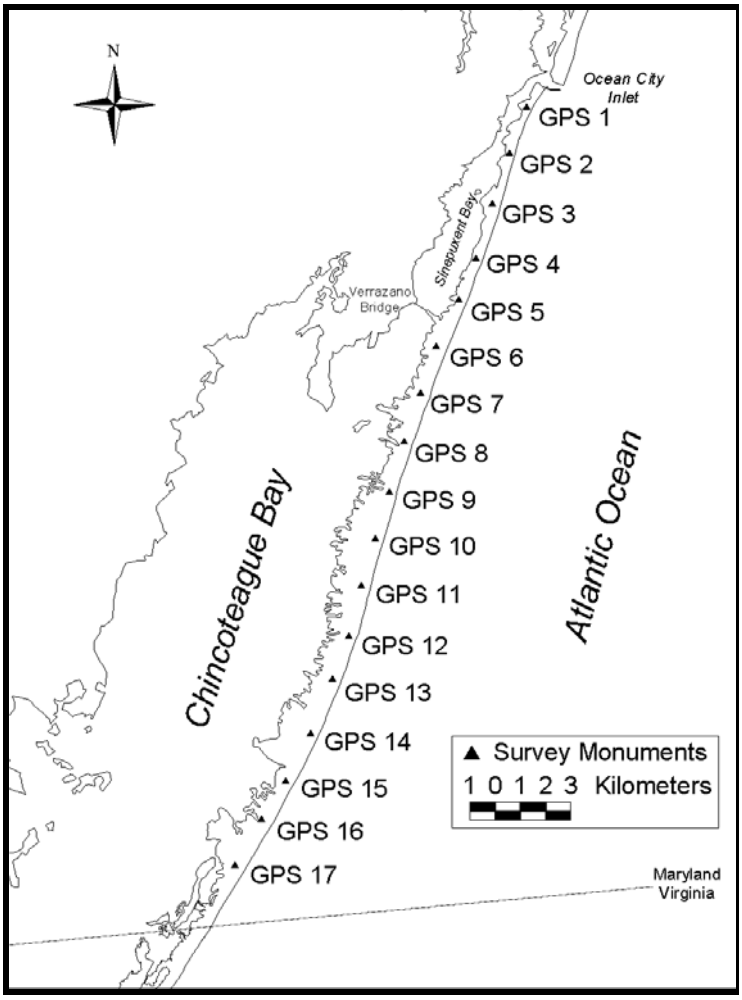
Assateague Island National Seashore

Geomorphological Monitoring Program

2002 Report - not finalized



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Abstract

The Geomorphological Monitoring Program initiated in 1995 was continued at Assateague Island National Seashore in 2002. Surface elevations and coordinates were recorded along 22 beach profile transects in a spring, and a fall survey. Shoreline mapping was conducted in spring, summer, fall, and winter using differential Global Positioning System technology. All survey data were processed and compiled into representative graphics to illustrate geomorphological changes occurring on Assateague Island between 1999 and 2002.

Introduction

The dynamic nature of coastal barriers such as Assateague Island influences nearly every aspect of their ecology. Fundamentally disturbance driven systems, barrier islands and their endemic biota are continually shaped by physical forces on a time scale vastly accelerated in comparison to mainland systems. Because of the rapid pace and scope of change, long term monitoring is crucial to understanding natural barrier island conditions as well as anthropogenic influences.

The National Park Service (NPS) contracted with the U.S. Army Corps of Engineers (COE) in 1991 to develop recommendations for a coastal change monitoring program at Assateague Island. The results of this research were reported in "A Physical Monitoring Plan for Northern Assateague Island, Maryland" (Stauble, 1994). In 1995, ASIS initiated a long-term program to begin monitoring key aspects of island geomorphology. At present, the program includes three primary elements:

1. Documentation of the shore position on a quarterly basis in order to describe and evaluate long-term trends in shoreline stability, rates of shore change, and storm-driven change.

2. Documentation of cross-island beach profile elevations on a biannual basis in order to describe and evaluate trends in island topographic relief and storm-driven change.

3. LIDAR (Light Detections and Ranging) - Airborne laser technology that provides detailed (1 meter horizontal resolution with sub-15 cm vertical accuracy) topographic data on bare earth areas of the island. This project, a cooperative effort between NASA, USGS, and NPS, consists of semi-annual aerial surveys and has recently moved beyond the research stage and is now a part of the park geomorphological monitoring program. Methodologies involving data management and distribution are still under development.

Information developed by the monitoring program is intended to provide a general description of island conditions and provide a basis for evaluating long-term management strategies. Data generated by the program will also support coastal processes research,

habitat characterization studies, and assist in evaluating beach and berm restoration projects.

This report summarizes the methods used by ASIS staff to collect, process, analyze, and archive beach topographic profile and shoreline change data collected during 2002 as part of the long-term Geomorphological Monitoring program. Selected results are presented as maps and in graphical format.

Beach Topographic Profile Survey Methods:

The profile network baseline, established by Taylor, Wiseman and Taylor in 1993, and expanded by NPS personnel in 1995, provides horizontal and vertical controls for all data collection. Individual profile lines are numbered in consecutive order from north to south and prefaced in text by GPS or NPS, denoting whether the baseline monument was established by Taylor, Wiseman, Taylor, or NPS, respectively. Spacing between GPS monuments is 2.0 Km, with NPS monuments located approximately midway between GPS monuments. The result is a profile line density of 1 Km along the northern 10 Km of Assateague Island (commonly referred to as the "North End"), and a 2 Km density for the remainder of the Maryland portion of the island (Figure 1), for a total of 22 lines. There are no profile transects in the Virginia section of Assateague.

The baseline monument coordinates used during the 2002 survey session are listed in Table 1. Some changes have been made to the baseline network since 1999 (see *Notes* below Table 1). Ten new monuments and transects were established on the North End in 1999 for a Piping Plover habitat study. They begin in the north with NPS 0.5, are situated halfway between the original GPS and NPS monuments to produce a frequency of one monument every half kilometer, and are denoted with '.25' and '.75' thereafter. These monuments serve as backsight positions for profile transects, and remain valuable for this purpose and for their suitability as possible future profile sites. See the *Recommendations* section for further description of the needs in the long-term baseline monument network.

Profile surveys are conducted from each primary monument along the baseline and aligned roughly perpendicular to the ocean shoreline at a 291/111 degree azimuth from true north. A Nikon Top Gun total station (model DTM-A10LG) is operated by park staff to collect beach surface points along each transect line at approximate 10-meter intervals and at significant changes in topography. Points in any given transect are chosen by a second technician traversing the line with a laser-reflective prism pole. Specific locations of other notable features, including dune crests, dune bases, paved roads and trails are also recorded where applicable and tagged with a comment. Each profile line extends from wading depth oceanside to wading depth bayside (with 0.0 meters above sea level as a goal endpoint on either side) or up to the point where heavy vegetation obstructs the line of sight to the target. All transects are surveyed relative to a control monument or witness point along the baseline. Transects are listed according to general survey periods for 1995-2002 in Table 2.

Data points are recorded with an HP48/SX scientific calculator equipped with Nikon DR-48 surveying software. Raw data files are downloaded to a PC, converted to a delimited ASCII file format, and exported to Microsoft Excel for graphics production. Data files for individual profile lines are labeled according to the monument number and date of survey, and are organized into subdirectories labeled by the date of survey. For example, GPS2-1099.txt is an ASCII text file containing the data for GPS-2 during the October 1999 survey session (Table 3). All files are stored as digital XYZ coordinates (Northing, Easting, Elevation) in the UTM coordinate system, and referenced to NAD-83. Vertical datum was NGVD 1929. Survey files are finally arranged in a Microsoft Access database in the ASIS Electronic Library within Geomorphological Monitoring, Resource Identification Number (RIN) 10.07.107.

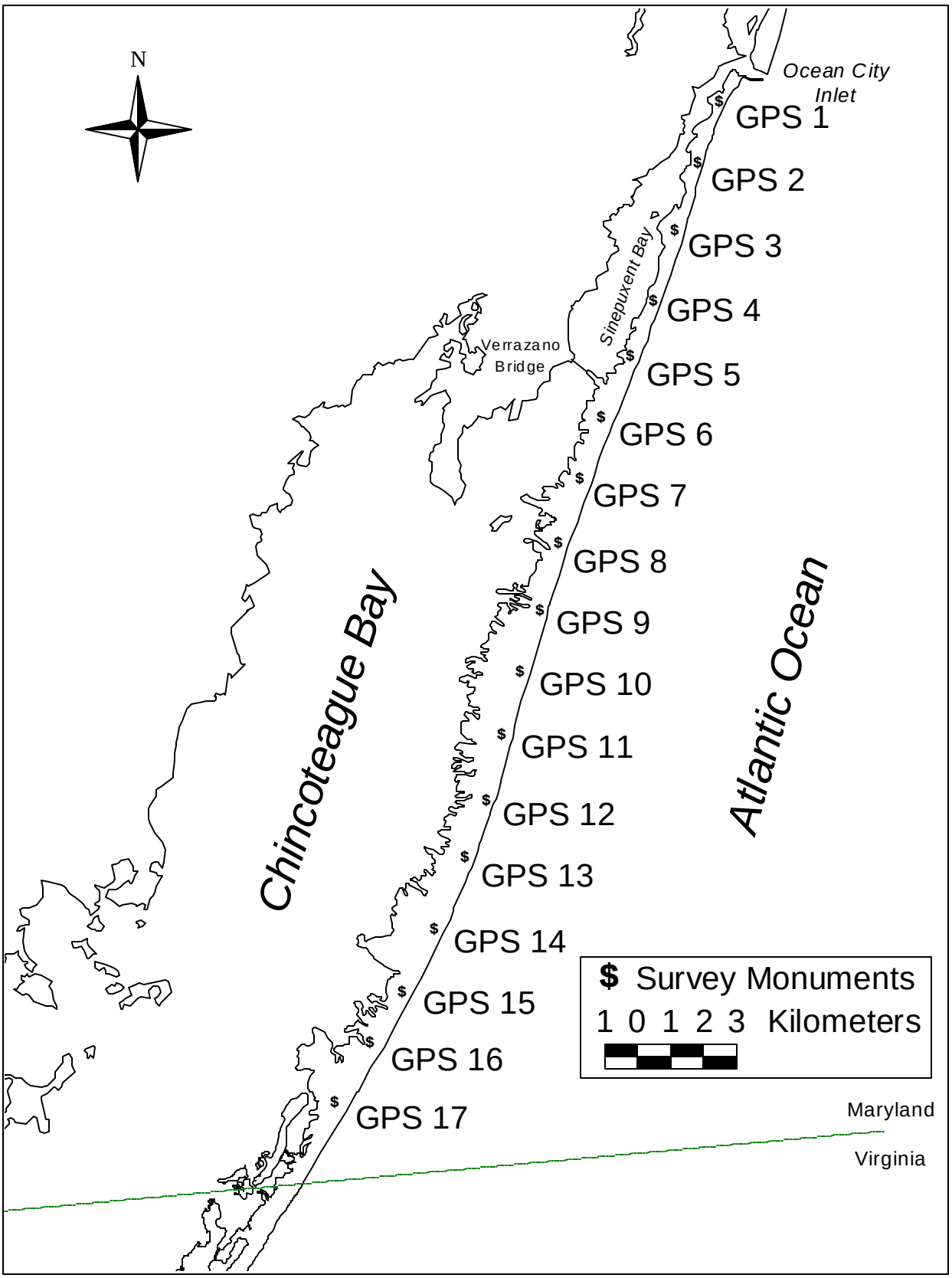

Figure 1. Locations of monuments comprising the survey baseline on Assateague Island, MD.

Table 1. Baseline monument coordinates used for beach topographic profile surveys in 2002.

All units in meters: coordinates are UTM, Zone 18, NAD 83; elevations are referenced to NGVD 1929.

STATION	NORTHING	EASTING	ELEVATION
GPS-1	4240962.45	491103.65	1.575
NPS-1.25	4240477.64	490915.61	1.801
NPS-1.5	4240045.01	490747.02	3.057
NPS-1.75	4239581.42	490534.55	2.137
GPS-2	4239099.91	490368.52	2.005
NPS-2.25	4238633.54	490189.84	1.554
NPS-2.5	4238117.35	490028.8	1.786
NPS-2.75	4237644.88	489931.71	1.734
GPS-3	4237140.95	489666.85	1.576
NPS-3.25	4236632.8	489583.77	1.183
NPS-3.5 (reset to COE2)	4236172.39	489464.36	2.02
NPS-3.75 RESET	4235624.24	489179.2	1.391
GPS-4	4235180.94	489046.43	1.298
NPS-4.25 RESET	4234568.5	488913.31	4.268
NPS-4.5 RESET	4234255.36	488775.27	2.175
NPS-4.75	4233717.78	488641.05	2.234
GPS-5	4233268.28	488444.81	1.942
NPS-5.25	4232796.32	488296.93	3.014
NPS-5.5	4232371.65	488031.39	2.191
NPS-5.75	4231840.43	487930.11	5.005
GPS-6	4231472.12	487613.02	1.573
GPS-7	4229625.42	486835.32	1.42
GPS-8	4227683.22	486221.2	1.59
GPS-9	4225844.71	485716.1	1.24
GPS-10	4224012.78	485202.53	1.55
GPS-11	4222115.87	484685.27	1.07
GPS-12	4220078.98	484127.32	1.65
GPS-13	4218245.73	483460.87	0.79
GPS-14	4216307.24	482635.1	1.52
GPS-15	4214448.84	481726.8	1.83
GPS-16	4212759.09	480783.77	1.49
GPS-17	4211025.28	479733.44	1.27

Notes:

NPS-3.75 RESET position data obtained with total station, 08-2000.
NPS-4.25 RESET position data obtained with total station, 10-2000 (replaces monument COE1 which was destroyed in 2001).
NPS monuments denoted as x.25, and x.75 were established by NPS personnel in 1999.
Benchmarks GPS2, NPS3.5 and GPS4 were reset in 1998 by the US Army Corps of Engineers through GPS technology.
NPS4.5 was reset in 1998 by NPS using GPS and total station.
Remaining GPS benchmark locations (Northings & Eastings) taken from Taylor, Wiseman and Taylor, 1993.
GPS benchmark elevations for stations GPS-1 through GPS-7 were updated by Grosskopf, 1995.
GPS benchmark elevations for stations GPS-8 through GPS-17 taken from Taylor, Wiseman, and Taylor, 1993
Witness point locations for benchmarks GPS-9 through GPS-17 obtained with GPS.
Elevation for existing 1977 benchmarks taken from NOAA/NOS.

Table 2. Beach profile survey dates by transect, 1995-2001.

Survey Line	Mar 1995	Sep 1995	Mar 1996	May 1996	Sep 1996	Apr 1997	Sep 1997	Feb 1998	Apr 1998	Jun 1998	Oct 1998	Apr 1999	Oct 1999	May 2000	Aug 2000	Oct 2000	May 2001	Oct 2001
GPS-1	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*
NPS-1.5	*	*	*		*	*	*		*		*	*	*	*	*	*	*	*
GPS-2	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*
NPS2.5	*	*	*		*	*	*	*	*		*	*	*	*	*	*	*	*
GPS-3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NPS-3.5	*	*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-4	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*
NPS-4.5	*	*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-5	*	*	*	*	*	*	*	*	*		*	*	*	*		*	*	*
NPS5.5		*	*		*	*	*	*	*		*	*	*	*		*	*	*
GPS-6		*	*		*	*	*	*	*		*	*	*	*		*	*	*
GPS-7		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-8		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-9		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-10		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-11		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-12		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-13		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-14		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-15		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-16		*	*		*	*	*		*		*	*	*	*		*	*	*
GPS-17		*	*		*	*	*		*		*	*	*	*		*		*

Table 3. Portion of ASCII data file GPS-2 1099.txt.

POINT #	NORTHING	EASTING	ELEVATION (METERS)
1	4239100	490368.5	2.005
2	4239581	490534.6	2.137
3	4239106	490353.4	1.7728
4	4239111	490339	1.6695
5	4239114	490332.2	1.7564
6	4239115	490328.7	2.0777
7	4239120	490315.4	1.5354
8	4239126	490300.8	1.3773
9	4239132	490285.7	1.1367
10	4239137	490270.9	1.0119
11	4239143	490256.3	1.0041
12	4239149	490241.1	0.8947

Beach Topographic Profile Survey Results and Discussion

Beach profiles from 2002 are graphically presented in Figures 2A-2V. Transects from the northern half of the study area (GPS1-GPS9) are compared to Fall 2000 profiles. Graphs of GPS10-GPS17 include comparison profiles from the Fall of 1999. Tighter comparison spans are
chosen in the North to account for generally higher rates of change. Of all Assateague Island, the northernmost 8 kilometers has experienced the most significant change in topography during the past 60 years due to the influence of the adjacent Ocean City inlet and its northern jetty.

Transect lines surveyed in 2001 included GPS-1 through GPS-17 and NPS-1.5 through NPS-5.5. The spring data were collected from, approximately, April 23 to May 23. The fall sampling period ran from around September 24 to October 19. On May 10, three transect lines (NPS1.25, NPS2.5, and NPS3.5) were collected on the North End to supply NASA/USGS with ground control data in support of a LIDAR survey. LIDAR ground support surveys consist of profile and/or shoreline collections, and are usually completed on the same day/time as the flight (aerial LIDAR surveys are conducted at low tide on clear days). On September 5, twenty-one vinyl targets were placed in a grid pattern on the North End and the center points were captured with the Total Station. These points are being used for georectification of digital aerial photos acquired in conjunction with a NASA LIDAR survey flown this day.

Figures 2A-2J represent what is commonly referred to as the “North End”; it is characterized by a relatively low topographic relief with surface elevations ranging from 0.0 m or less at the shoreline to approximately 3.0 m (NGVD 29). Lines GPS1 – NPS4.5 (Figures 2A-2H) represent true cross-island profiles, in that their extent includes complete surface elevations from the ocean to the bay shoreline (the GPS1 line of sight is now obstructed by vegetation on the western side and was not extended to the bay in 2001 – future collections will require the use of prism pole extensions).

The constructed berm[1] is displayed in Figures 2E-2G. Overall, the elevation of the berm seems to have decreased slightly since 1999, with some spreading, and rounding off as seen in Figures 2F-2G. As for the relatively significant height increase (up to 1.5 meters) in the west end of line NPS4.5 (Fig. 2H), this could be natural dune movement, combined with protection of vegetation on the west end to encourage build-up, and/or a lack of overwash. A similar accretion at approximately fifty meters west of the baseline is seen in the next profile south, GPS5, though it is a fraction of what is seen at NPS4.5.

In the report, "A Physical Monitoring Plan For Northern Assateague Island, Maryland" (September 1994) author Donald Stauble describes coastal processes that influence geomorphology of the area. Longshore transport of sediment is "to the south over most of the fall, winter, and spring months, but a seasonal reversal to the north occurs during the late spring and summer months. This seasonal drift is controlled mainly by weather conditions" (p21). Stauble notes that the "highest waves [generally occurring during the winter] approach the shoreline from the northeast and east, while the smaller waves approach the coast from the east and southeast [late spring and summer months]" (p21). Winter storms – generally Nor'easters –occur at a higher frequency than summer/fall tropical storms and hurricanes (these also generally create a southerly drift, but are of a shorter duration and less frequent, providing more rebuilding time). Evidence of the general southerly movement of sand can be seen in the coastal offset on the North side of Ocean City inlet (p21).

Per Stauble's description, any perceived changes will have to be viewed in light of meteorological conditions – and 2001, like the previous two years, proved to be a fairly uneventful weather year. One might be correct in assuming that, within an average year, a foreshore accretion would occur during the lull of the late spring and summer. Inspection of the North End graphs seems to support this, where seven of the ten transects display an increase in maximum berm height from the Spring to the Fall. Profiles to the south of these, however, do not appear to display any discernable pattern. Further, a look at graphs of fall of 2000 (not included here) compared to those of spring of 2001 reveals the alternate pattern of erosion during the winter months over the length of the study area except for the Northern 5 Km (could be the result of ebb shoal protection; this effect is detailed in the *Shoreline Discussion* to follow). In general, it is difficult to interpret large-scale directional movement with the limited nature of linear transects. Furthermore, displayed small-scale changes could result from subjectivity introduced into the profile collection process with various technicians interpreting a "best", or most representative, profile.

The 3 Km of Assateague Island immediately south of the Verrazano Bridge is commonly referred to as the "developed zone" and is dominated by a well-developed, artificial dune line and steeply sloping beach (Figures 2K-2M). The remaining 10 Km of the Maryland portion of Assateague Island, represented by survey lines GPS9-GPS17 (Figures 2N-2V),

[1] Following 1998 storm damage, the NPS implemented an emergency beach restoration project designed to restore the ocean berm within a severely affected area between 5.0 and 7.5 Km south of the Ocean City inlet. Between September and October 1998, the US Army Corps of Engineers oversaw the delivery of approximately 200,000 cubic yards of sand to this critical area and constructed a berm just less than 3.0 meters (8 feet NGVD) in elevation. In 1999 this artificially constructed berm attained a more natural topography as it was subjected to the physical forces of wind and water.

is characterized by smaller dune features (averaging 4.0-6.0 m NGVD) separated by low overwash gaps of varying widths and extents. According to the COE analysis, the effects of the inlet jetties are minimized along this entire section of the park, which is open to 4-wheel drive vehicles and is referred to as the off-road vehicle (ORV) zone. The topography of the northern extent of the ORV zone exhibits a relatively wider beach, compared to that of the developed zone, and is bordered on the western edge by numerous, low dune formations.

In the ORV zone, Line GPS 14 (Fig 2S) has seen the loss of a foredune since the fall of 1999 which may be due to a possible slight movement off line by the surveyor after performing a station reset, or from longitudinal shifting of the dune. At GPS17, the spring 2001 profile was not collected due to a discrepancy in benchmark position coordinates that has since been resolved. GPS12 was not completed in the Spring due to an oversight by the operators.

Cross-island profiles will continue to be collected for the Geomorphological Monitoring program, and as supplemental data for various programs and projects. LIDAR support surveys are valuable ground-truthing for the evolving LIDAR program and for their occasional inclusion in a geomorphological transect set. Ground-truthing surveys will continue to be scheduled for NASA LIDAR flights. Profiles will be important in analyzing the upcoming COE construction and nourishment project that is scheduled for a Fall 2002 start.

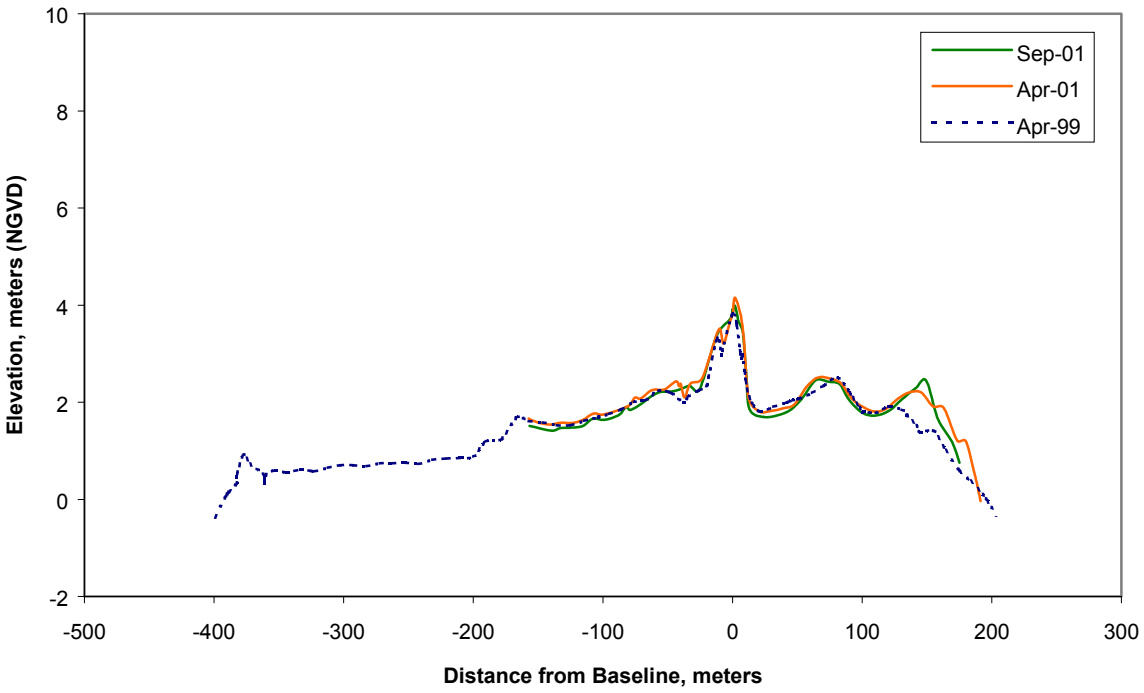

Figure 2A. Survey line GPS-1.

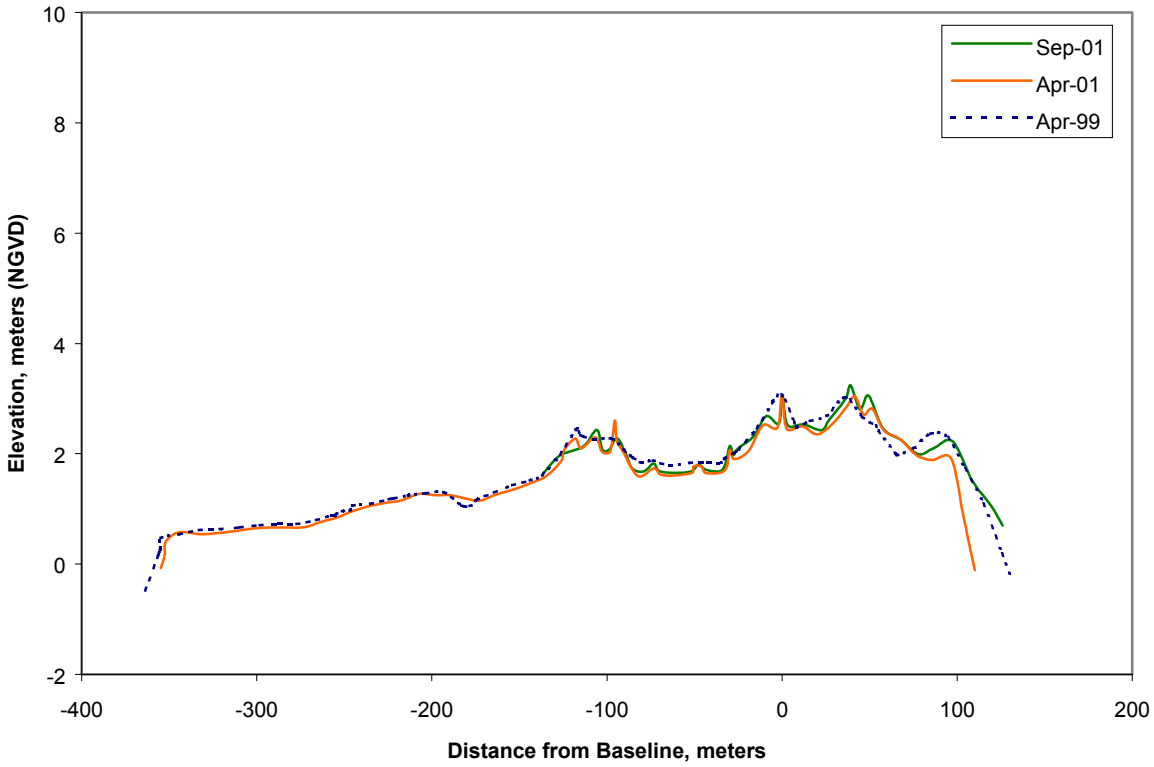

Figure 2B. Survey line NPS-1.5.

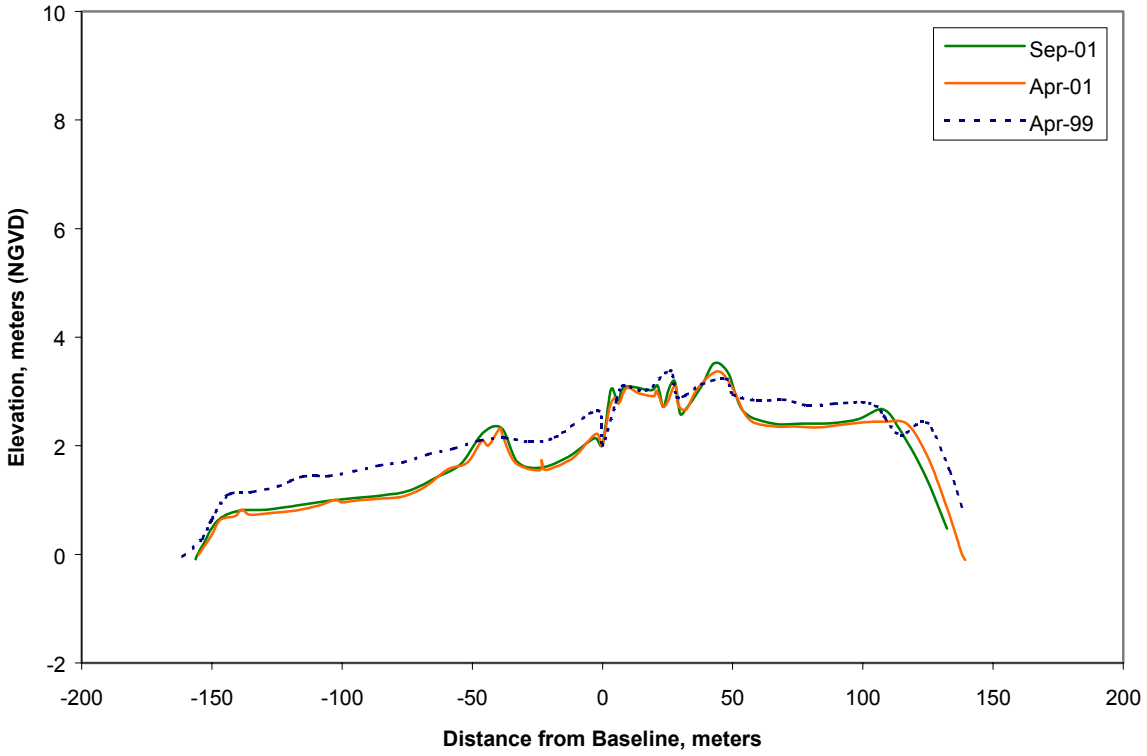

Figure 2C. Survey line GPS-2.

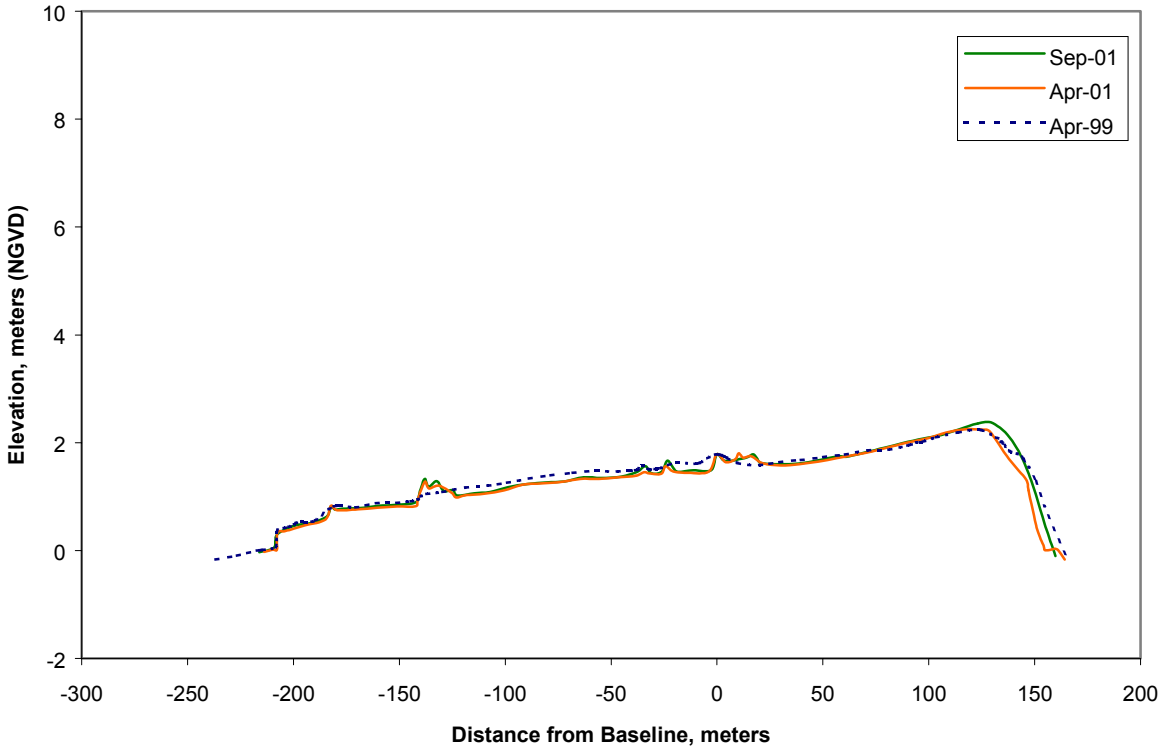

Figure 2D. Survey line NPS-2.5.

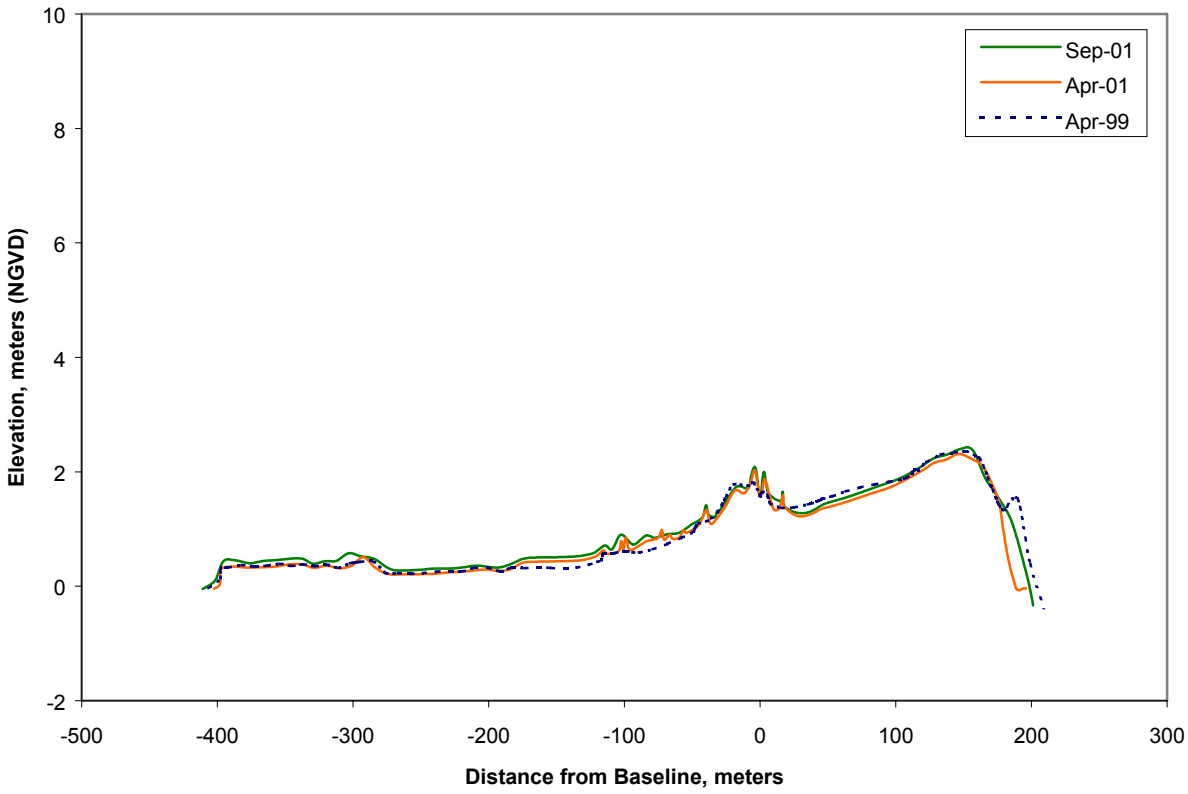

Figure 2E. Survey Line GPS-3

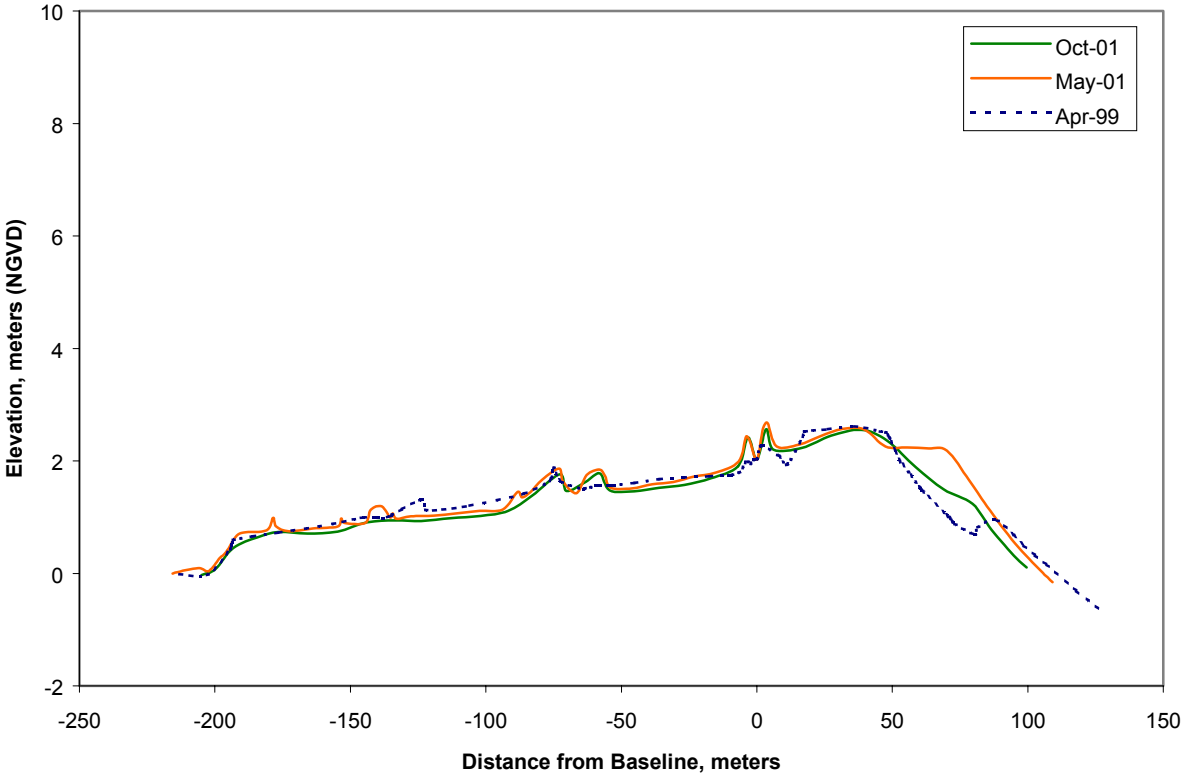

Figure 2F. Survey Line COE2 (NPS-3.5 reset)

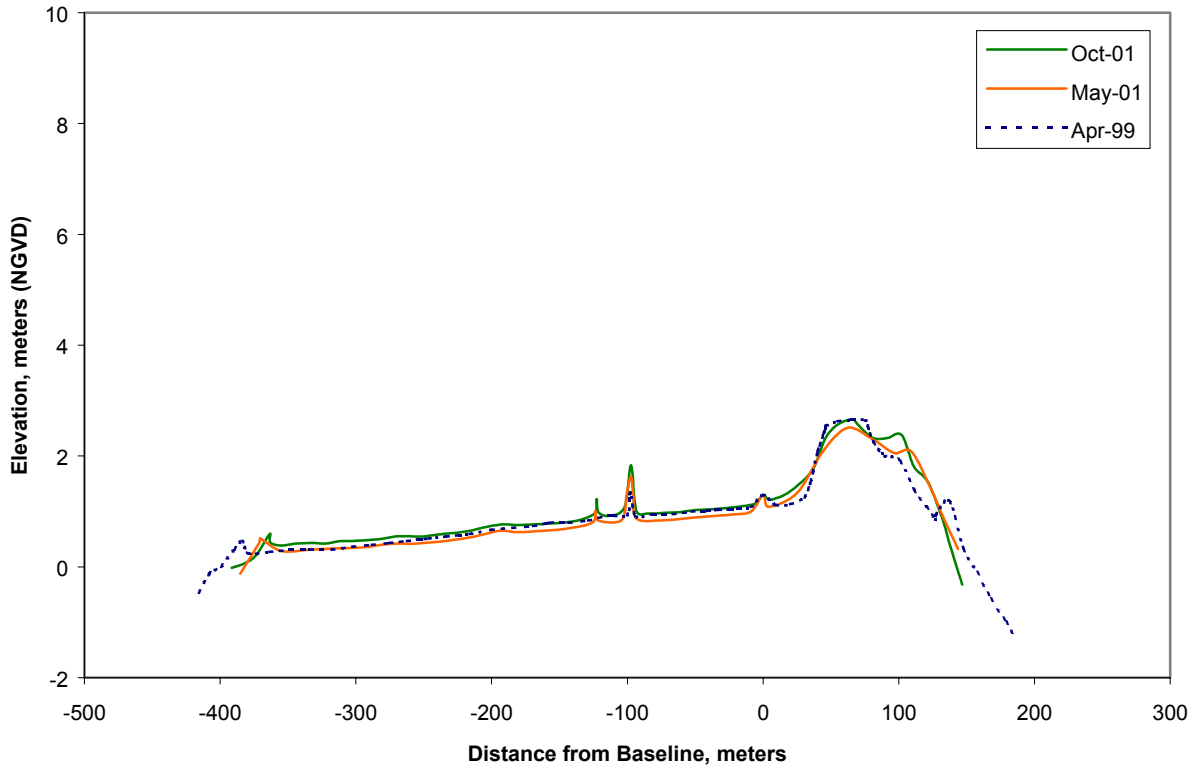

Figure 2G. Survey Line GPS-4

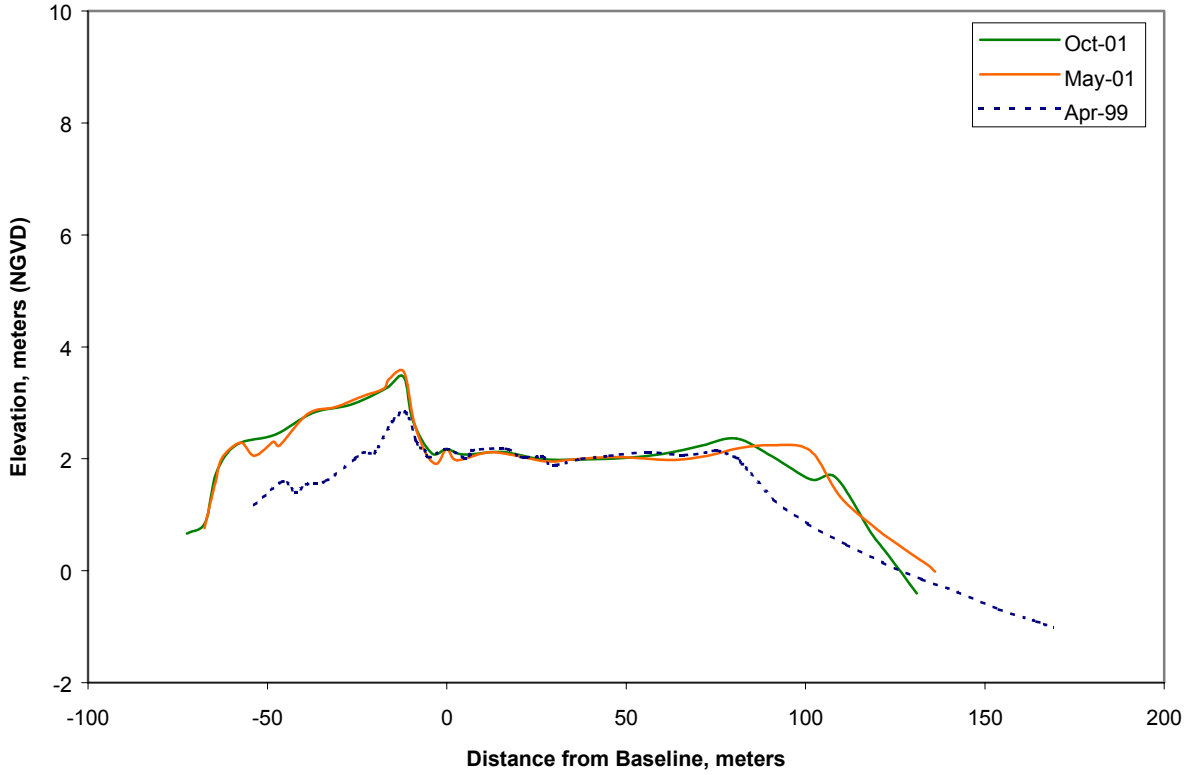

Figure 2H. Survey Line NPS-4.5

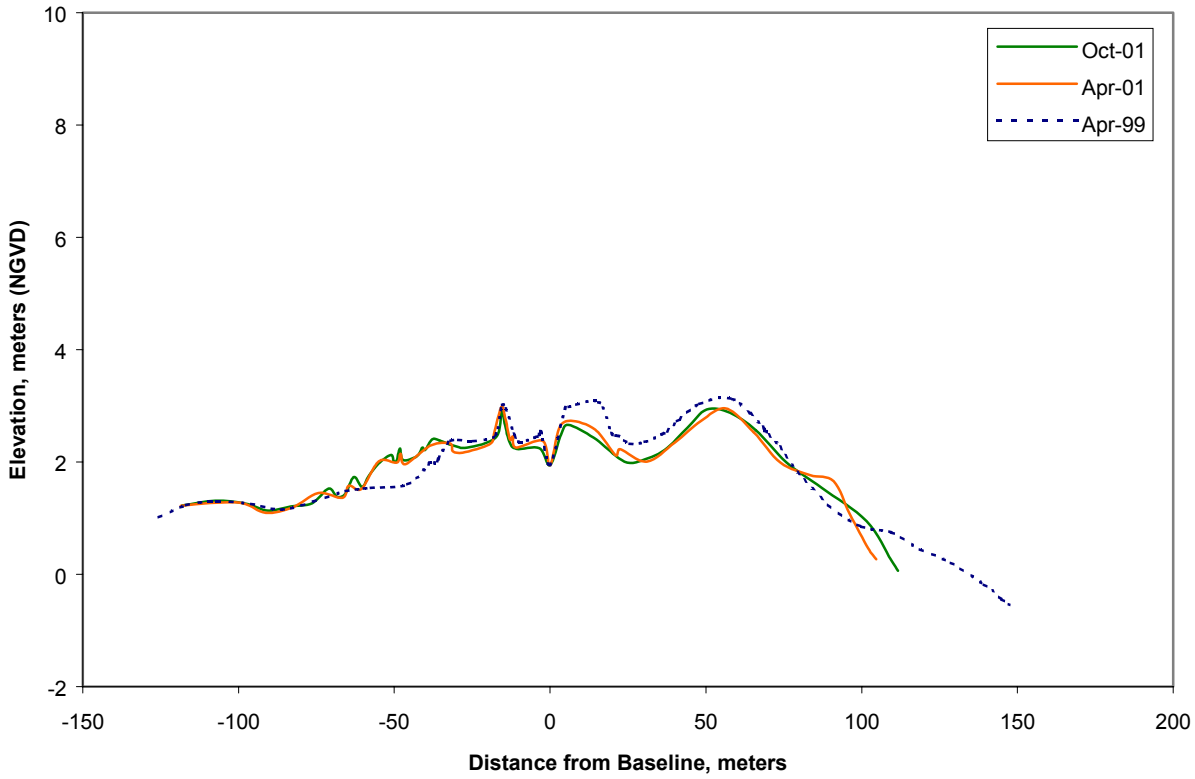

Figure 2I. Survey Line GPS-5

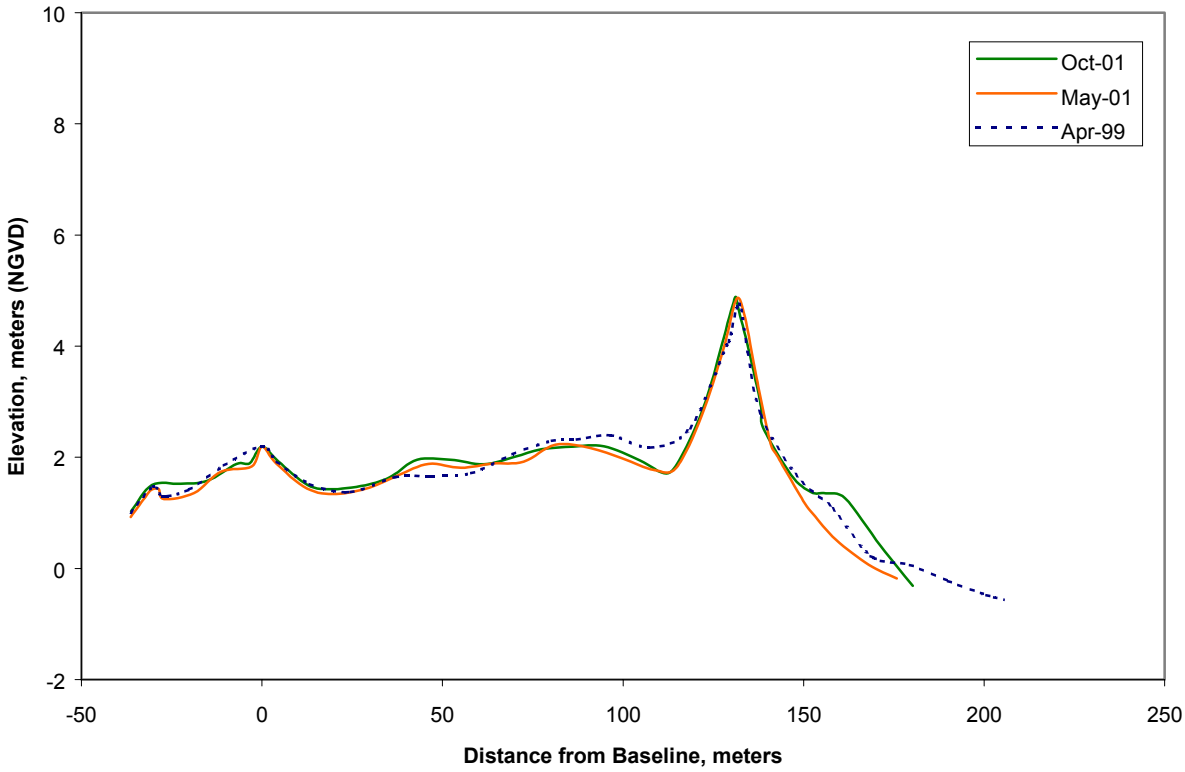

Figure 2J. Survey Line NPS-5.5

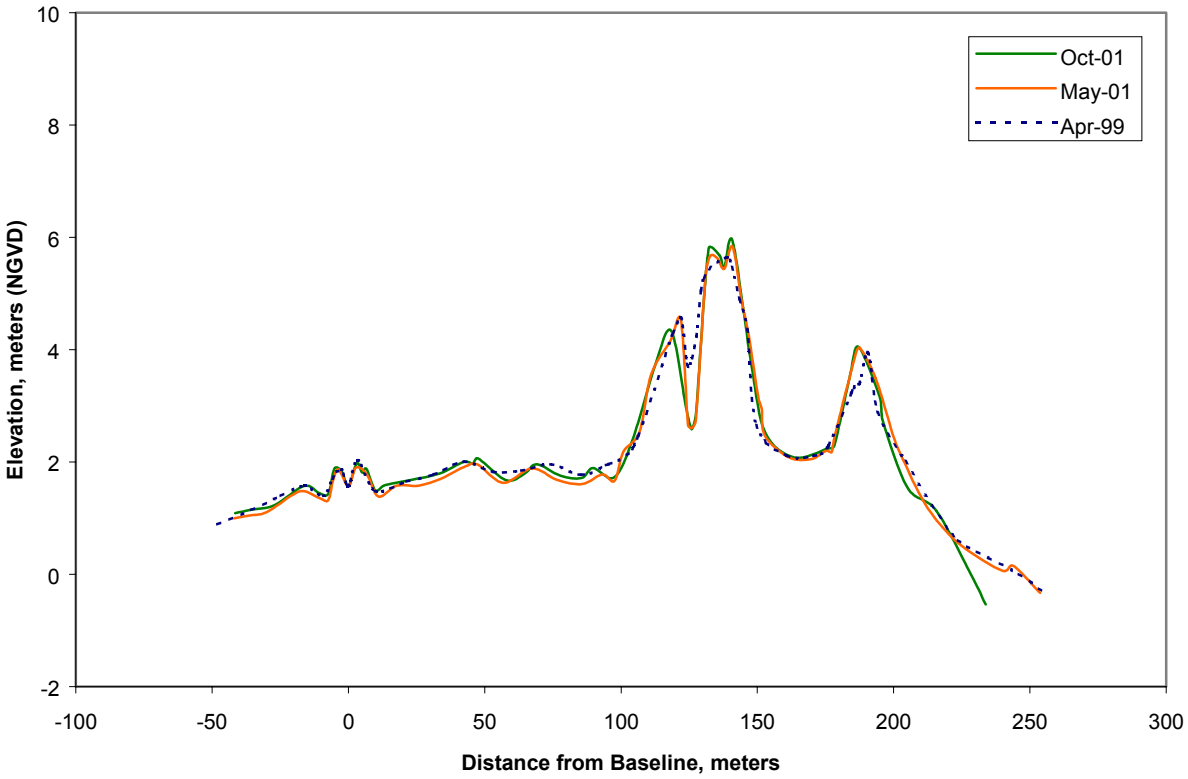

Figure 2K. Survey line GPS-6

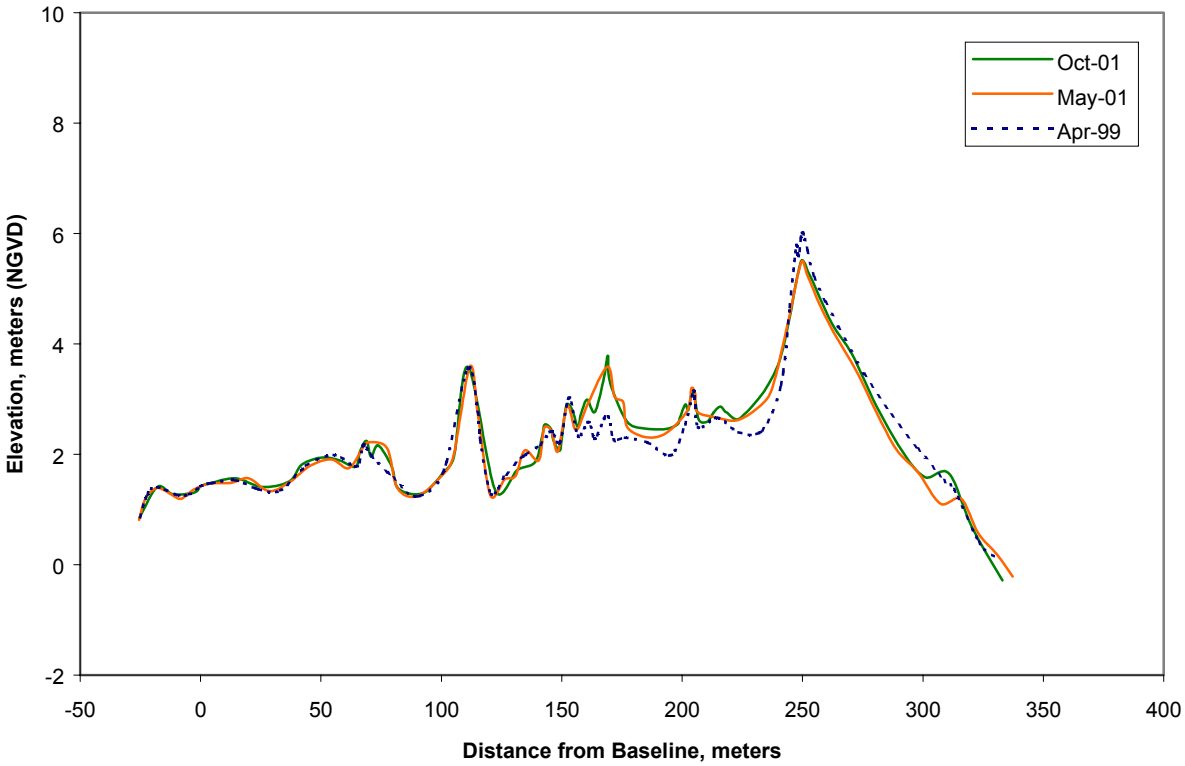

Figure 2L. Survey Line GPS-7

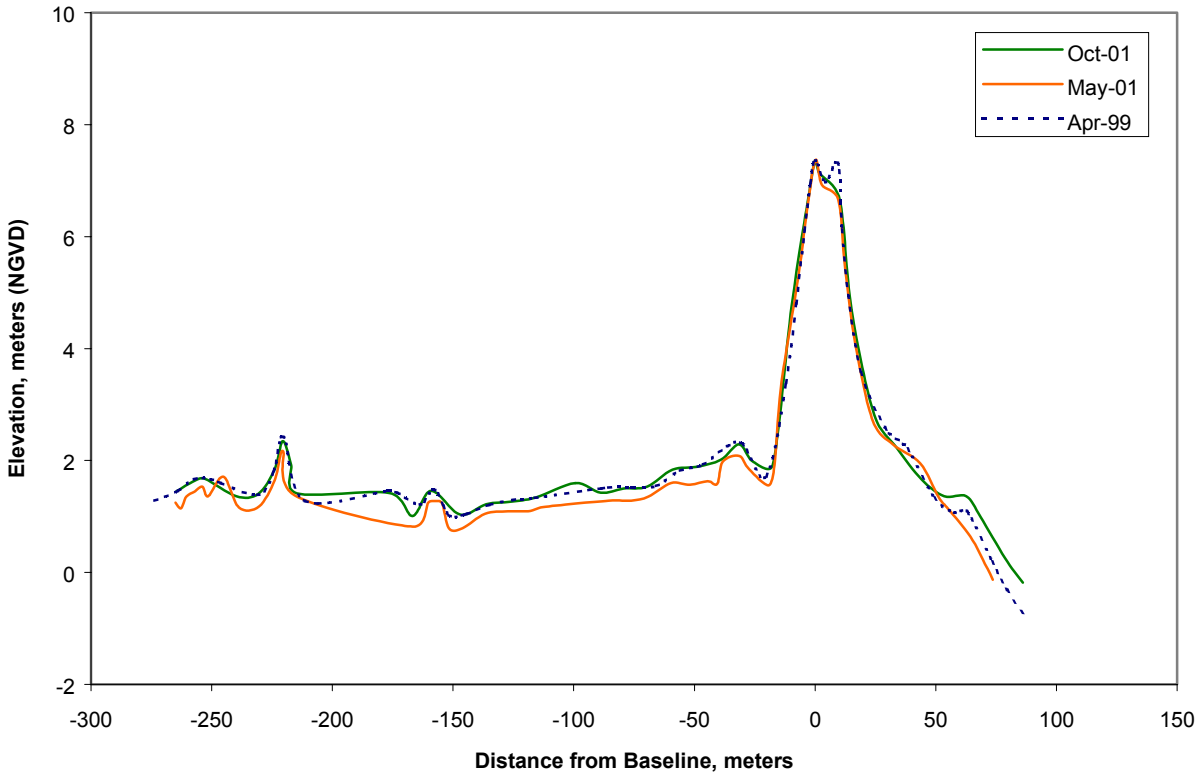

Figure 2M. Survey Line GPS-8

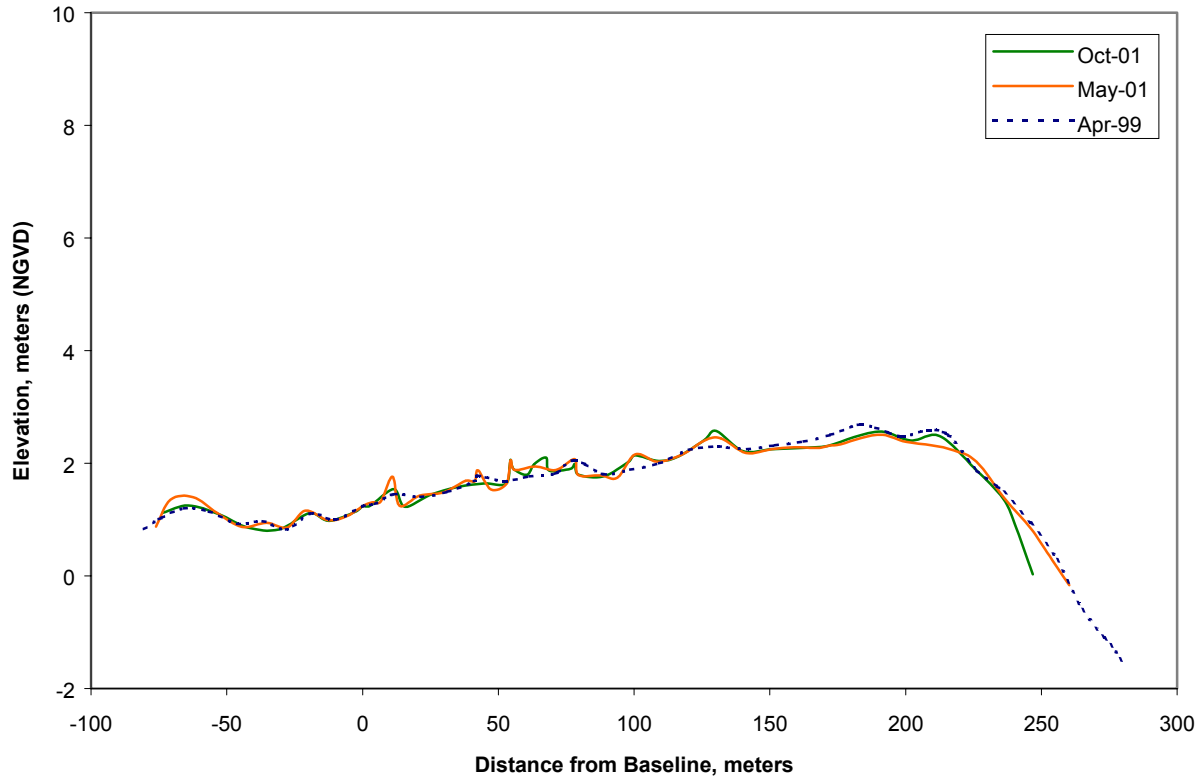

Figure 2N. Survey Line GPS-9

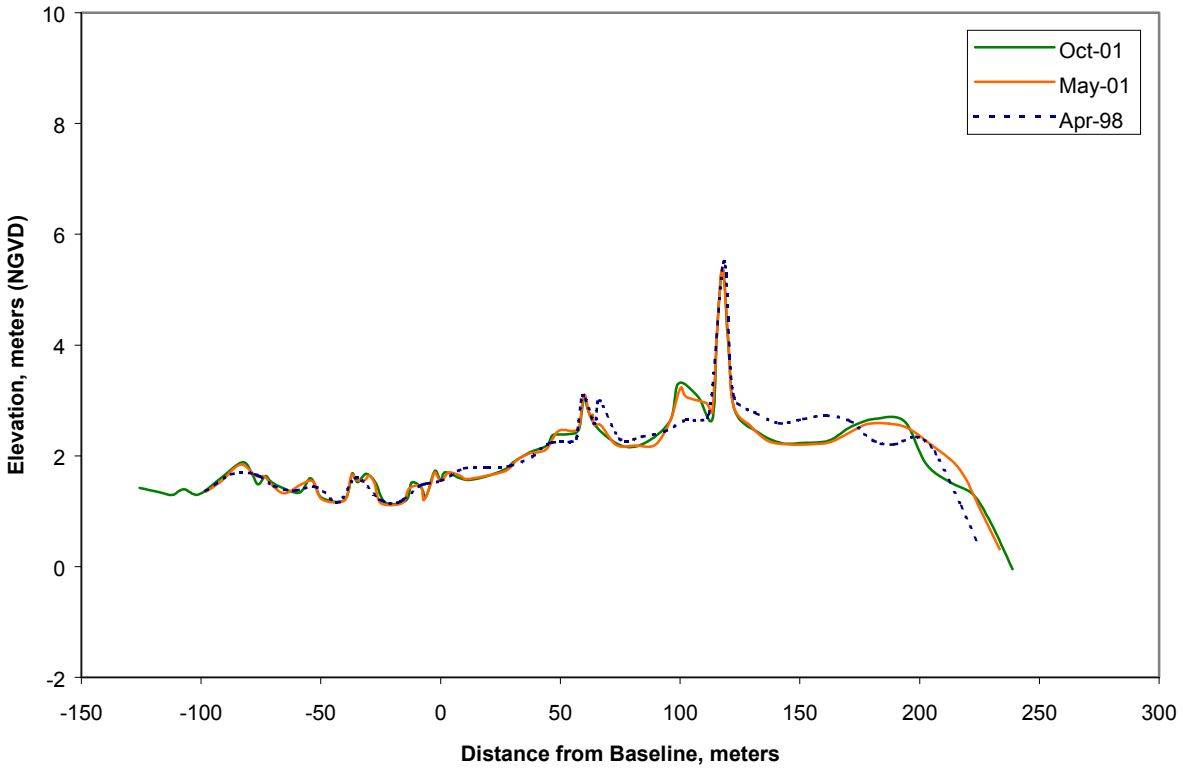

Figure 2O. Survey Line GPS-10

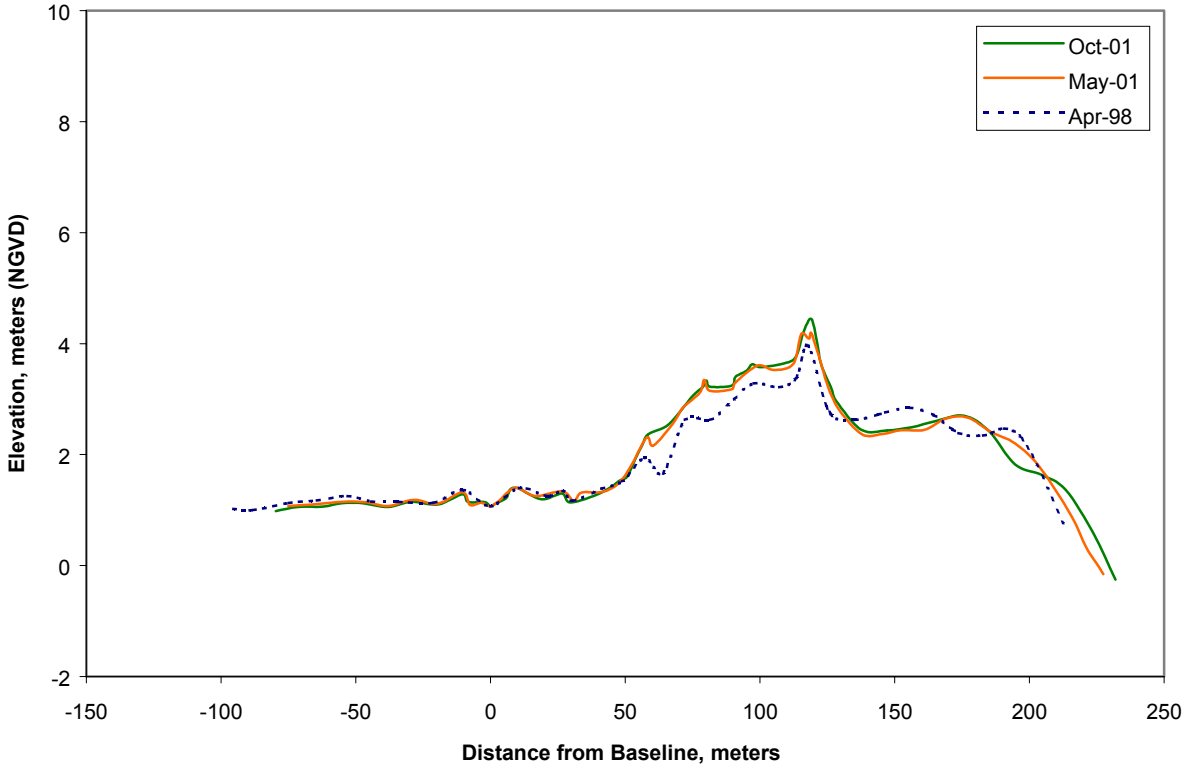

Figure 2P. Survey Line GPS-11

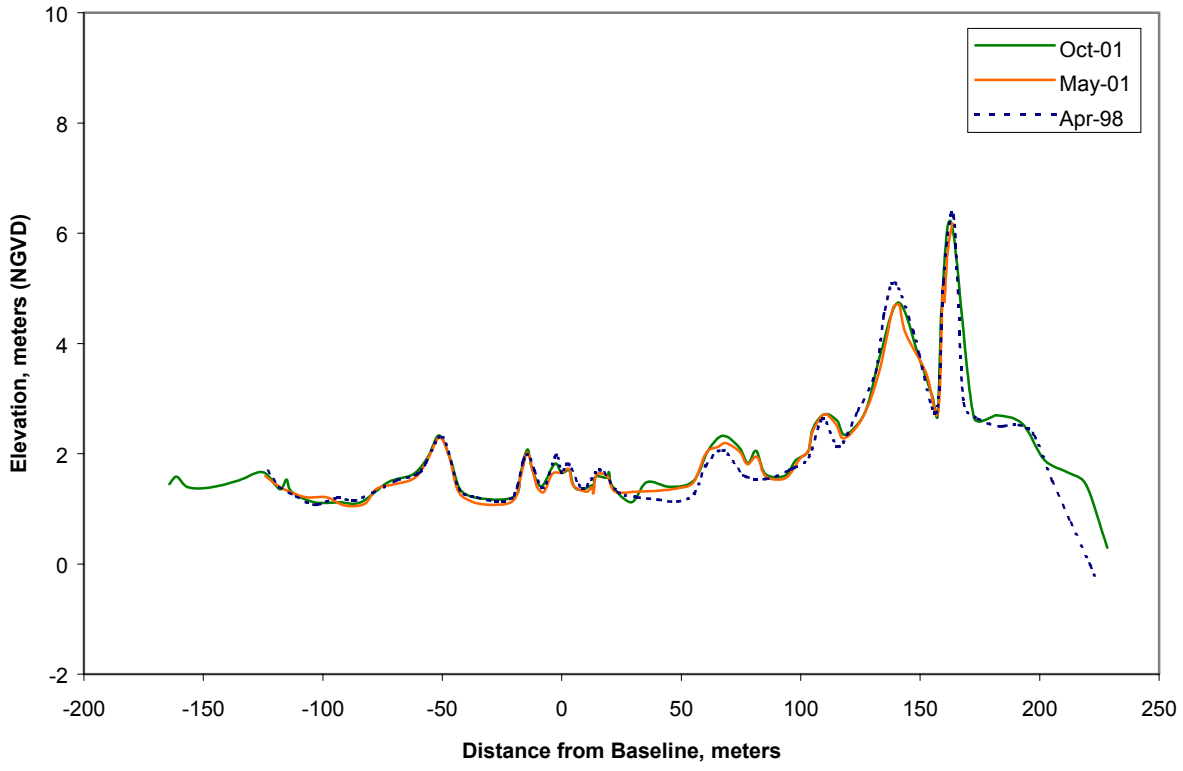

Figure 2Q. Survey Line GPS-12

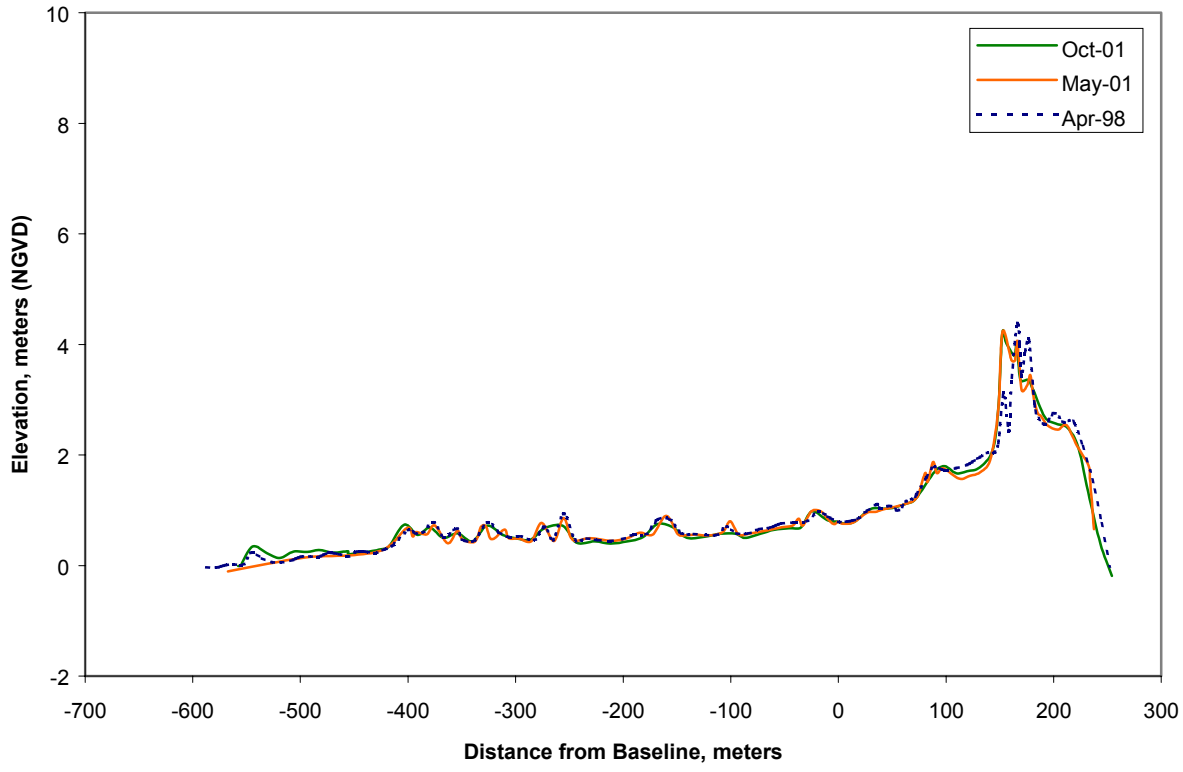

Figure 2R. Survey Line GPS-13

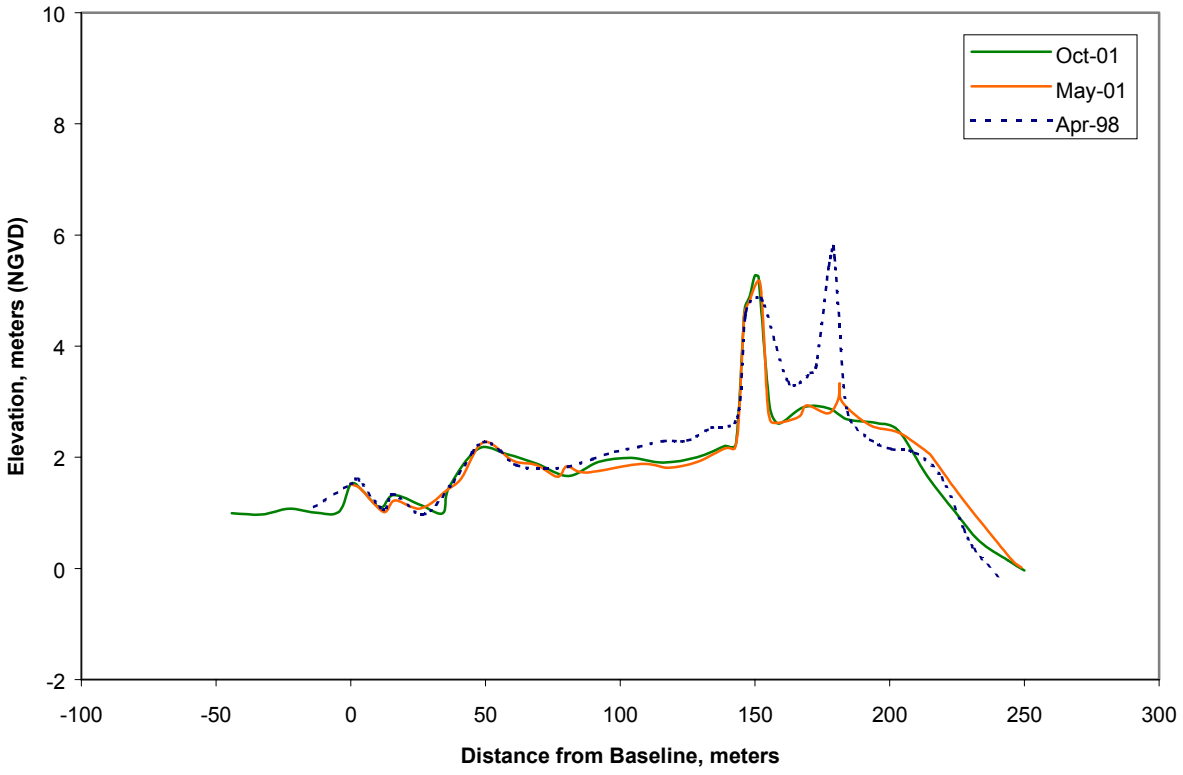

Figure 2S. Survey Line GPS-14

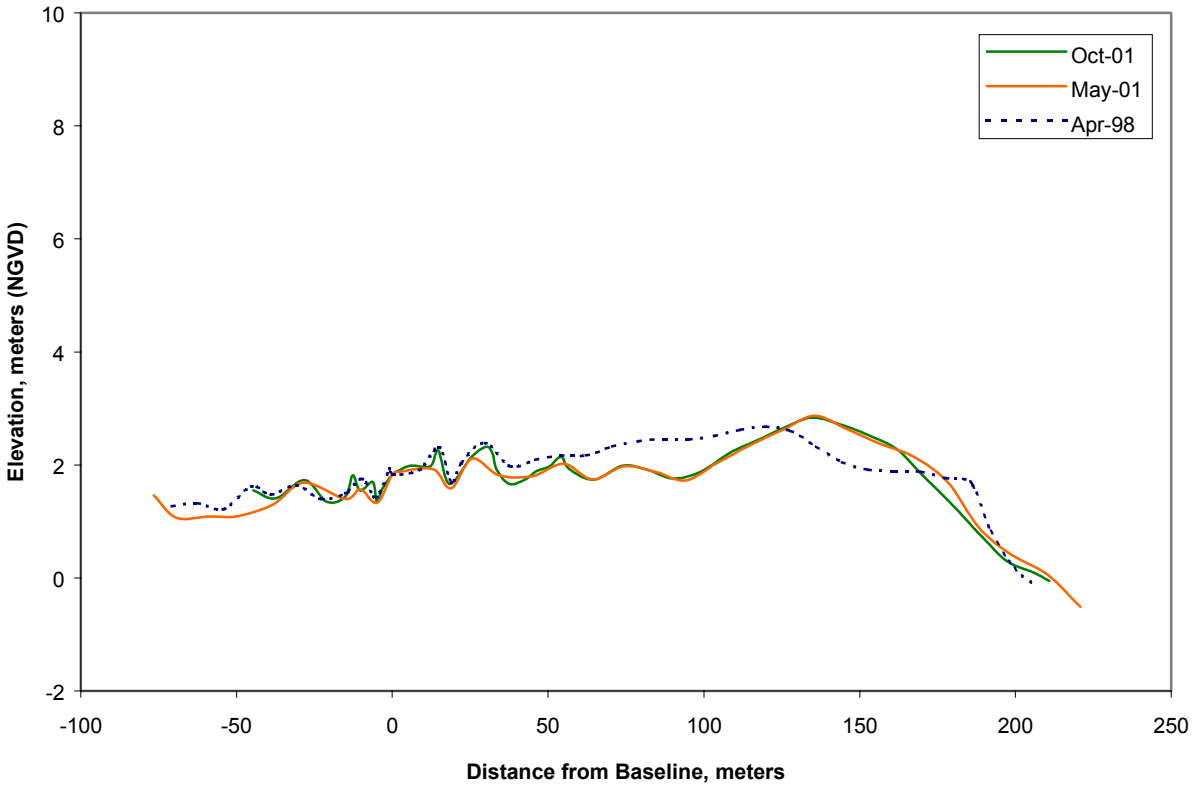

Figure 2T. Survey Line GPS-15

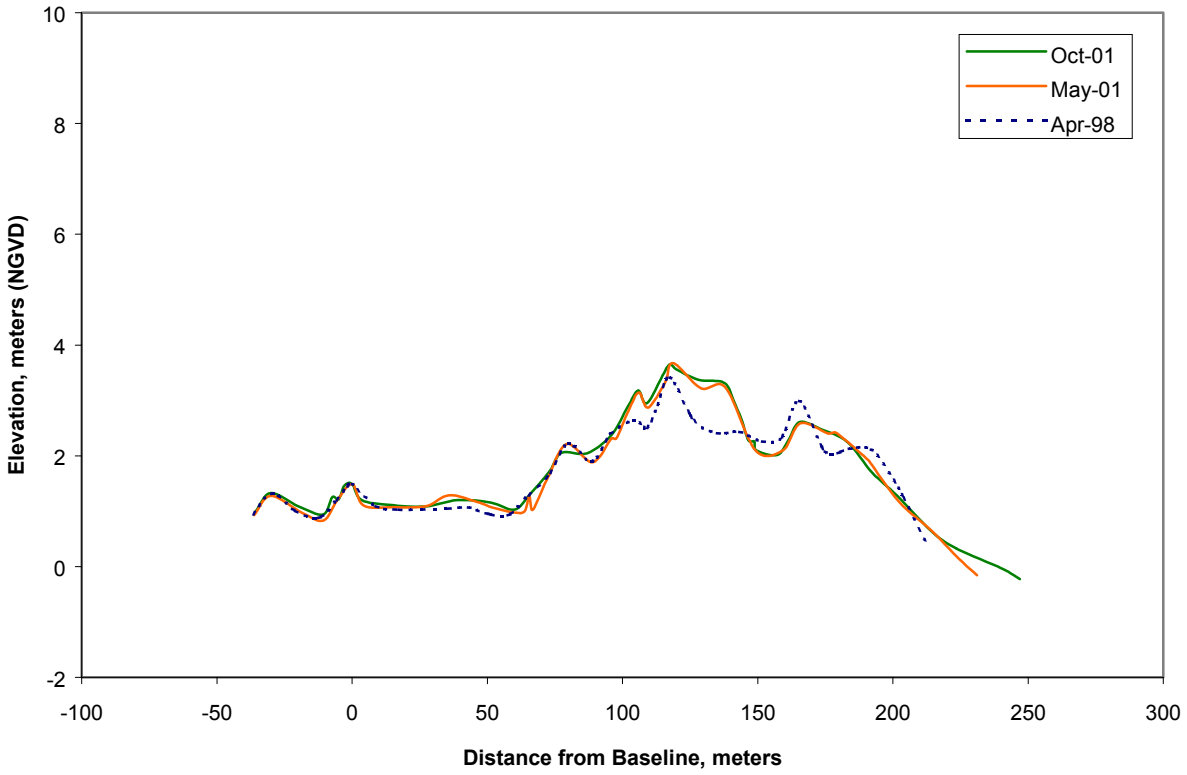

Figure 2U. Survey Line GPS-16

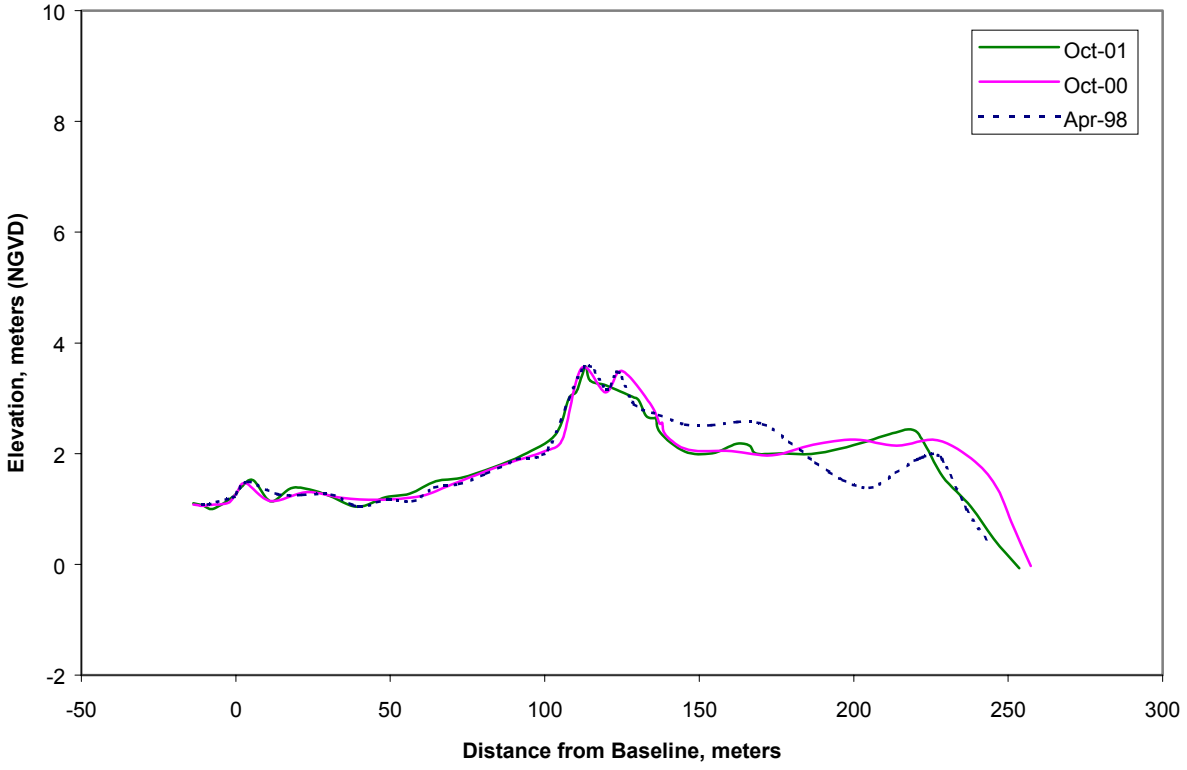

Figure 2V. Survey Line GPS-17

GPS Shoreline Survey Methods:

Standard kinematic differential GPS survey methods are employed for all shoreline surveys of Assateague Island. The GPS survey equipment is the Trimble Pathfinder ProXR system, which integrates an updated GPS receiver with MSK beacon real-time differential capability. This system provides the option of foregoing the establishment of a local base station and the post-processing of field data, while maintaining sub-meter accuracy standards for field mapping. Within each shoreline survey session, the location of a known surveyed point is occupied and recorded within the data file to serve as an accuracy check for survey data.

Shoreline mapping is planned for periods when the predicted high tides run close to the Mean High Water (MHW) at sites like the Ocean City Fishing Pier, Isle of Wight Bay, and Wallops Island. Prior to surveys, in addition to visual checks at Assateague, near-real time tide levels are checked at various regional stations including Wachapreague (VA), Lewes (DE) and Kiptopeke (VA) (no immediate-vicinity stations are available online) via the NOAA website, <www.tidesonline.nos.noaa.gov>. Additionally, a QuickPlan (a module of the PathFinder Office software), is utilized to generate a list of observation times that would optimize the accuracy of the desired GPS configuration. Considering the frequency of abnormal tide levels, it is often most efficient to take advantage of average tide levels as they occur, foregoing real-time coordinates as necessary. The GPS is therefore configured to record points at all times (i.e., including times when radio-link is lost), and post-processing (methodology covered below) is required to correct (differential correction) position data.

Optimally, shoreline mapping is completed before the midpoint of each season. For example, the "Spring" shoreline is captured in early spring to document effects of the predominating meteorological and tidal conditions of the winter season . In Winter and Summer, the position of the Maryland ocean shoreline is surveyed. In Spring and Fall, the Maryland and Virginia ocean shorelines, the northern 8 Kilometers of the Maryland bay shoreline, and the bayside extent of the southern tip of the island - 'The Hook' (Figure 5) - are surveyed.

Surveys along the ocean shoreline are accomplished by driving a four wheel ATV at a relatively constant speed (between 5 and 10 mph) along the high tide line. For the purposes of this monitoring program, the actual ocean 'shoreline' is defined as the position of the most recent high tide, evidenced by the obvious wet/dry sand line or deposited wrack. The GPS receiver is configured to record positions at a very short interval (typically one position every 2 seconds) for the best representation of the shoreline position. The North End bay shoreline is surveyed by walking the actual water line within two hours of the most recent high tide, while the GPS receiver records positions every 3 seconds. In areas along the bayside that lack dry uplands, the shoreline is identified as the open water/vegetation margin. This allows for tidal creeks and other shoreline irregularities to be included within the surveyed line. All surveys are executed during near-average tidal ranges, allowing several days before and after lunar water level extremes.

GPS data files are downloaded to the PC using the PathFinder Office utility software, and all files are differentially corrected through post-processing. Although, as explained above, post-processing of data is not required with real-time capable equipment, post-processing is performed because it accounts for the points that are not real-time corrected (points collected when the radio-link is down), results in generally more accurate position data for all points, and introduces a basic level of consistency to surveys. Base station files for post-processing differential correction are downloaded from the New Jersey Department of Environmental Protection's website, <http://www.state.nj.us/dep/gis/>. Shoreline files are checked for accuracy by comparing the collected known-point position to actual, and then exported as a GIS shapefile.

Individual files for each shoreline segment are labeled according to the specific area surveyed, MD for Maryland or VA for Virginia, followed by an "O" for ocean or "B" for bay, along with the survey date. For example, the file labeled "MDO399" contains the data collected along the Maryland ocean shoreline during March 1999. All data files are stored on the hard drive of the PC in the Shoreline project of the PathFinder Office software. Shoreline maps are finally combined within their respective seasons as one Arcview GIS shapefile, E.g., 'Shoreline 0499' contains a shapefile of the entire shoreline position collected in April or, the Spring, of 1999. Metadata are produced, and the information is filed in the Electronic Library under RIN 10.07.111, Shoreline Processes.

GPS Shoreline Survey Results and Discussion

Mapping the horizontal shoreline position with GPS can be useful in understanding the dynamics of a barrier island like ASIS. Although patterns of shoreline change are difficult to assess when examining a limited data set, general trends of accretion, erosion, and migration are identifiable. Figure 6 shows the extents of both the southern and northern areas of study emphasis. The shoreline position along the Maryland portion of Assateague Island from 2001 is compared to that of March of 1998 in Figure 7; the Virginia lines of these periods are presented in Figure 8.

This year, a survey was performed on June 1 and 8 of the North End bay shoreline; and on June 13 and 14 of the ocean shoreline. Note that the bay line was extended to Route 611 this survey (may be of interest to do this every other year or so). True Spring and Summer lines were not completed, as the Spring survey was performed so late, in effect producing a combined seasonal shoreline. Again, begun later than is ideal, the Fall ocean line was surveyed on October 22 and 30, and the bayside on November 8-9. The Winter survey of the Maryland ocean shoreline was completed on December 20-21. Delays in beginning and/or completing surveys were caused by extended extreme tide events. See the *Recommendations* section for a suggested survey schedule.

A survey of the North End (Inlet to State Park boundary) ocean shoreline was completed on May 10 to provide ground support for a LIDAR fly-over. Both high and low tide lines were collected: the operator mapped the high wrack-line, then at the terminus, turned and

collected the wet-dry line at time of low tide (when LIDAR surveys are flown). This process was repeated during a LIDAR flight on June 5.

Before interpretation of shoreline maps, one must first recognize the error that is introduced by viewer subjectivity when determining the high-tide line, and be aware of the role that variable tide levels *within* the average tide window play in shoreline appearance – this is most evident on the bayside (seen in insets 1 and 2 of Figure 6) where low-lying features are sensitive to small changes in water level. And, most significantly, as was covered in the Profile Survey Discussion, one must recognize the influence that meteorological events and conditions have on shorelines.

No significant patterns appear to have emerged since late 1998 to 1999. That period saw the rebound of island area – most distinctly in the North End – after the losses suffered from the storms of early 1998. On the bayside, the coastal storms produced overwashes that cut numerous small guts between 5.5 and 7.5 kilometers south of the inlet. These were subsequently filled in 1999 creating a more even and regular bay shoreline (inset 2). In this vicinity on the oceanside, there is a similar recoupment of beach area.

There are three distinct areas on the bayside that show receded shoreline on the November 2001 line as compared to the June 2001 (inset 1). This is likely due to influence of higher than normal tide on the low, flat topography of these periodically inundated areas. During the initial window of opportunity for fall collections, tide levels were abnormally and extremely high; concentration was then placed on the profile survey. When the first acceptable tidal range occurred for shoreline mapping – while not too far into winter conditions – the map was completed during what was a higher than average tide.

Shoreline position is also fairly stable on the Maryland oceanside since an eastward accretion after 1998 (inset 1, 2). Since an apparent movement west from fall 1999 to 2000, there has not been discernable shifting of the North End ocean line. The ebb shoal continues to protect the extreme North End (the area within approximately 1 Km from the inlet - inset 1 of Figure 6), by dissipating incoming wave energy (Underwood, p. 56). An additional effect of the ebb shoal is a continued sediment nourishment of the North End. Underwood states that it attaches to the island 600 m south of the south jetty (p. 99) and acts as a "sand bridge" (p. 114) to channel material to the North End (note the eastward accretion above the 1 Km mark since 1998). Northeasterly weather systems cause the shoal to elongate, flatten, and spread material to the south/southwest along northern Assateague (p. 113). There appears to be a slight western retreat from June to November of the ocean shoreline around the ebb shoal intersection. This could possibly be explained by a lack of sand import during the summer when sediment transport is less substantial and generally from the south.

Changes within 2001 are minimal on the Virginia end of the island (Figure 8), but trends since 1998 can be identified. For simplifying discussion of the Virginia 'Hook', it is possible to visualize the formation as a human foot. Inset 4 of Figure 8 displays an approximate 300 meter expansion of the 'sole' since 1998. On the 'heel' there was

accretion (not pictured) from 1997 – 2000; then, in 2001 the heel eroded, took a more rounded shape, and the sole grew. Southwesterly expansion of the sole could be further evidence of predominant southerly longshore sediment movement. Along the length from the state line south into inset 3 of Figure 8, no patterns seem to emerge.

Shoreline position surveys will continue along Assateague Island as part of the long-term Geomorphological Monitoring program in order to build the necessary database for future analysis. They will also be valuable as ground-truthing data, along with topographic profiles, for future LIDAR surveys.

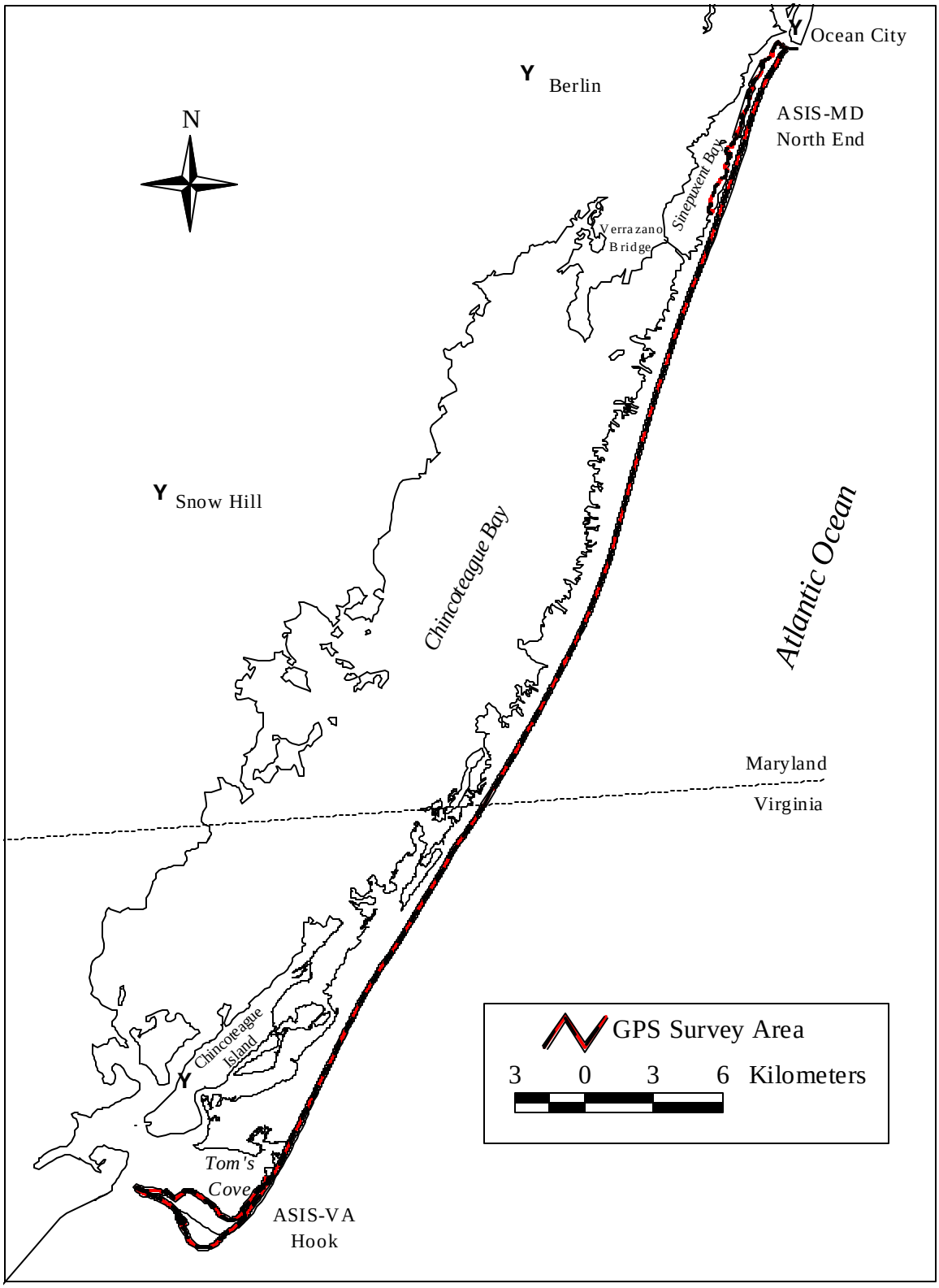

Figure 3. The Extent of GPS shoreline surveys on Assateague Island, 2001

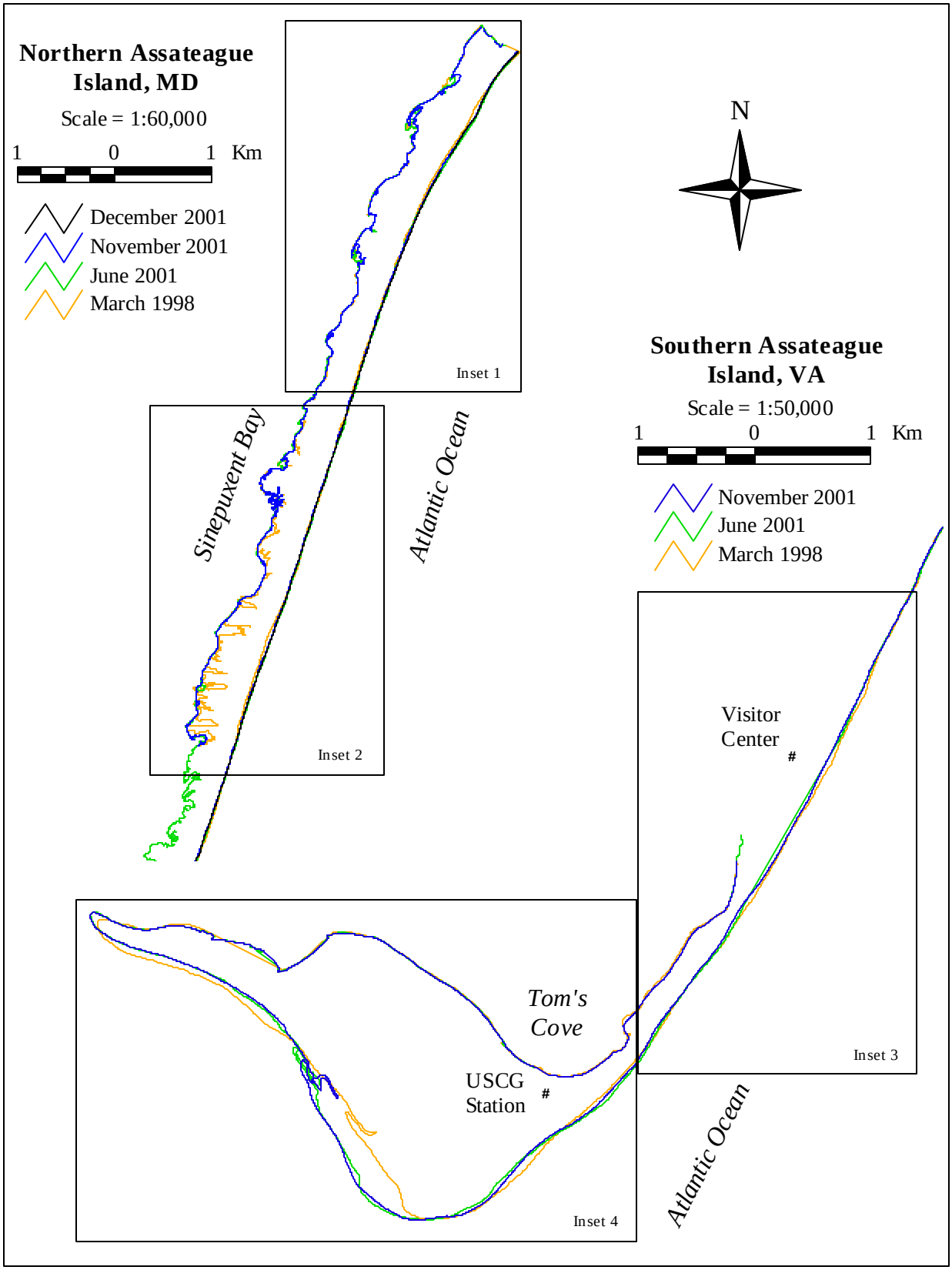

Figure 6. The Northern and Southern study areas within the Shoreline Monitoring Program of Assateague Island National Seashore, 2001. The March 1998 shoreline is shown for comparison.

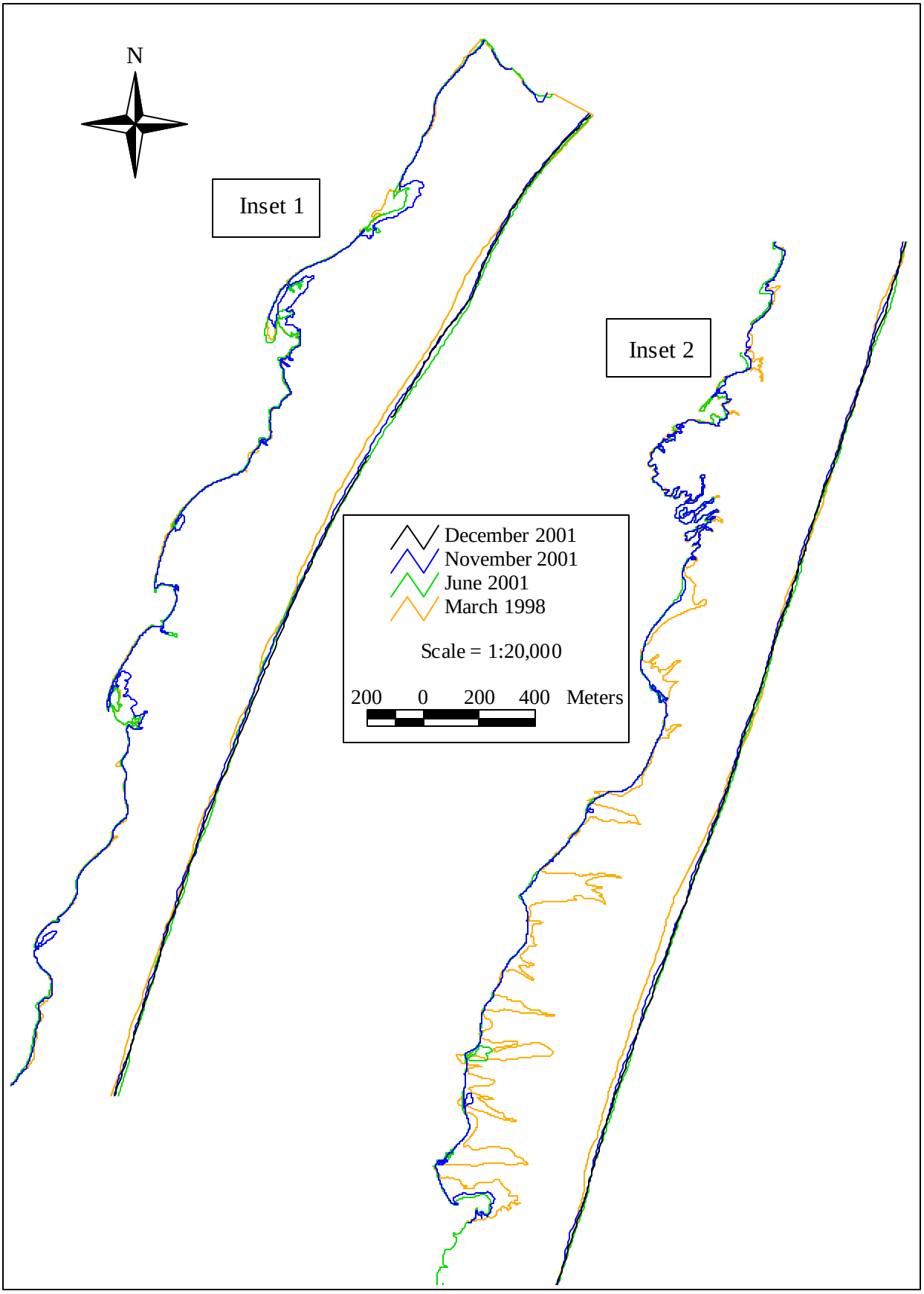

Figure 7. Insets 1 and 2 of Figure 6 showing shoreline change on the North End, Maryland.

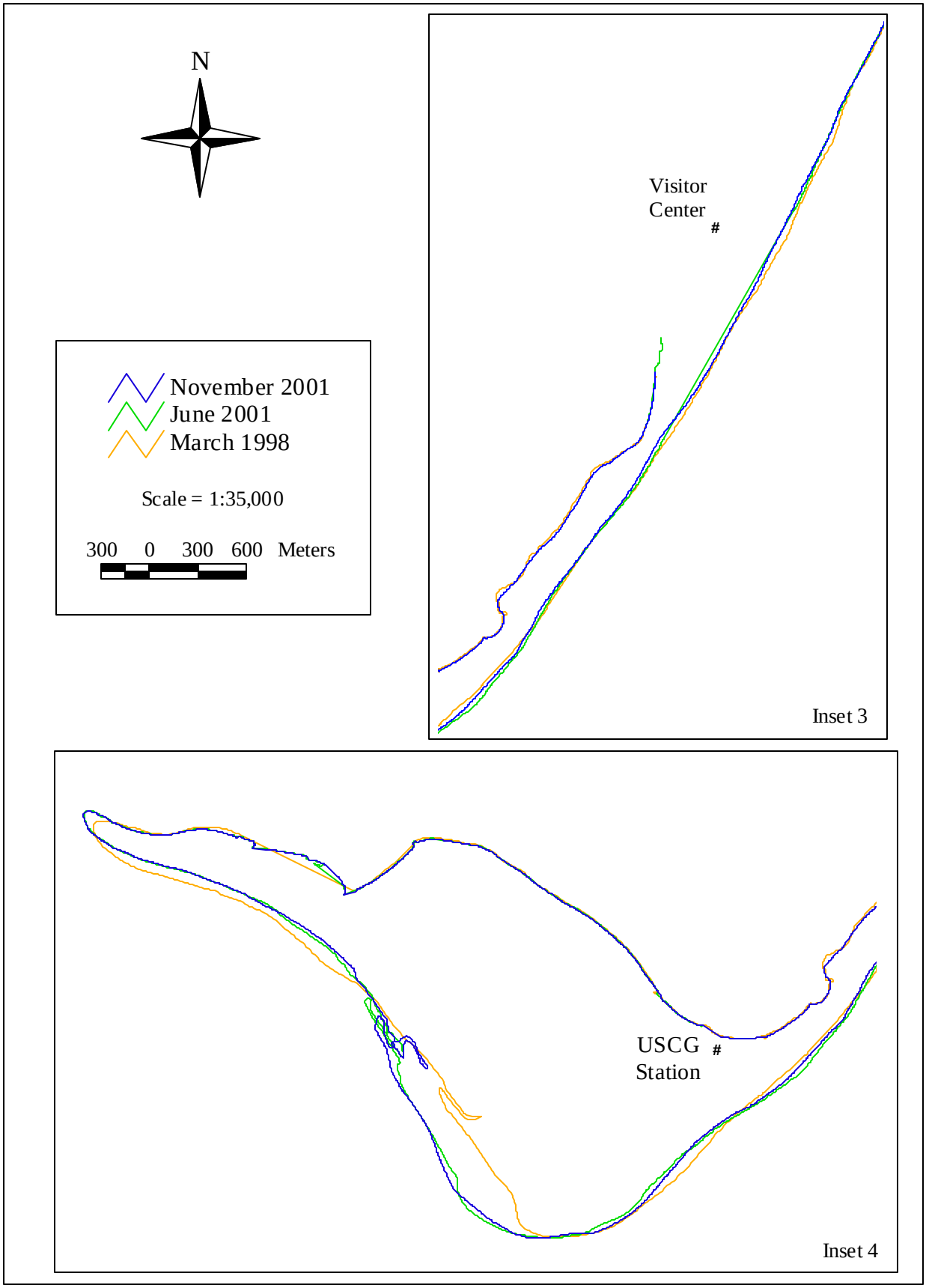

Figure 8. Insets 3 and 4 of Figure 6 showing shoreline change in the Southern section, the 'Hook', Virginia.

LIDAR Discussion

LIDAR data are collected by a NASA air survey crew as points (xyz format) and are processed by USGS Coastal Geology Center and Assateague staff into ESRI formatted point, TIN (Triangular Irregular Network), and Grid data sets. Though LIDAR surveys are still in the research phase, data have been used by park managers in limited analyses of Piping Plover and Seabeach Amaranth habitat, and in small-scale beach surface difference calculations (elevation change detection). LIDAR survey data can also be used to quantify large-scale beach surface changes; applications such as this are becoming powerful tools in coastal management and geomorphological research. Although limited in areal extent, ground surveys (profiles and shorelines) remain viable monitoring methods at Assateague that provide data for qualitative and quantitative analysis of seasonal, and weather event effects on island geomorphology, as well as field verification for LIDAR surveys,

Recommendations

It is desirable to have at least the entire North-end monument network re-occupied (as well as repaired/reinforced where needed) with survey-grade GPS. As has been covered elsewhere in this report (see Table 1), there are disparate origins for many of the monument positions.

Profile transects and shoreline positions in the area of the COE 2002 restoration project will need to be surveyed prior to contractor activity (the fall survey should start no later than mid-August in the North End).

All attempts should be made to adhere to standard seasonal survey schedules as much as possible. Barring unforeseen conditions such as extreme tide events/poor weather, the following is a guide to target starting times for geomorphological monitoring surveys:

Spring:	early – mid March start
Summer:	mid June
Fall:	Late August – early September
Winter:	late November – early December

Generally, profile collections are begun prior to shoreline surveys in the Spring and Fall. Profile surveys are not as dependant upon tide levels as shoreline mapping is, thereby allowing for coordination among staff within a certain time frame regardless of tides.

Finally, development and improvement of data management procedures – including analysis, integration, backup, and archiving – should be priorities for program staff.

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Underwood, S.G., 1995. Historical Development of Ocean City Inlet Ebb Shoal and it's Effect on Northern Assateague Island, U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, Vicksburg, MS.