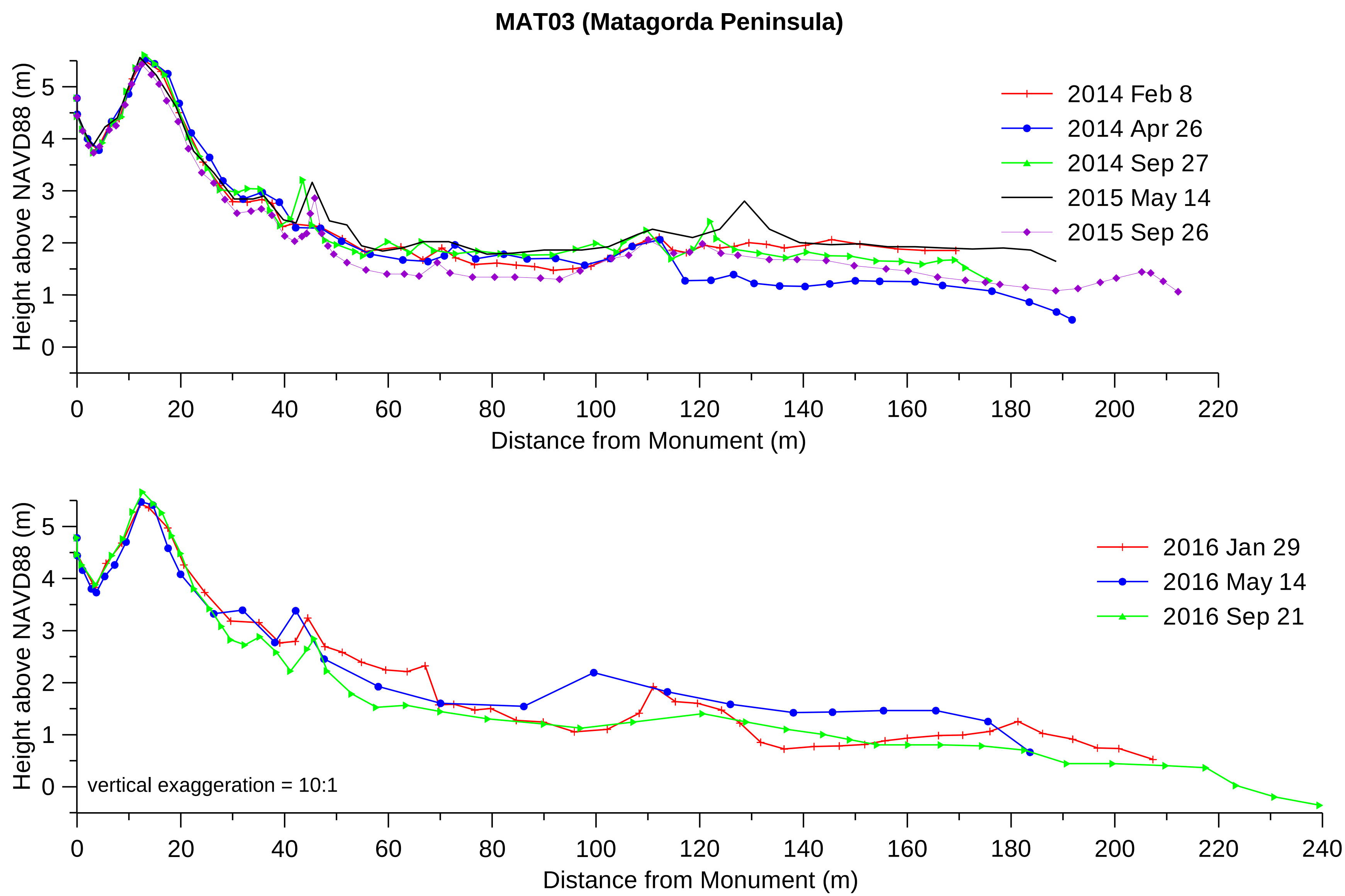


MAT03 (Matagorda Peninsula)
Height above NAVD88 (m)
Distance from Monument (m)
2005 Mar 8
2005 Nov 17
2006 May 6
2006 Sep 23
2007 Jan 13
0
1
2
3
4
5
-20
0
20
40
60
80
100

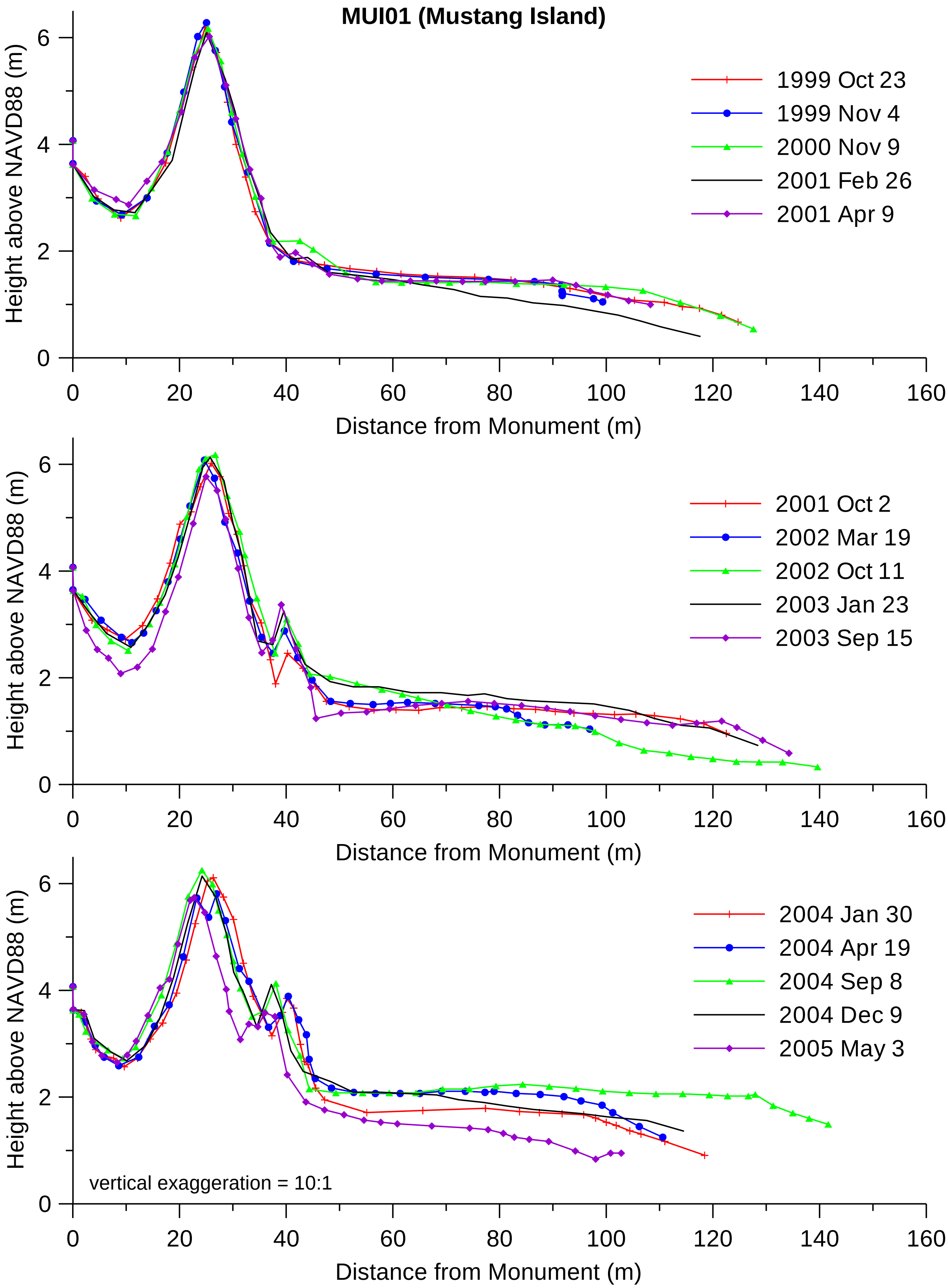


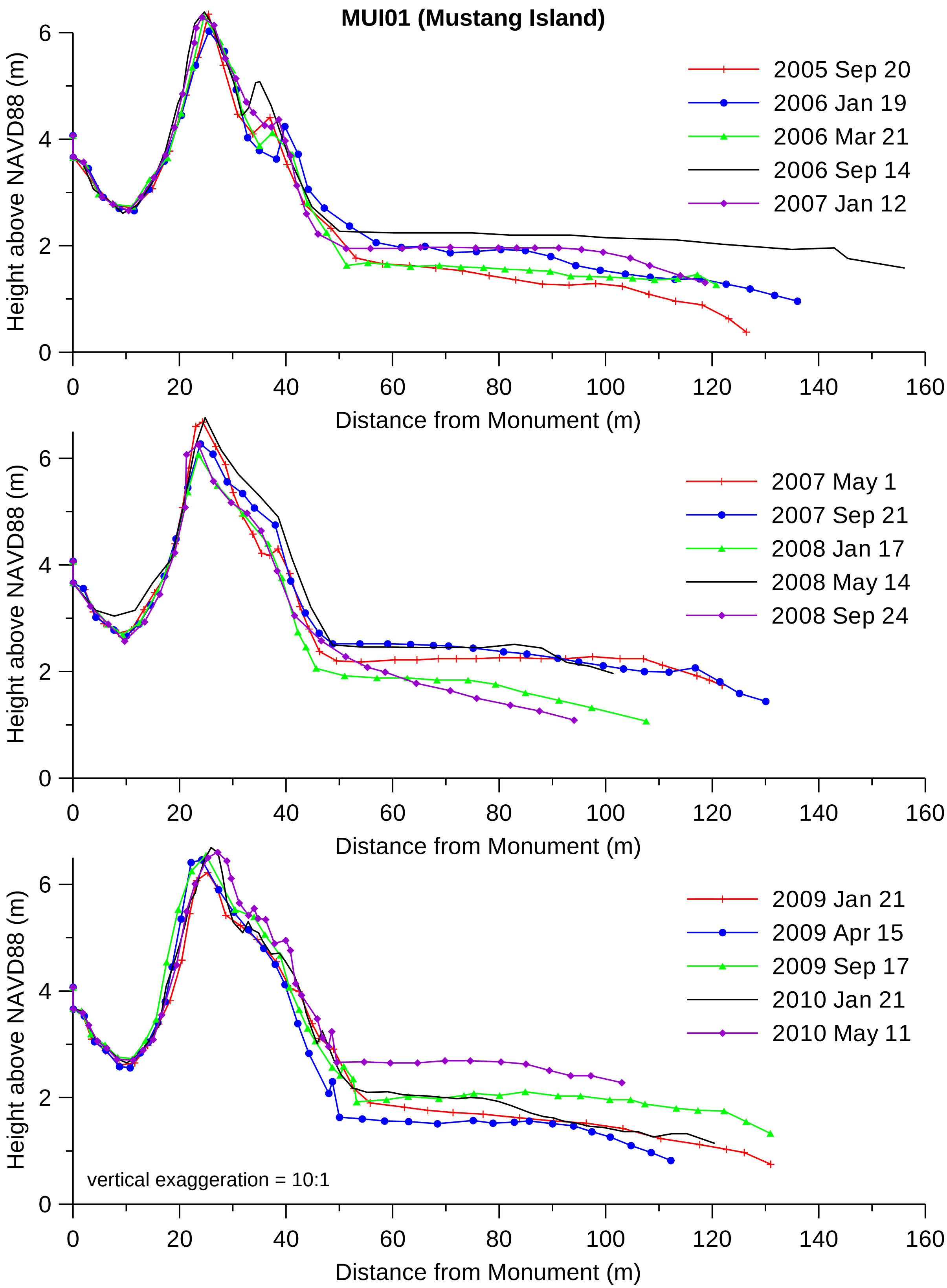
Height above NAVD88 (m)
Distance from Monument (m)
2007 May 12
2007 Sep 22
2008 Sep 27
2009 May 30
2009 Sep 26
vertical exaggeration = 10:1
0
1
2
3
4
5
0
20
40
60
80
100
120

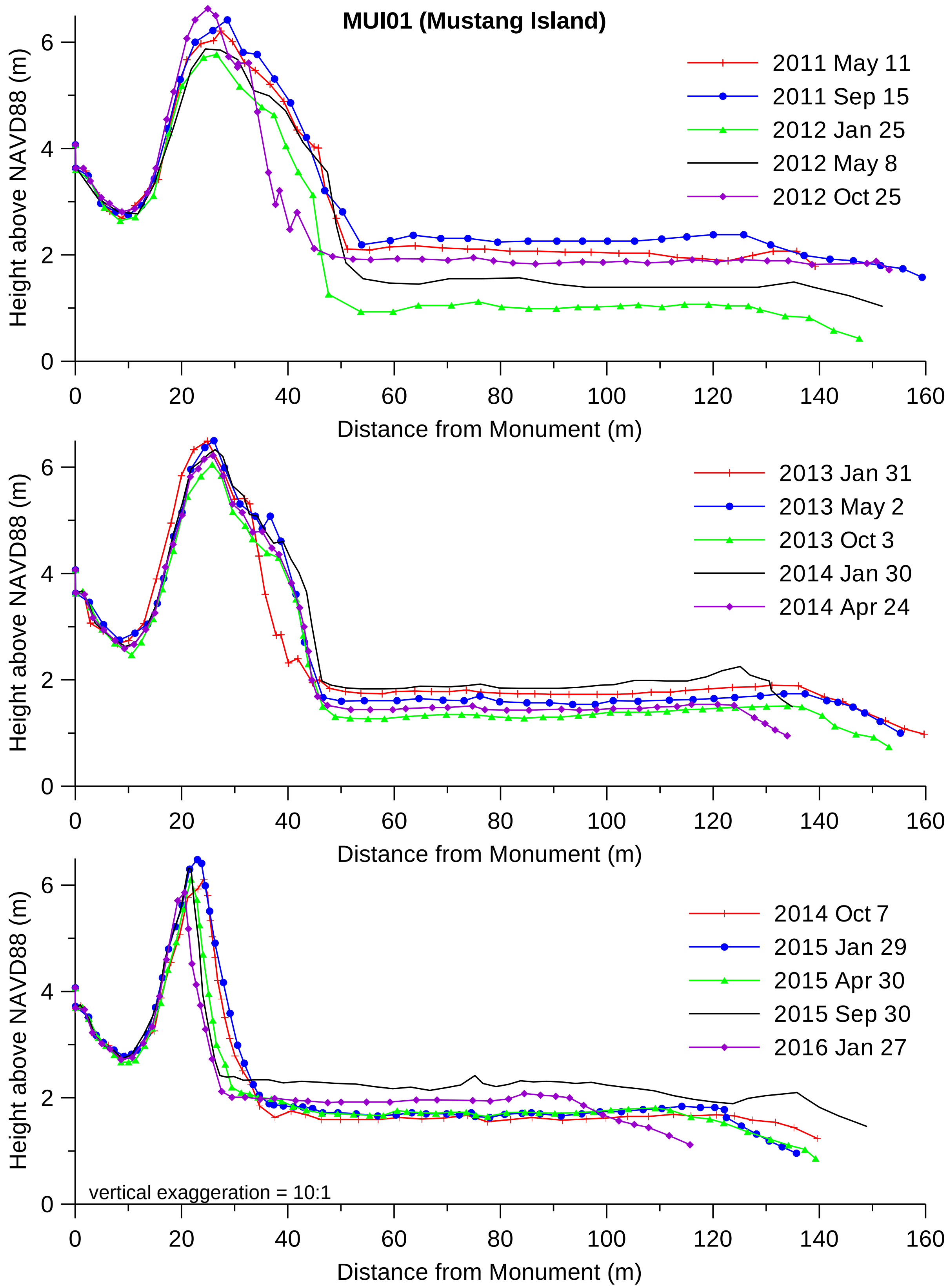

MAT03 (Matagorda Peninsula)
2010 Feb 19
2010 May 24
2011 Feb 26
2011 Jun 3
2011 Sep 24
Height above NAVD88 (m)
Distance from Monument (m)
2012 Jan 27
2012 May 9
2012 Sep 22
2013 Jan 31
2013 Sep 28
vertical exaggeration = 10:1

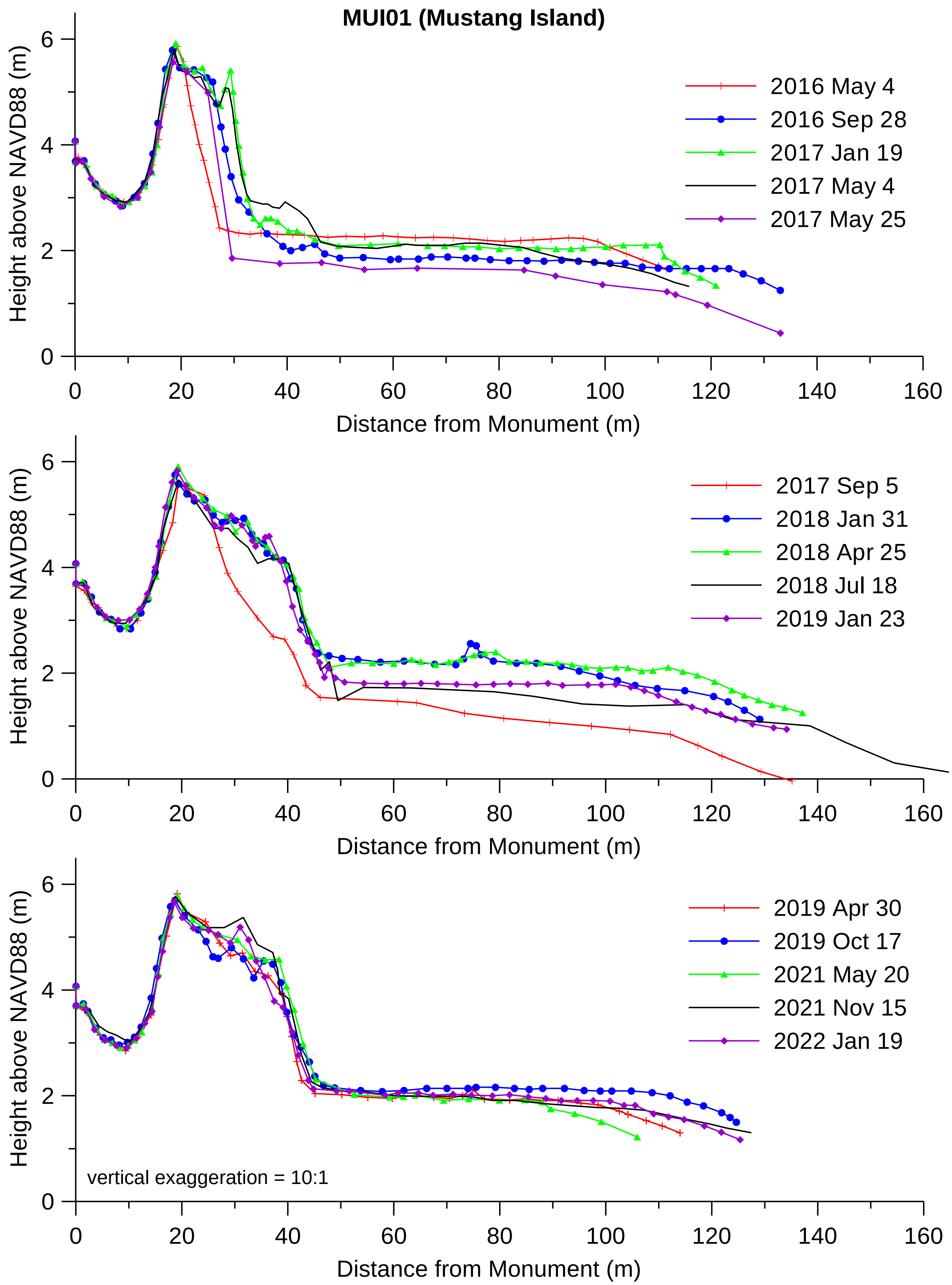

MAT03 (Matagorda Peninsula)
Height above NAVD88 (m)
Distance from Monument (m)
2014 Feb 8
2014 Apr 26
2014 Sep 27
2015 May 14
2015 Sep 26
2016 Jan 29
2016 May 14
2016 Sep 21
vertical exaggeration = 10:1

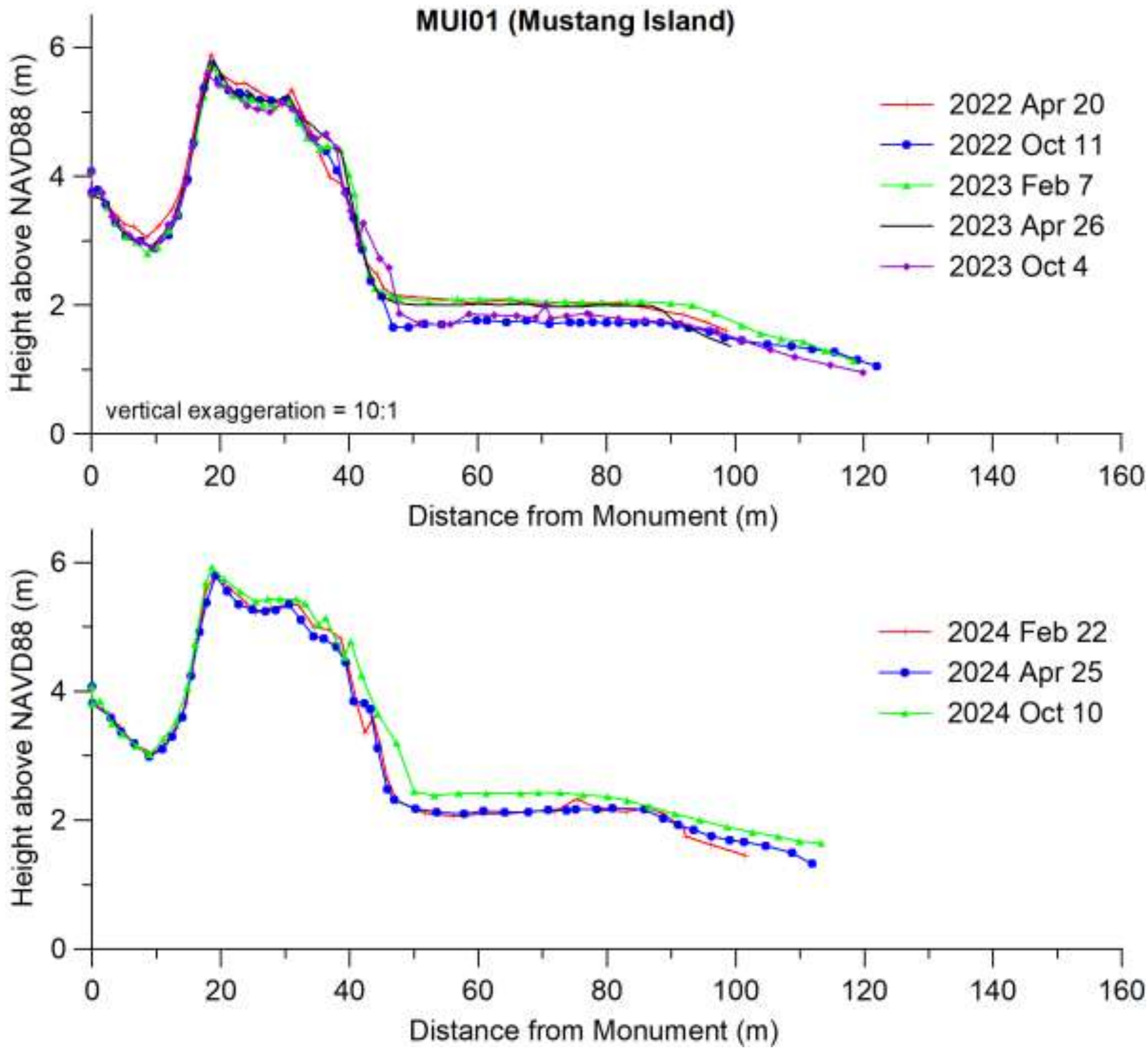
MUI01


MUI01 (Mustang Island)
Height above NAVD88 (m)
Distance from Monument (m)
1999 Oct 23
1999 Nov 4
2000 Nov 9
2001 Feb 26
2001 Apr 9
2001 Oct 2
2002 Mar 19
2002 Oct 11
2003 Jan 23
2003 Sep 15
2004 Jan 30
2004 Apr 19
2004 Sep 8
2004 Dec 9
2005 May 3
vertical exaggeration = 10:1

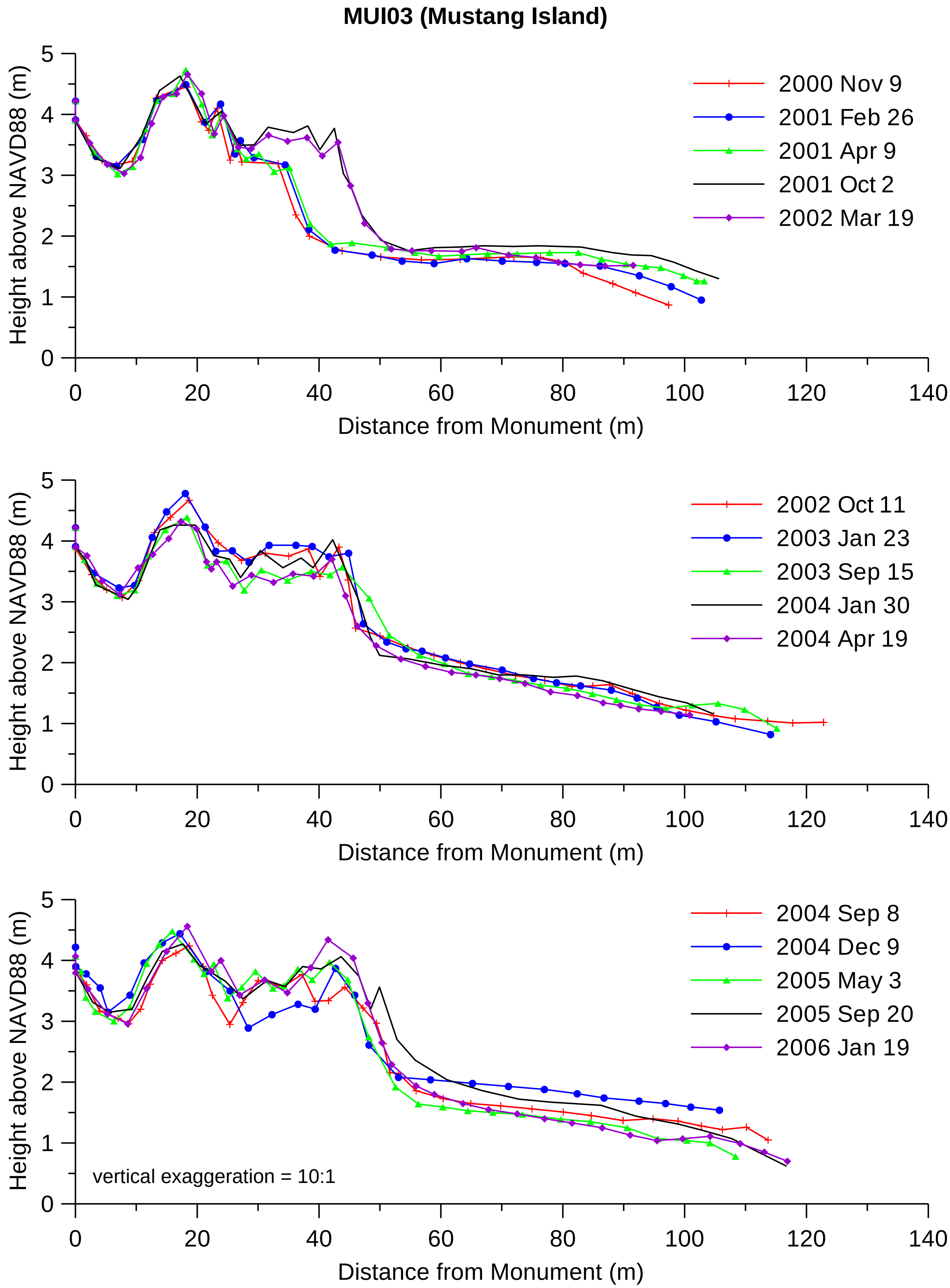

MUI01 (Mustang Island)
Height above NAVD88 (m)
Distance from Monument (m)
2005 Sep 20
2006 Jan 19
2006 Mar 21
2006 Sep 14
2007 Jan 12
2007 May 1
2007 Sep 21
2008 Jan 17
2008 May 14
2008 Sep 24
2009 Jan 21
2009 Apr 15
2009 Sep 17
2010 Jan 21
2010 May 11
vertical exaggeration = 10:1


MUI01 (Mustang Island)
Height above NAVD88 (m)
Distance from Monument (m)
0
2
4
6
0
20
40
60
80
100
120
140
160
2011 May 11
2011 Sep 15
2012 Jan 25
2012 May 8
2012 Oct 25
2013 Jan 31
2013 May 2
2013 Oct 3
2014 Jan 30
2014 Apr 24
2014 Oct 7
2015 Jan 29
2015 Apr 30
2015 Sep 30
2016 Jan 27
vertical exaggeration = 10:1

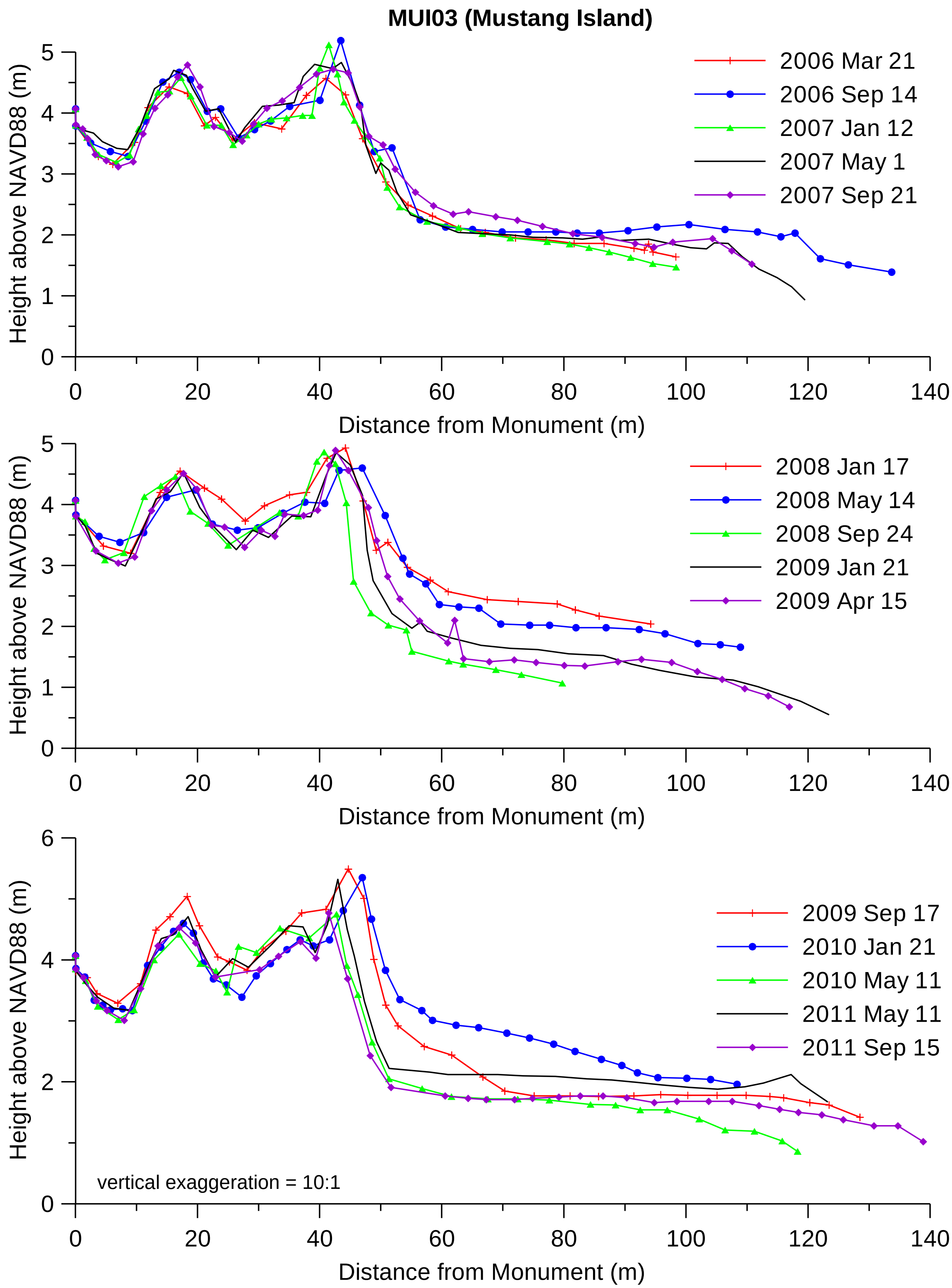

MUI01 (Mustang Island)
Height above NAVD88 (m)
Distance from Monument (m)
2016 May 4
2016 Sep 28
2017 Jan 19
2017 May 4
2017 May 25
2017 Sep 5
2018 Jan 31
2018 Apr 25
2018 Jul 18
2019 Jan 23
2019 Apr 30
2019 Oct 17
2021 May 20
2021 Nov 15
2022 Jan 19
vertical exaggeration = 10:1


MUI01 (Mustang Island)
Height above NAVD88 (m)
Distance from Monument (m)
vertical exaggeration = 10:1
2022 Apr 20
2022 Oct 11
2023 Feb 7
2023 Apr 26
2023 Oct 4
2024 Feb 22
2024 Apr 25
2024 Oct 10

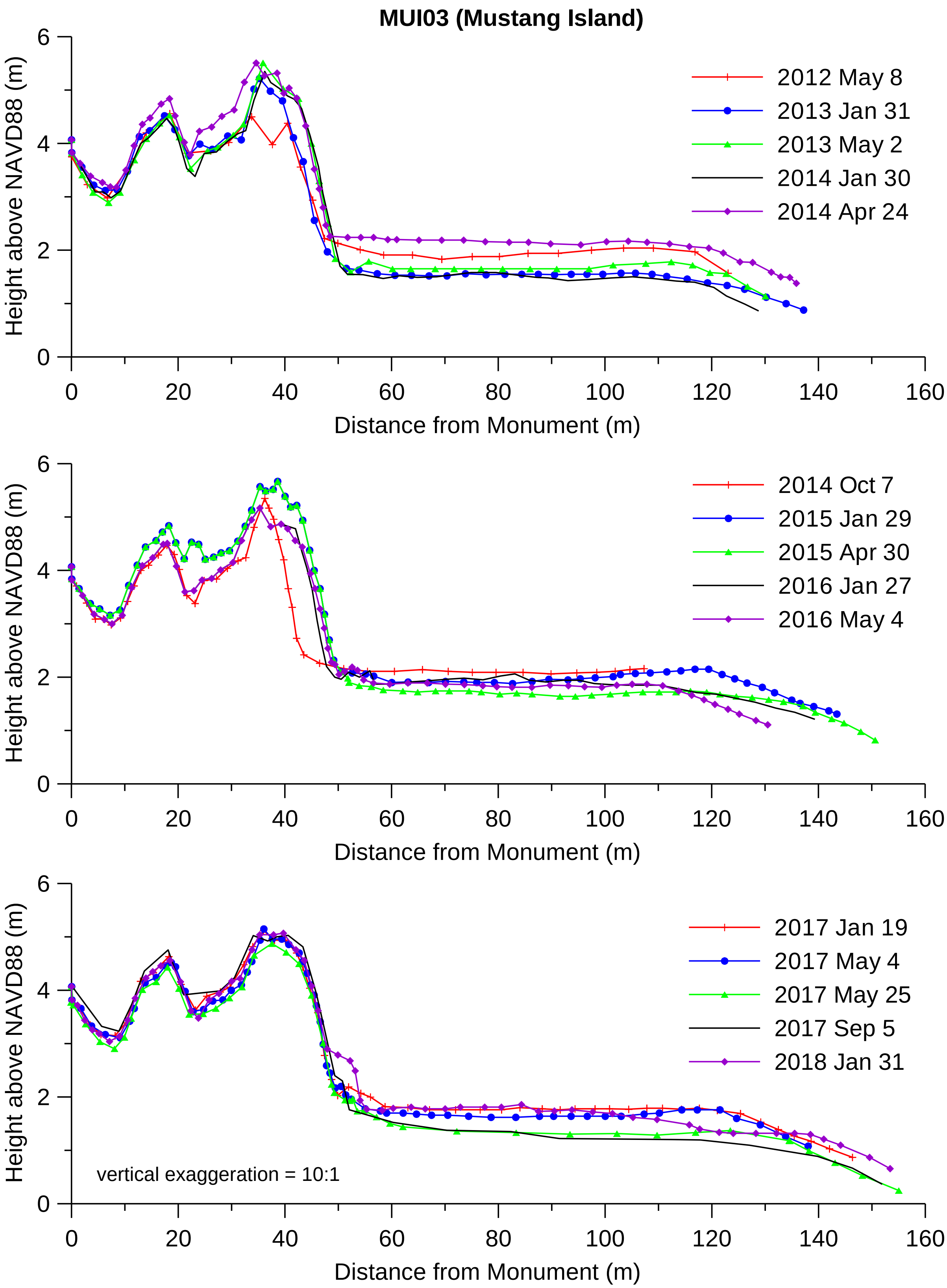
MUI03



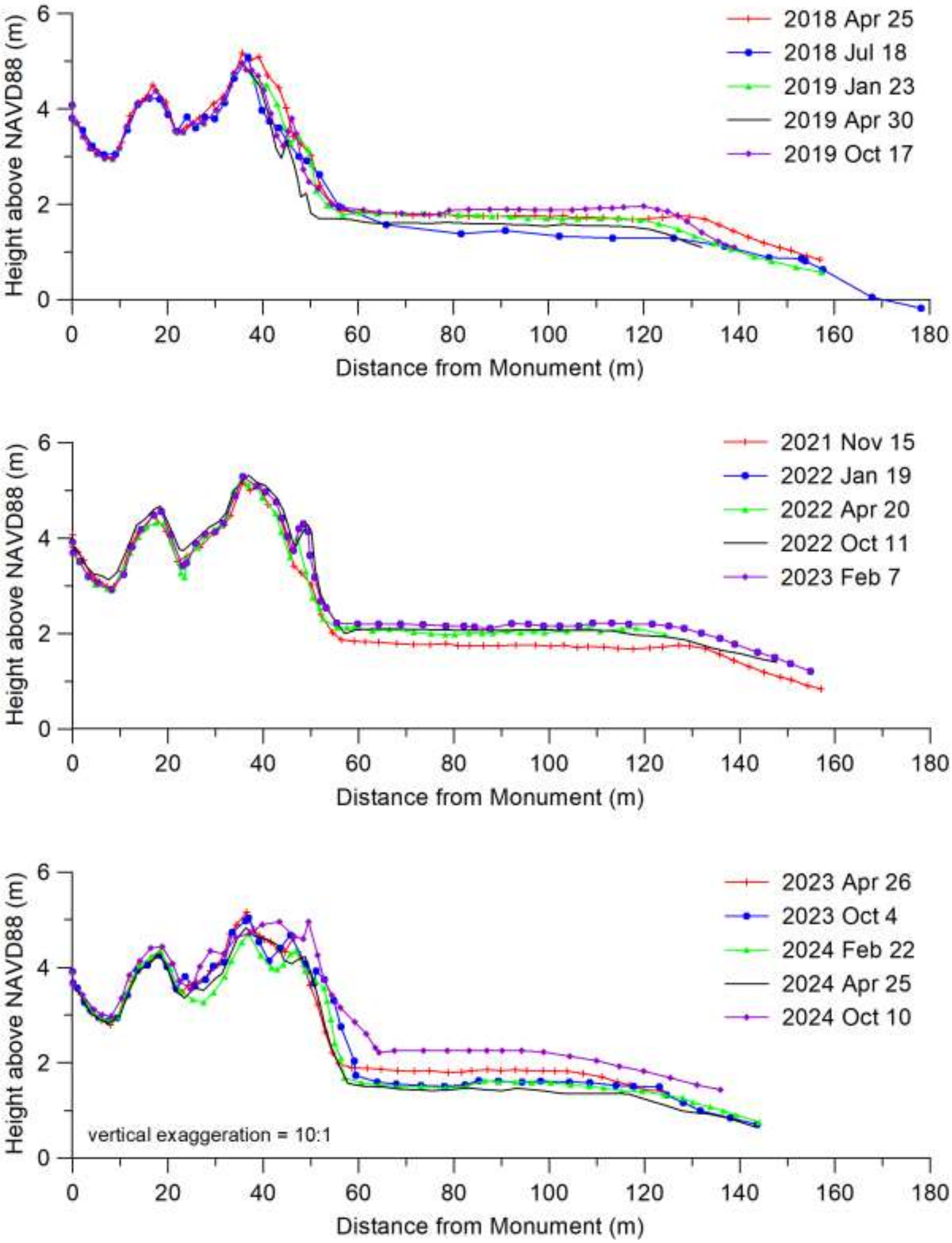
MUI03 (Mustang Island)
Height above NAVD88 (m)
Distance from Monument (m)
2000 Nov 9
2001 Feb 26
2001 Apr 9
2001 Oct 2
2002 Mar 19
2002 Oct 11
2003 Jan 23
2003 Sep 15
2004 Jan 30
2004 Apr 19
2004 Sep 8
2004 Dec 9
2005 May 3
2005 Sep 20
2006 Jan 19
vertical exaggeration = 10:1



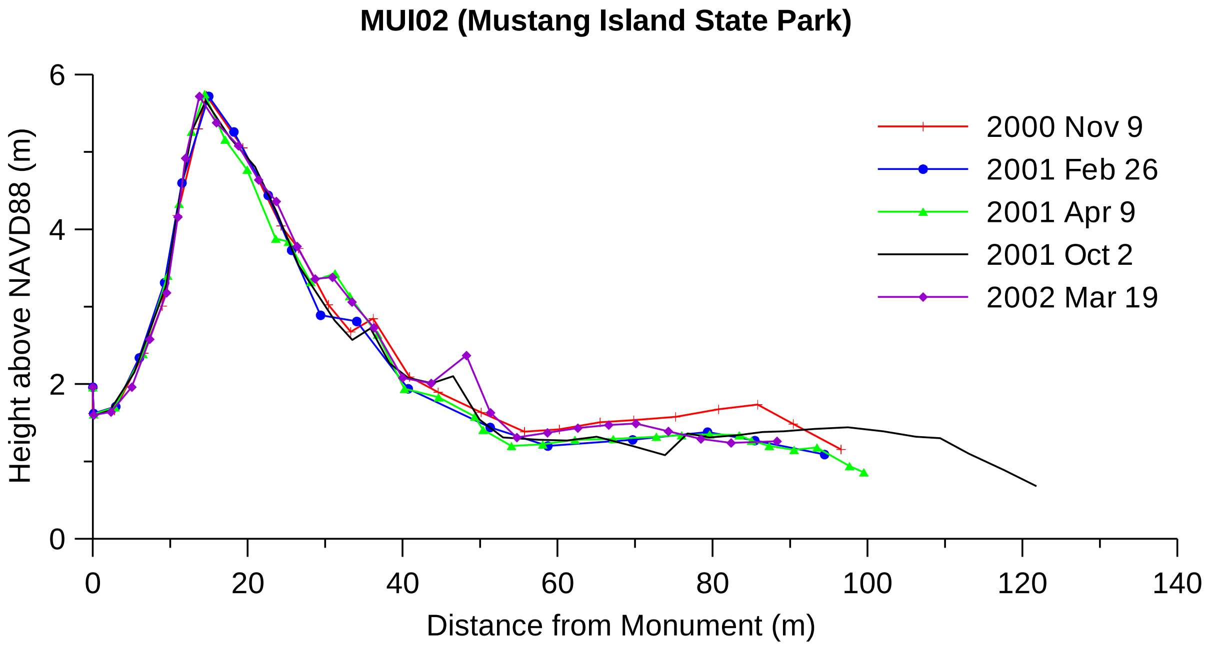
MUI03 (Mustang Island)
Height above NAVD88 (m)
Distance from Monument (m)
2006 Mar 21
2006 Sep 14
2007 Jan 12
2007 May 1
2007 Sep 21
2008 Jan 17
2008 May 14
2008 Sep 24
2009 Jan 21
2009 Apr 15
2009 Sep 17
2010 Jan 21
2010 May 11
2011 May 11
2011 Sep 15
vertical exaggeration = 10:1

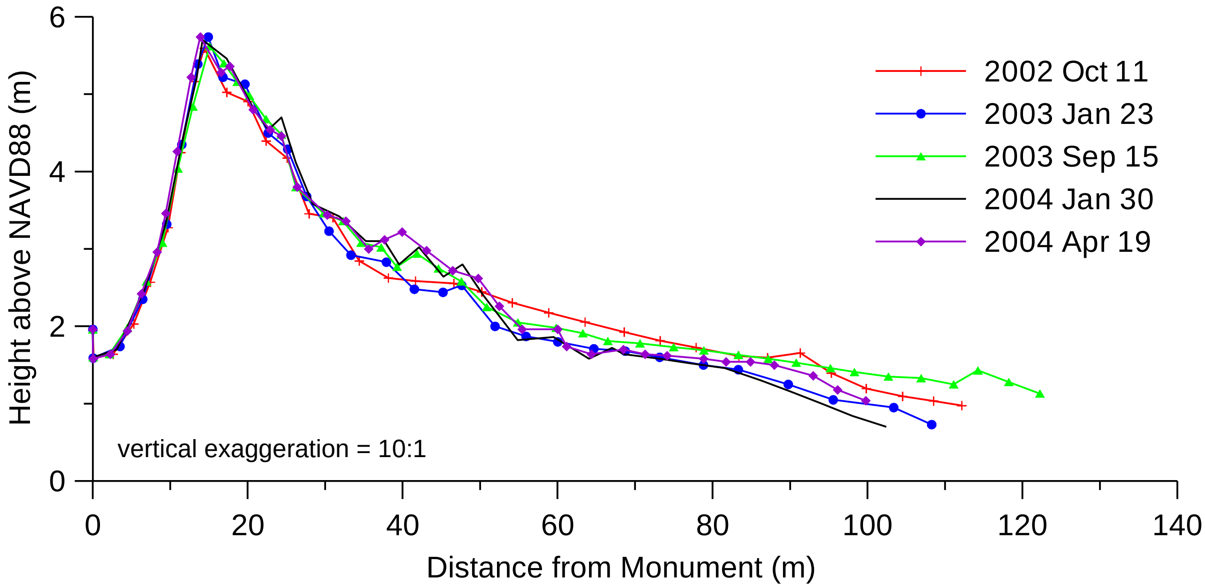

MUI03 (Mustang Island)
Height above NAVD88 (m)
Distance from Monument (m)
2012 May 8
2013 Jan 31
2013 May 2
2014 Jan 30
2014 Apr 24
2014 Oct 7
2015 Jan 29
2015 Apr 30
2016 Jan 27
2016 May 4
2017 Jan 19
2017 May 4
2017 May 25
2017 Sep 5
2018 Jan 31
vertical exaggeration = 10:1

MUI03 (Mustang Island)

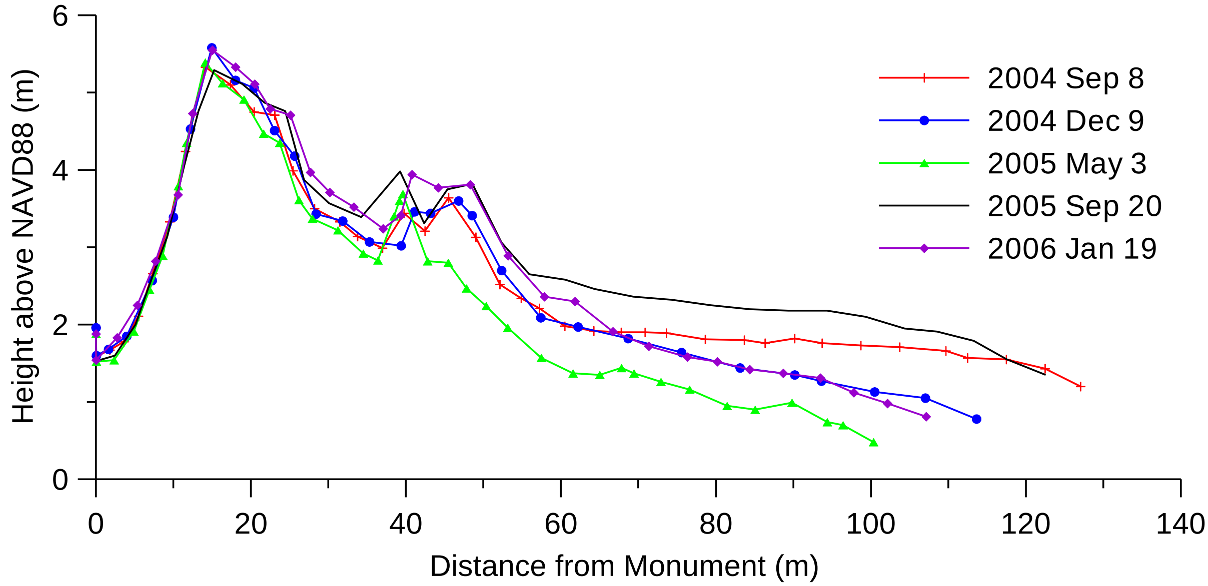


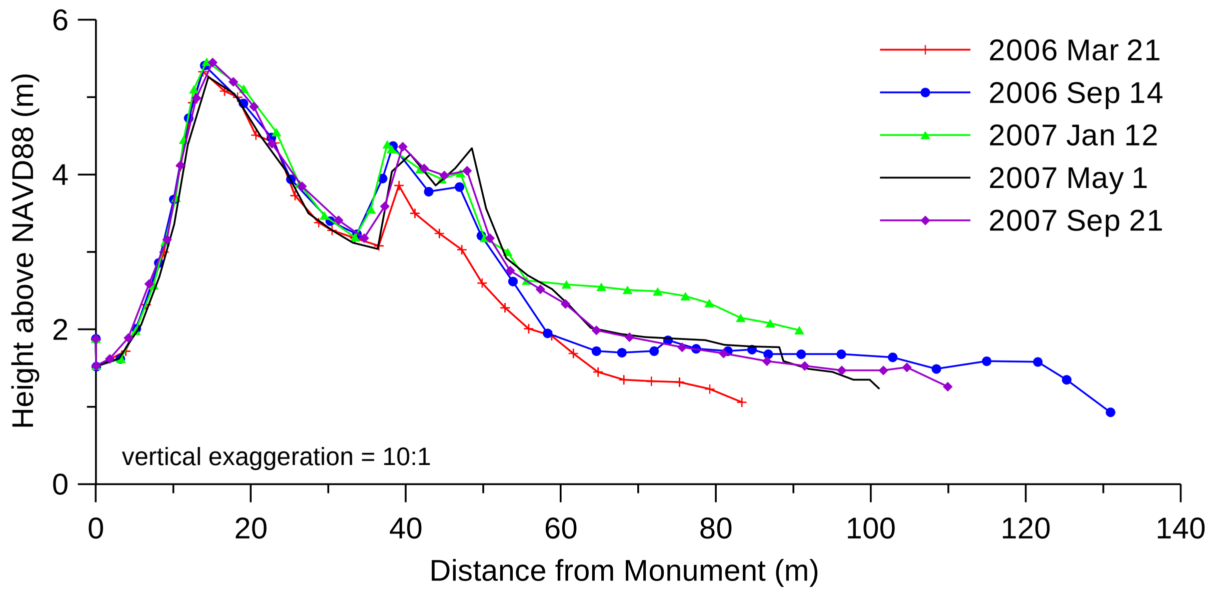
MUI02

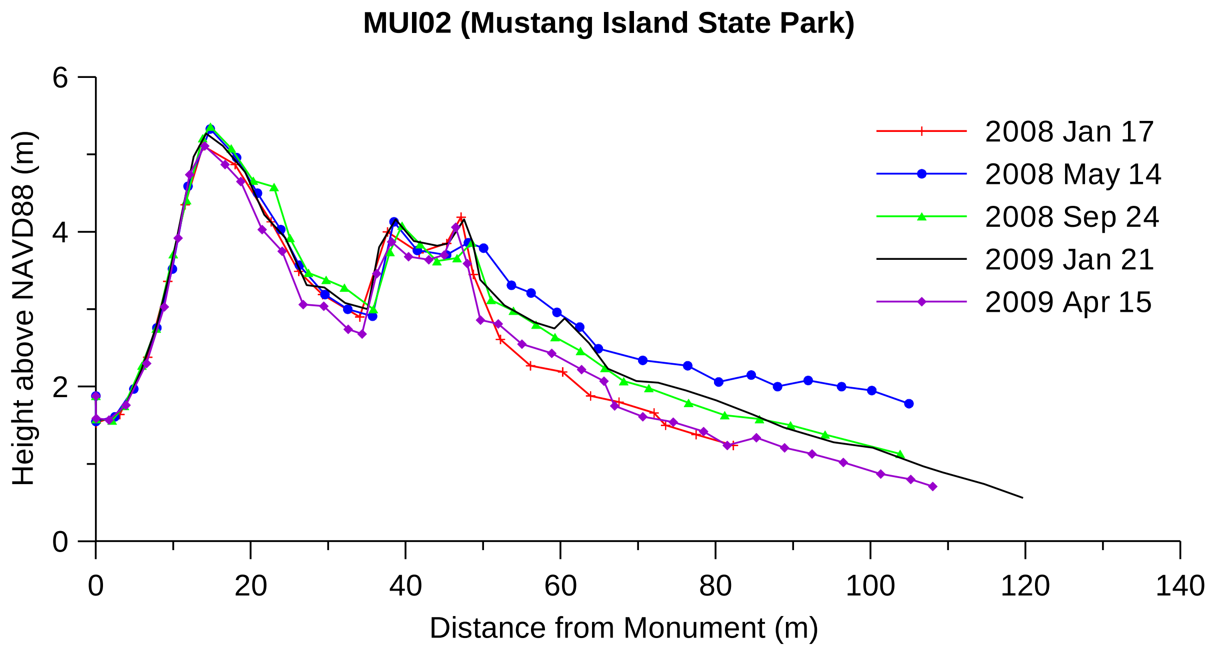

MUI02 (Mustang Island State Park)
Height above NAVD88 (m)
Distance from Monument (m)
2000 Nov 9
2001 Feb 26
2001 Apr 9
2001 Oct 2
2002 Mar 19
0
2
4
6
0
20
40
60
80
100
120
140

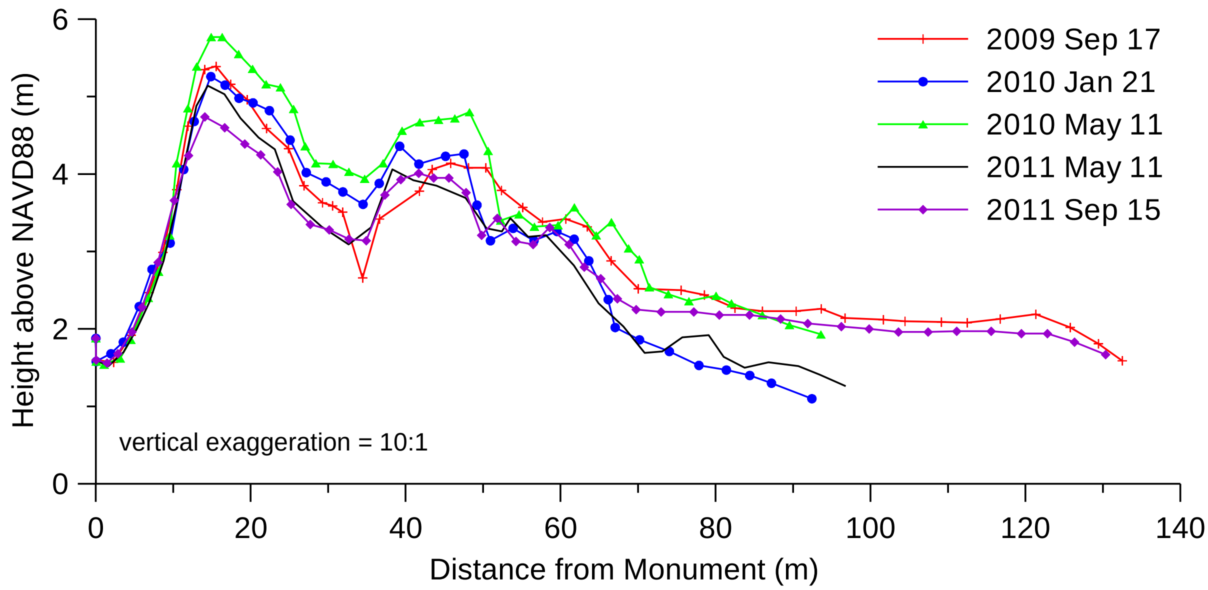

Height above NAVD88 (m)
Distance from Monument (m)
2002 Oct 11
2003 Jan 23
2003 Sep 15
2004 Jan 30
2004 Apr 19
vertical exaggeration = 10:1
0
2
4
6
0
20
40
60
80
100
120
140

MUI02 (Mustang Island State Park)

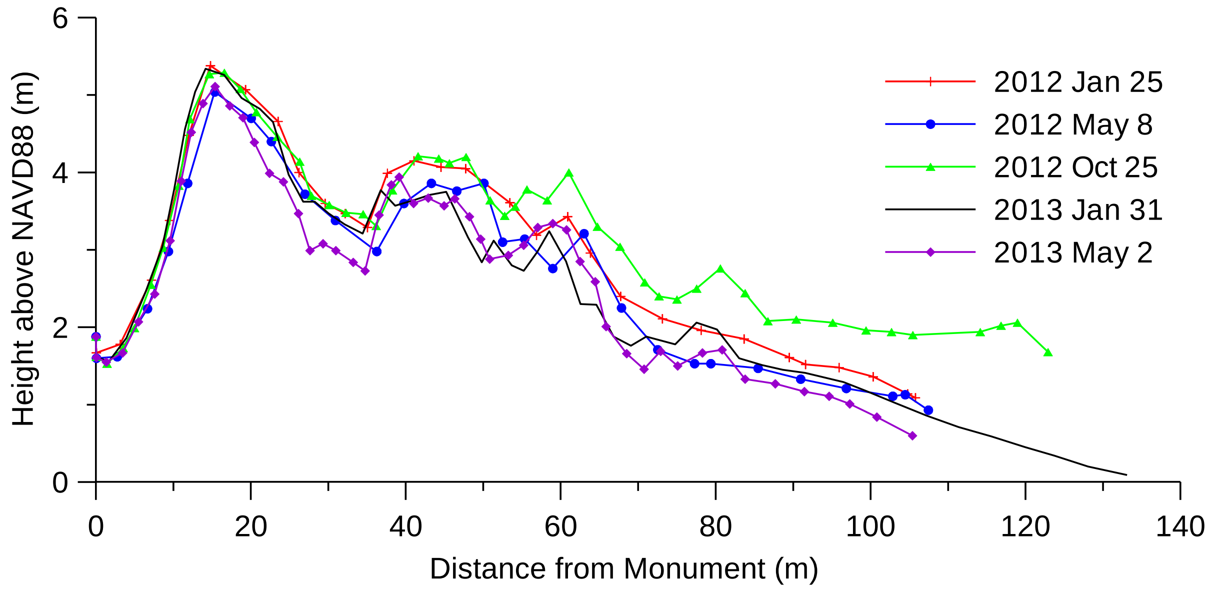


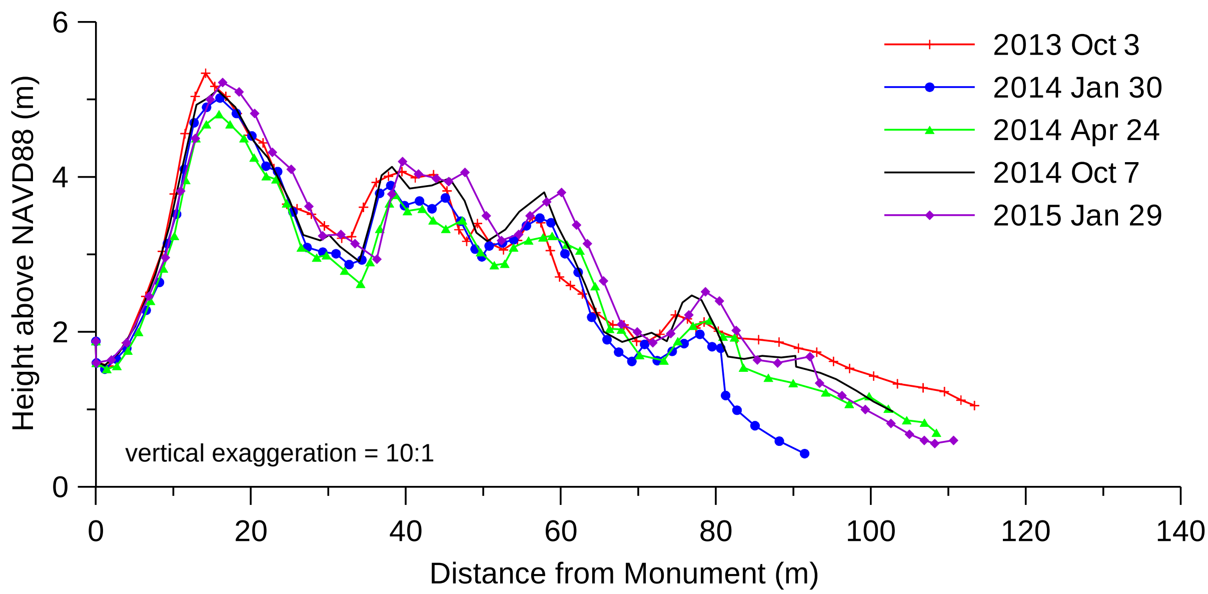



MUI02 (Mustang Island State Park)
Height above NAVD88 (m)
Distance from Monument (m)
2008 Jan 17
2008 May 14
2008 Sep 24
2009 Jan 21
2009 Apr 15
0
2
4
6
0
20
40
60
80
100
120
140

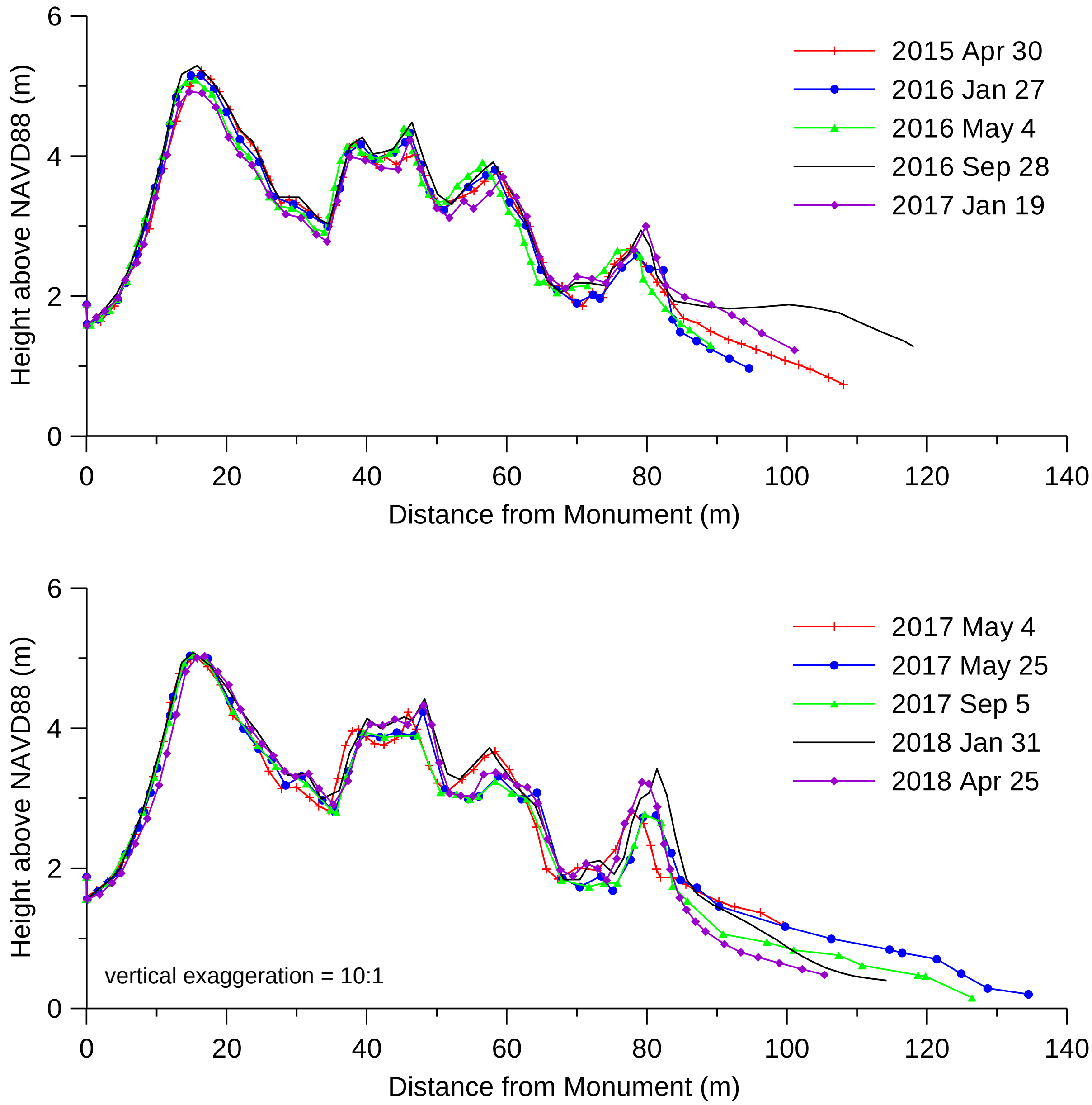

Height above NAVD88 (m)
Distance from Monument (m)
2009 Sep 17
2010 Jan 21
2010 May 11
2011 May 11
2011 Sep 15
vertical exaggeration = 10:1
0
2
4
6
0
20
40
60
80
100
120
140

MUI02 (Mustang Island State Park)

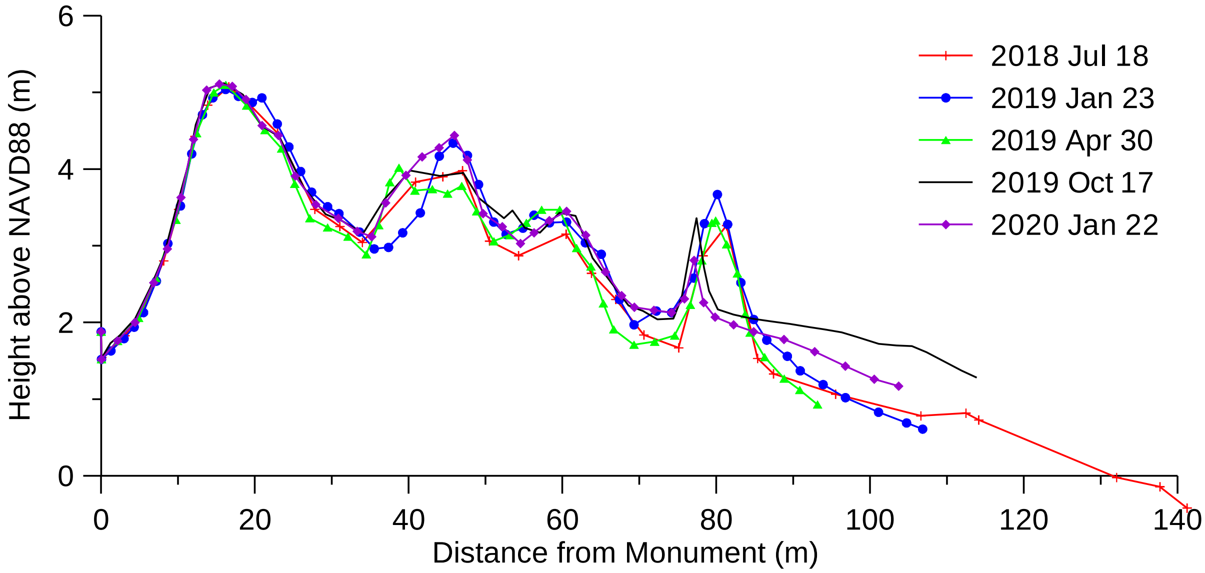


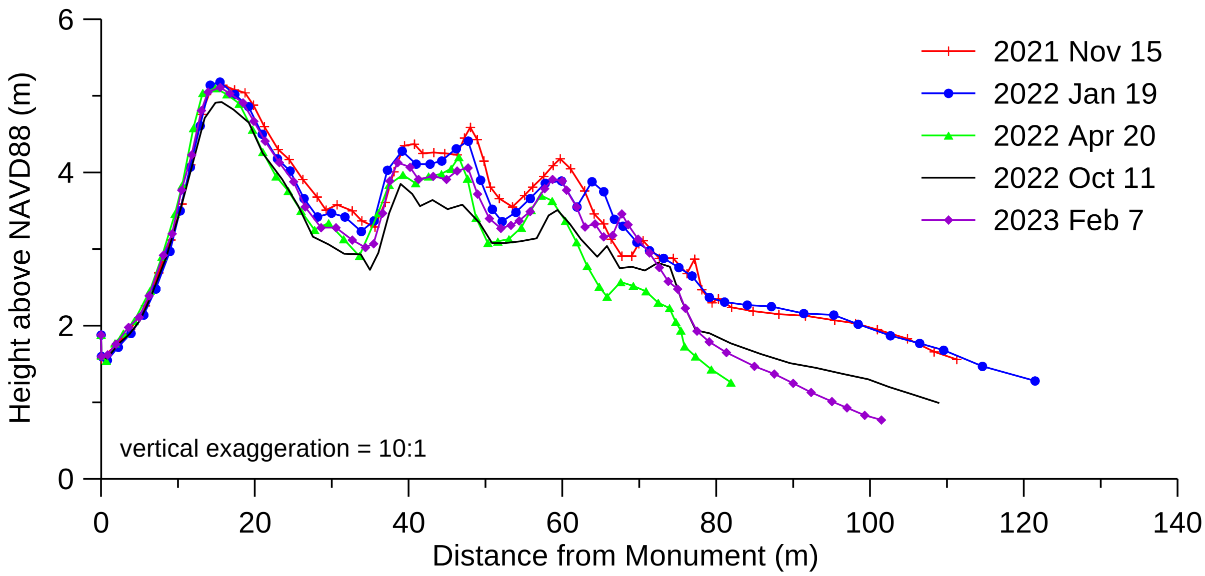


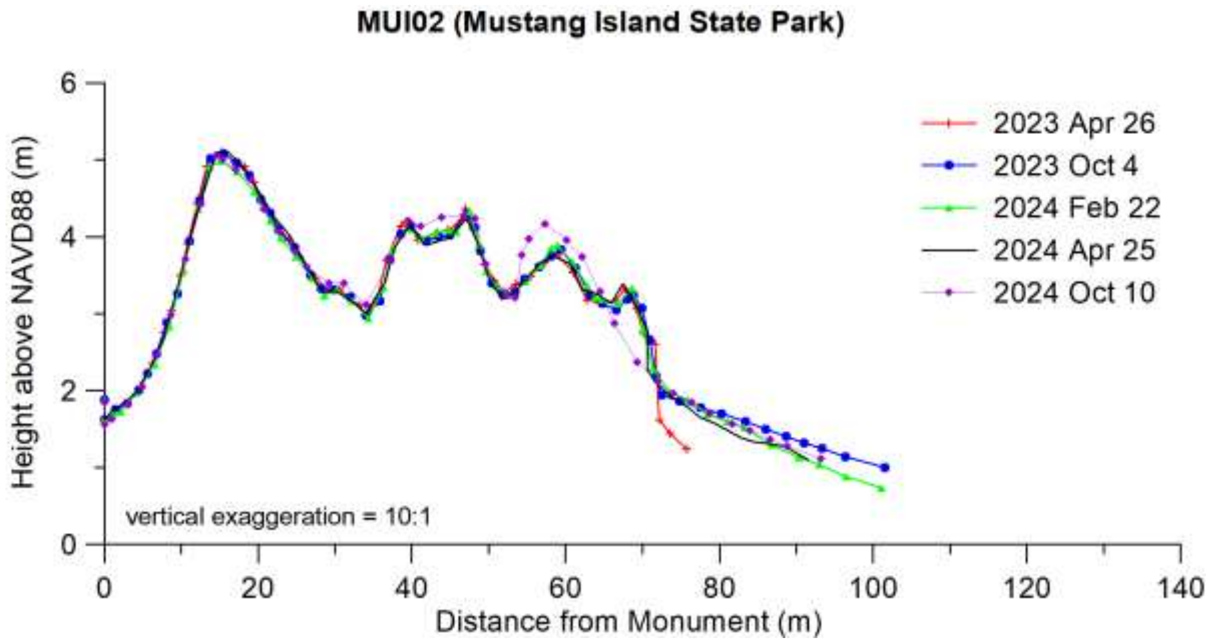
MUI02 (Mustang Island State Park)



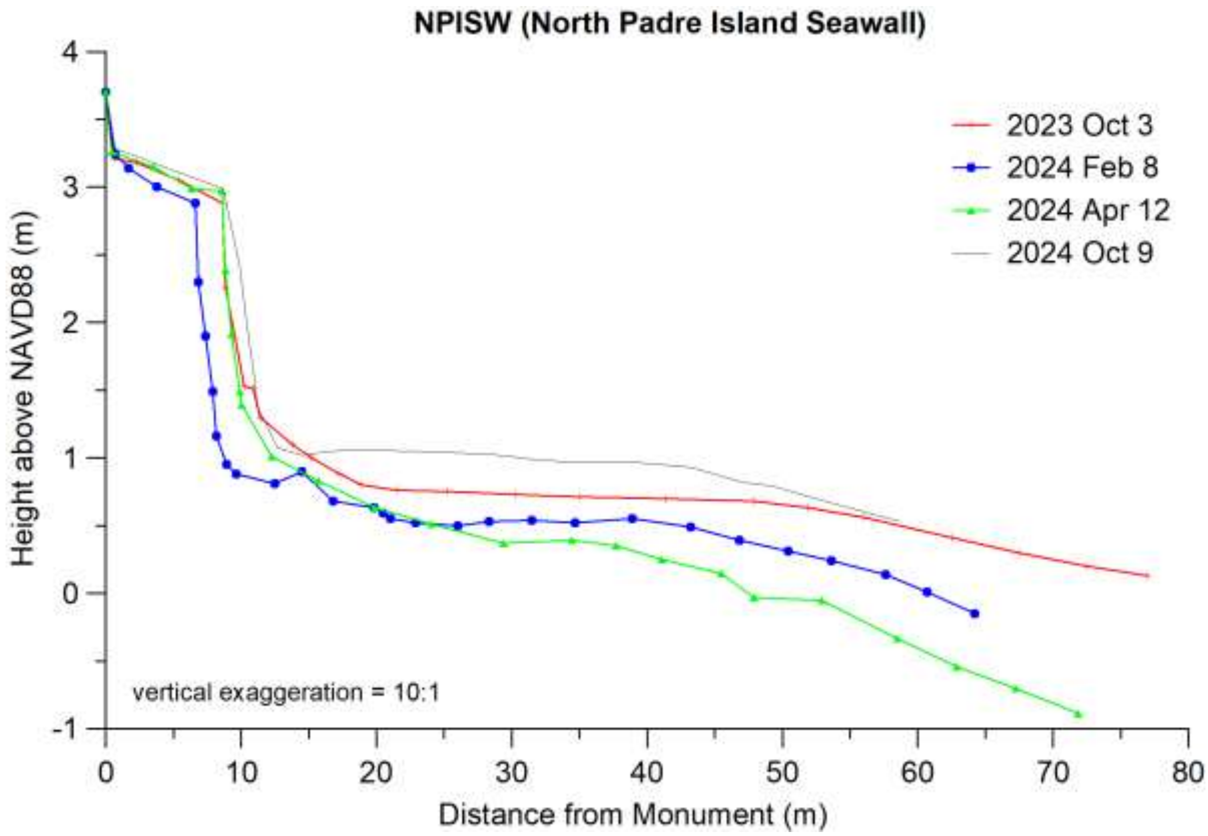
MUI02 (Mustang Island State Park)





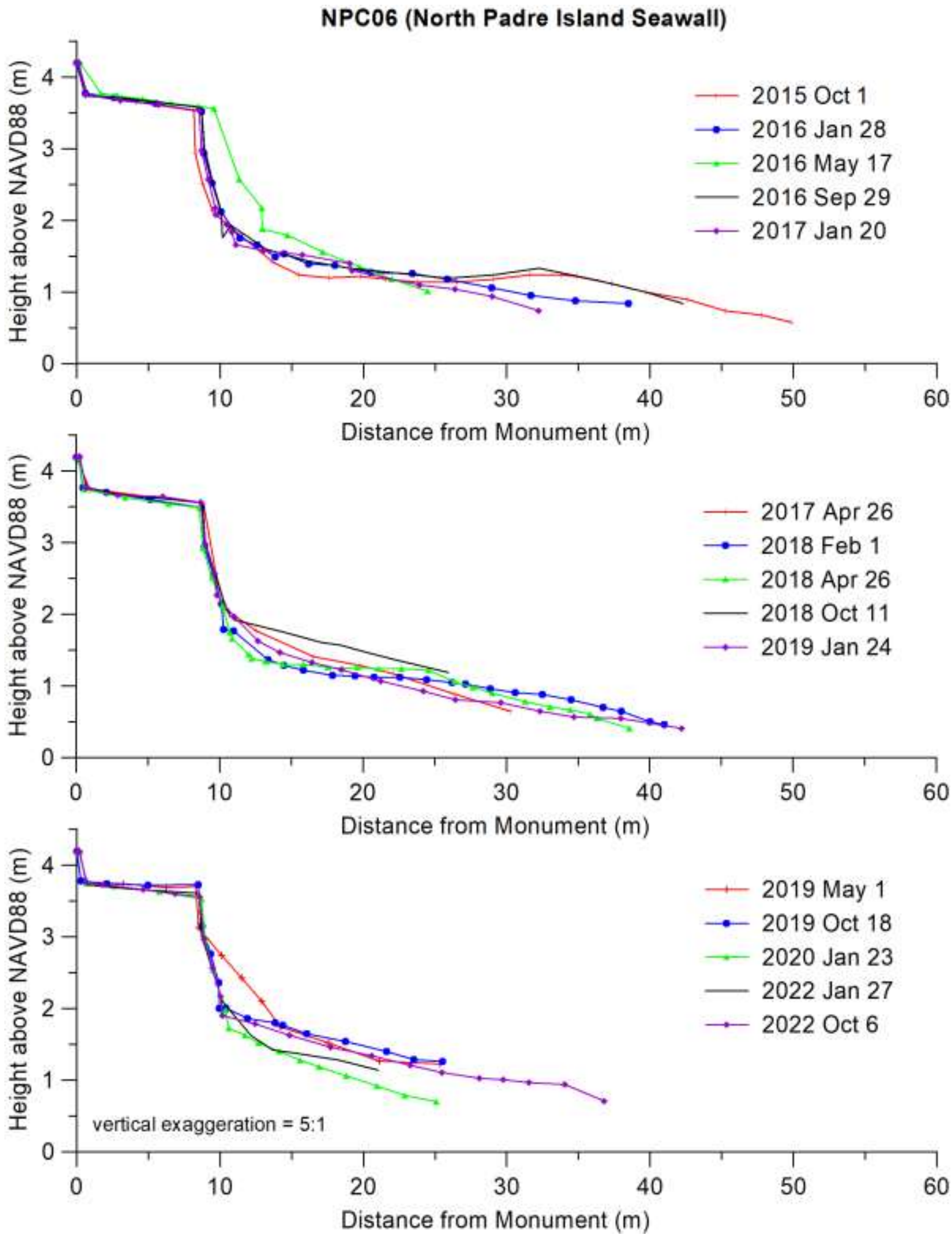

MUI02 (Mustang Island State Park)
Height above NAVD88 (m)
Distance from Monument (m)
2023 Apr 26
2023 Oct 4
2024 Feb 22
2024 Apr 25
2024 Oct 10
vertical exaggeration = 10:1
0
2
4
6
0
20
40
60
80
100
120
140

NPISW

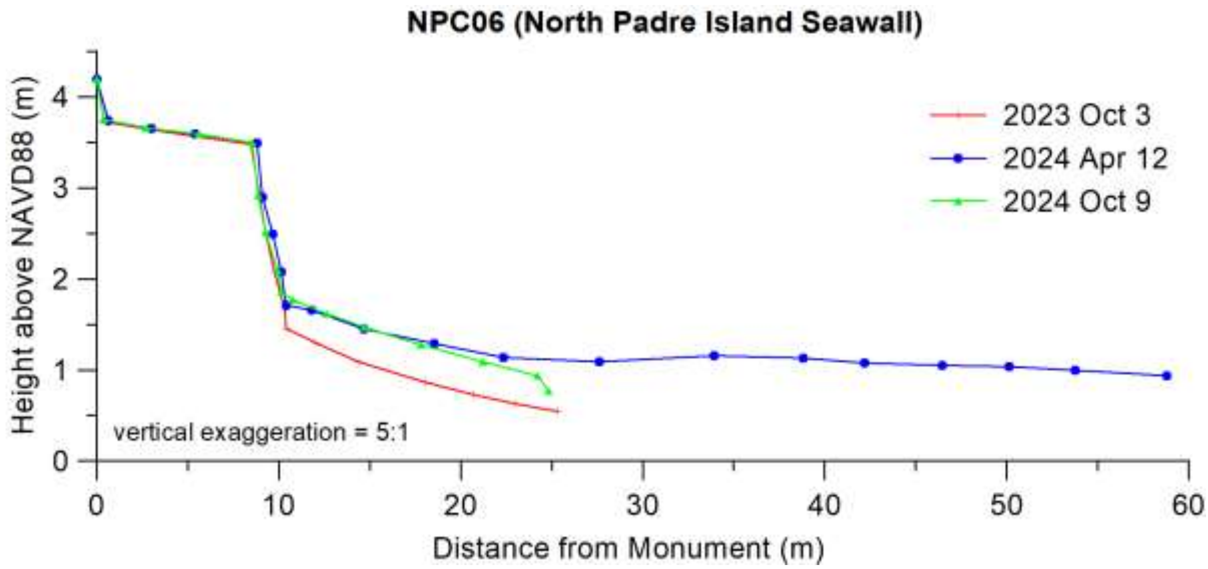


NPISW (North Padre Island Seawall)
2023 Oct 3
2024 Feb 8
2024 Apr 12
2024 Oct 9
Height above NAVD88 (m)
4
3
2
1
0
-1
vertical exaggeration = 10:1
0
10
20
30
40
50
60
70
80
Distance from Monument (m)

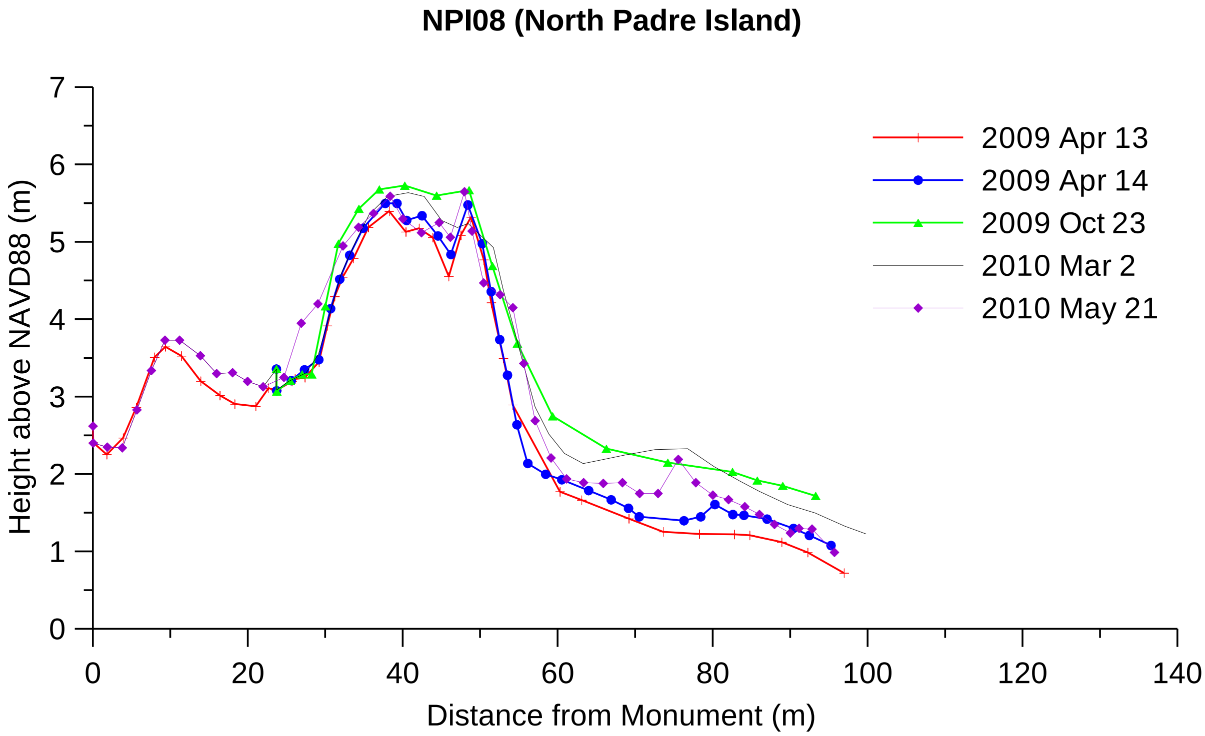
NPC06

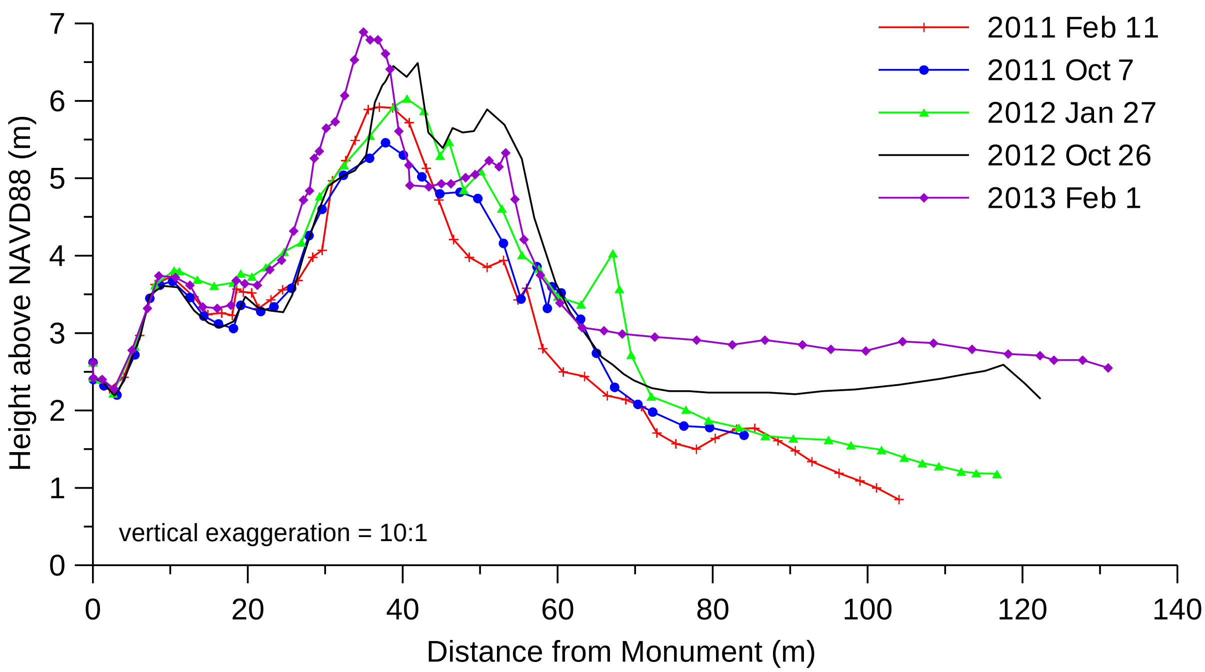


NPC06 (North Padre Island Seawall)
Height above NAVD88 (m)
Distance from Monument (m)
2015 Oct 1
2016 Jan 28
2016 May 17
2016 Sep 29
2017 Jan 20
2017 Apr 26
2018 Feb 1
2018 Apr 26
2018 Oct 11
2019 Jan 24
2019 May 1
2019 Oct 18
2020 Jan 23
2022 Jan 27
2022 Oct 6
vertical exaggeration = 5:1

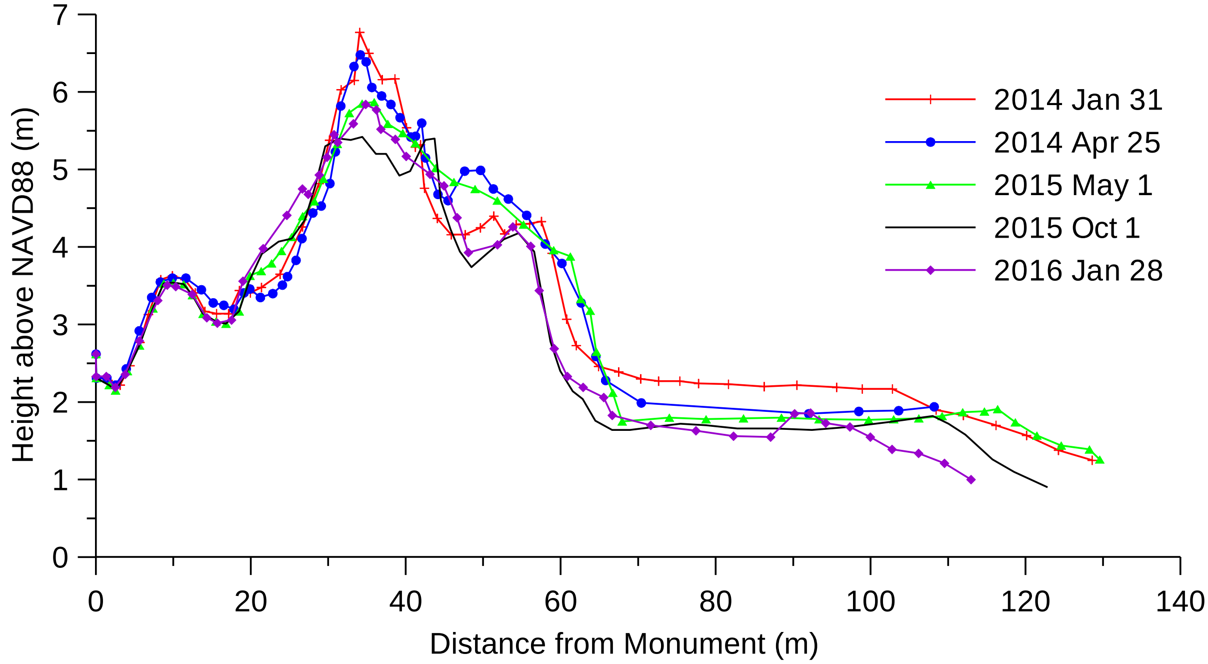

NPC06 (North Padre Island Seawall)
Height above NAVD88 (m)
Distance from Monument (m)
2023 Oct 3
2024 Apr 12
2024 Oct 9
vertical exaggeration = 5:1
0
1
2
3
4
0
10
20
30
40
50
60

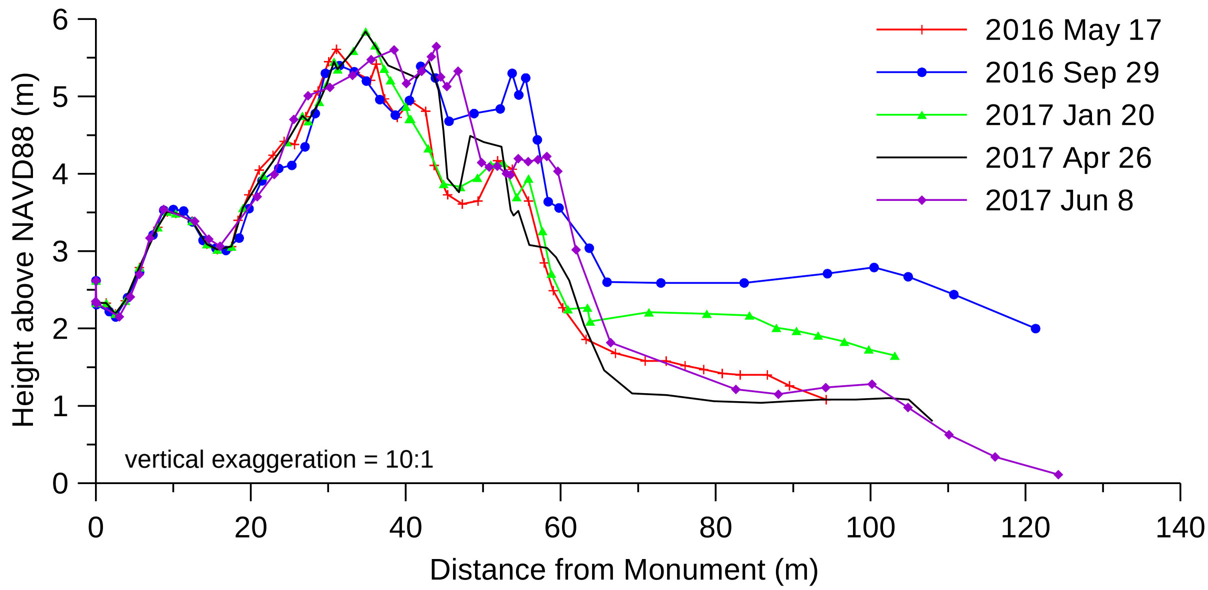
NPI08


NPI08 (North Padre Island)
Height above NAVD88 (m)
Distance from Monument (m)
2009 Apr 13
2009 Apr 14
2009 Oct 23
2010 Mar 2
2010 May 21
0
1
2
3
4
5
6
7
0
20
40
60
80
100
120
140

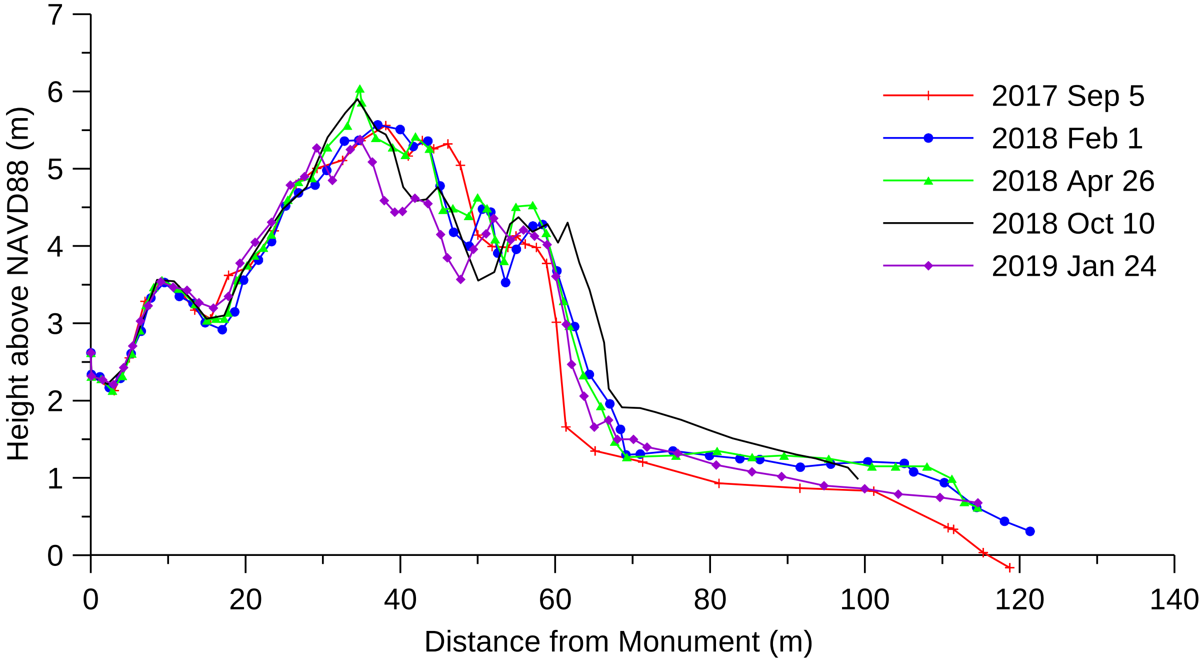

Height above NAVD88 (m)
Distance from Monument (m)
2011 Feb 11
2011 Oct 7
2012 Jan 27
2012 Oct 26
2013 Feb 1
vertical exaggeration = 10:1
0
1
2
3
4
5
6
7
0
20
40
60
80
100
120
140

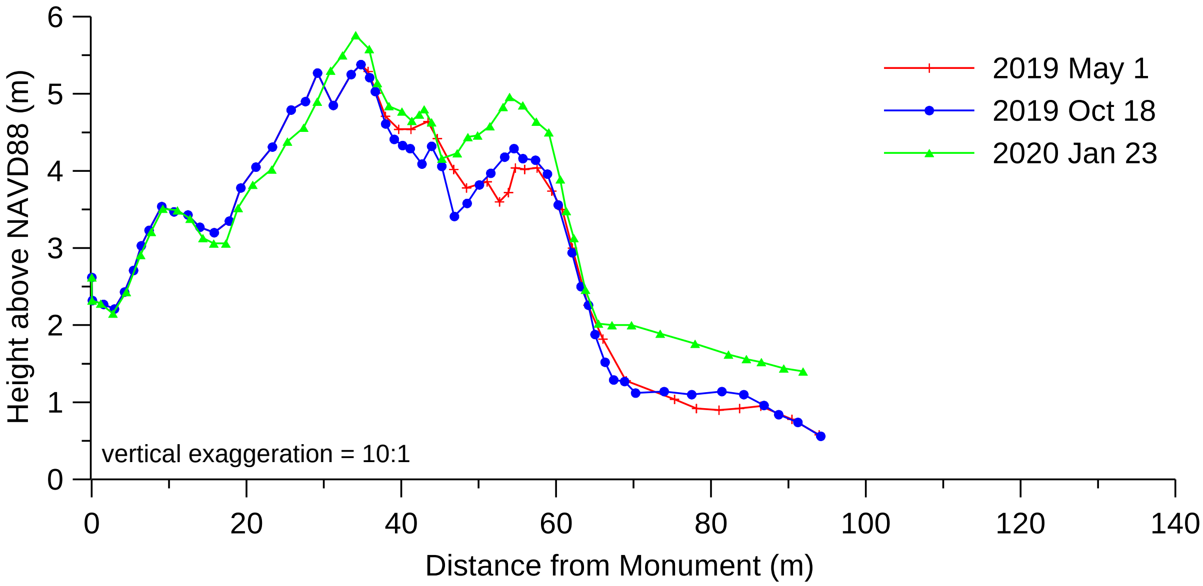
NPI08 (North Padre Island)



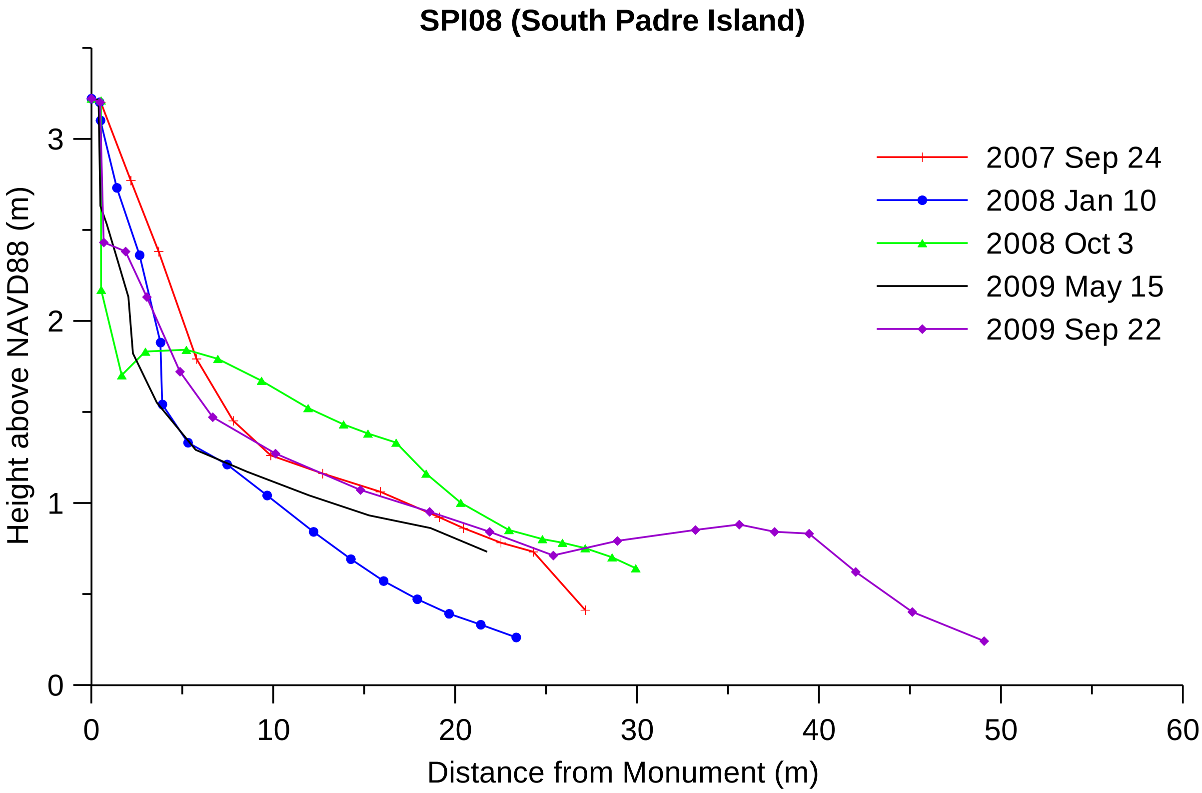


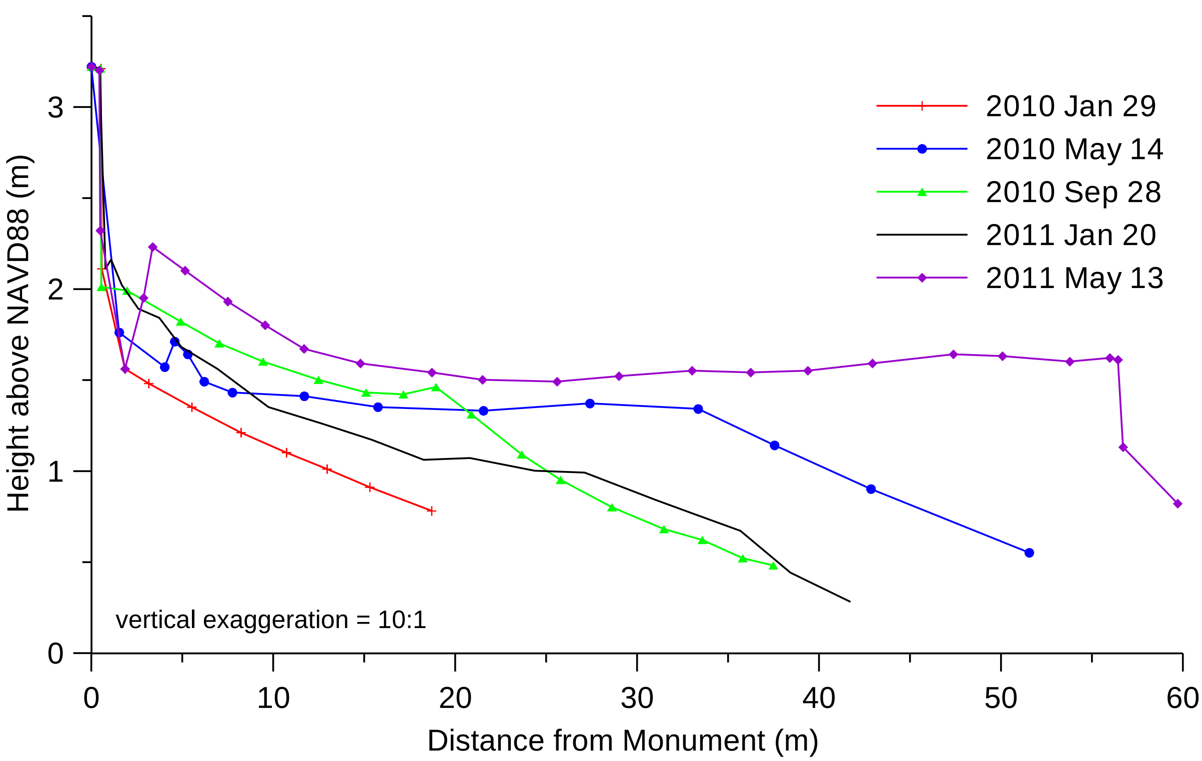
NPI08 (North Padre Island)



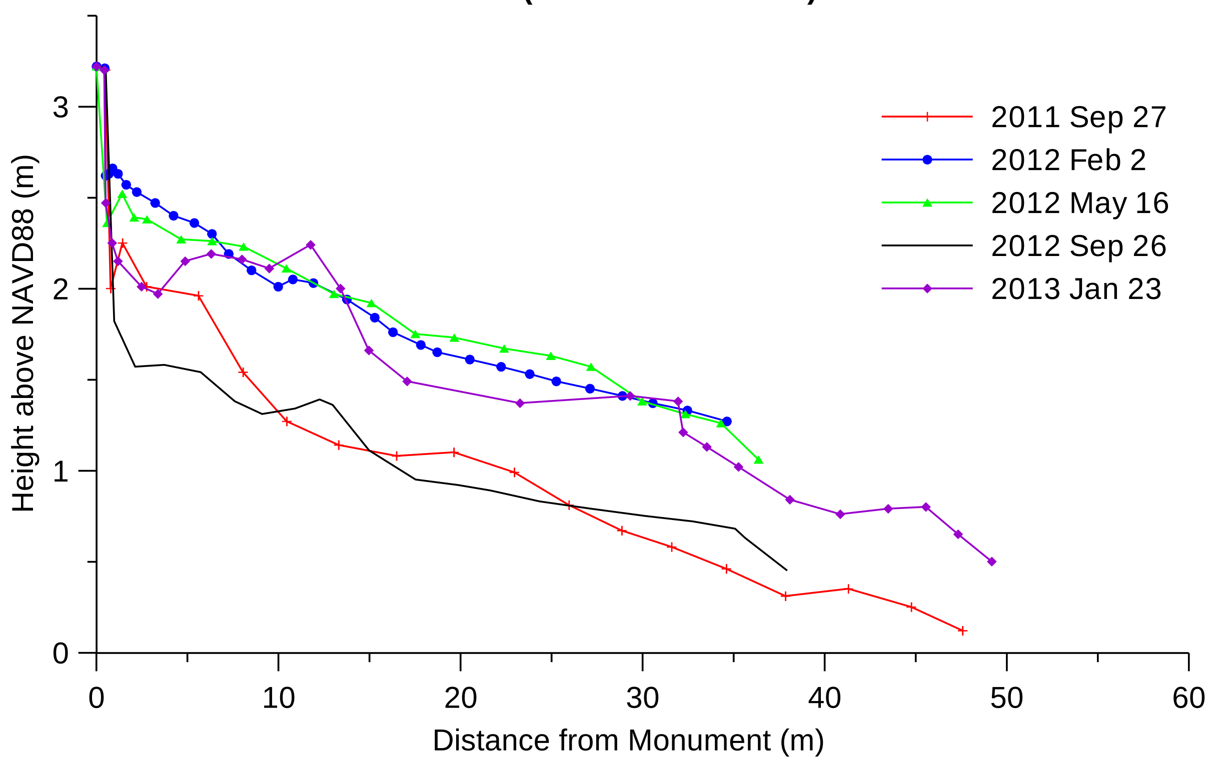


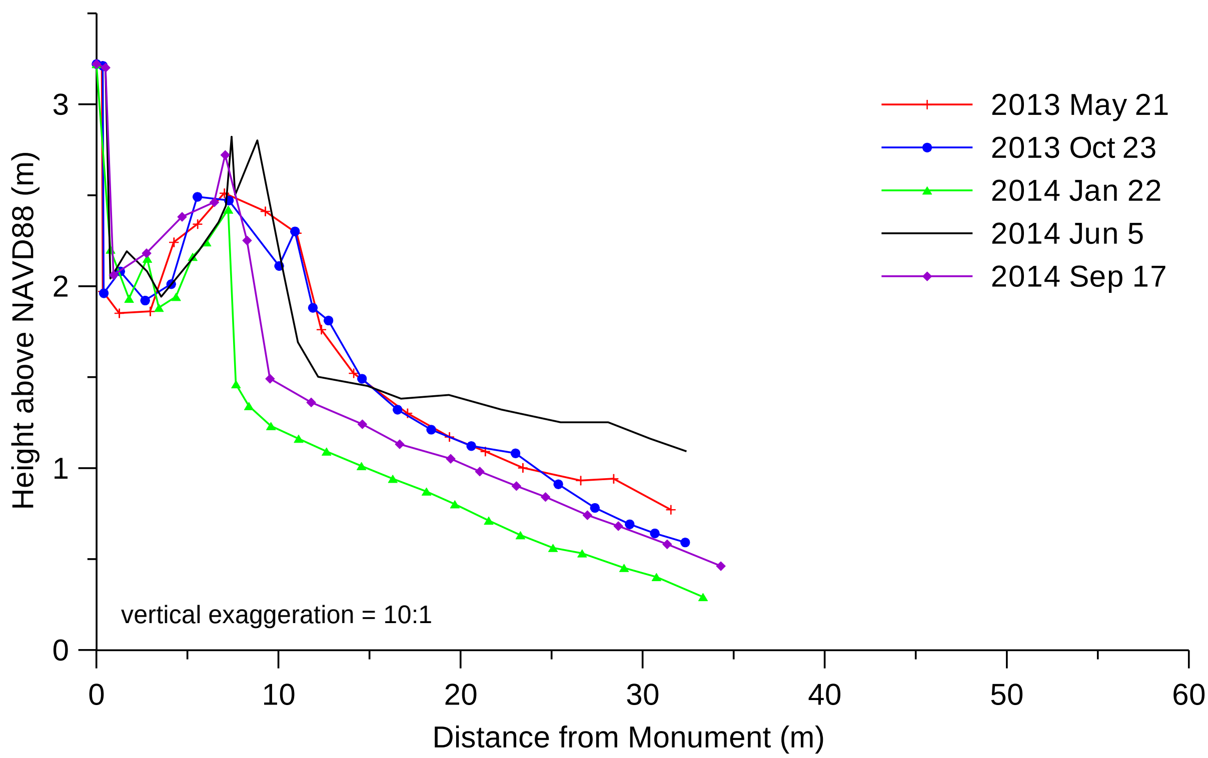
SPI08


SPI08 (South Padre Island)
Height above NAVD88 (m)
Distance from Monument (m)
0
1
2
3
0
10
20
30
40
50
60
2007 Sep 24
2008 Jan 10
2008 Oct 3
2009 May 15
2009 Sep 22

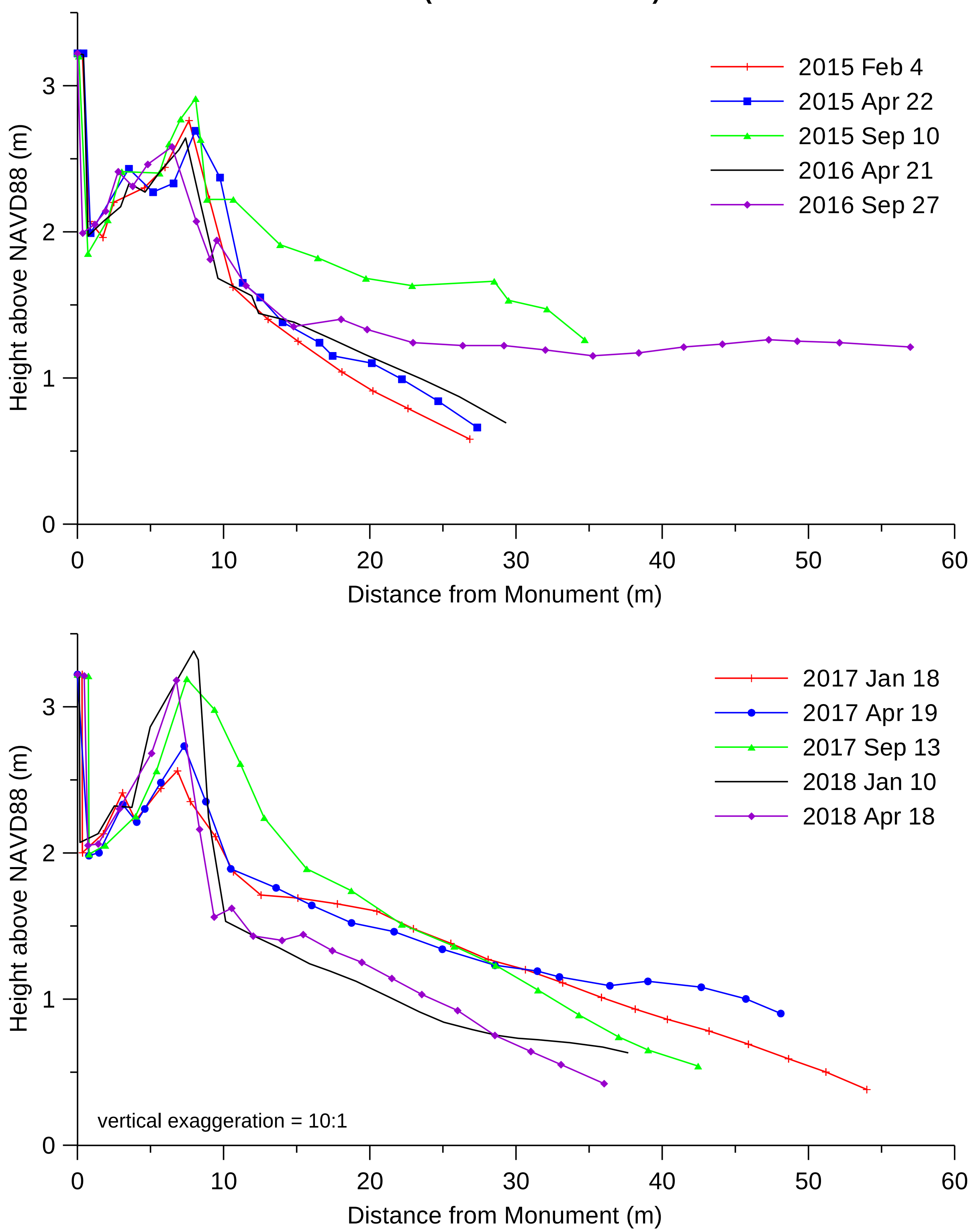

Height above NAVD88 (m)
Distance from Monument (m)
0
1
2
3
0
10
20
30
40
50
60
2010 Jan 29
2010 May 14
2010 Sep 28
2011 Jan 20
2011 May 13
vertical exaggeration = 10:1

SPI08 (South Padre Island)

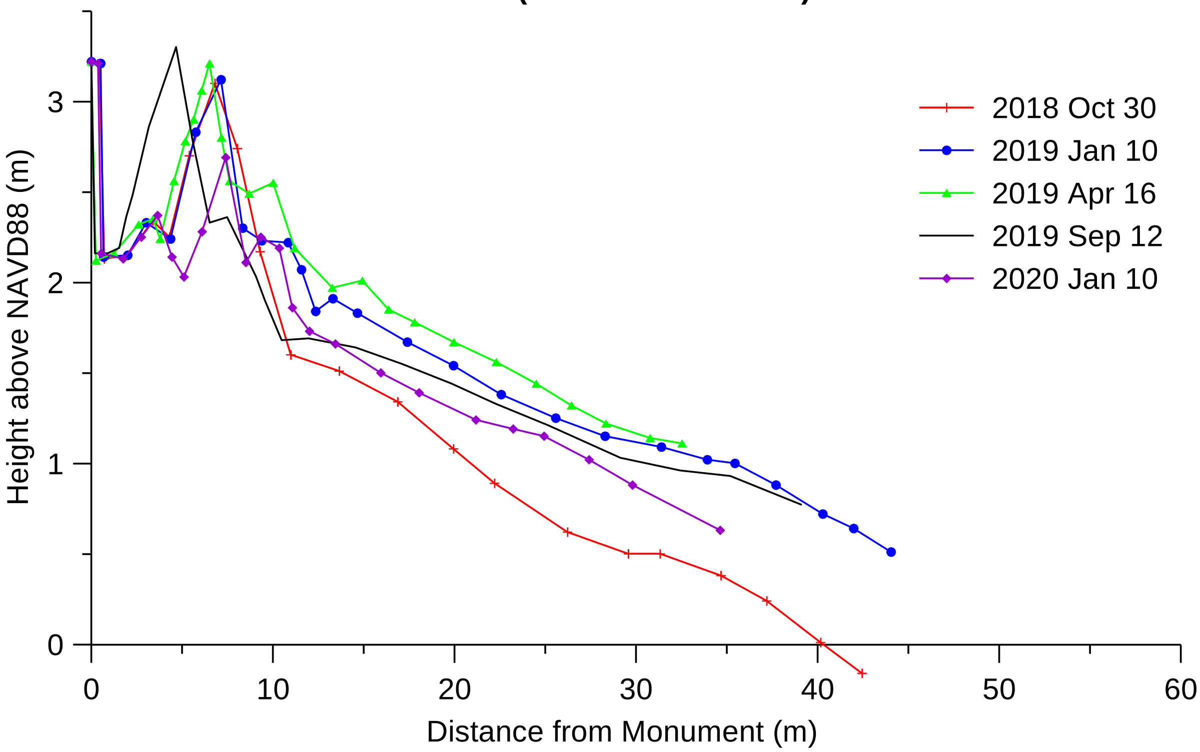


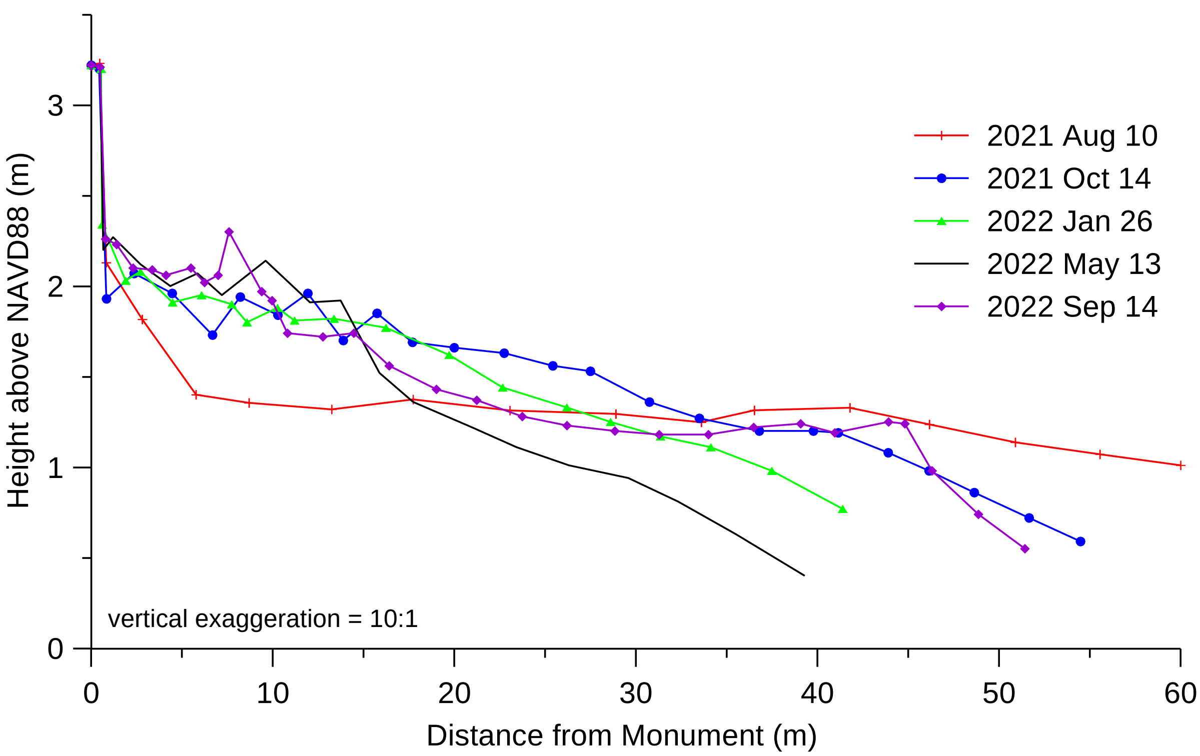


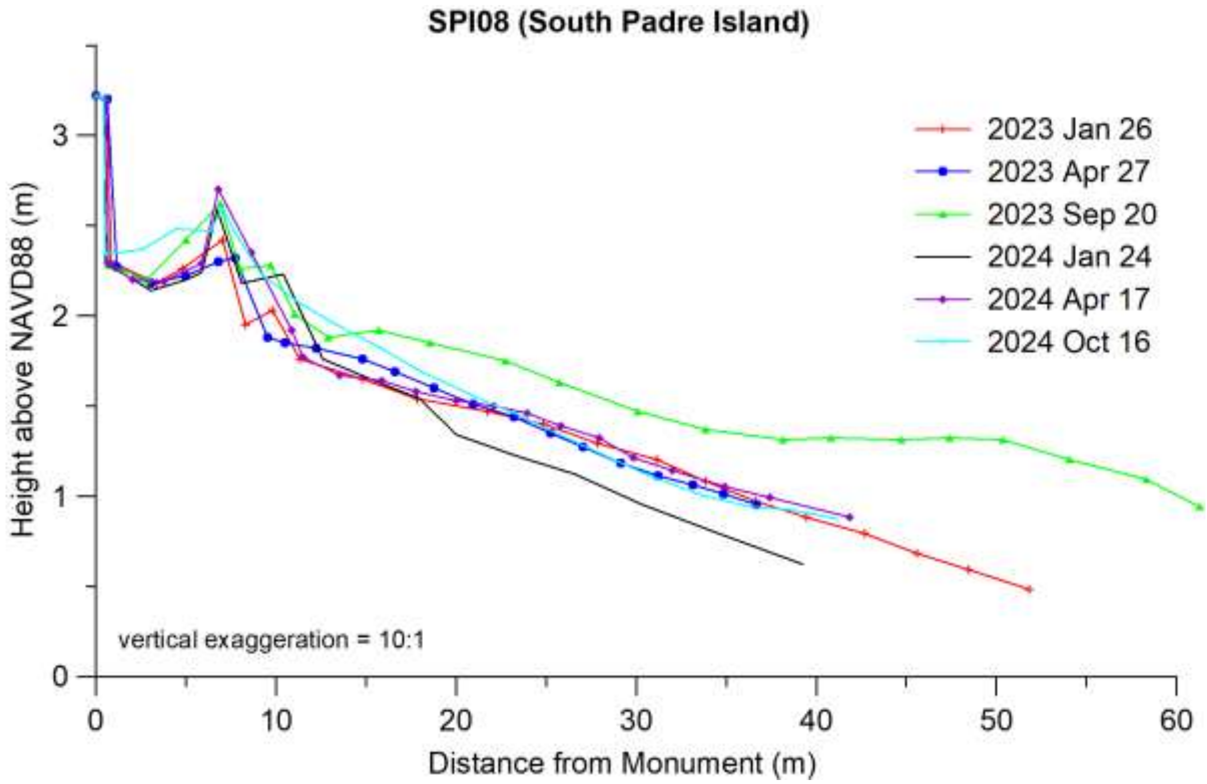
SPI08 (South Padre Island)



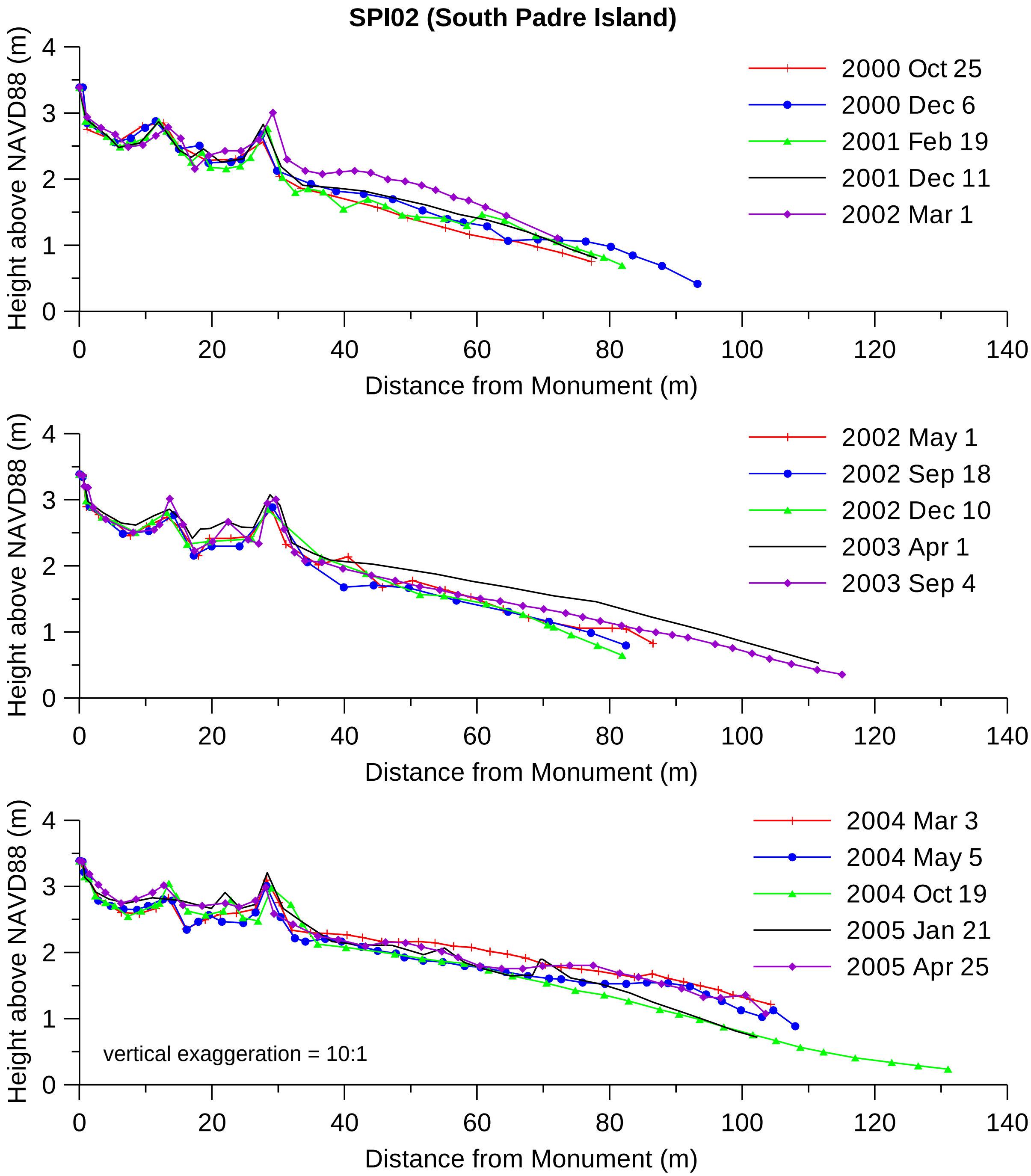
SPI08 (South Padre Island)



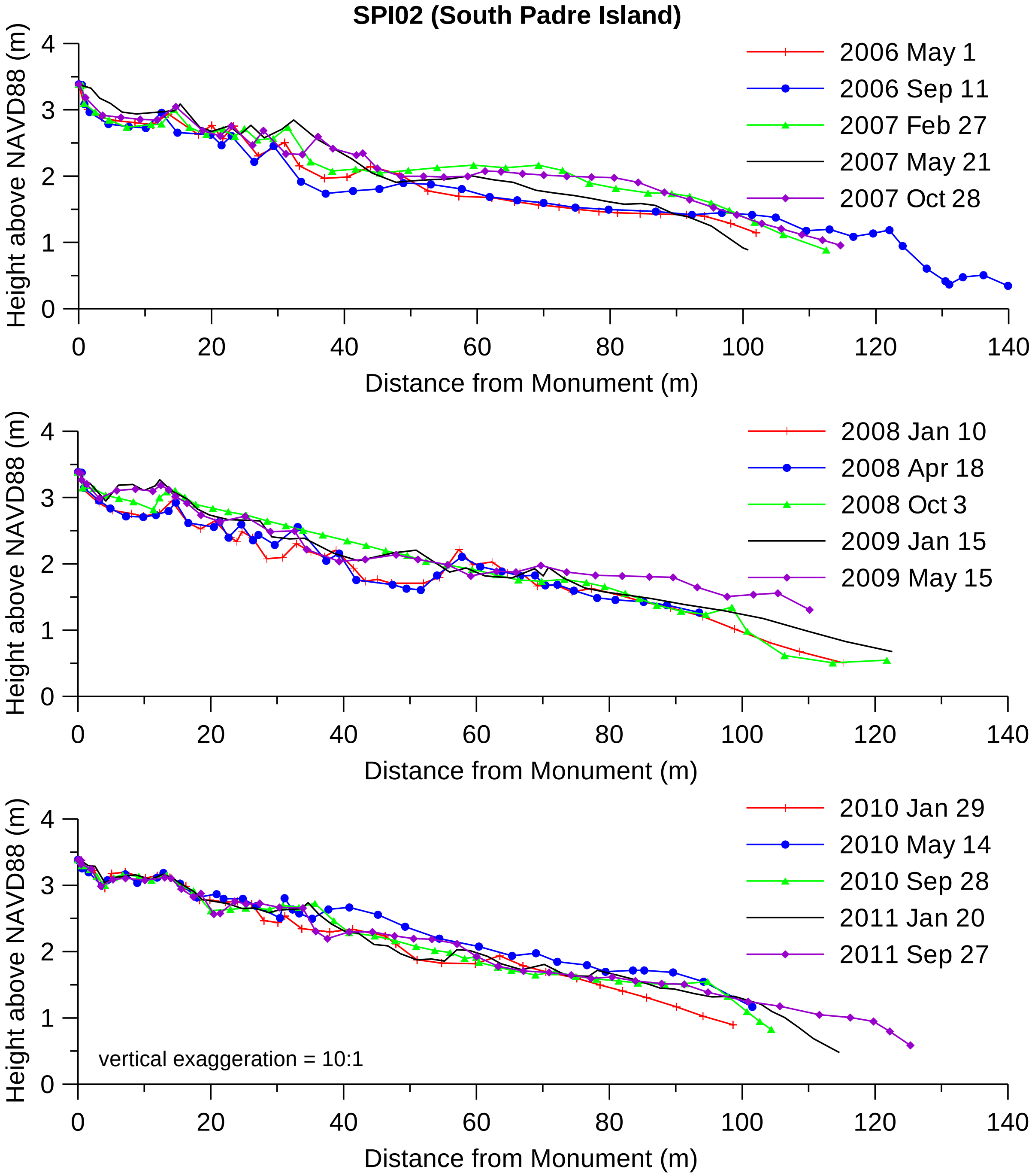



SPI08 (South Padre Island)
Height above NAVD88 (m)
Distance from Monument (m)
2023 Jan 26
2023 Apr 27
2023 Sep 20
2024 Jan 24
2024 Apr 17
2024 Oct 16
vertical exaggeration = 10:1
0
1
2
3
0
10
20
30
40
50
60

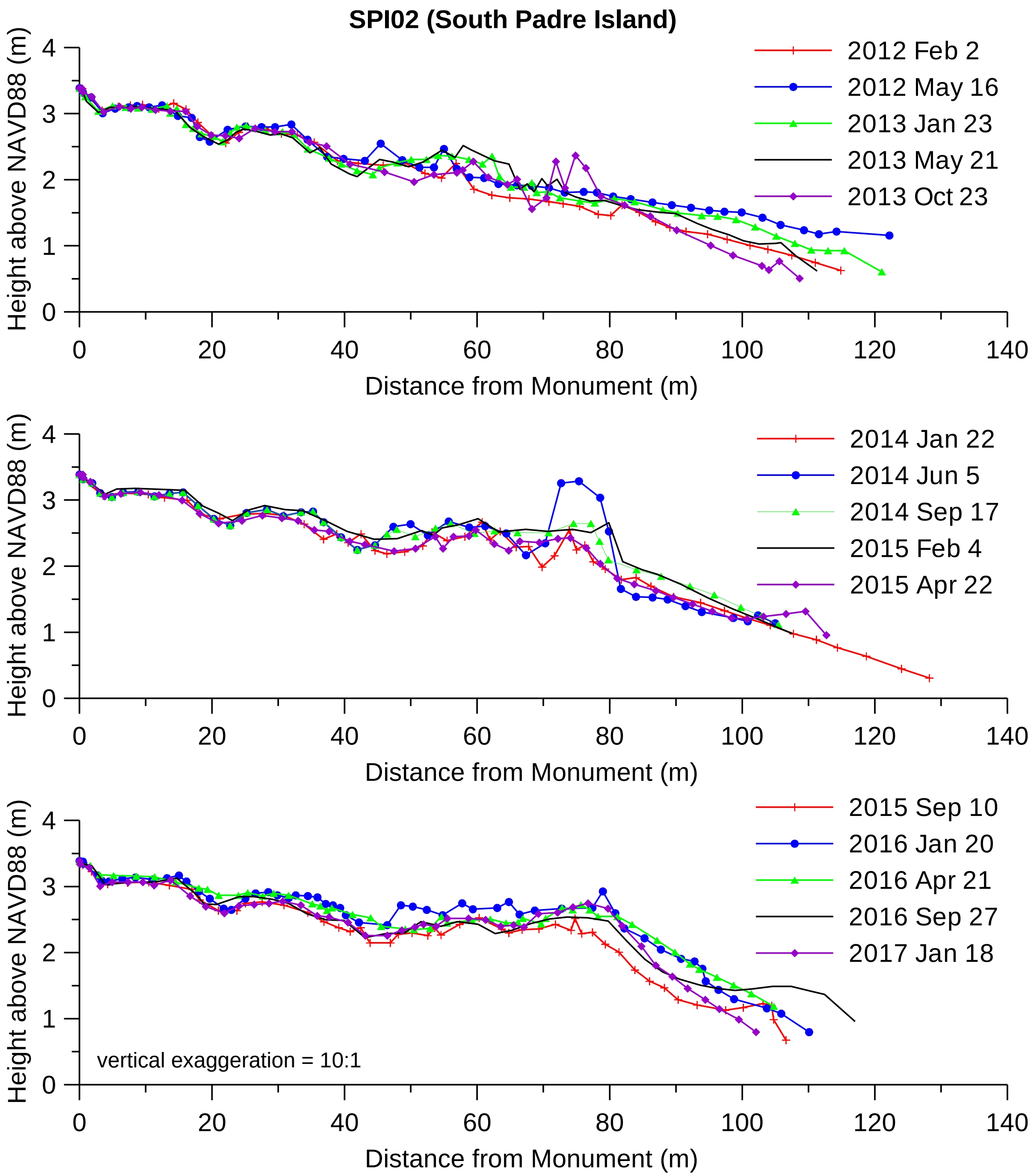
SPI02

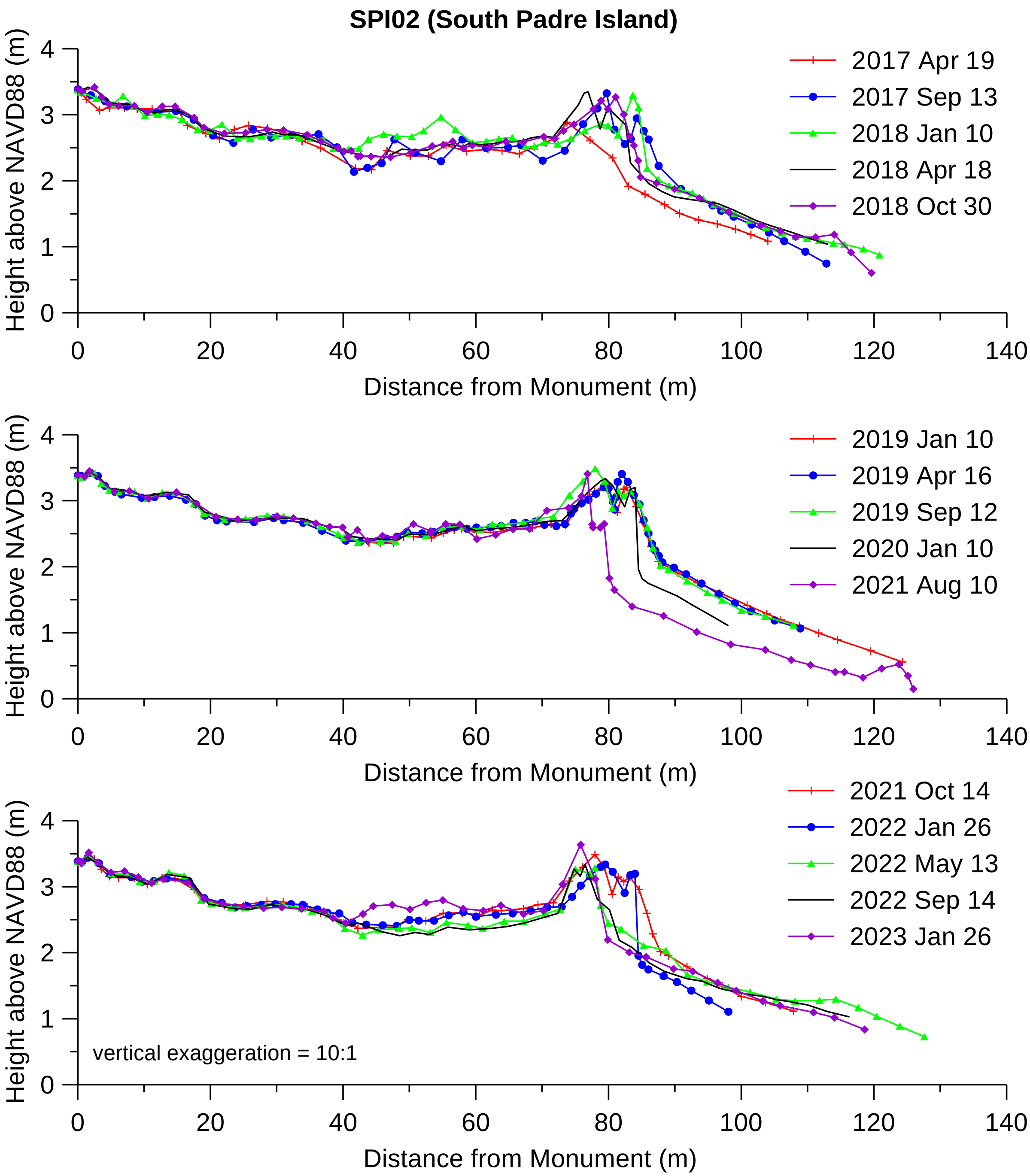


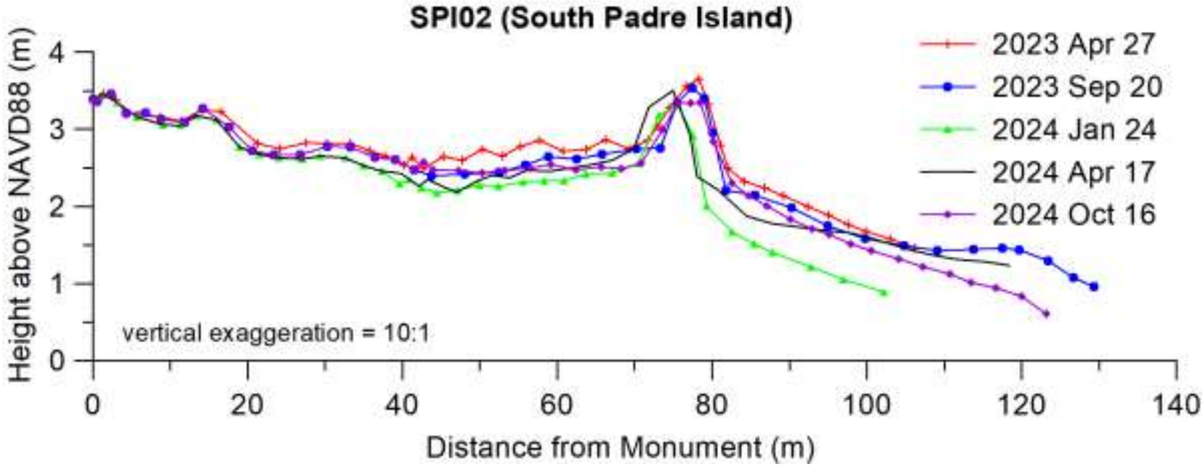
SPI02 (South Padre Island)
Height above NAVD88 (m)
Distance from Monument (m)
2000 Oct 25
2000 Dec 6
2001 Feb 19
2001 Dec 11
2002 Mar 1
2002 May 1
2002 Sep 18
2002 Dec 10
2003 Apr 1
2003 Sep 4
2004 Mar 3
2004 May 5
2004 Oct 19
2005 Jan 21
2005 Apr 25
vertical exaggeration = 10:1



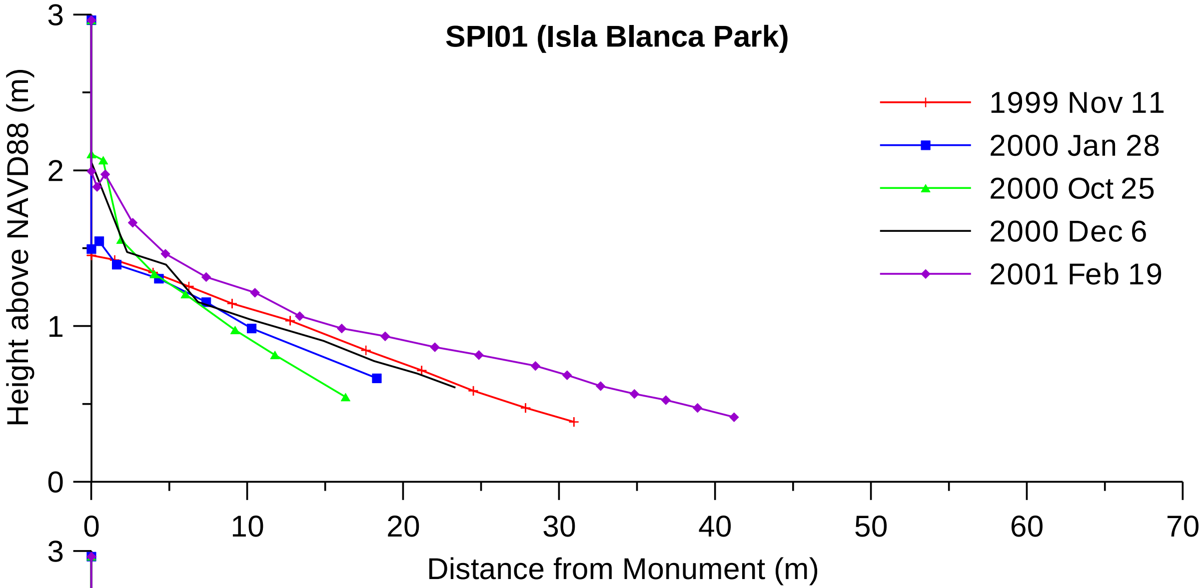
SPI02 (South Padre Island)
Height above NAVD88 (m)
Distance from Monument (m)
2006 May 1
2006 Sep 11
2007 Feb 27
2007 May 21
2007 Oct 28
2008 Jan 10
2008 Apr 18
2008 Oct 3
2009 Jan 15
2009 May 15
2010 Jan 29
2010 May 14
2010 Sep 28
2011 Jan 20
2011 Sep 27
vertical exaggeration = 10:1

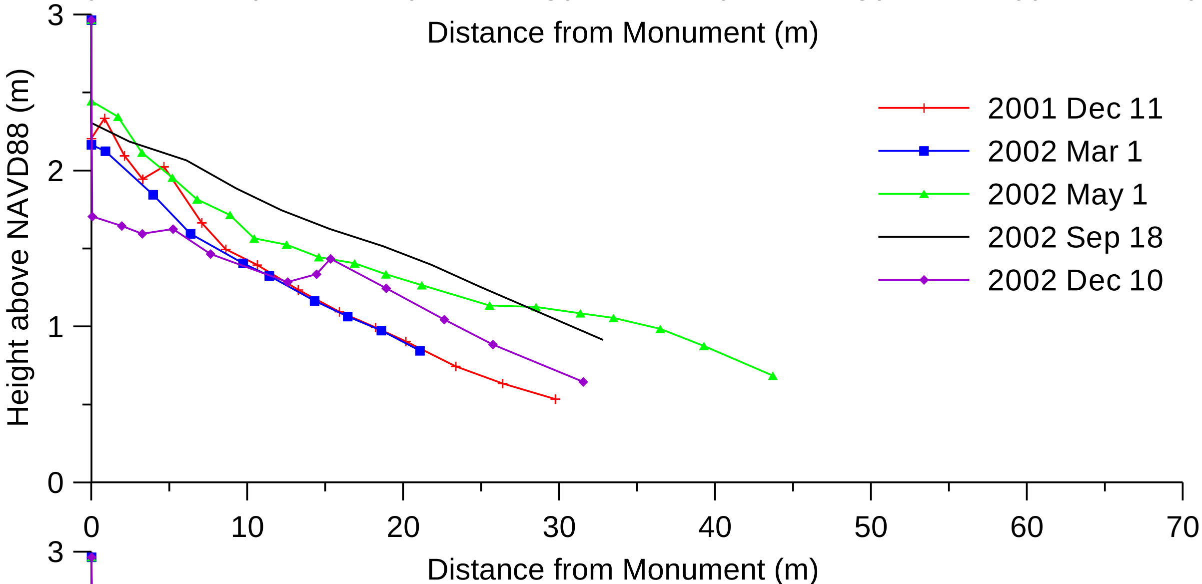

SPI02 (South Padre Island)
Height above NAVD88 (m)
Distance from Monument (m)
2012 Feb 2
2012 May 16
2013 Jan 23
2013 May 21
2013 Oct 23
2014 Jan 22
2014 Jun 5
2014 Sep 17
2015 Feb 4
2015 Apr 22
2015 Sep 10
2016 Jan 20
2016 Apr 21
2016 Sep 27
2017 Jan 18
vertical exaggeration = 10:1

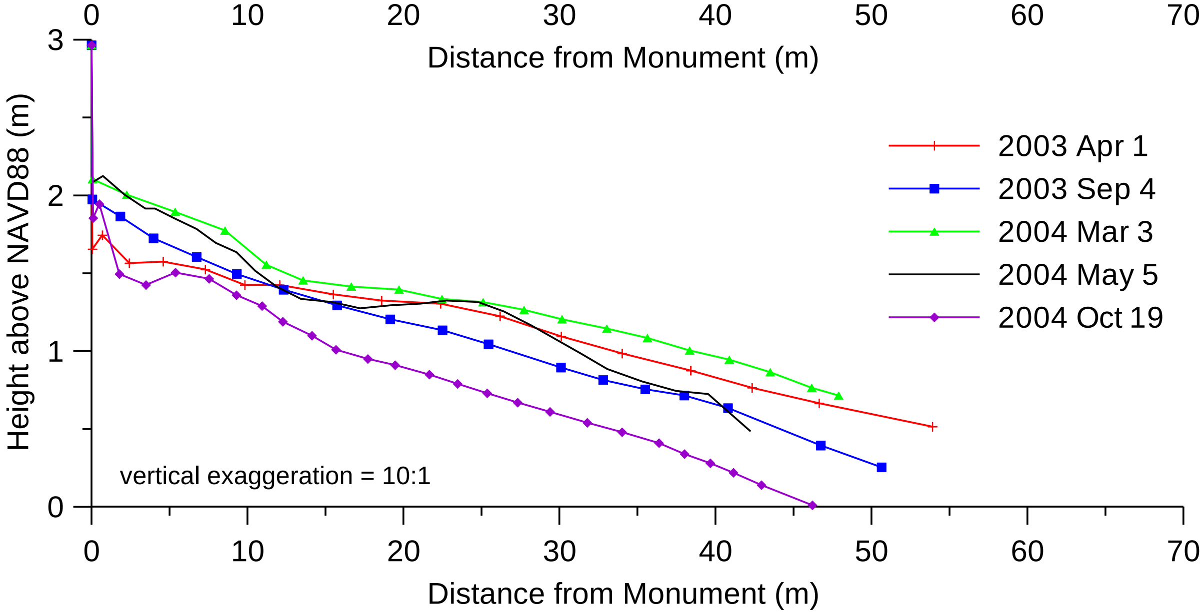

SPI02 (South Padre Island)
Height above NAVD88 (m)
Distance from Monument (m)
2017 Apr 19
2017 Sep 13
2018 Jan 10
2018 Apr 18
2018 Oct 30
2019 Jan 10
2019 Apr 16
2019 Sep 12
2020 Jan 10
2021 Aug 10
2021 Oct 14
2022 Jan 26
2022 May 13
2022 Sep 14
2023 Jan 26
vertical exaggeration = 10:1
0
1
2
3
4
0
20
40
60
80
100
120
140

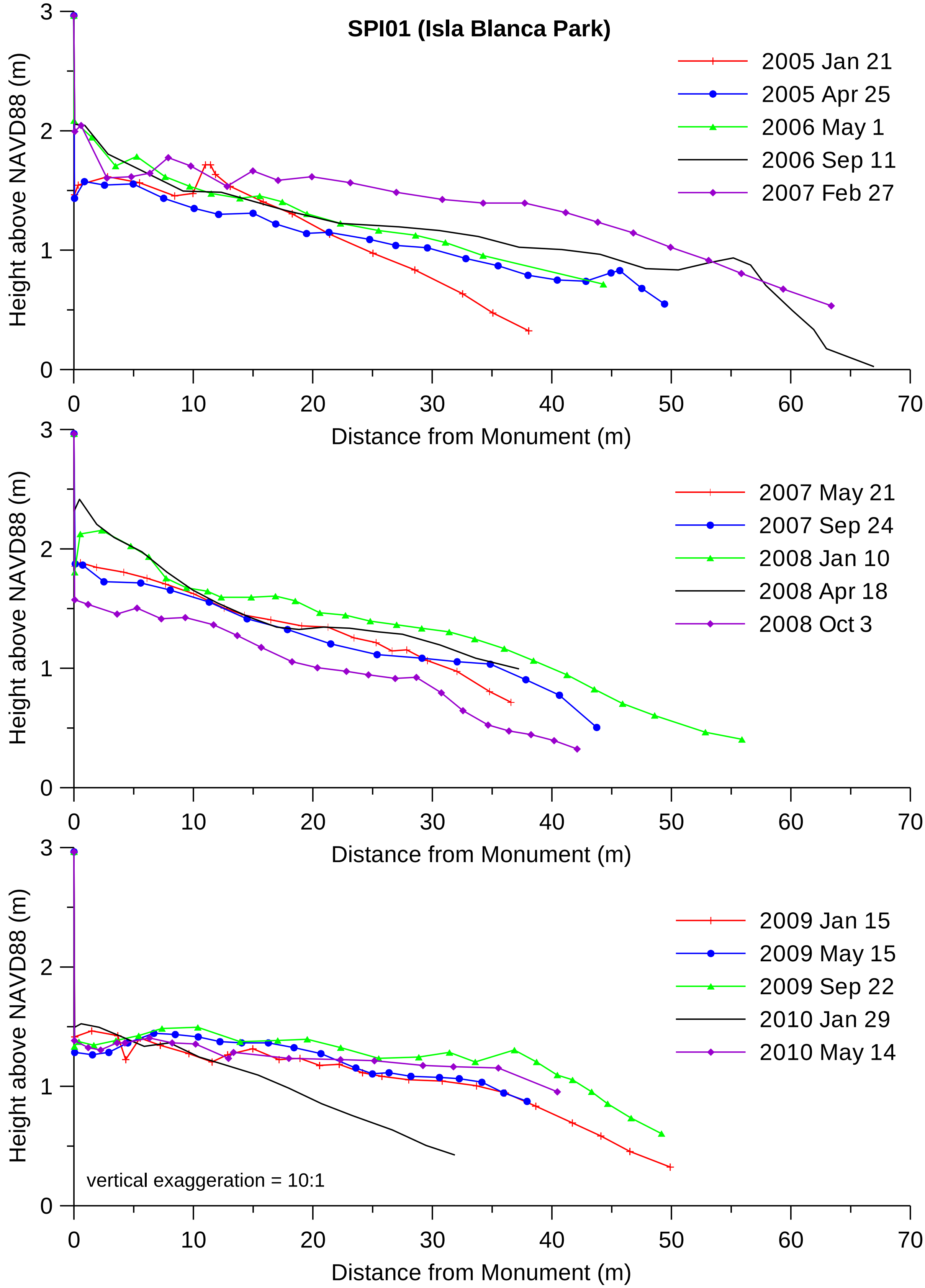

SPI02 (South Padre Island)
Height above NAVD88 (m)
Distance from Monument (m)
vertical exaggeration = 10:1
2023 Apr 27
2023 Sep 20
2024 Jan 24
2024 Apr 17
2024 Oct 16
0
1
2
3
4
0
20
40
60
80
100
120
140

SPI01

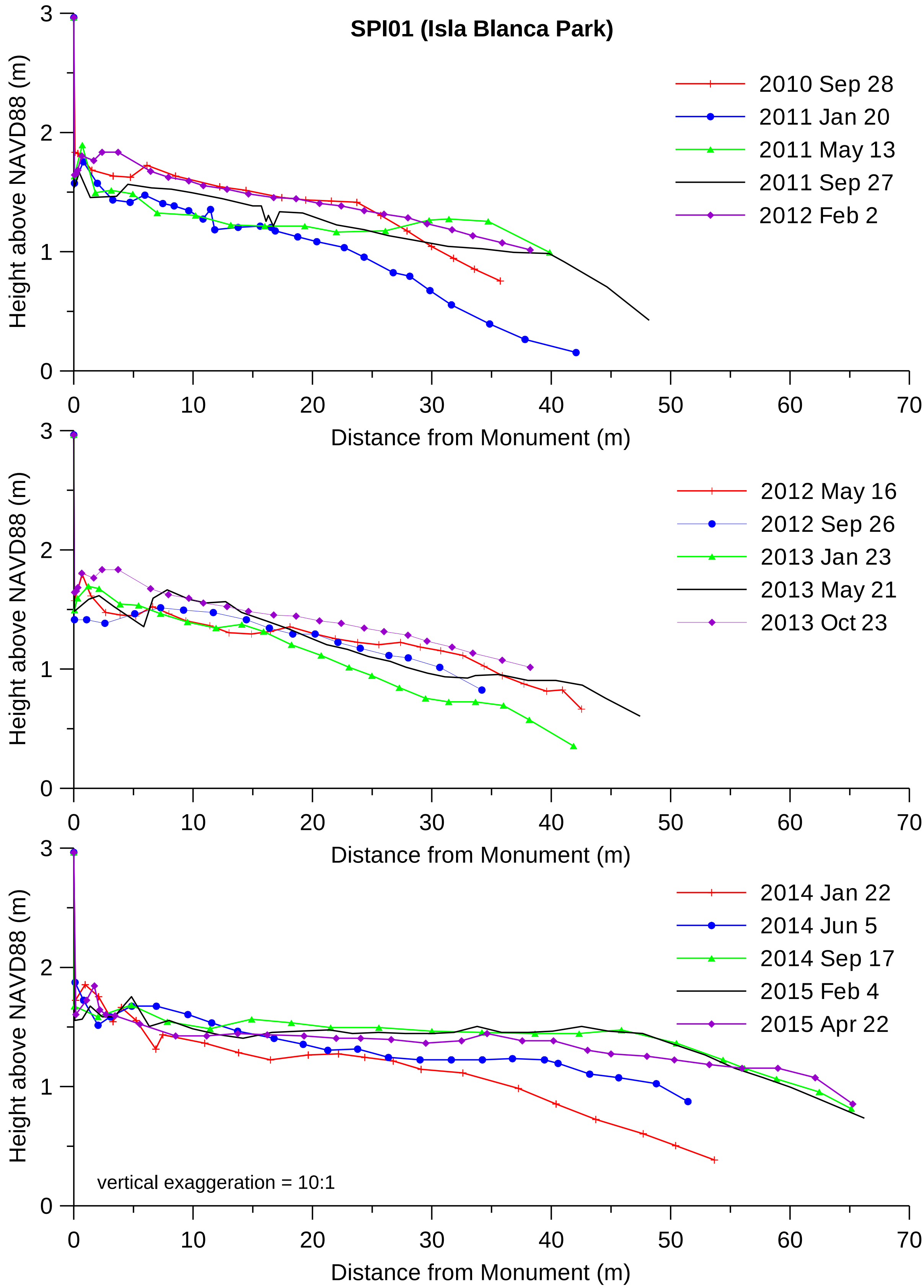

SPI01 (Isla Blanca Park)
Height above NAVD88 (m)
Distance from Monument (m)
1999 Nov 11
2000 Jan 28
2000 Oct 25
2000 Dec 6
2001 Feb 19
0
1
2
3
0
10
20
30
40
50
60
70

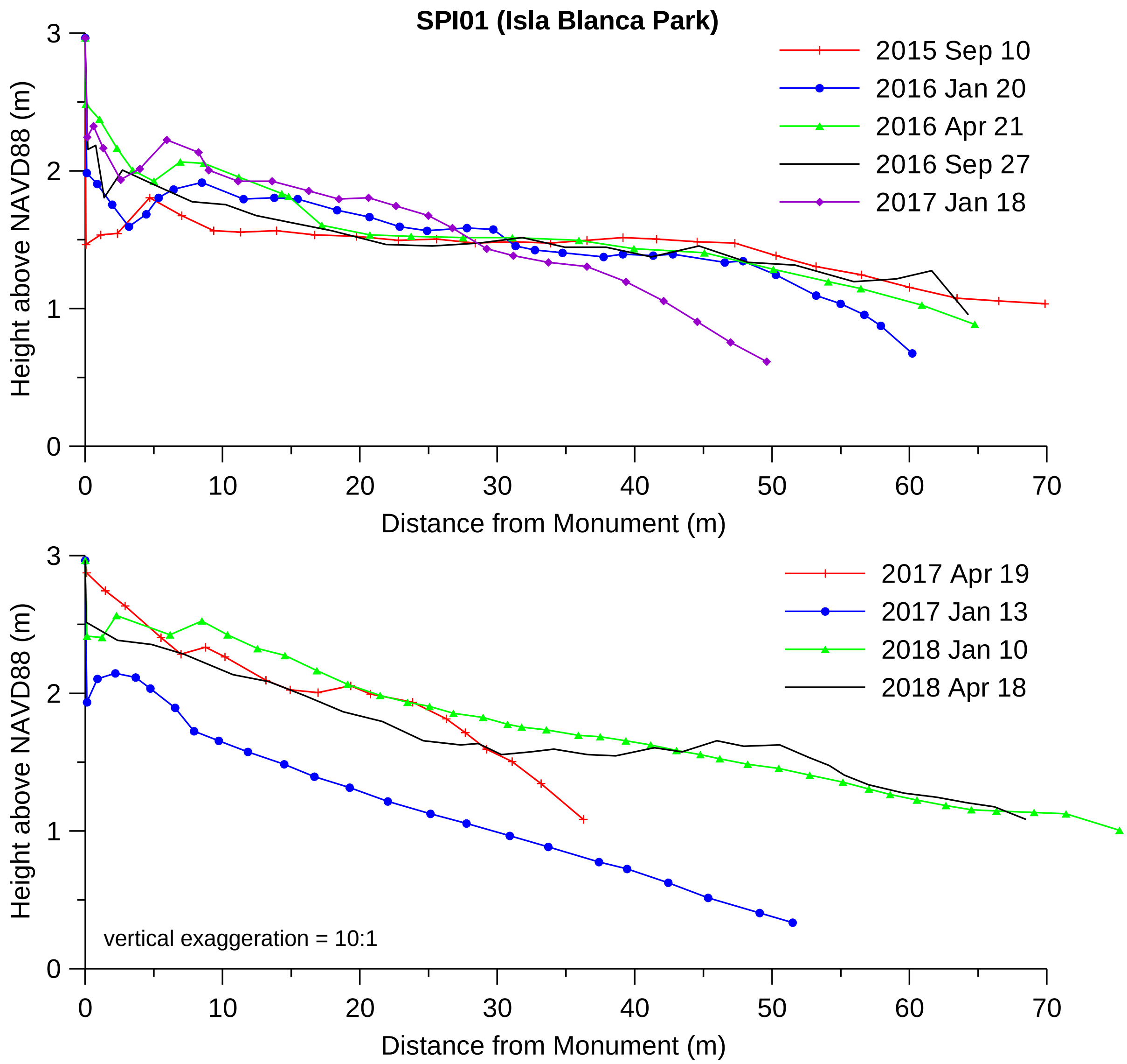

Height above NAVD88 (m)
Distance from Monument (m)
2001 Dec 11
2002 Mar 1
2002 May 1
2002 Sep 18
2002 Dec 10
0
1
2
3
0
10
20
30
40
50
60
70


Height above NAVD88 (m)
Distance from Monument (m)
2003 Apr 1
2003 Sep 4
2004 Mar 3
2004 May 5
2004 Oct 19
vertical exaggeration = 10:1
0
1
2
3
0
10
20
30
40
50
60
70

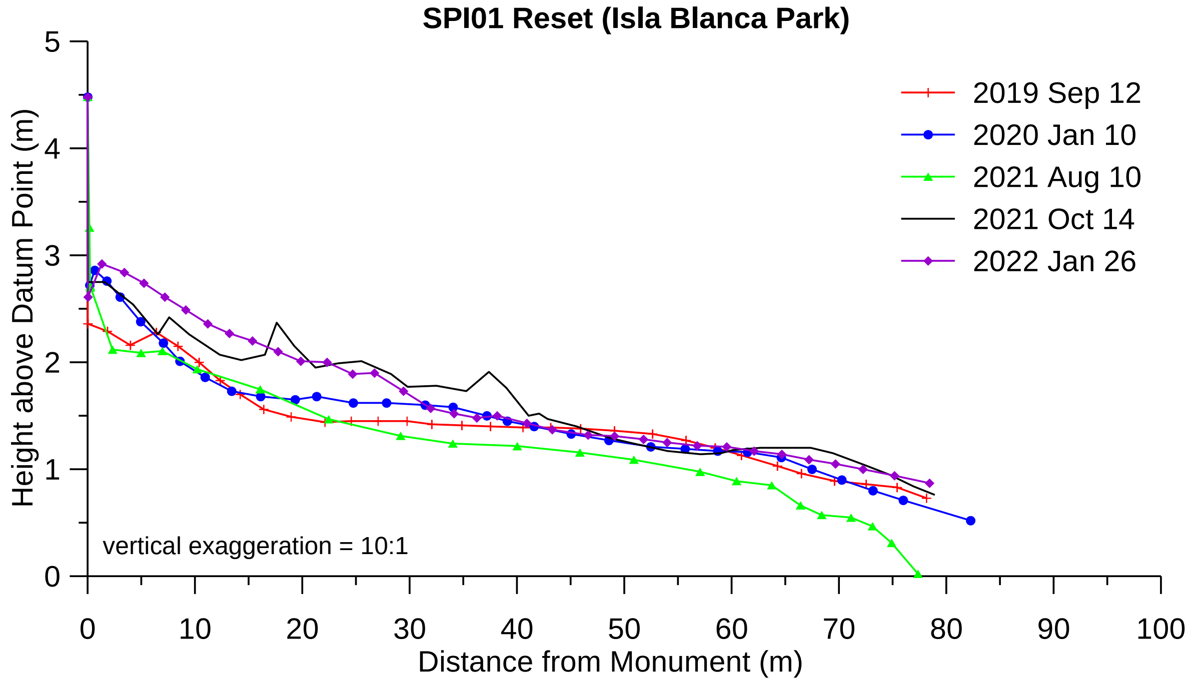


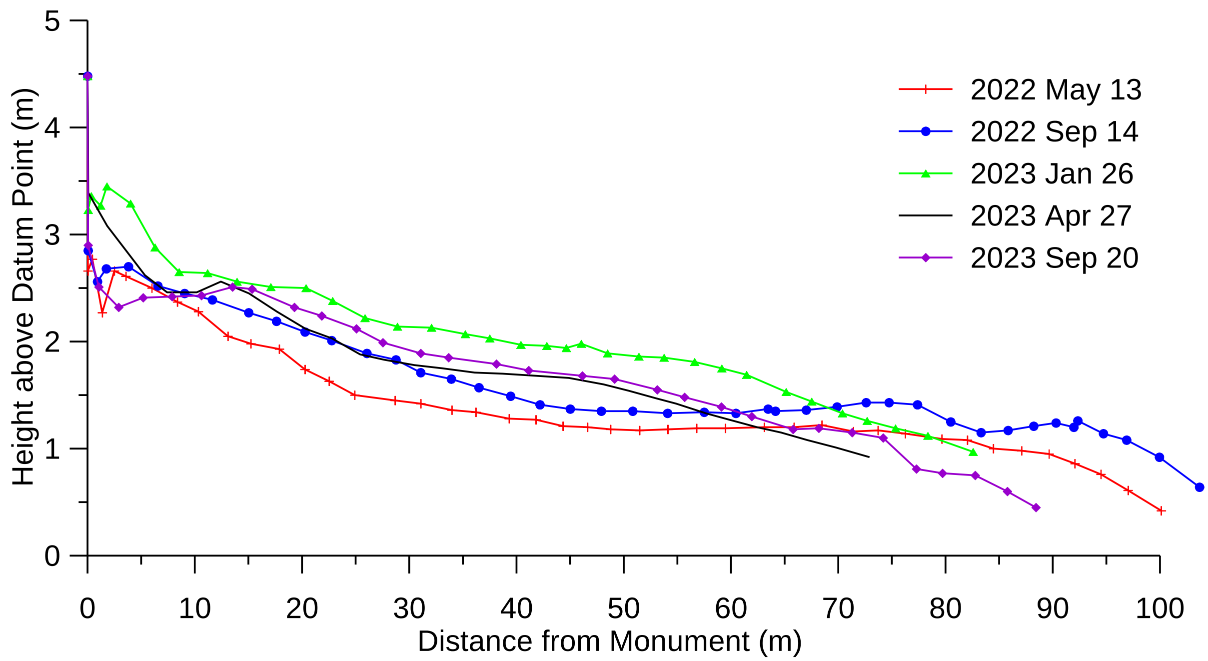
SPI01 (Isla Blanca Park)
2005 Jan 21
2005 Apr 25
2006 May 1
2006 Sep 11
2007 Feb 27
2007 May 21
2007 Sep 24
2008 Jan 10
2008 Apr 18
2008 Oct 3
2009 Jan 15
2009 May 15
2009 Sep 22
2010 Jan 29
2010 May 14
Height above NAVD88 (m)
Distance from Monument (m)
vertical exaggeration = 10:1

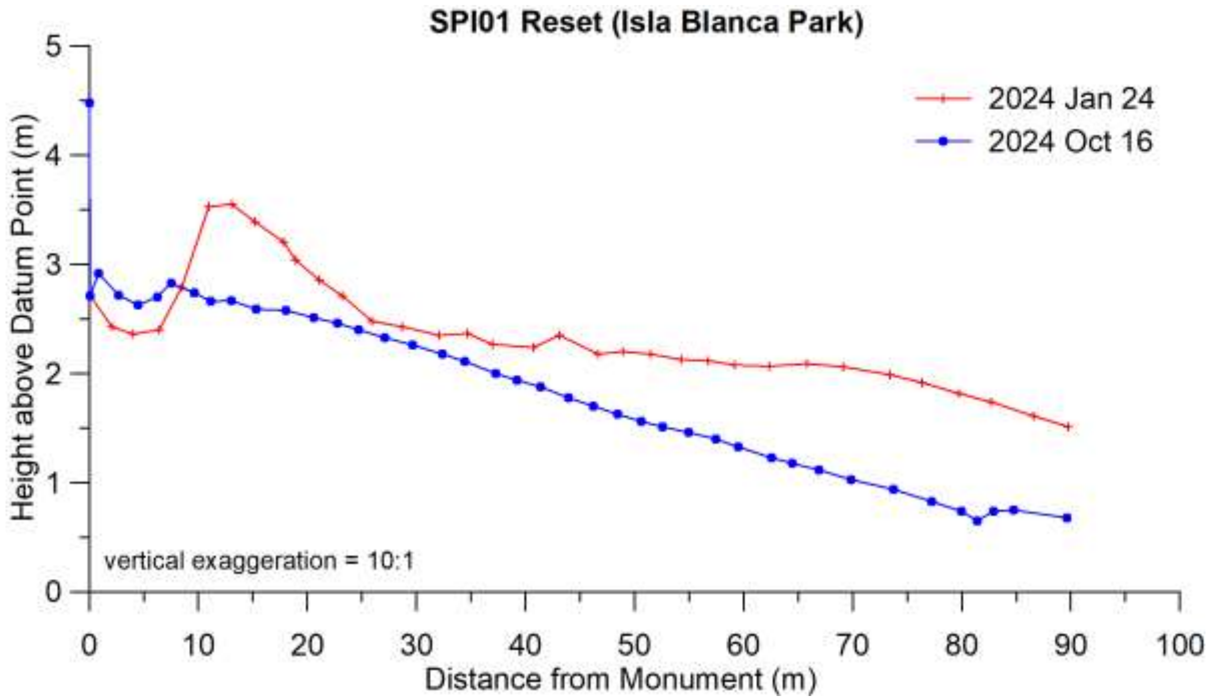

SPI01 (Isla Blanca Park)
Height above NAVD88 (m)
Distance from Monument (m)
2010 Sep 28
2011 Jan 20
2011 May 13
2011 Sep 27
2012 Feb 2
2012 May 16
2012 Sep 26
2013 Jan 23
2013 May 21
2013 Oct 23
2014 Jan 22
2014 Jun 5
2014 Sep 17
2015 Feb 4
2015 Apr 22
vertical exaggeration = 10:1


SPI01 (Isla Blanca Park)
2015 Sep 10
2016 Jan 20
2016 Apr 21
2016 Sep 27
2017 Jan 18
Height above NAVD88 (m)
Distance from Monument (m)
2017 Apr 19
2017 Jan 13
2018 Jan 10
2018 Apr 18
Height above NAVD88 (m)
vertical exaggeration = 10:1
Distance from Monument (m)

SPI01R


SPI01 Reset (Isla Blanca Park)
2019 Sep 12
2020 Jan 10
2021 Aug 10
2021 Oct 14
2022 Jan 26
vertical exaggeration = 10:1
Height above Datum Point (m)
Distance from Monument (m)


2022 May 13
2022 Sep 14
2023 Jan 26
2023 Apr 27
2023 Sep 20
Height above Datum Point (m)
Distance from Monument (m)


SPI01 Reset (Isla Blanca Park)
2024 Jan 24
2024 Oct 16
Height above Datum Point (m)
vertical exaggeration = 10:1
Distance from Monument (m)
0
1
2
3
4
5
0
10
20
30
40
50
60
70
80
90
100