

FINAL REPORT

Texas High School Coastal Monitoring Program: Ball, Port Aransas, and Port Isabel High Schools, 2003-2005

Tiffany L. Hepner and James C. Gibeaut



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Scott W. Tinker, Director

John A. and Katherine G. Jackson School of Geosciences

The University of Texas at Austin

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Tiffany L. Hepner and James C. Gibeaut

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**Coastal
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Group**

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INTRODUCTION

The Texas Coastal Monitoring Program engages people who live along the Texas coast in the study of their natural environment. High school students, teachers, and scientists work together to gain a better understanding of dune and beach dynamics there. Scientists from The University of Texas at Austin (UT) provide the tools and training needed for scientific investigation. Students and teachers learn how to measure the topography, map the vegetation line and shoreline, and observe weather and wave conditions. By participating in an actual research project, the students obtain an enhanced science education. Public awareness of coastal processes and the Texas Coastal Management Program is heightened through this program. The students' efforts also provide coastal communities with valuable data on their changing shoreline.

This report describes the program and our experiences during the 2003–2004 and 2004–2005 academic years. During this time, Ball High School on Galveston Island completed its seventh and eighth years in the program, and Port Aransas and Port Isabel High Schools completed their fifth and sixth years (Fig. 1). All three high schools are continuing the program during the 2005–2006 academic year, and the program is expanding to an additional three schools in the Bay City, Texas, region. Discussions of the data collected by the students, and recommendations for future high school projects are also included in this report. A manual with detailed field procedures, field forms, classroom exercises, and teaching materials was prepared during the first year of the project at Ball High School in 1997–1998. The program is also enhanced by a continuously updated Web site (<http://txcoast.beg.utexas.edu/thscmp/>).

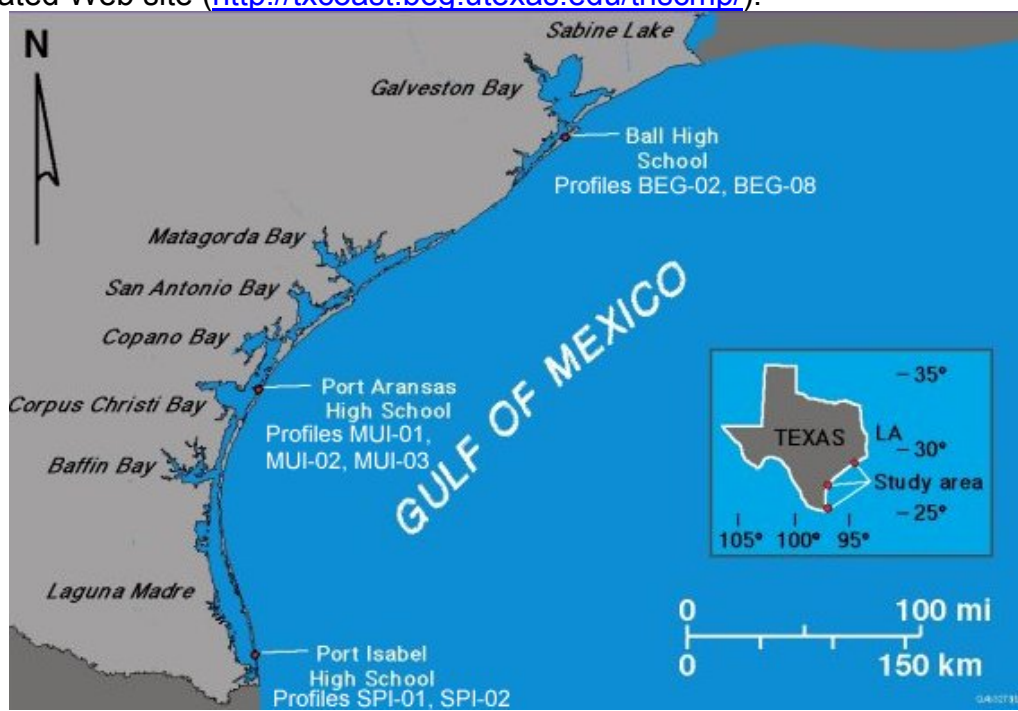


Figure 1. Participating schools.

PROGRAM DESCRIPTION

Goals

The coastal monitoring program has three major goals:

- (1) *Provide high school 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. UT scientists provide background information and guide inquiries about the data, but students are encouraged to form their own hypotheses and to test them. 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.* We expect that participating students will discuss the program with their parents, classmates, and neighbors, further expanding the reach of the program. We also expect the program to attract media attention, as it has in the past. Port Isabel High School and the Texas High School Coastal Monitoring Program were featured in a March 4, 2004, article in the *Valley Morning Star* newspaper. A paper featuring the program and data collected by the high school students was published in the fall 2004 issue of *Shore & Beach* (Vol. 72, No. 4), the journal of the American Shore & Beach Preservation Association. A World-Wide Web site (<http://txcoast.beg.utexas.edu/thscmp/>) containing the latest information is central to the community outreach part of the project. Coastal residents may wish to view the effects of a storm that strikes the upper coast. They are able to do so by accessing the Texas High School Coastal Monitoring Program Web site to view maps, graphs, and photographs collected by Ball High School. Curiosity may drive this inquiry at first, but eventually there is an increased awareness and appreciation of coastal processes and how future storms could affect a community.
- (3) *Obtain 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 of Economic Geology (Bureau) at UT has conducted a 30-year research program to monitor shorelines and investigate coastal processes. An important part of this program is the repeated mapping of the shoreline and measurement of beach profiles. Over time, these data are used to determine the rate of shoreline change. A problem we face is the limited temporal resolution in 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 quasi-periodic 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 Texas High School Coastal Monitoring Program helps 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 in the high school monitoring program is at least three class field trips during the academic year, weather permitting. During each trip, students visit several locations and apply scientific procedures to measuring beach morphology and making observations on beach, weather, and wave conditions. These procedures were developed during the program's pilot year (1997–1998) and are presented in detail in a manual and on the Web site that also includes field forms. Following is a general discussion of the field measurements.

- (1) *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. The students begin the profile at a presurveyed 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.
- (2) *Shoreline and vegetation line mapping.* Using a differential Global Positioning System (GPS) receiver, students walk along the vegetation line and shoreline mapping these features for display on Geographic Information System software. The GPS mapping provides measurements of the rate of change.
- (3) *Sediment sampling.* Students occasionally take sediment samples along the beach profile at the foredune crest, berm top, and beach face. They then sieve the samples, weigh the grain-size fractions, and inspect the grains using a microscope. These samples show the dependence of sand characteristics on the various processes acting on the beach.
- (4) *Beach processes.* Students measure wind speed and direction, estimate the width of the surf zone, and observe the breaker type. They note wave direction, height, and period and estimate longshore current speed and direction using a float, stop watch, and tape measure. From these measurements, students can infer relationships between physical processes

and beach changes in time and space. Students also learn to obtain weather and oceanographic data from resources on the Internet.

Training

UT scientists provide teachers with all the training, information, field forms, and equipment needed to conduct field and lab measurements. During the school year, UT scientists accompany students on at least one field trip and make at least two classroom visits, which may be included with the field trips. The classroom visits provide students with even more insight into conducting scientific research. The scientists discuss with the students general and theoretical issues regarding scientific research, as well as specific techniques and issues related to coastal research. The visits also provide scientists with an opportunity to ensure quality of the data.

Data Management, Data Analysis, and Dissemination of Information

The World-Wide Web is central to the dissemination of data collected for this program. A Web site (<http://txcoast.beg.utexas.edu/thscmp/>), which resides on a UT server, was implemented toward the end of the 1998–1999 academic year. The Web site provides all the information needed to begin a beach monitoring program, as well as curriculum materials for high school teachers. Each school in the program has an area on the Web site for posting its data and observations, including photos taken by an electronic camera. UT scientists manage the data in an electronic database and make it available to the public. UT scientists also evaluate the data in light of coastal management problems. Students and the public can now interactively plot beach profiles and retrieve data through the Web site.

STUDENT, TEACHER, AND SCIENTIST INTERACTIONS DURING THE 2003–2004 AND 2004–2005 ACADEMIC YEARS

UT scientists, Dr. Gibeaut, Dr. Gutierrez, and Ms. Hepner, worked with teachers Mr. Ron Wooten of Ball High School, Mr. William Slingerland of Port Aransas High School, and Mr. Kevin Tenison and Dr. Michelle Zacher of Port Isabel High School. Mr. Wooten chose his Advanced Placement Environmental Science classes to participate in the program. Mr. Slingerland chose his Aquatic Sciences class (2004–2005) to participate in the program, although during the 2003–2004 academic year, the Aquatic Sciences class was not offered at Port Aransas High School. Mr. Slingerland therefore recruited his Math Models class to continue with the program during the academic year. Mr. Tenison's Advanced Placement Environmental Science class participated during the 2003–2004 academic year. Port Isabel High School biology teacher, Dr. Zacher, utilized her Advanced Placement Biology and General Biology classes during the 2004–2005 academic year. Approximately 70 students in the 9th, 10th, 11th, and 12th grades actively participated during this 2-year time frame.

The Bureau applied for and successfully acquired additional funding from the Meadows Foundation to expand the program to three schools in the Bay City region. Teacher training for staff from Van Vleck Middle School and Tidehaven Middle School was held in early March 2005. The first field trips for both of these schools were held in late April 2005. This grant expands the Texas High School Coastal Monitoring Program not only to additional schools but to younger students. These students are making the same field measurements as the high school students, but they are visiting only one profile site per field trip. The additional funding from the Meadows Foundation will also support another school from the Bay City region. Bay City High School students will begin monitoring beaches during the 2005–2006 academic year. Bay City area schools are monitoring the Matagorda Peninsula beach northeast of the mouth of the Colorado River. The Bureau has also proposed adding a seventh school to the Texas High School Coastal Monitoring Program.

UT scientists visited each school at least twice. The visits coincided with field trips. During and after field trips and during lectures, UT scientists discussed careers in science and university life with students. These visits by UT scientists served not only to enhance scientific instruction, but they also gave students insight into science as a career.

During the field trips, students were divided into two or three teams, depending on the size of the class. One team measured the profile while the other team collected data on weather and waves and conducted a GPS survey of the shoreline and vegetation line. Team members had specific tasks, and students took turns performing them. After each team completed its tasks at the first location, the teams switched roles so that everyone would have an opportunity to conduct all measurements.

Dividing students into two five- to seven-member teams works well. One team conducts the beach profile and the other measures the processes and the shoreline. Each team finishes at about the same time, although for short profiles, the profiling team may finish early. In this case, an extra task can be assigned to the profiling team. It is important to assign each student a job to keep him or her focused and interested. Time for a little fun should also be allowed. People normally think of the beach as a place of recreation, and participation in this project should not change that. In fact, it is hoped that program participants will enjoy going to the beach even more because of their newly acquired knowledge and observation skills.

The day of the field trip, students meet in the teacher's classroom to organize equipment and gather additional materials that they may need for the day (coolers with ice and water, lunches, etc.). Throughout the day, data and samples are collected from two or three locations. Sufficient time is allotted for lunch and breaks. On some trips there is time for additional scientific inquiry, such as visiting the Laguna Madre Nature Trail on South Padre Island or

observing the wetlands at Galveston Island State Park. All trips allow ample time for careful data collection and having the students back at school about 1 hour before the end of the day. During this hour, equipment and samples are stored, and data are filed or transferred to the computer. Following are details on the activities at each school.

Ball High School

Mr. Ron Wooten's AP Environmental Science classes at Ball High School participated in field trips on September 3, 2003; December 2, 2003; May 24, 2004; October 5, 2004; January 27, 2005; and April 28, 2005. They conducted surveys at the same two locations as previous Ball High classes, one at the Galveston Island State Park, BEG02, and one on Follets Island southwest of San Luis Pass, BEG08 (Fig. 2). The Bureau has also been measuring these profiles since the 1980's. Ms. Hepner accompanied the class and provided further training and background information to the students.

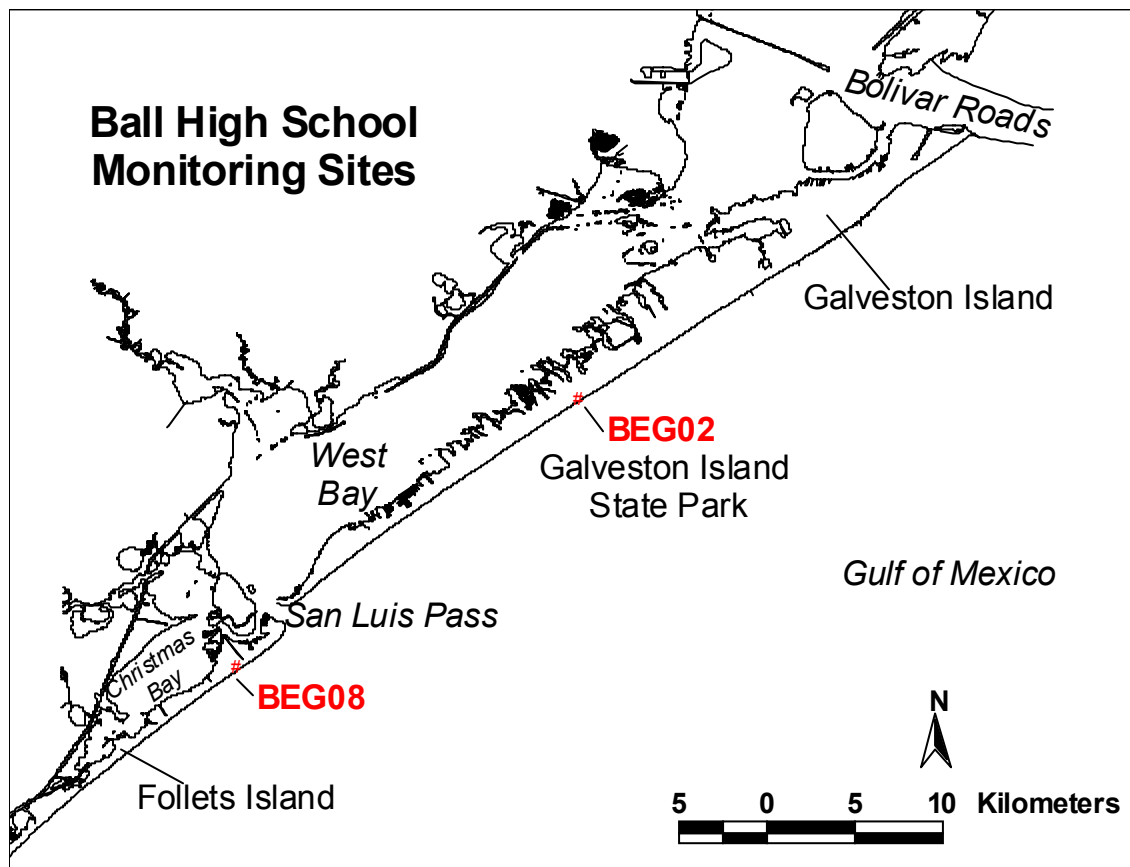


Figure 2. Location map of Ball High School monitoring sites.

On January 27, 2005, students from Ms. Brenda Paloski's Geology Meteorology and Oceanography class from Pasadena Memorial High School

accompanied Ball High School students on their second field trip. Owing to inclement weather conditions, the students collected data at the Galveston Island State Park site only. In order to enhance the visiting students' experience, Dr. Gibeaut and Ms. Hepner led the classes to other sites of interest to coastal geologists on Galveston Island. They visited both ends of the Galveston seawall and the Pirates Beach subdivision to examine geotextile tubes. Ms. Paloski hopes to have her students participate in additional field trips during subsequent academic years.

Port Aransas High School

Port Aransas students participated in field trips on September 15, 2003; January 20, 2004; April 19, 2004; September 8, 2004; December 9, 2004; and May 3, 2005. Mr. Slingerland's class collects data at three profile locations on Mustang Island, MUI01, MUI02, and MUI03 (Fig. 3). The Aquatic Sciences class was dropped during the 2003–2004 academic year because too few students enrolled in the class. In order to continue the program, Mr. Slingerland enlisted the help of his Math Models class. Math Models is a 3rd-year math in which students learn the application of mathematics and how it is modeled in everyday life. Subjects include scale and proportion, statistics, interest rate and banking, consumer math, etc. Mr. Slingerland decided that collection of mathematical data and seeing how it was used for real science would be a wonderful project for the class. The students responded enthusiastically to the project. It is not every day that you visit the beach during a math class. Concepts learned by the students through the Texas High School Coastal Monitoring Program included the metric system, recording, and how data are used to understand natural trends.

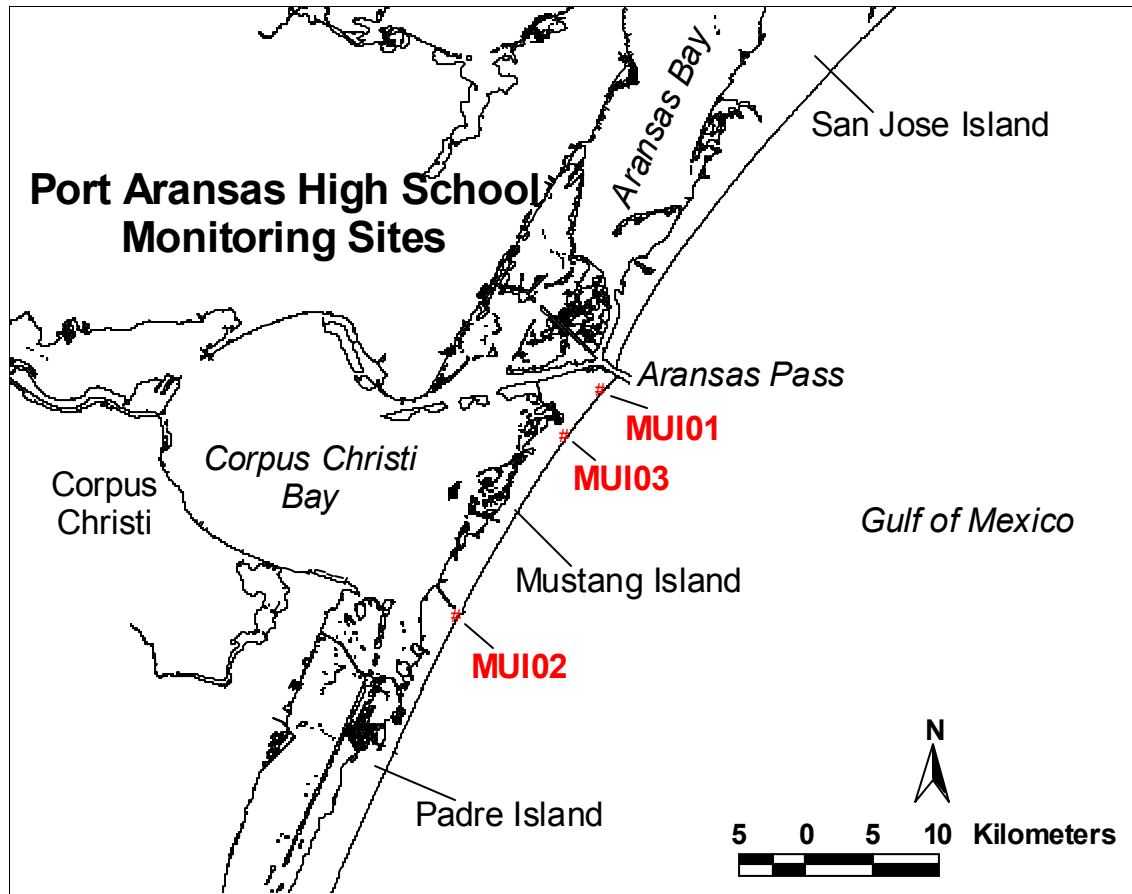


Figure 3. Location map of Port Aransas High School monitoring sites.

Port Isabel High School

Mr. Tenison's AP Environmental Science class participated in field trips on September 4, 2003; March 3, 2004; and May 5, 2004. Port Isabel students collect data from two sites: SPI01 in Isla Blanca Park and SPI02 at Beach Access #13 Moonlight Circle (Fig. 4).

Because Mr. Tenison retired at the end of the 2003–2004 academic year, the Port Isabel principal and superintendent determined that Dr. Zacher would be the logical leader of the Texas High School Coastal Monitoring Program. She is the general Biology, Advanced Placement Biology, and Anatomy and Physiology teacher at the high school. During the first field trip, on October 19, 2004, Dr. Zacher decided to use the 8 students in the Advanced Placement Biology class and 12 students from General Biology classes. The original idea was to include a different set of 12 biology students during each remaining field trip. Twenty students proved to be a handful during the first trip. Ms. Hepner and Dr. Zacher had a difficult time keeping all of the students (especially the AP students) actively engaged while on the field trip. The eight members of the AP biology class chose two students from the General Biology classes to join them on the January 21, 2005 and April 25, 2005 field trips. On the April 25, 2005, field trip, in

addition to shoreline measurement, the class used a seine net to catch and release aquatic organisms in Laguna Madre.

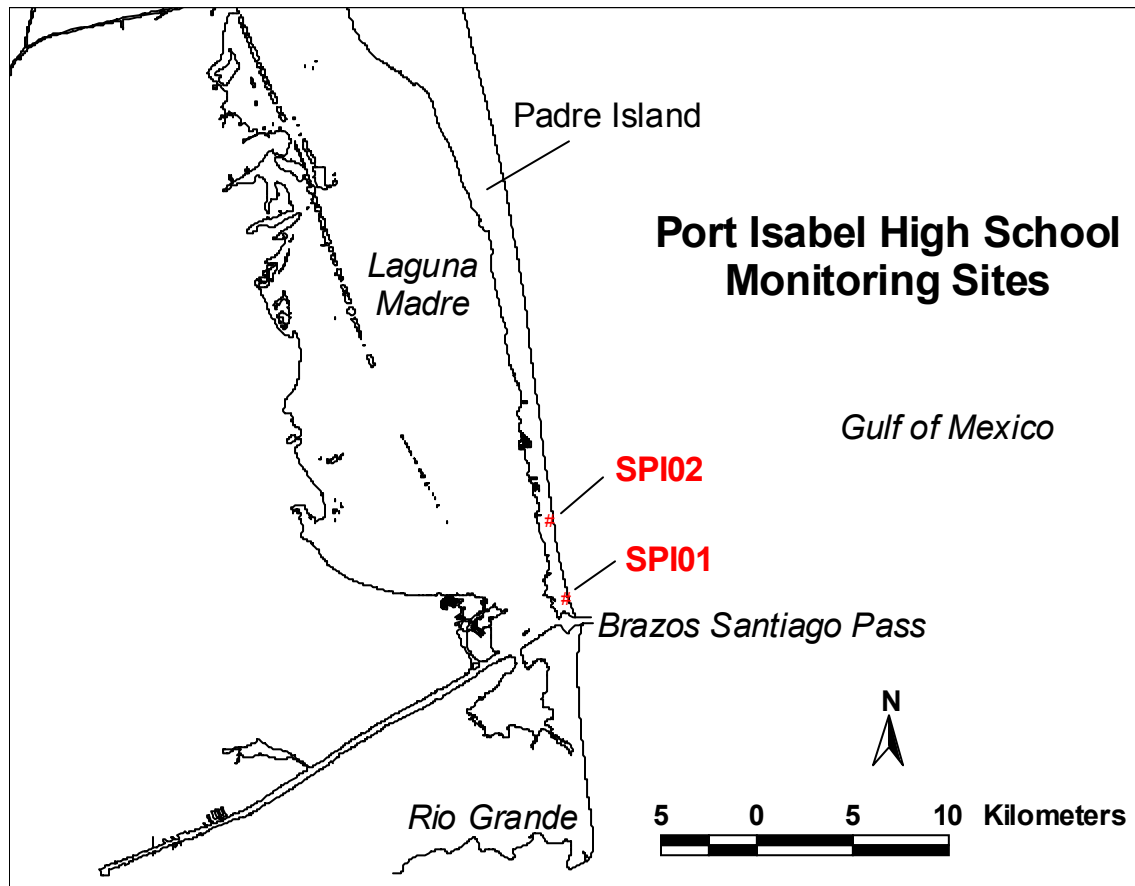


Figure 4. Location map of Port Isabel High School monitoring sites.

EFFECTS ON SCIENCE CURRICULUM

The Texas High School Coastal Monitoring Program addresses several requirements of Texas Essential Knowledge and Skills (TEKS) for science, and the program was relevant in the following 2003–2005 Texas high school courses: (1) Environmental Systems; (2) Aquatic Sciences; and (3) Geology, Meteorology, and Oceanography. The Texas High School Coastal Monitoring Program also addresses several National Science Education Standards: (1) unifying concepts and processes in science, (2) science as inquiry, (3) physical science, (4) Earth and space science, (5) science and technology, and (6) science in personal and social perspectives.

TEKS and Standards related to applying scientific methods in field and laboratory investigations in these courses are well covered in the Coastal Monitoring Program. Specific requirements, such as (1) collecting data and making measurements with precision, (2) analyzing data using mathematical methods, (3) evaluating data and identifying trends, and (4) planning and

implementing investigative procedures, are an excellent fit with the program. TEKS and Standards that require students to use critical thinking and scientific problem solving to make informed decisions are also well served. Teachers and scientists can use the program to illustrate to students the role science could, should, or does play in developing public policy. A case study of a local erosion problem could be used to illustrate.

The ability to enter data through the Web site and to make immediate comparisons with earlier data is expected to increase the interest of students in their measurements and observations. Keeping the Access database on-line has proven to be a difficult task, however. Recently we have had to change a server that houses the Web-site material, and several page links and coding for the interactive part of the Web site have not updated properly. The code must be searched line by line to determine where the links have failed—a daunting task. Therefore, students have not been able to upload data through the Web site this academic year. The Web site is an important component of the program and will hopefully be running again before the start of the 2005–2006 academic year.

Additional upgrades are planned for the Web site that will enhance students' experience. Several exercises have been developed as part of a National Science Foundation grant that utilize the data collected by participants in the program. These have not been added to the site yet because of plans to reorganize the Web-site design. We recently received funding to create an interactive virtual field trip that will be a main feature of the Web site. We also intend to expand the site to make it more of a national resource that will be useful to teachers and students not directly involved in the program.

EFFECTS ON SCIENTIFIC RESEARCH, COASTAL MANAGEMENT, AND PUBLIC AWARENESS

During the 2003–2004 and 2004–2005 academic years, Ball High School students measured profile locations in Galveston Island State Park (BEG02, Fig. 2) and on Follets Island to the southwest of Galveston Island. Ball High School students had measured these same locations in previous years, and the Bureau had conducted quarterly surveys at these locations from 1983 through 1985 after Hurricane Alicia. Since 1985, however, the beaches had been surveyed on an irregular schedule, about once per year, and only when specific projects were funded to do so or when Bureau personnel were in the area conducting other work. The high school beach-monitoring program helps ensure that the time series at these key locations are continued. The Galveston Island State Park profile has increased importance because it served as a control site for comparing profiles measured in front of geotextile tube projects along Pirates Beach to the northeast. Results of a study utilizing data collected by Ball High School students have been published in *Shore & Beach*, the journal of the American Shore & Beach Preservation Association. The data have added to our understanding of recovery of beaches and dunes following storms (Hurricane

Alicia, Tropical Storm Frances, Hurricane Claudette) that have impacted the area.

Port Aransas and Port Isabel High Schools continued the beach-profile time series at their established locations. The profile and processes data that the students collected have been incorporated into the beach-profile database at the Bureau, and scientists are using these data to investigate beach erosion patterns. These data can be viewed at the Texas High School Coastal Monitoring Program Web site at <http://txcoast.beg.utexas.edu/thscmp/>.

Although it will take time to incorporate the data into products that support coastal management, it is clear that the data will be useful in explaining beach cycles and defining short-term versus long-term trends. Defining these trends is important for making decisions regarding coastal development and beach nourishment. The program has increased public awareness through the students. On the basis of inquiries from people wishing to enter their school or group in the THSCMP, we think that the program is reaching the public. Television reports, presentations at conferences, and newspaper articles have helped. The Web site will continue to be instrumental in extending the reach of the program and increasing public awareness of coastal processes.

SCIENTIFIC RESULTS OF 1997–2005 STUDIES

The first goal of the Texas High School Coastal Monitoring Program is to provide high school students with an inquiry-based learning experience, which is achieved by involving students in a real-world research project. The student-collected beach data can and have been used by researchers at the Bureau to help respond to several beach-related issues. The data are also available to coastal managers and the public on-line at <http://txcoast.beg.utexas.edu/thscmp/>.

Profile data are entered into the public-domain software package called “Beach Morphology and Analysis Package” (BMAP). BMAP Version 2, developed by the U.S. Army Corp of Engineers, is commonly used by coastal engineers and scientists for beach-profile analysis. Beach-volume calculations were accomplished using BMAP. Shoreline and vegetation-line positions are determined from notes made by students and scientists while in the field collecting data. The shoreline is designated by the wet/dry line or a berm crest. Volume, shoreline, and vegetation-line plots for sites collected by Ball, Port Aransas, and Port Isabel High Schools are found in Appendix B. Profile plots are in Appendix C.

Students from Ball High School have been collecting data for the Coastal Monitoring Program since 1997. During this time, Tropical Storm Frances (September 1998) played a major role in reshaping the beaches in Galveston County. Several other severe storms have impacted the study area since the inception of the program. Allison (2001), Fay (2002), and Hurricane Claudette

(2003) have caused varying amounts of damage to beaches and dunes along the Texas coast (Fig. 5). Data collected by Ball High School students on Galveston Island have been used by scientists at the Bureau to track beach and dune recovery stages following Tropical Storm Frances. The storm caused significant damage to beaches along the southeast coast of Texas that was comparable to damages caused by category-3 Hurricane Alicia in 1983.

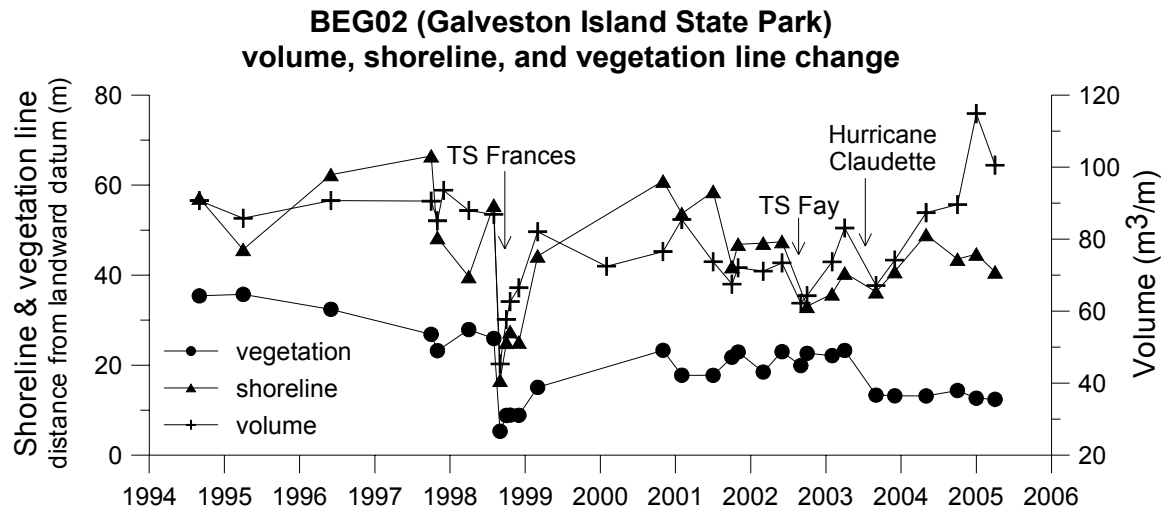


Figure 5. Profile volume, shoreline, and vegetation-line changes at Galveston Island State Park.

The BEG02 beach profile at Galveston Island State Park is being incorporated into another study by Bureau scientists. The Bureau is responsible for monitoring impacts of the geotextile tubes that have been installed along Galveston Island, Follets Island, and Bolivar Peninsula. Tropical Storm Frances placed many homes on this stretch of coast in danger of being damaged or destroyed during subsequent storms and gradual shoreline retreat. In an effort to prevent such damage from occurring, geotextile-tube storm protection projects were constructed as temporary erosion control measures. BEG02, located in Galveston Island State Park, is adjacent to a subdivision where the erosion control devices have been installed. One of the observations made during this study involved beach widths measured from the base of the geotextile tube or dune to the waterline. The BEG02 profile site in Galveston Island State Park is south of a geotextile-tube project in the Pirates Beach community. The beach in the relatively natural area of the State Park was wider than it was in front of the subdivision owing to the lack of restriction caused by placement of the geotextile-tubes (Gibeaut et al., 2003) (Fig. 6).

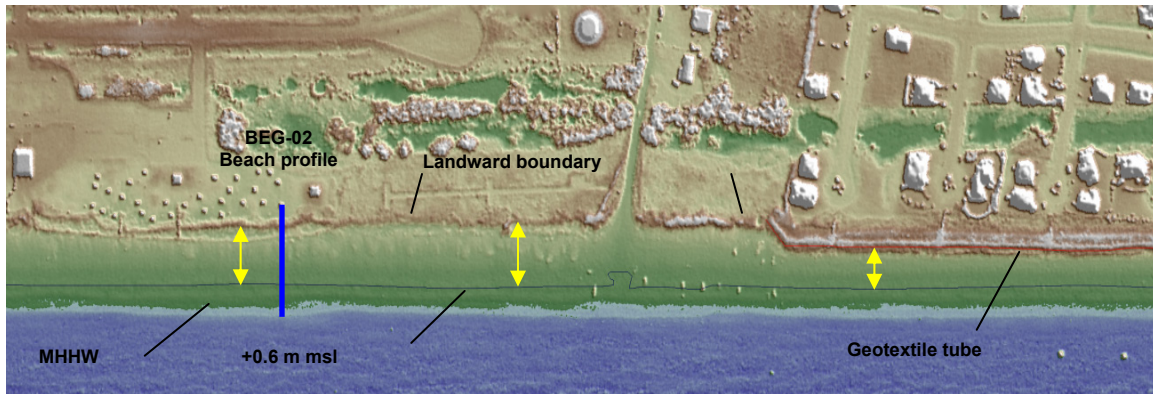


Figure 6. Lidar topographic relief image of Galveston Island State Park and Pirates Beach subdivision. Note difference in beach width between the natural beach and in front of the subdivision.

Port Aransas and Port Isabel High Schools have been collecting beach-profile data and coastal-process observations since 1999. Although neither location has experienced the type of dramatic shoreline change that Galveston and Follets Islands have, the information gained from the students' work has been beneficial to Bureau researchers' understanding of the dynamics of the Texas coast. Biannually Brazos Santiago Pass, the southern border of South Padre Island, is dredged. The Pass serves as the southern Gulf of Mexico access to the Gulf Intracoastal Waterway and the Port of Brownsville. Dredged material is placed on beaches of South Padre Island, and the two sites monitored by Port Isabel High School students are within the nourishment areas. The SPI02 monitoring site has also been used by students and scientists to monitor the growth of dunes. When the monitoring site was established in August 2000, neither vegetation nor dunes at this location were seaward of the seawall. Since that time, sand fences have been installed, and vegetation has been planted. Profile data have been quantifying the effects of these actions (Fig. 7).

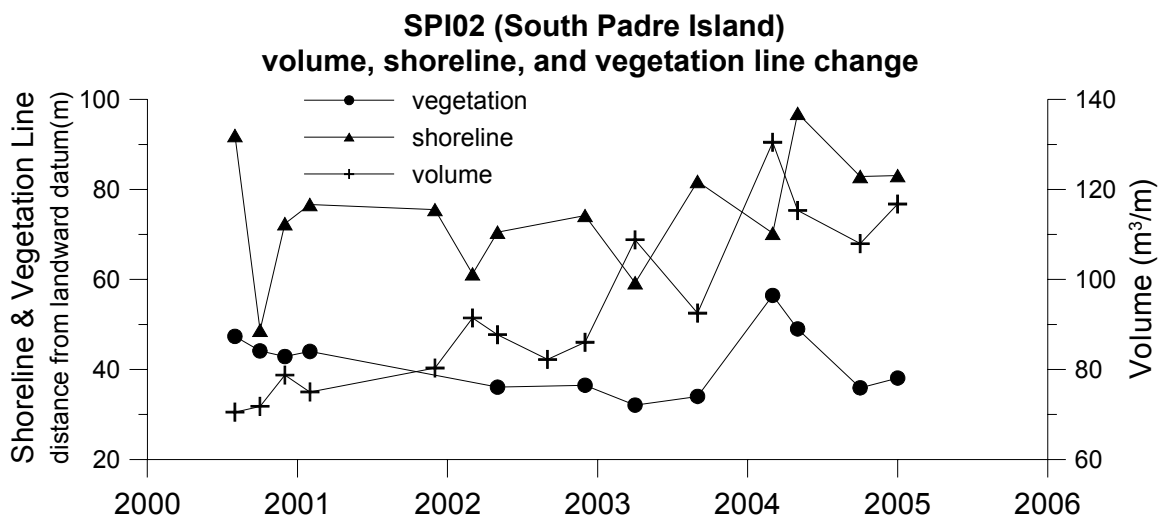


Figure 7. Changes at SPI02 on South Padre Island due to installation of sand fence and beach nourishment.

Future measurements by all three high schools will show not only change through time at each location, but also spatial variation along the Texas coast. Through time the data collected from Galveston, Follets, Mustang, and South Padre Islands will help scientists gain a better understanding of the relationship between coastal processes, beach morphology, and shoreline change at these locations along the Texas coast.

CONCLUSIONS

The Texas High School Coastal Monitoring Program provides high school students with a real-world learning experience outside the everyday classroom. The coastal monitoring program not only provides hands-on education, but it also complies with many TEKS requirements. The 2003–2004 and 2004–2005 academic years were productive, with Ball High School, Port Aransas High School, and Port Isabel High School collecting data on several field trips.

In the 8 years since the inception of The Texas High School Coastal Monitoring Program, work of the students at Ball, Port Aransas, and Port Isabel High Schools has been beneficial to Bureau researchers and coastal managers. Efforts of the students have been useful to several research projects that the Bureau has conducted. Availability of data through the Program's Web site allows access to coastal managers and the public. Scientists, students, and the public will continue to gain a better understanding of coastal processes and shoreline change along the Texas coast through this successful student research program.

RECOMMENDATIONS

We consider the seventh and eighth years of the Texas High School Coastal Monitoring Program a success and offer the following recommendations for continuance and expansion of the program.

1. Emphasize to students that they are working on a real research project and are collecting scientifically valid data that will eventually appear in a scientific publication. This is a major point that makes this program different from most other field trips or laboratory exercises. Asking students to conduct experiments that have real consequences seems to make a difference to many students, and it probably improves the quality of the data.
2. Clearly tell students about the specific scientific problems being addressed, but also emphasize that what they are gaining in experience is not just how to measure beaches but how to conduct scientific field research in general. Students are also learning a different way of viewing their surroundings.

3. Survey a reasonable number of beaches, which, in most cases, means two or three. The program goals of scientific research and science education could be at odds with one another. From a purely scientific point of view, it would be desirable to acquire as many data as possible. That approach, however, would not allow time for discussions on the beach that are not directly related to the measurements. It would also hinder the development of observation skills and keep students from enjoying their work.
4. The number of official field trips depends on the class, but a maximum of four trips is reasonable. Some trips may have to be cancelled because of bad weather or other unusual circumstances. Cancelled trips can be difficult to reschedule. Therefore, some freedom must be allowed in the program regarding number of trips and sites measured. Even if just one good data set is collected during the year it will be useful scientifically. Some students might be encouraged to make additional trips on weekends or after school. Interested students should be encouraged to use the program in a science fair project.
5. When adding schools or a new teacher to the program, a 1- to 2-day seminar before the school year begins and including as many teachers as possible is desirable. Instruction would be more efficient, and teachers and scientists would benefit by exchanging ideas.
6. A Web site adds an important dimension to the project, especially when multiple schools are participating. A Web site at which students can exchange observations with other schools in Texas increases the educational value of the program by allowing students to observe differences in the processes acting along the coast. A Web site also illustrates to students how the Internet can be used to conduct research. Furthermore, the Internet is important in increasing public awareness of coastal processes. Providing immediate feedback to students through the Internet is important. Students want to see their data and photographs on the Web, and feedback increases their interest in the project.
7. Encourage teachers to incorporate the data into the curriculum for their other classes. One of the goals of the program is to increase public awareness and understanding of coastal processes and hazards. Disseminating data gathered by their peers may increase the interest of students not directly involved in the Coastal Monitoring Program. Data collected and knowledge gained from analysis of the data are applicable to all Environmental Science, Geology, Aquatic Sciences, and Oceanography curricula.

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APPENDIX A: PROFILE INFORMATION

Galveston Island and Follets Island profile coordinates are in NAD83. Heights above the GRS80 Ellipsoid were converted to North American Vertical Datum 88 (NAVD88) using the Geiod99 Ellipsoid Model.

Profile	Latitude (deg min)	Longitude (deg min)	Easting (m)	Northing (m)	HAE (m)	NAVD88 (m)	Azimuth (M)
BEG02	29 11.64	94 57.09	310255.20	3231059.16	-24.75	2.54	139
BEG08	29 3.22	95 8.90	290838.52	3215830.51	-25.21	2.09	145

Mustang Island profile coordinates are in NAD83. Heights above the GRS80 Ellipsoid were converted to North American Vertical Datum 88 (NAVD88) using the Geiod99 Ellipsoid Model.

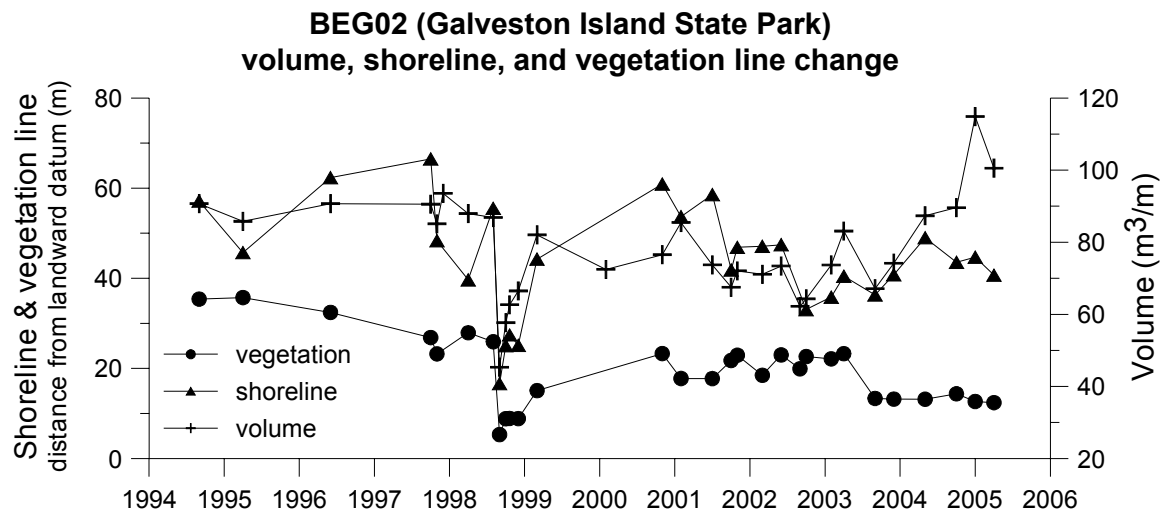
Profile	Latitude (deg min)	Longitude (deg min)	Easting (m)	Northing (m)	HAE (m)	NAVD88 (m)	Azimuth (M)
MUI01	27 49.53	97 03.40	691396.24	3079393.46	-22.29	3.79	123
MUI02	27 40.42	97 10.19	680502.58	3062388.03	-24.14	1.69	120
MUI03	27 47.66	97 05.08	688697.42	3075882.34	-22.08	3.95	125

South Padre Island profile coordinates are in NAD83. Heights above the GRS80 Ellipsoid were converted to North American Vertical Datum 88 (NAVD88) using the Geiod99 Ellipsoid Model.

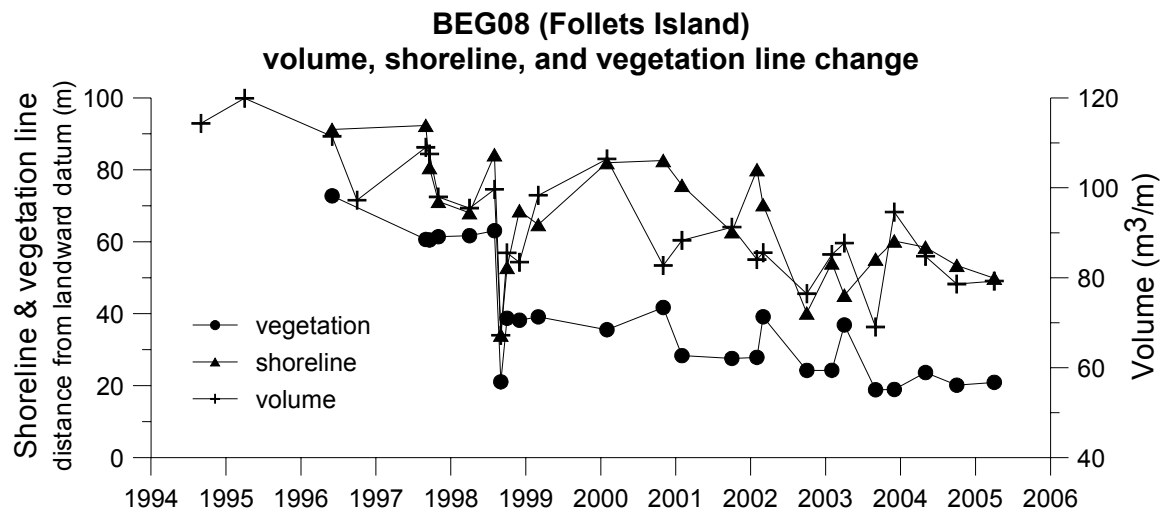
Profile	Latitude (deg min)	Longitude (deg min)	Easting (m)	Northing (m)	HAE (m)	NAVD88 (m)	Azimuth (M)
SPI01	26 4.57	97 9.46	684274.71	2885422.83	-18.48	2.75	70
SPI02	26 6.79	97 9.93	683438.99	2889509.24	-18.11	3.19	78

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

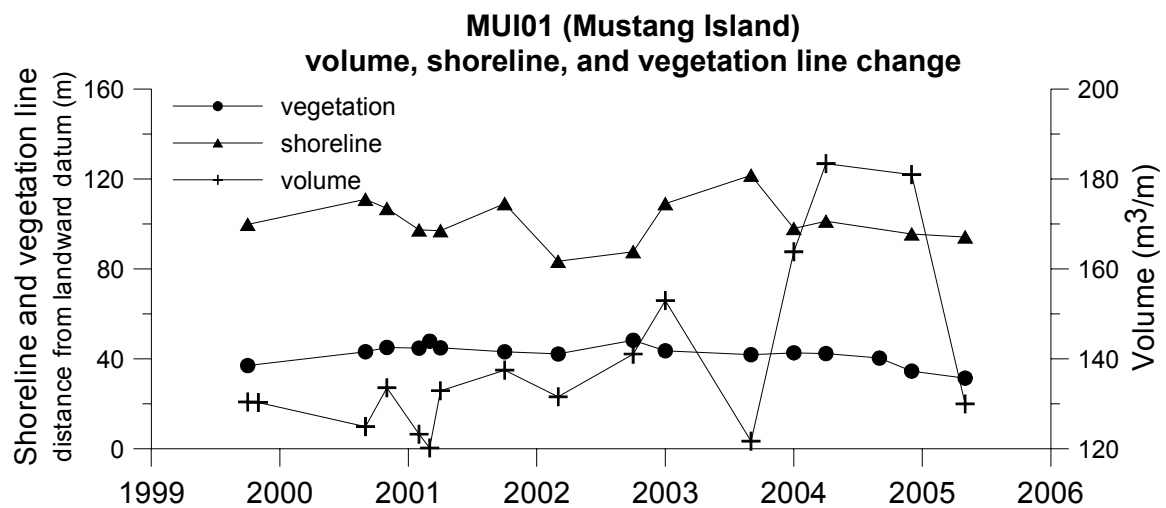
BEG02 volumes are calculated from datum to 1.5 m below datum. Profiles that did not extend to -1.5 m were extrapolated.



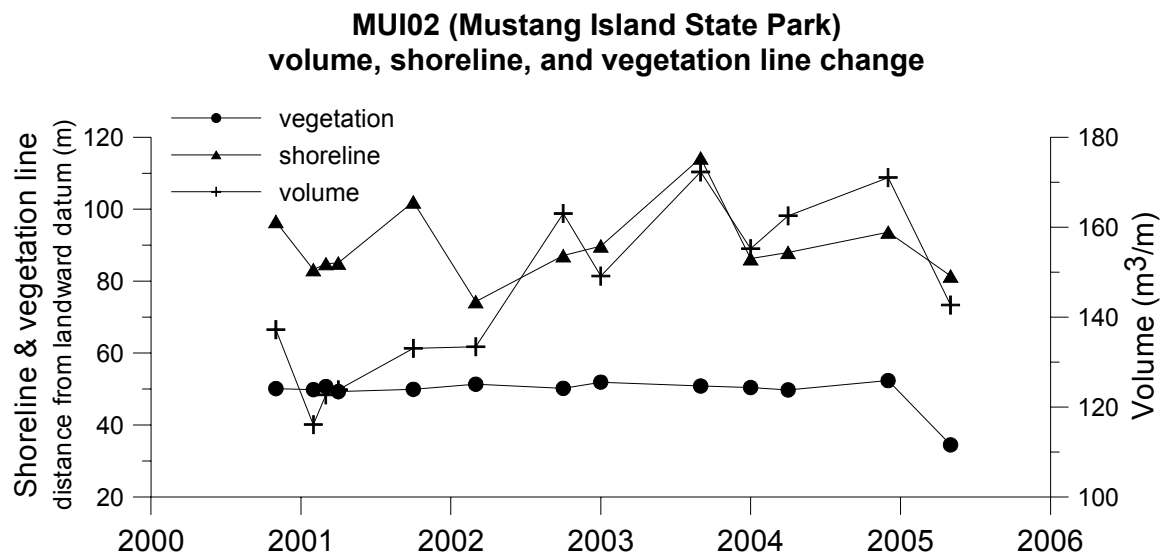
BEG08 volumes are calculated from datum to 1.5 m below datum. Profiles that did not extend to -1.5 m were extrapolated.



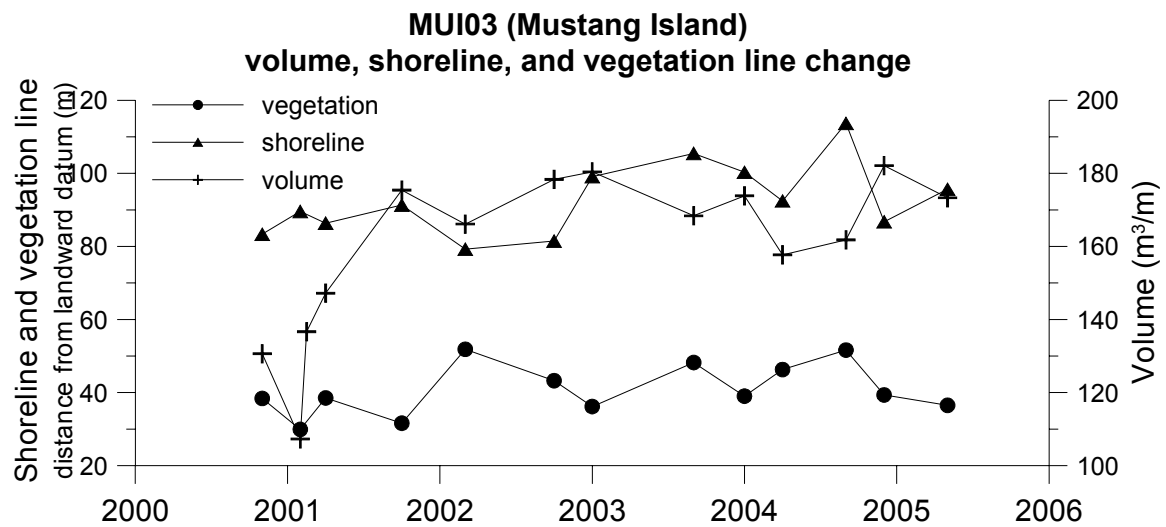
MUI01 volumes are calculated from datum to 3 m below datum. Profiles that did not extend to -3 m were extrapolated.



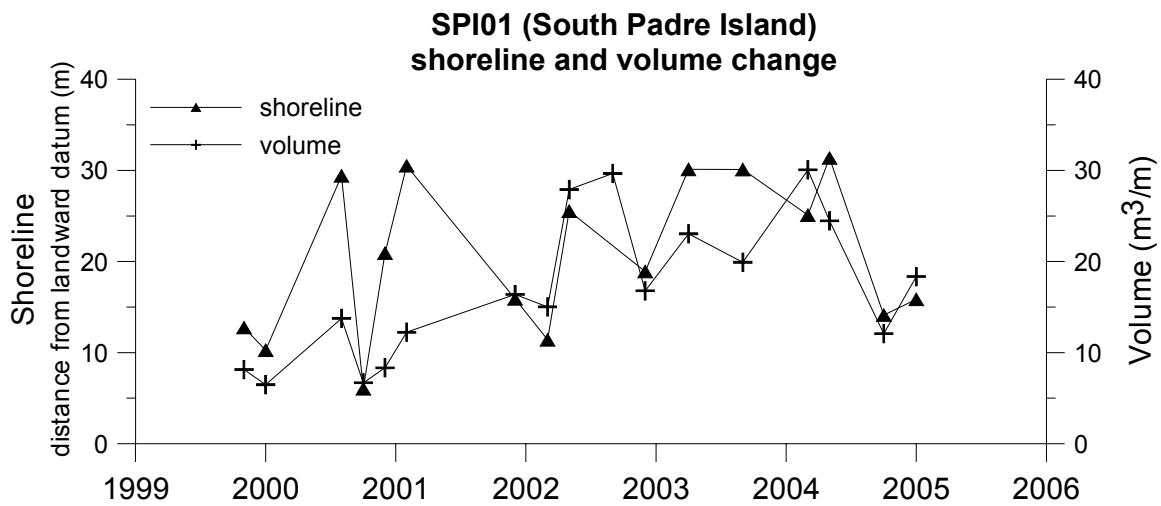
MUI02 volumes were calculated from datum to 1 m below datum. Profiles that did not extend to -1 m were extrapolated.



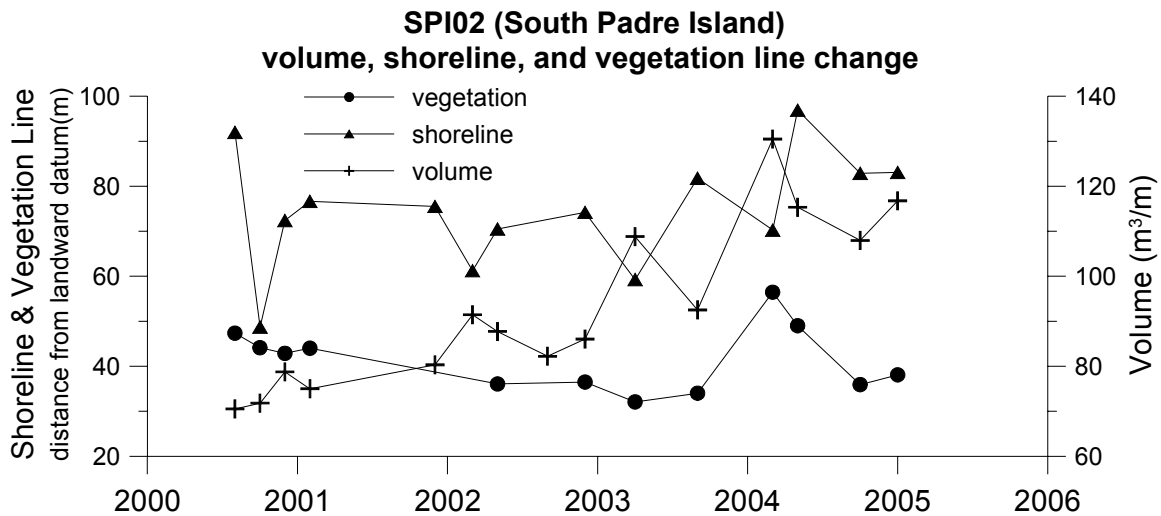
MUI03 volumes were calculated from datum to 3.25 m below datum. Profiles that did not extend to -3.25 m were extrapolated.



SPI01 volumes were calculated from datum to 2.25 m below datum. Profiles that did not extend to -2.25 m were extrapolated.

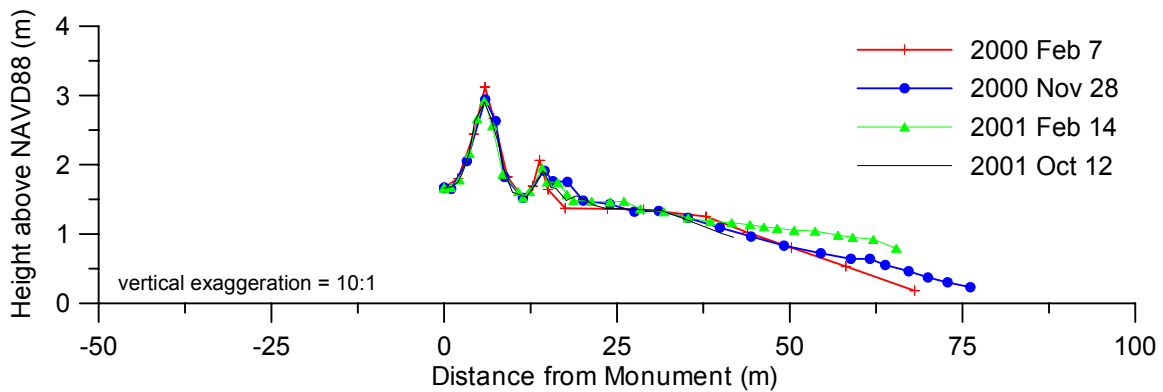
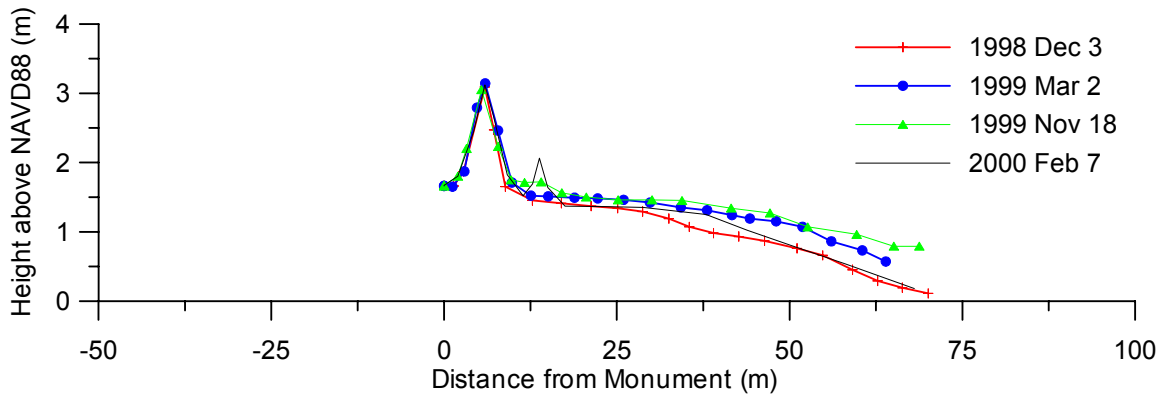
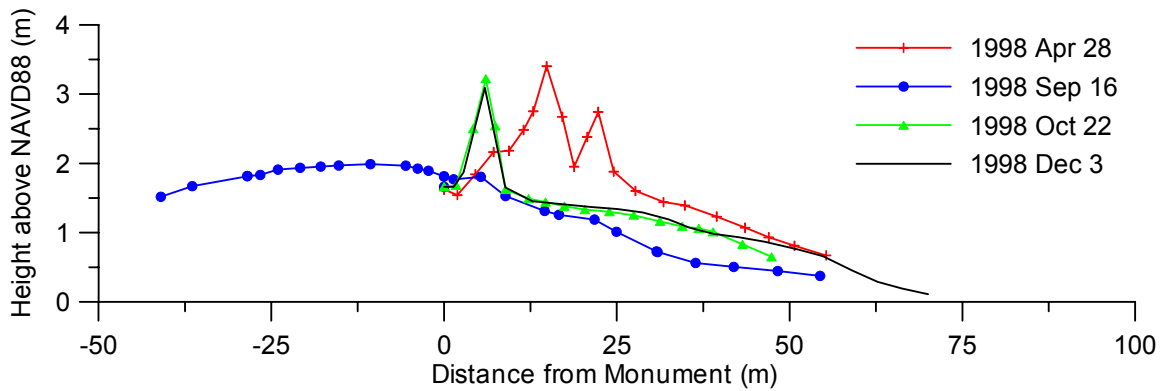
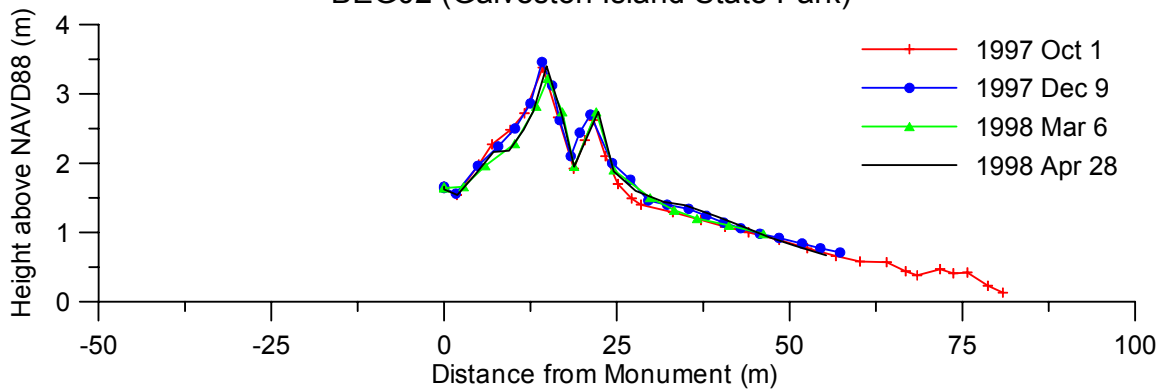


SPI02 volumes were calculated from datum to 2.5 m below datum. Profiles that did not extend to -2.5 m depth were extrapolated.

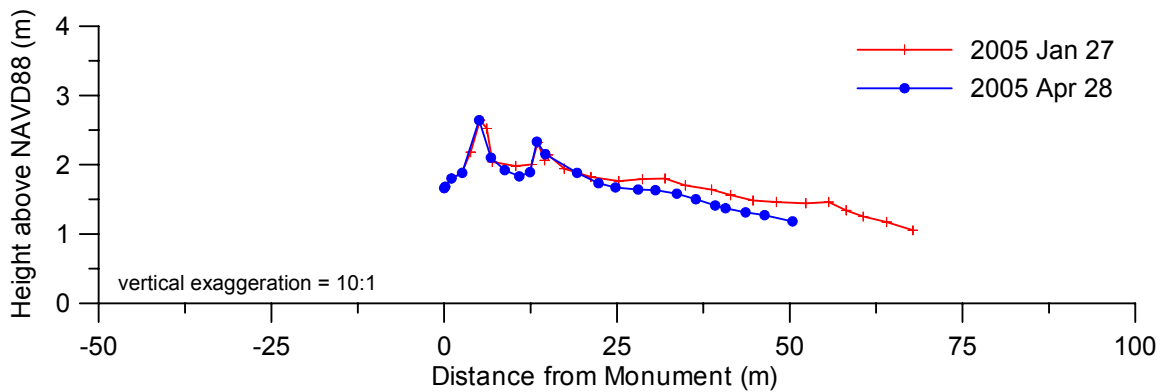
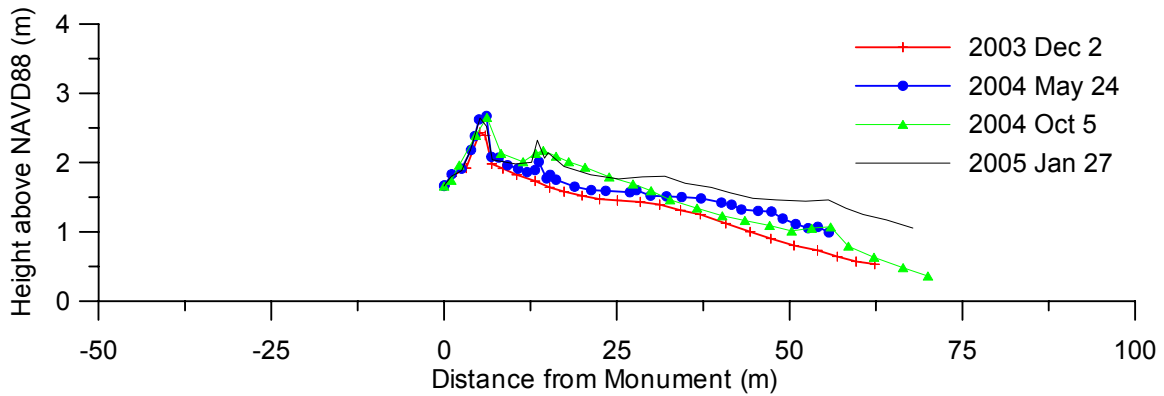
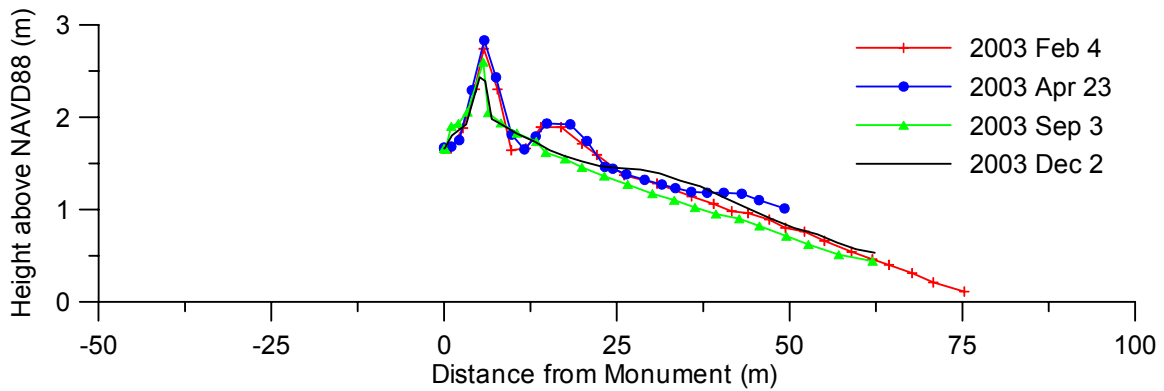
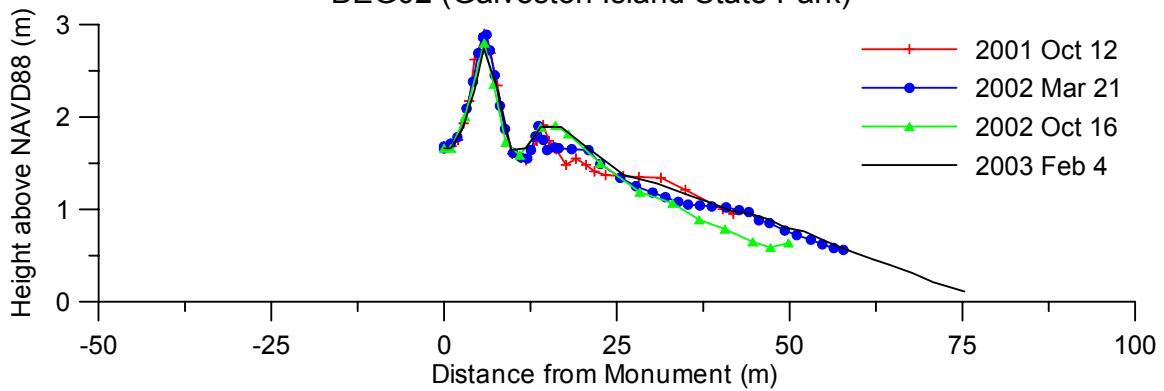


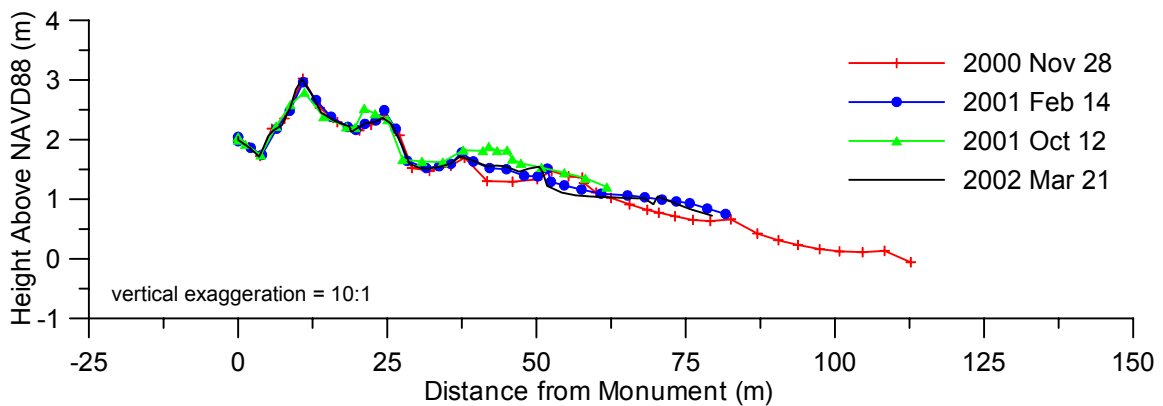
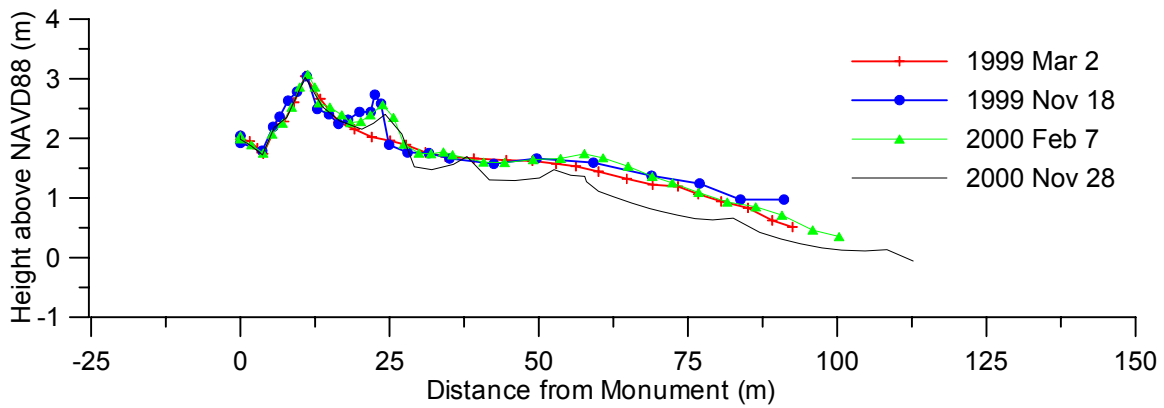
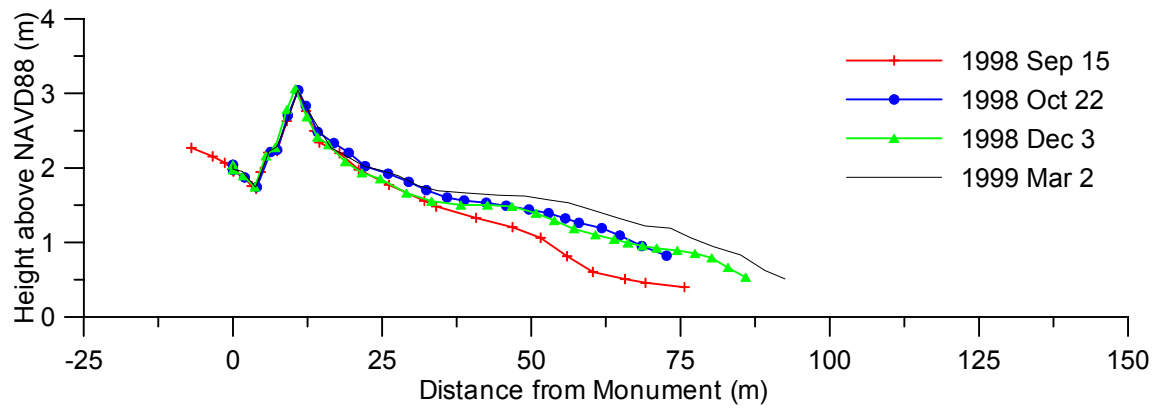
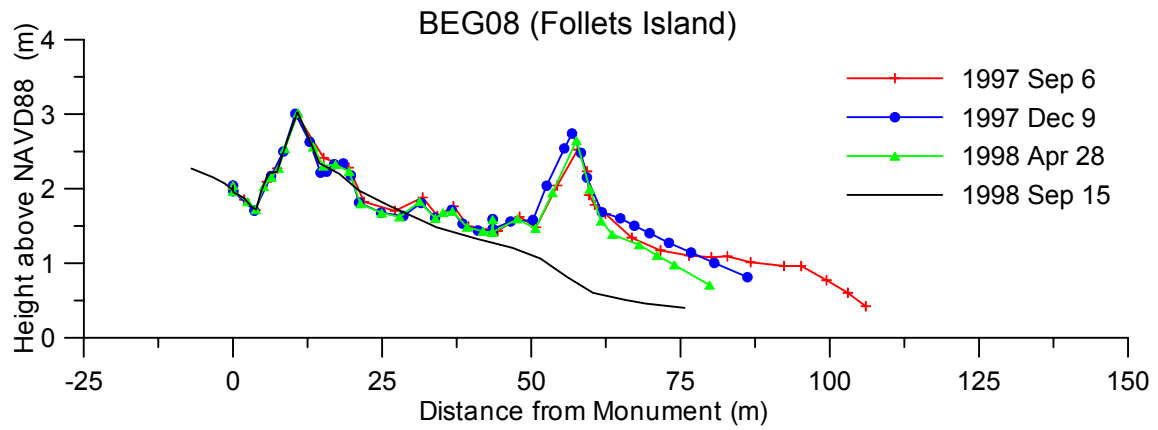
APPENDIX C: GRAPHS OF BEACH PROFILES

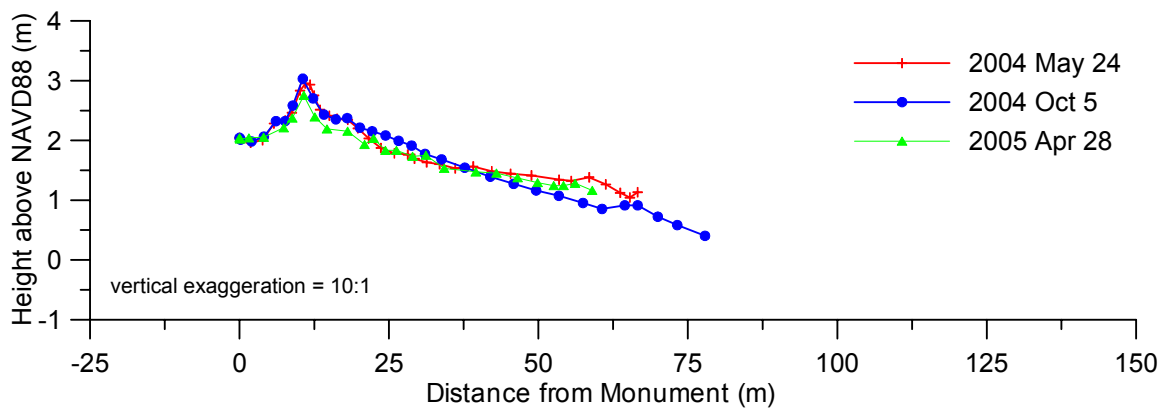
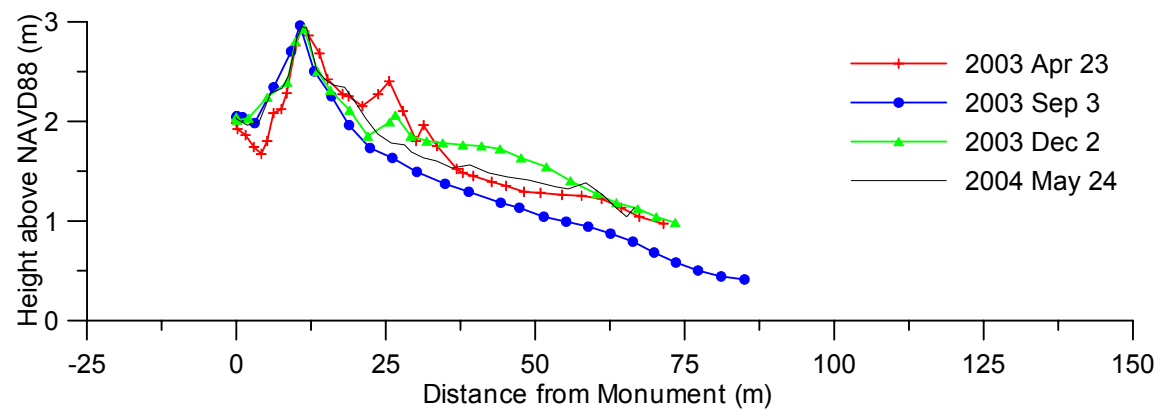
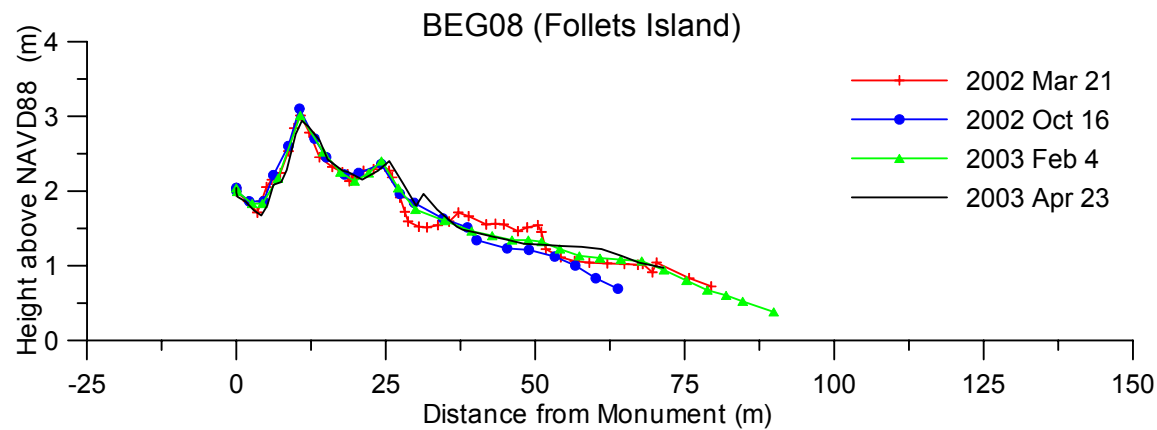
BEG02 (Galveston Island State Park)

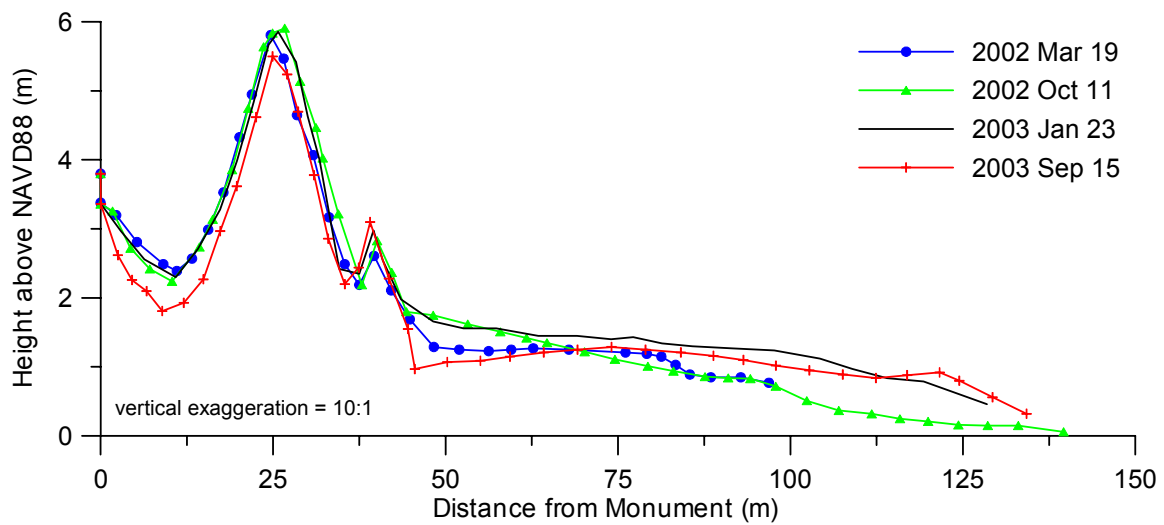
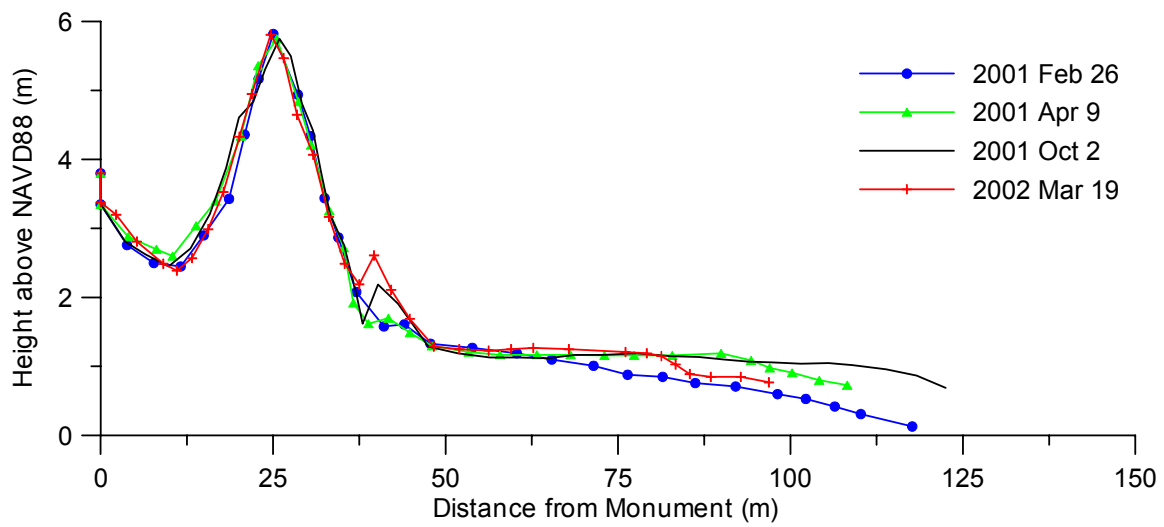
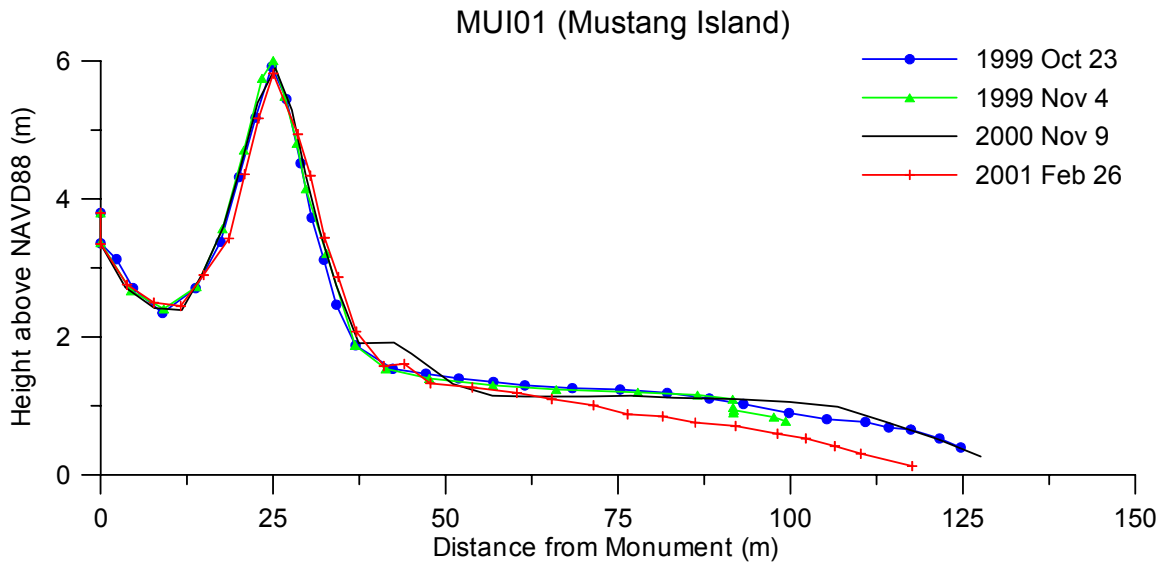


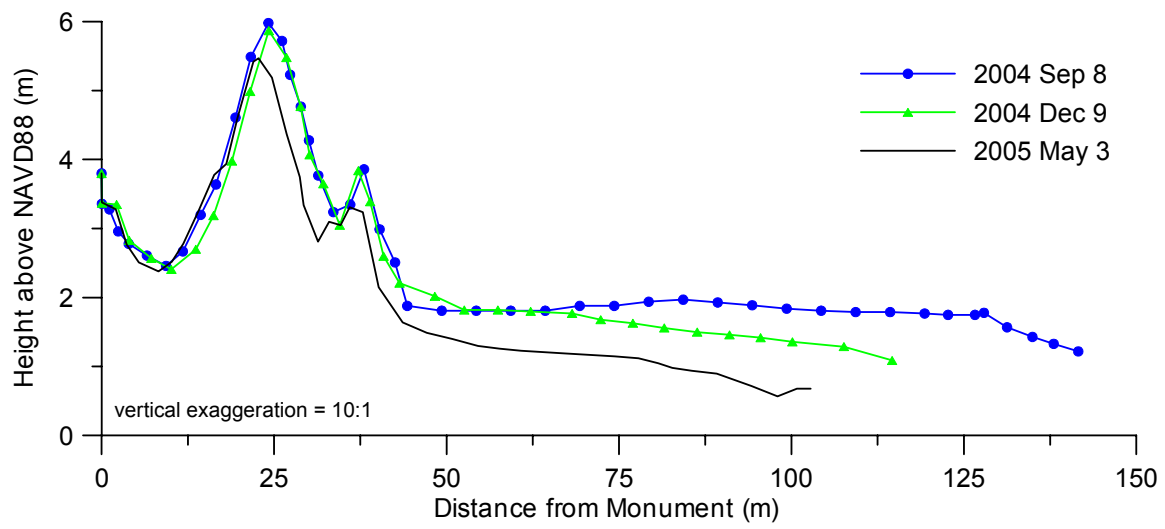
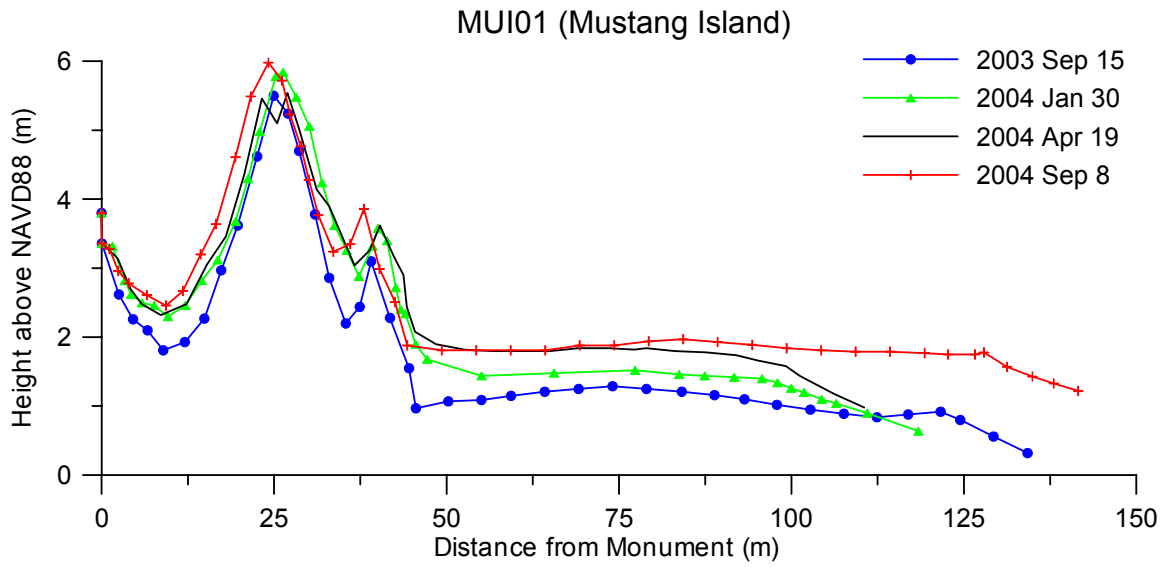
BEG02 (Galveston Island State Park)

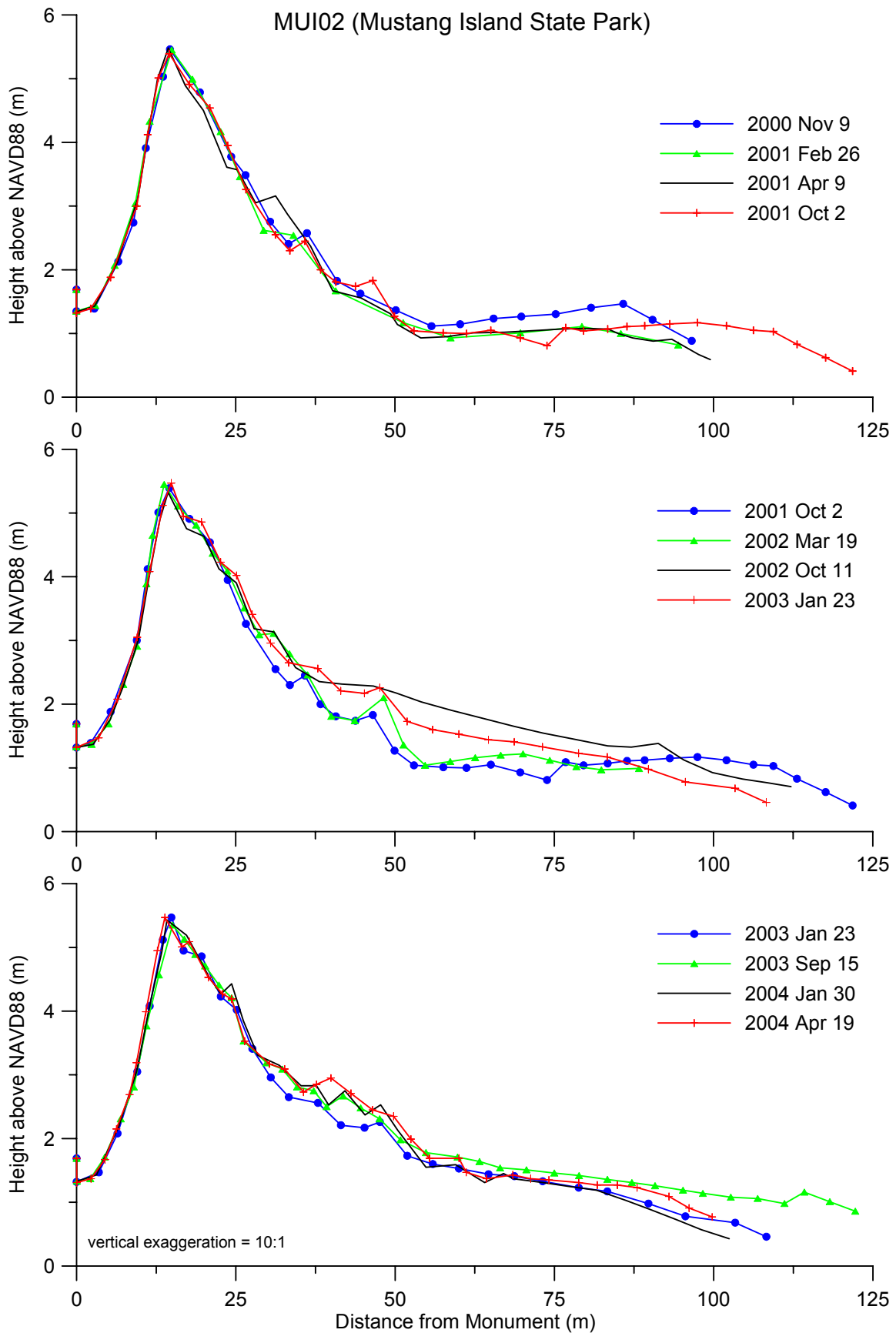


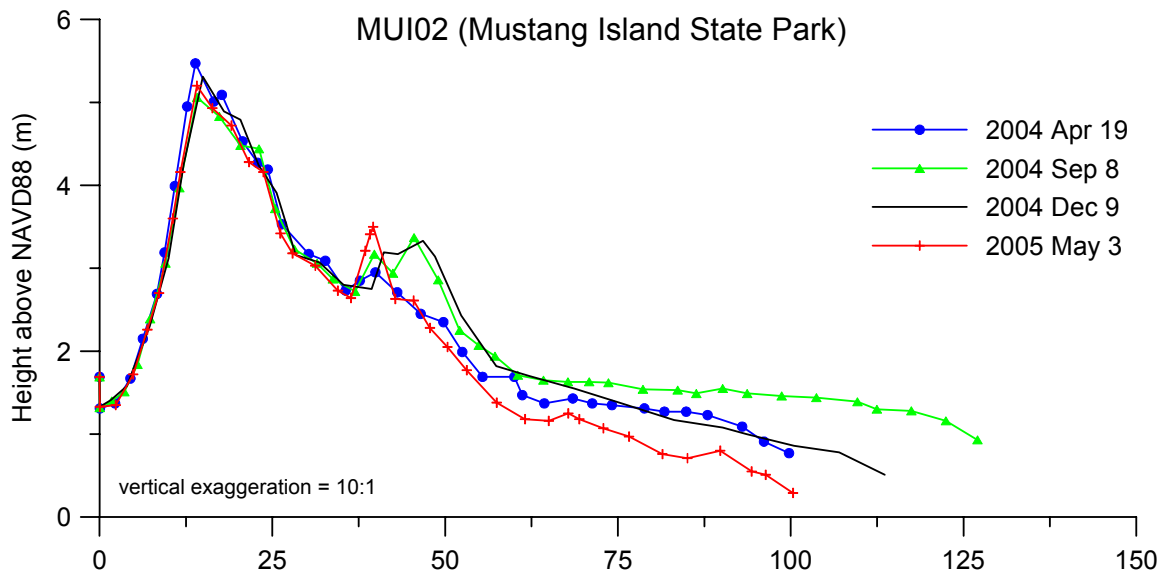




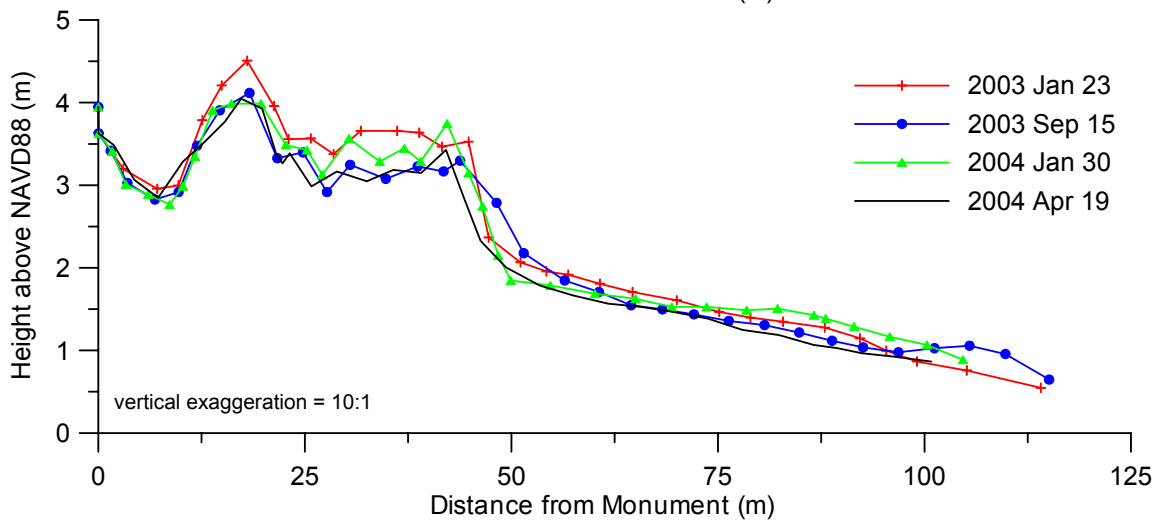
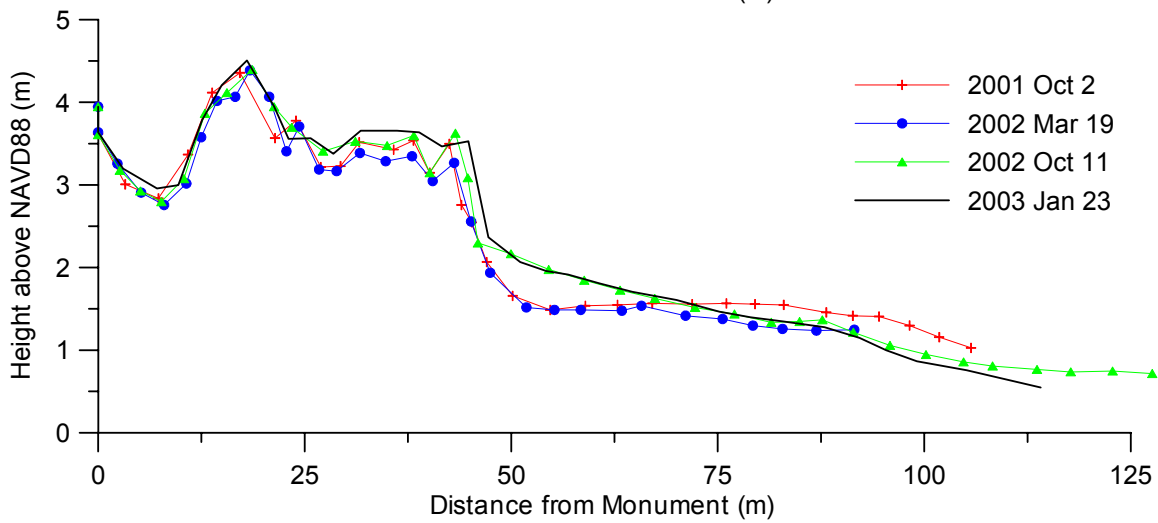
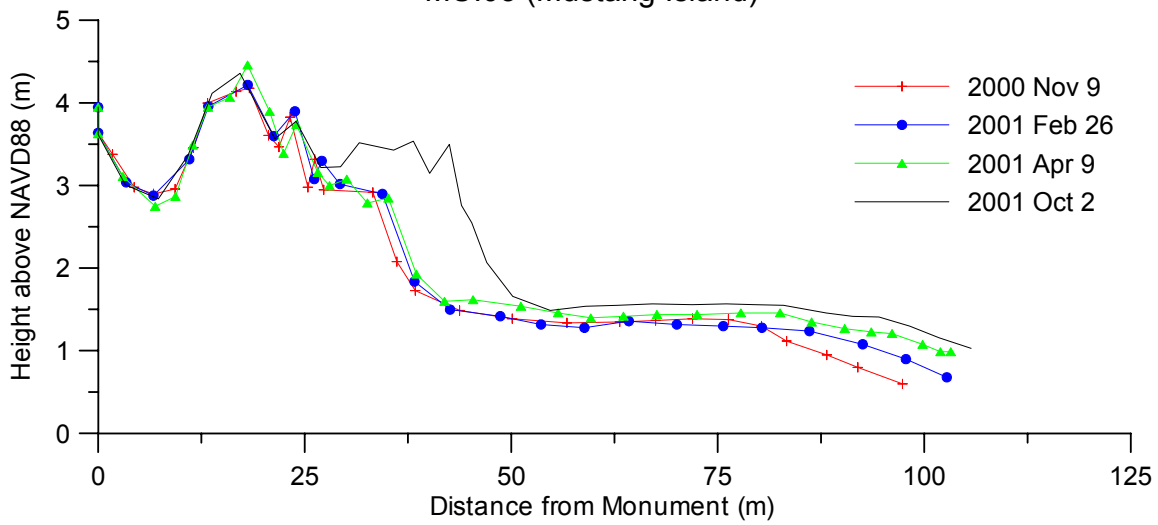


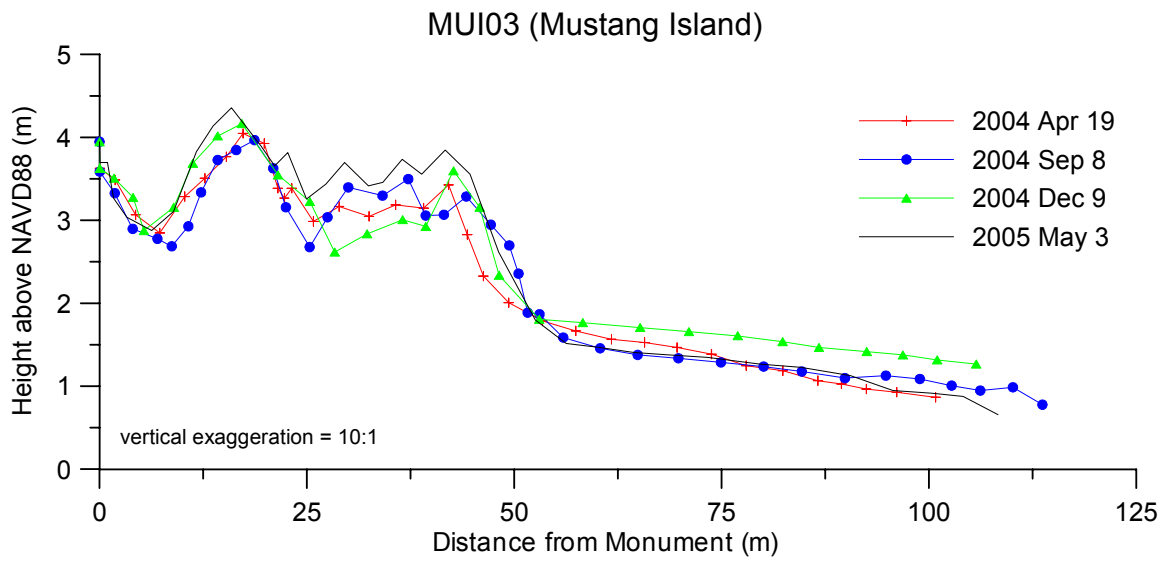




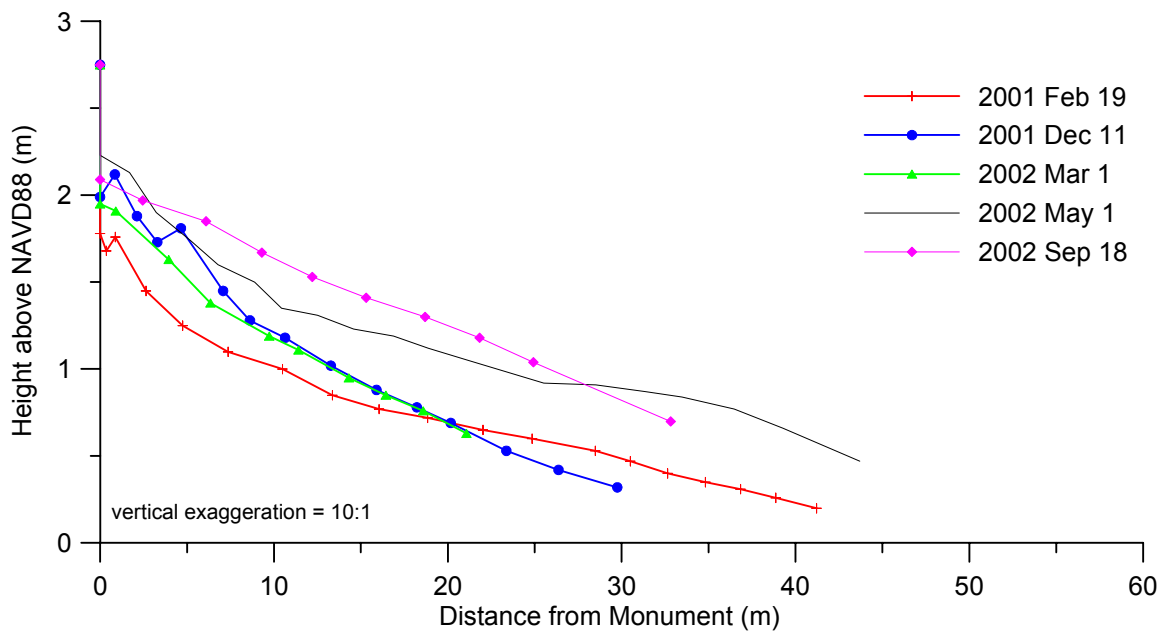
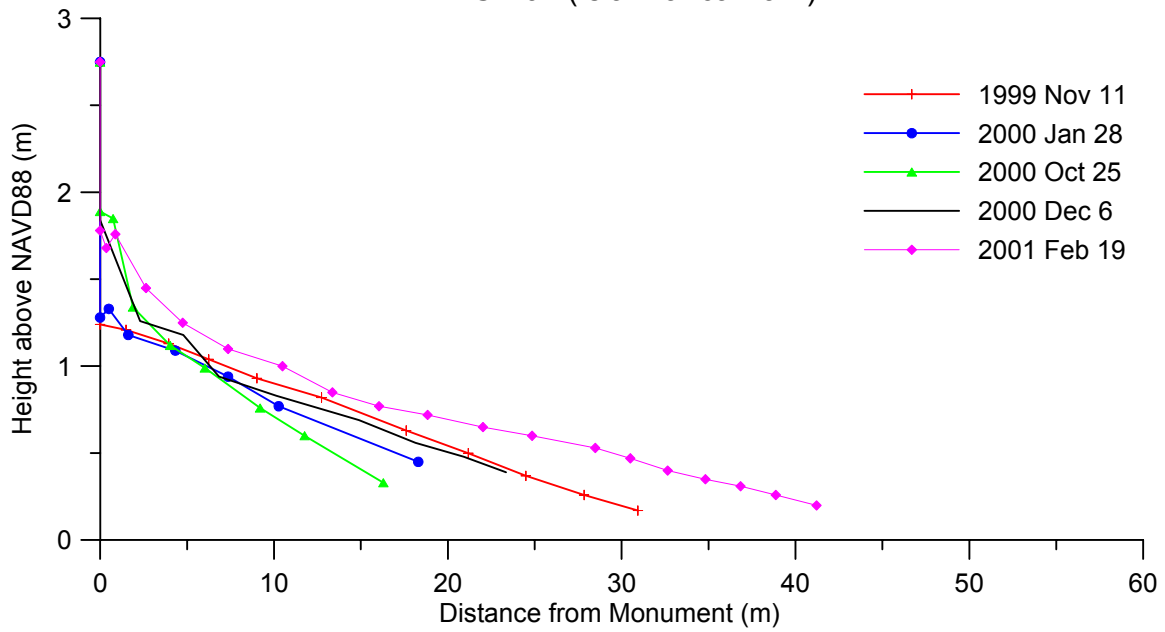


MUI03 (Mustang Island)





SPI01 (Isla Blanca Park)



SPI01 (Isla Blanca Park)

