

Cove Point Horseshoe Crab Survey 2013

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Project Description

This year's work is part of a larger, multi-year study of horseshoe crab spawning at Cove Point, MD, supported by funding from the Cove Point Natural Heritage Trust. Yearly spawning counts show that spawning activity has declined over the last decade. We are working to 1) determine size and structure for this horseshoe crab population, 2) construct beach profiles for Cove Point, and 3) examine spawning at the nearby Flag Ponds beach, as well as horseshoe crab movement between these two areas. Data collected in this study will allow us to estimate spawning population size, evaluate Cove Point beach as a spawning area, and help determine if females will utilize nearby beaches, such as Flag Ponds, if Cove Point becomes an unsuitable spawning habitat.

Methods

Survey and Tagging

Cove Point beach was surveyed during four tidal and lunar cycles: late May, two cycles in June and the beginning of July. Based upon a Maryland DNR tide table, a day was chosen as the highest tide for that cycle. One survey was conducted on this day and three more were conducted before and after the highest tide. Four days were therefore surveyed for each tide cycle. Each of these surveys consisted of a single pass from Cove Point Lighthouse to the stone rip-rap at the northern end of the beach within one hour of the nighttime highest tide. Spawning females, associated males, and any single males were marked with GPS and their locations plotted using Google Earth. A spawning female with any associated males was considered a spawning group. Surveys were conducted by the PI or technicians Stephanie Siemek or Dimitra Neonakis, with one or two additional student workers each night.

Most Cove Point spawning animals were tagged with standard USFW tags (Fig. 1). These were

Figure 1. A standard USFW horseshoe crab tag, and a crab with attached tag showing tagging location. Picture credits: USFW.



obtained from US Fish and Wildlife and are standard tags for horseshoe crabs. They were attached by drilling a small hole along the left edge of the prosoma and pushing the tag into the hole. Prosomal width was recorded for all tagged crabs. The tagging served two purposes. First,

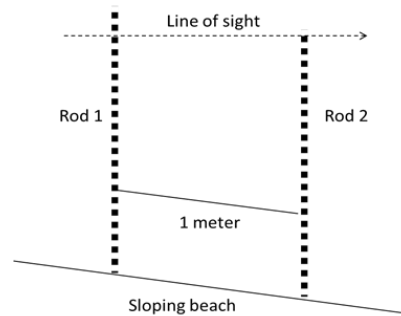
it allowed us to detect repeated spawning and movement between spawning beaches. Second, recapture data in the second year should help us to estimate population size for animals utilizing these beaches.

Horseshoe crabs were also tagged at Flag Ponds beach. This beach was surveyed on the highest nighttime tide once during both June tide cycles. The primary purpose of these surveys was tagging, in order to increase the number of tagged crabs and track any crabs that moved between beaches. Some crabs were also counted to get an estimate of spawning numbers, although there were too many animals to obtain a complete count.

Beach Profiles

Two students used Emery rods to conduct a beach profile at each benchmark (Emery, 1961). Their use is shown in Figure 2. First, 22 benchmark stations were established that ranged from the lighthouse (station 1) to the riprap at the northern end of the beach (station 22). The coordinates of each benchmark station were recorded to provide a permanent marker. Rod 1 was placed at a benchmark station, and rod 2 was stretched 1 meter toward the water. By observing differences between the 1 cm marks on each rod, the elevation change for that meter was determined. Elevation change for each meter from the benchmark to the water's edge was measured in a similar fashion. These measurements were used to construct a profile at each benchmark station, showing vertical elevation change and beach slope.

Figure 2. Diagram showing the use of Emery rods on a downward sloping beach.



Sand cores, 1 cm in width and 20 cm deep, were also collected at each station one meter from the low tide waterline. Cores were returned to the laboratory, dried, weighed and poured through a stack of sieves with standard size numbers 5, 35, 60, 120 and 230. These represent mesh sizes of 4, 0.595, 0.250, 0.125 and 0.063 mm, respectively. The fraction retained by each sieve was collected and weighed, allowing us to determine the relative proportion of sand grain size classes in the sample. Small grain size is associated with low wave energy which may encourage spawning but also with hypoxic conditions which can affect egg survival.

Results and Discussion

Survey and Tagging

Below is a general description of activity for each tide cycle. Figure 3 shows the location of all spawning groups counted during the 2013 season. As in previous years, spawning was heaviest at the southern end of the beach, although a few spawning groups were observed within the breakwaters at the northern end of the beach.

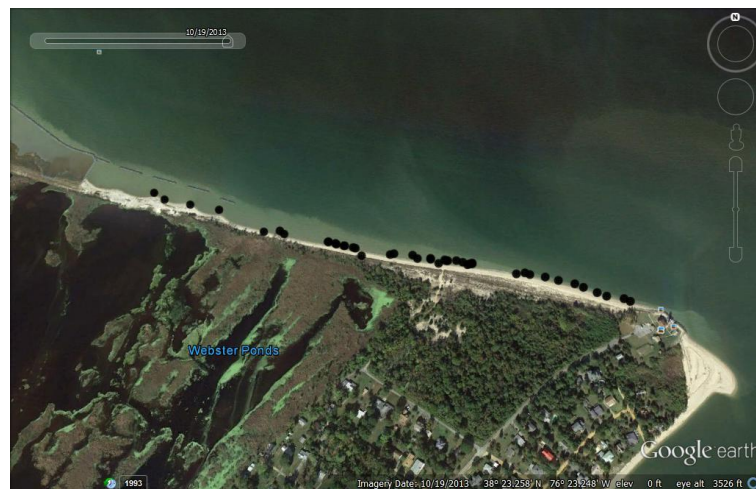
May 24-27 - Spawning began well, but a cold front and high winds appeared to shut down spawning after the first night. We counted and tagged five spawning pairs and one single male the first night, but none on any day after that for this tide cycle.

June 8-11 - Spawning began well, but heavy rain fell after the first night and may have affected spawning. Two spawning pairs were counted and tagged the first night, four (three tagged) the second night, four (three tagged) the third night, and none on the fourth night. Flag Ponds spawning was much heavier. We tagged 47 crabs during a single Flag Ponds survey on June 9 and counted 329 more. Other spawning groups were present on the beach.

June 22-25 - This was the strongest spawning run at Cove Point, with 27 spawning pairs observed and tagged. June 22: 16 pairs; June 23: 8 pairs; June 24: 5 pairs; June 25: 2 pairs. A total of 50 crabs were tagged during this tide cycle. As in early June, there appeared to be many more crabs at Flag Ponds. We tagged 110 crabs at Flag Ponds beach on a single night during this tide cycle. Other spawning groups were present on the beach.

July 7-10 - The spawning appeared to be ending. Two spawning pairs were observed and tagged during this tide cycle.

Figure 3. Location of all spawning groups surveyed on Cove Point beach in 2013.



Tagging Comparison between Cove Point and Flag Ponds

Spawning at Cove Point was low enough that most observed spawning groups were tagged. At Flag Ponds, density of spawning groups was much higher and only a subset of crabs was tagged. Both males and females were tagged, in rough proportion to their abundance on the beach.

A total of 244 crabs were tagged at Cove Point and Flag Ponds beaches. Tagging numbers, locations and days are summarized in Table 1. We visited Flag Ponds beach on June 9 and June 22 in order to increase the number of tagged animals. On June 9th, 17 females and 31 males were tagged, while 49 additional females paired with 280 additional males were observed. This was not a comprehensive count; there were additional spawning crabs on the beach. In comparison, four spawning females were observed at Cove Point on this date. On June 23rd, 18 females and 99

males were tagged at Flag Ponds beach, with many animals neither counted nor tagged. The Cove Point survey showed nine spawning females on June 23. A quantitative comparison is difficult due to differences in methods, but it is clear that many more crabs were present at Flag Ponds compared with Cove Point and the male/female ratio was much higher at Flag Ponds. Some females at Flag Ponds were surrounded by as many as 20 males.

Table 1. A summary of female and male tagging results for each sampling day.
CP = Cove Point beach, FP = Flag Ponds beach.

<u>Location</u>	<u>Date</u>	<u>Females</u>	<u>Males</u>	<u>Resightings</u>
CP	24-May	4	4	
CP	25-May	0	0	
CP	27-May	0	0	
CP	8-Jun	2	1	
CP	9-Jun	3	3	
CP	10-Jun	3	3	
CP	22-Jun	16	18	
CP	23-Jun	1	1	4 ¹
CP	24-Jun	3	8	3 ²
CP	25-Jun	2	3	2 ³
CP	7-Jul	2	2	
CP	8-Jul	0	0	
CP	9-Jul	0	0	
CP	10-Jul	0	1	1 ⁴
FP	9-Jun	16	31	
FP	23-Jun	18	99	4 ⁵
Totals		70	174	14

Resightings - 4¹: two females, two males from June 22 CP; 3²: one female, two males from June 22 CP; 2³: two males from June 24 CP; 1⁴: one female from July 7 CP; 4⁵: four males from June 9 FP. Two FP males tagged June 9 were also reported to USFW by phone. The first was observed on FP beach on June 11 and July 3, the second was found dead on FP beach on July 8.

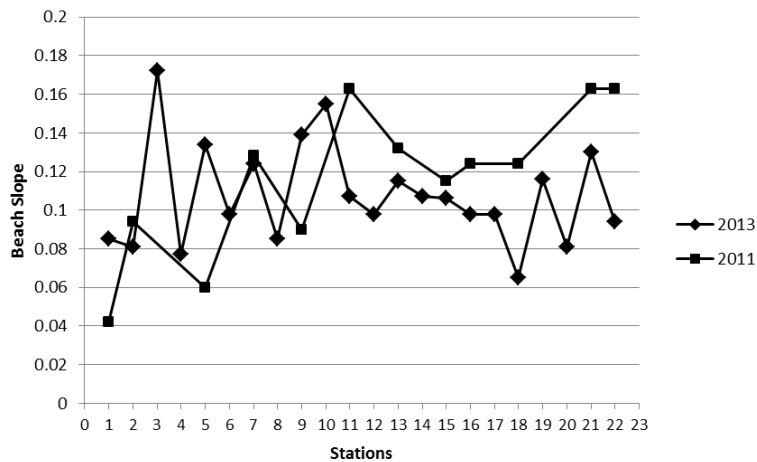
There were a limited number of resightings over the season. These included both males and females, suggesting that females can spawn more than once over a tide cycle. Cove Point resightings were always from a tagging during that tide cycle, while the four males resighted at Flag Ponds on June 23 were tagged on June 9 during the previous tide cycle. All resighted crabs were found at the beach where they were tagged; there was no observed movement between beaches.

Beach Profiles

Vertical beach profiles constructed for stations 1-22 are shown in Appendix 1. When a profile from the 2011 study was available it is presented with the 2013 profile for comparison. The pattern observed in 2011 is still generally accurate. There are three distinct areas: the northern beach, a stretch of beach in the middle region, and the southern beach. The southern beach

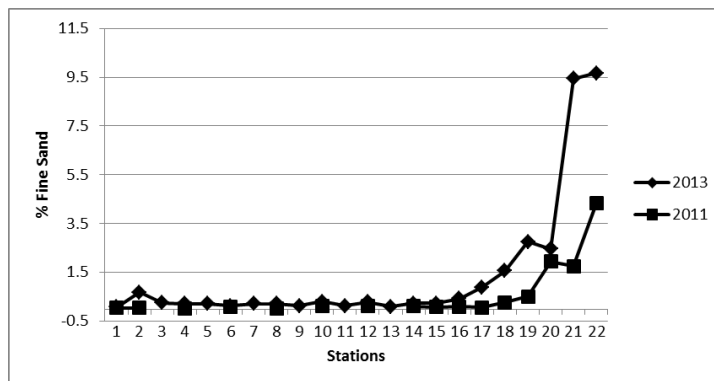
generally was wider, with less slope until the 1-2 meters of beach adjacent to the water. This suggests a stable beach with little erosion. The middle beach was short and steep, with a continuous slope down to the water. These profiles, along with exposed and dying vegetation, suggest erosion is occurring in this middle area. The northern beach appeared stable and in many ways similar to the southern beach. The area was wider, and the slope was generally less steep. There were some differences between the 2011 and 2013 profiles. The southern beach in 2013 is more steeply sloped than in 2011, while the northern beach is less sloped than in 2011 (Fig. 4). A more steeply sloped southern beach means higher wave energy in the transitional zone where horseshoe crabs spawn. This may disrupt spawning when the water is choppy. Conversely, the shallower slopes found on the northern beach, likely due to the action of the breakwaters, mean less wave energy in the spawning zone.

Figure 4. Beach slopes at stations 1 (lighthouse) through 22 (riprap) for 2013 and 2011. Compared with 2011, slopes in 2013 were generally higher at the southern beach and lower at the northern beach.



Examination of sand cores from each station showed that most (>80%) sand grains were in a medium or coarse range (>0.5 mm). Although fine sand (< 0.125 mm) made up a small proportion of the total, it differed between stations and between years (Fig. 5). In both 2011 and 2013, the percent fine sand increased at the northern beach. This percentage increased (10%) compared with 2011 (4%). This increase in fine sand, together with shallower slopes, likely reflects low wave energy due to the breakwaters. In this more protected area, fine sand can accumulate. This area seems suitable for horseshoe crab spawning, unless the finer sand packs tight enough to produce hypoxic conditions. It is interesting that several spawning groups were observed within this area for the first time in 2013.

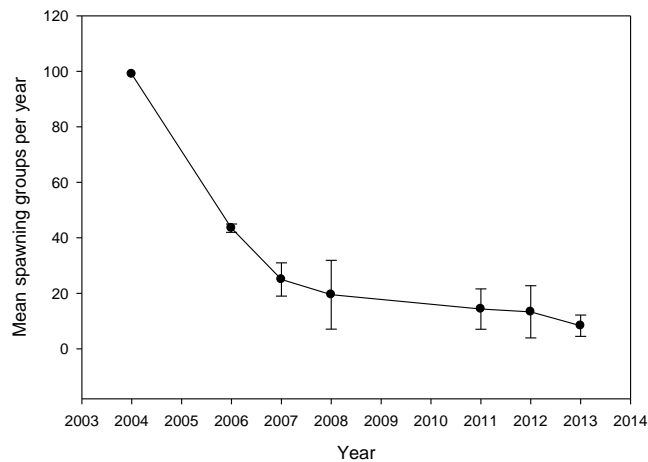
Figure 5. Percent fine sand in sand cores collected at stations 1 (lighthouse) through 22 (riprap) in 2013 and 2011.



Spawning Declines at Cove Point Beach

Our surveys of horseshoe crab spawning at Cove Point beach began in 2004 and have produced a long-term record of spawning numbers. Figure 6 shows the average number of spawning groups observed over this period. These averages are based on a single count on the highest tide for three tide cycles each season. In 2004, 99 spawning groups were observed in a single survey. The 2005 survey is not shown as only two groups were observed that year. The averages for 2006, 2007, 2008, 2011, 2012 and 2013 represent three surveys per year.

Figure 6. Mean spawning groups per night from 2004 through 2013. Error bars are \pm SEM.



There is clearly a downward trend, and 2013 represents the lowest spawning counts over this period. Based upon the 2012 survey data, it appeared that spawning at Flag Ponds was not dramatically different from Cove Point, and anecdotal evidence suggested a decline there also. This implied a population decline rather than a deterioration of Cove Point as a spawning habitat. However, in 2013 spawning at Flag Ponds was very high, while Cove Point continued to decline. These newer data suggest that increasing numbers of crabs may not be utilizing Cove Point beach.

Any explanation for this decline is speculative. The beach profiles suggest that the beach restoration project has stabilized the beach in the northern area and reduced erosion. In most areas, the beach seems wide enough, and beach sand the correct composition to facilitate spawning. It is encouraging that a few females spawned inside the breakwater area in 2013, but the overall spawning trend is down.

One possibility concerns the expansion of the marsh behind the beach. When photographs of the beach are compared over a long period (Fig. 7), it appears that open water in Cove Point marsh has expanded from 1998 to today. The overall open water area has not changed dramatically, but in the northern and middle beach areas there is less dry land and vegetation buffer between the marsh and the beach. In previous years we have measured hydrogen sulfide in beach pore water and found it to be high when marsh water is adjacent to the beach. It is possible that marsh water, high in sulfide, is moving through beach sand into the Bay and is detectable by horseshoe crabs.

Spawning activity is negatively correlated with the presence of hydrogen sulfide (Botton et al, 1988). This could help to explain the decline in crabs utilizing the beach and why the majority of animals that do spawn there are found on the southern beach, away from the marsh. It would also explain the spawning pattern observed in early June. This was a full moon, and we expected heavy spawning activity. Spawning had begun in our first survey on June 8th. A storm hit the next day, with heavy rain. Few crabs were observed for the remainder of the tide cycle, although we counted more than 300 crabs at Flag Ponds on June 9. It is possible that marsh water draining through the beach following the storm shut down spawning activity at Cove Point.

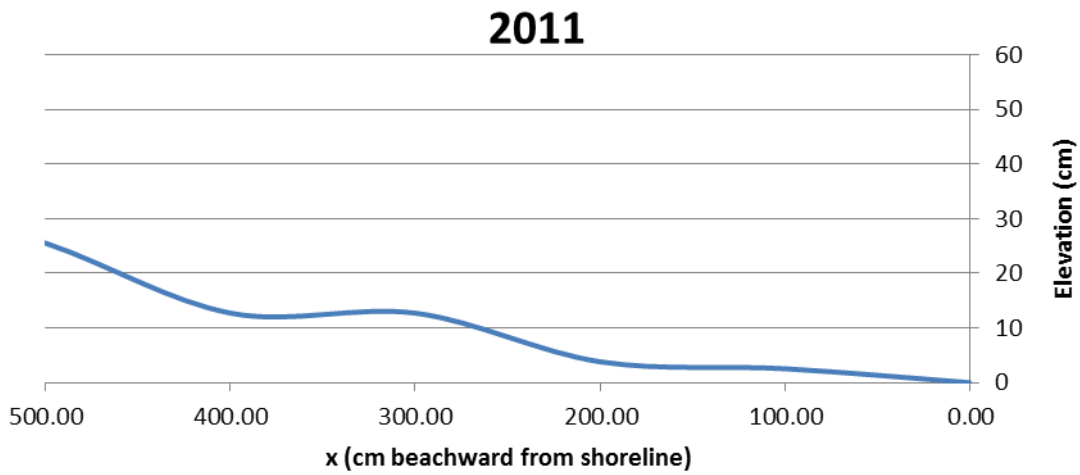
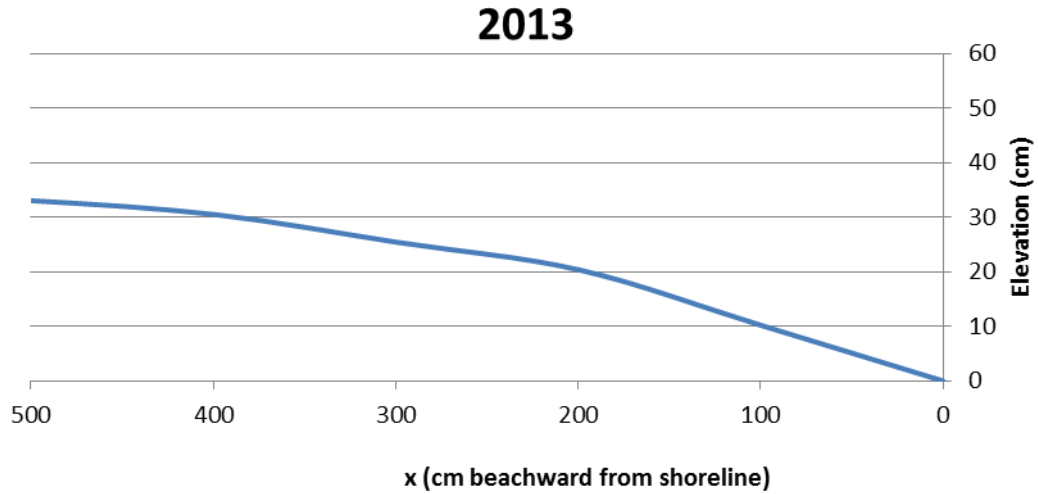
Our tagging program, as it continues, should provide information concerning this mid-Chesapeake horseshoe crab population size. If spawning activity at Cove Point does not reflect expected numbers given the population, then attention should be paid to the deterioration of Cove Point beach as a spawning area. Increased marsh drainage could help, although this may not be feasible. The breakwaters, established along the northern beach to reduce wave energy, appear to have stabilized and expanded the beach. Their expansion southward could have a similar effect along the eroding portion of the beach and could have a positive effect on horseshoe crab spawning activity.



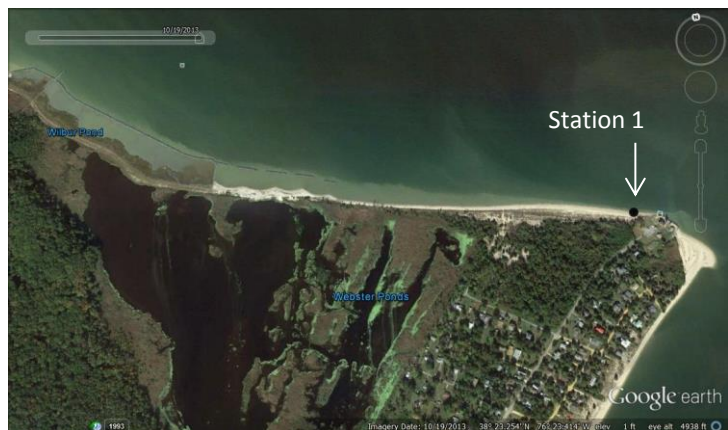
Figure 7. *Google Earth* images of Cove Point marsh from 1998 to 2013. The restoration project and breakwaters can be seen in the 2011 and 2013 photographs.

Appendix 1
Beach Profiles for Stations 1 (lighthouse) through 22 (riprap)

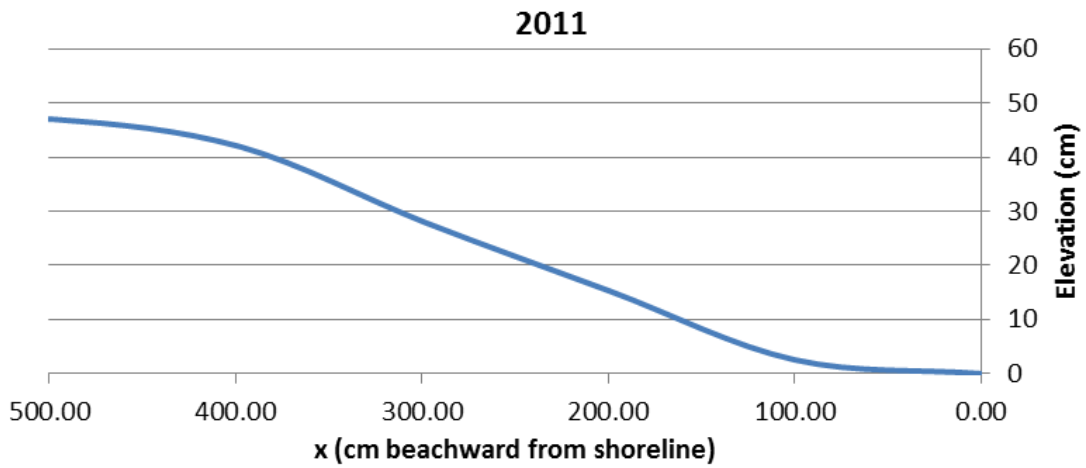
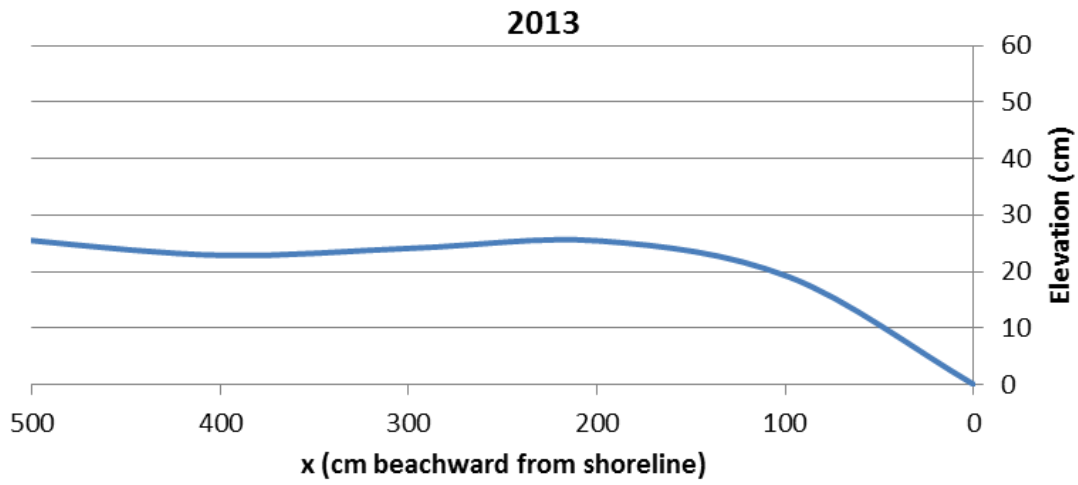
Station 1



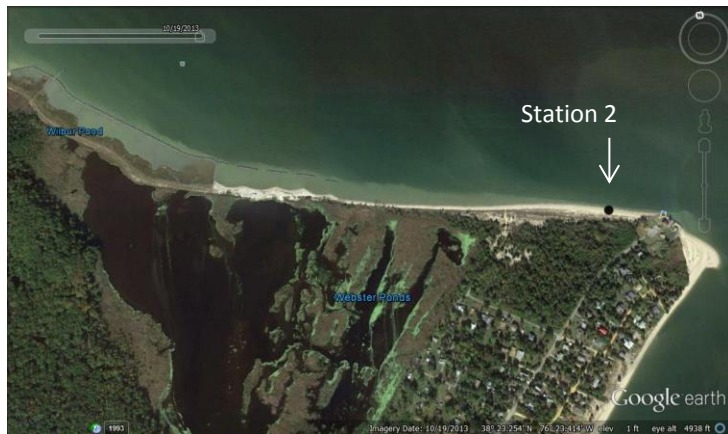
Station 1 shows sand buildup and a steeper slope in 2013 compared with 2011, suggesting sand accretion along this part of the beach.



Station 2

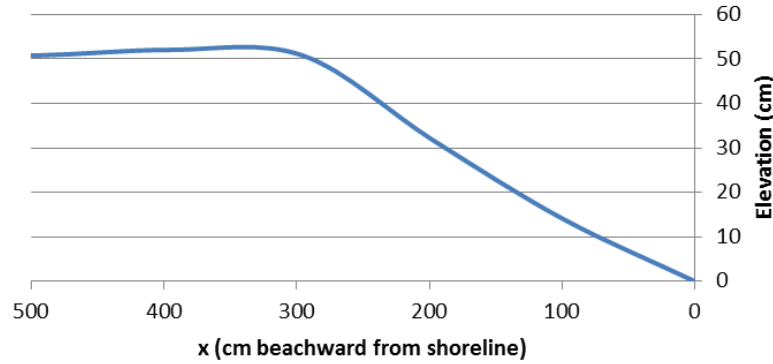


Station 2 also shows sand buildup and a steeper slope in 2013 compared with 2011.

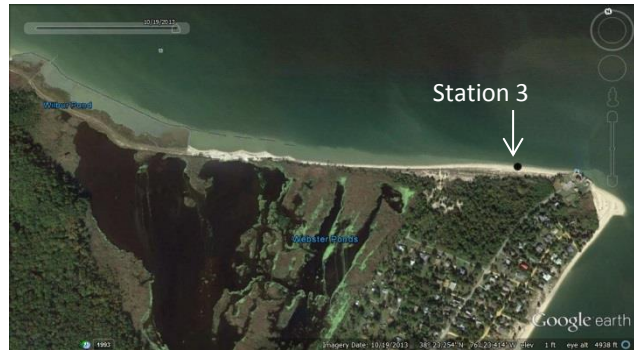


Stations 3 and 4

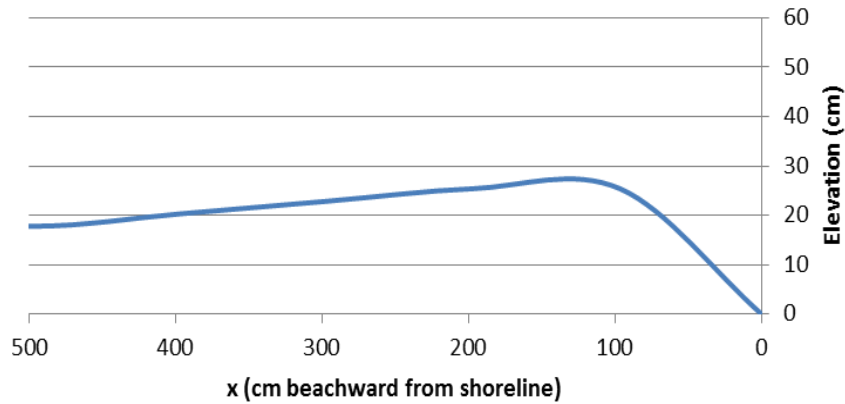
Station 3 2013



Station 3 had no 2011 counterpart. The profile shows a steeper, concave slope, suggesting higher wave energy and some erosion.



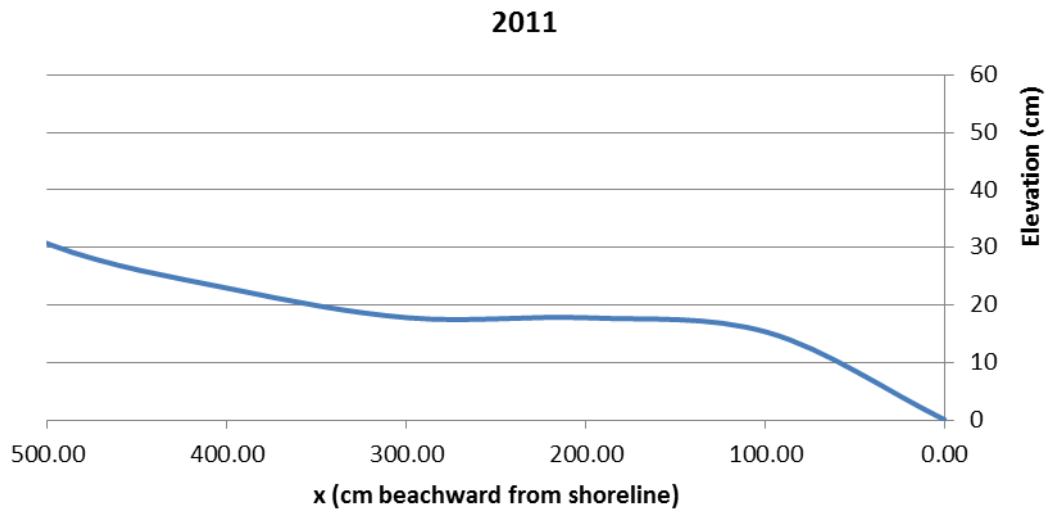
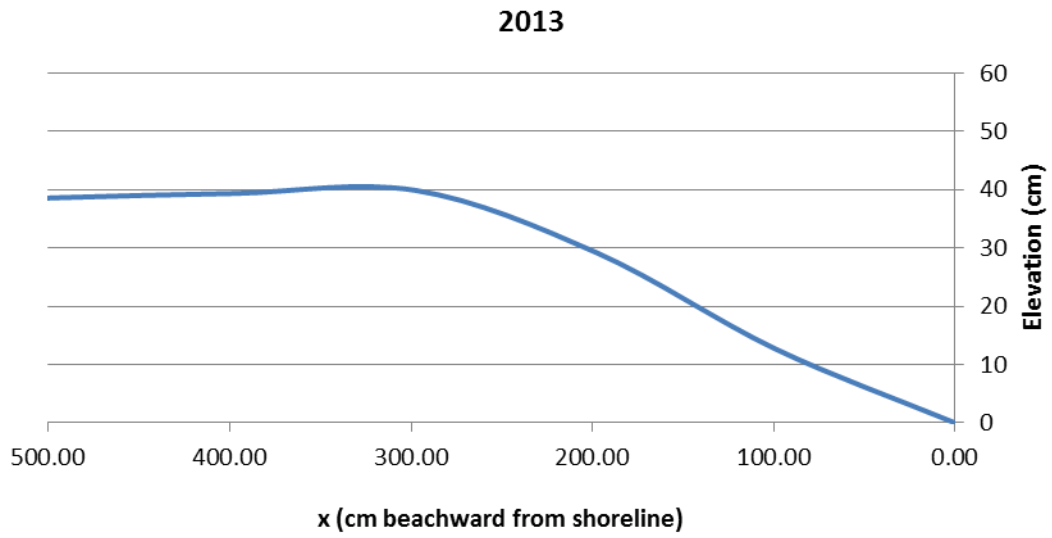
Station 4 2013



Station 4 had no 2011 counterpart. It also has a steep slope but less concavity. The buildup about one meter from the water suggests sand accretion.



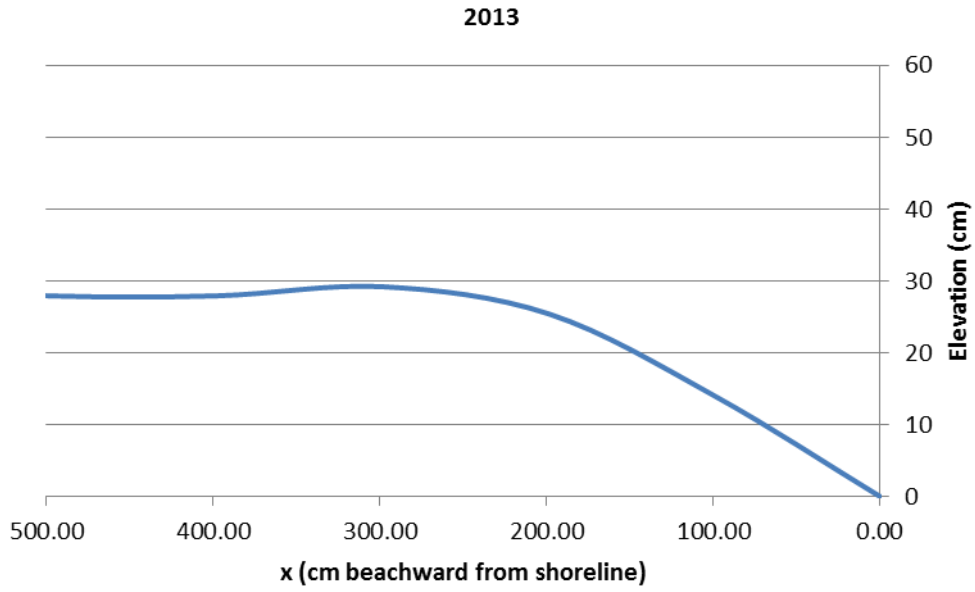
Station 5



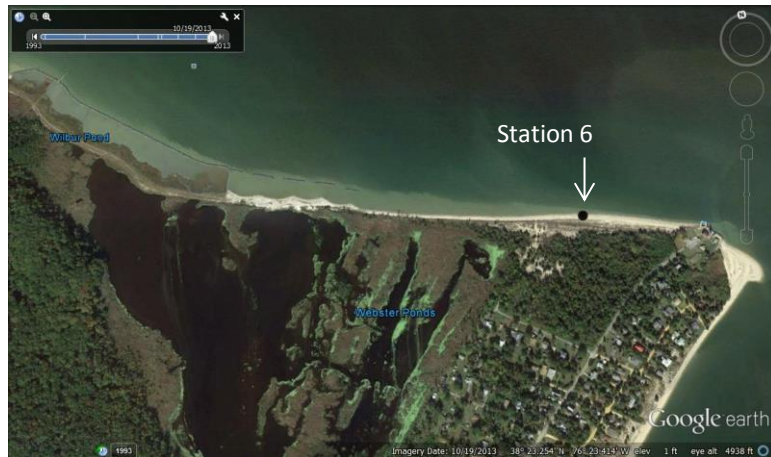
Station 5 shows sand buildup and a steeper slope in 2013 compared with 2011.



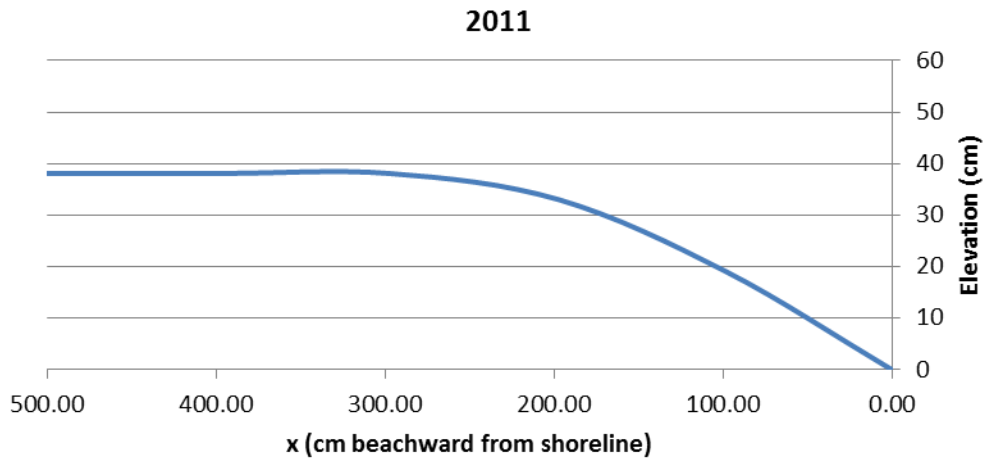
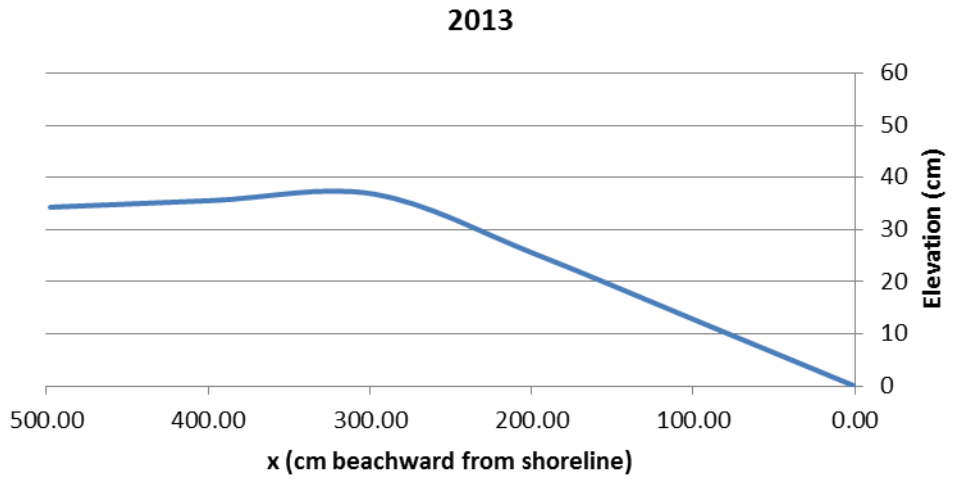
Station 6



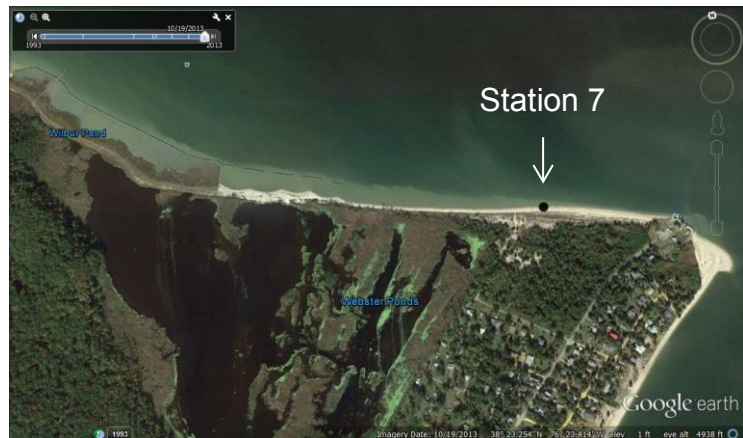
Station 6 had no 2011 counterpart. The slope is moderately steep, with a slight ridge at about 3 meters.



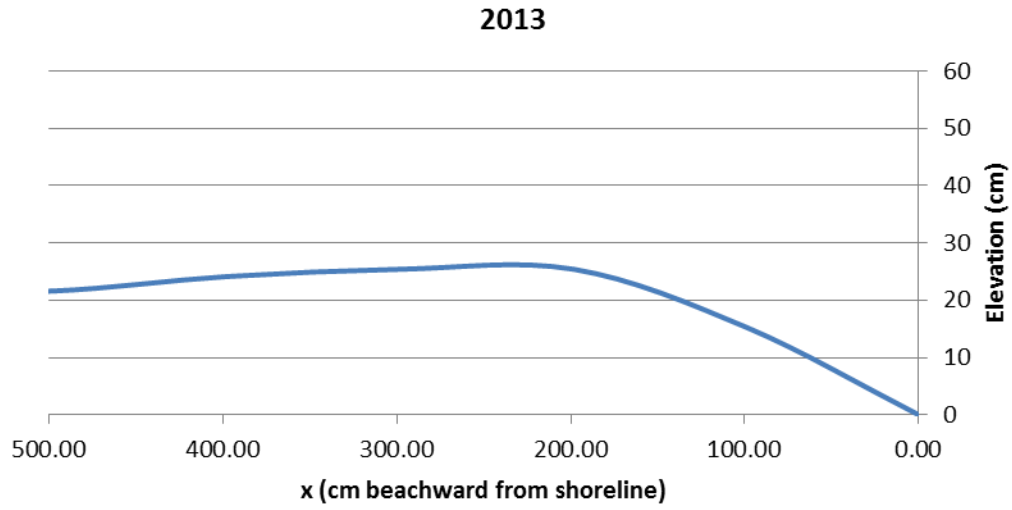
Station 7



Station 7 shows a reduced slope in 2013 compared with 2011, and some elevation loss beginning about 3 meters from the waterline.



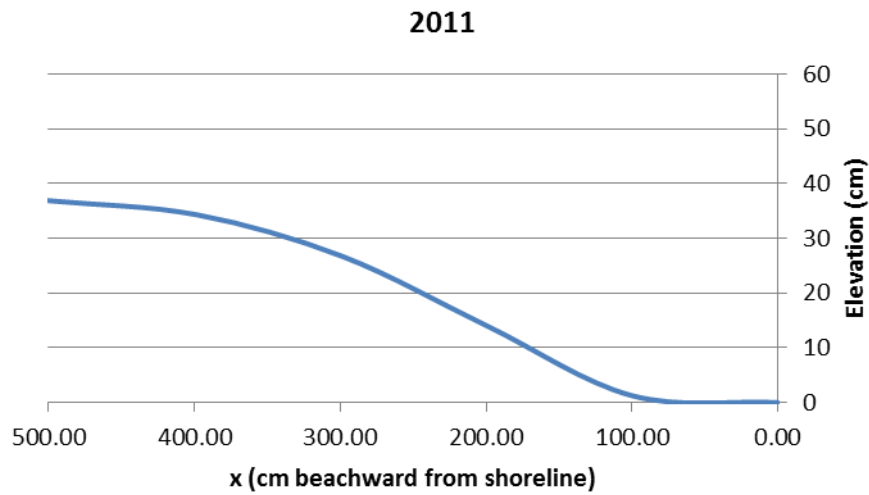
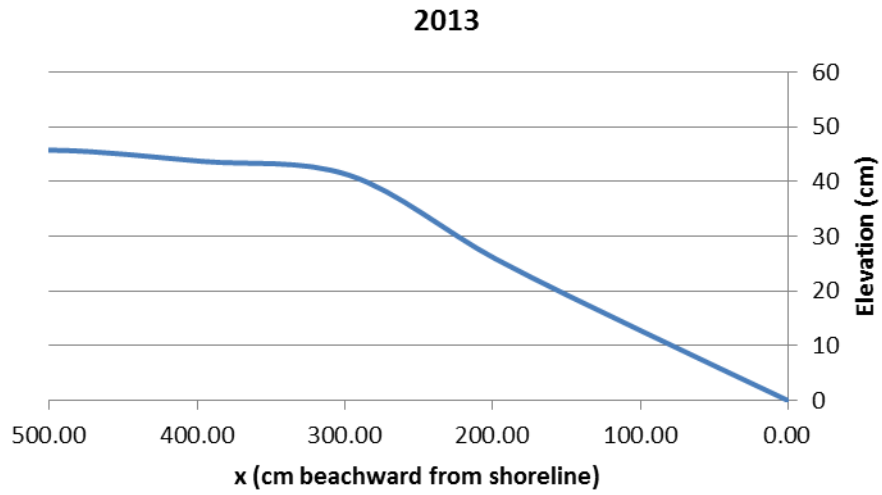
Station 8



Station 8. There is no 2011 counterpart. The 2013 profile shows a shallow, sloping beach profile with a lower elevation 5 meters from the waterline.



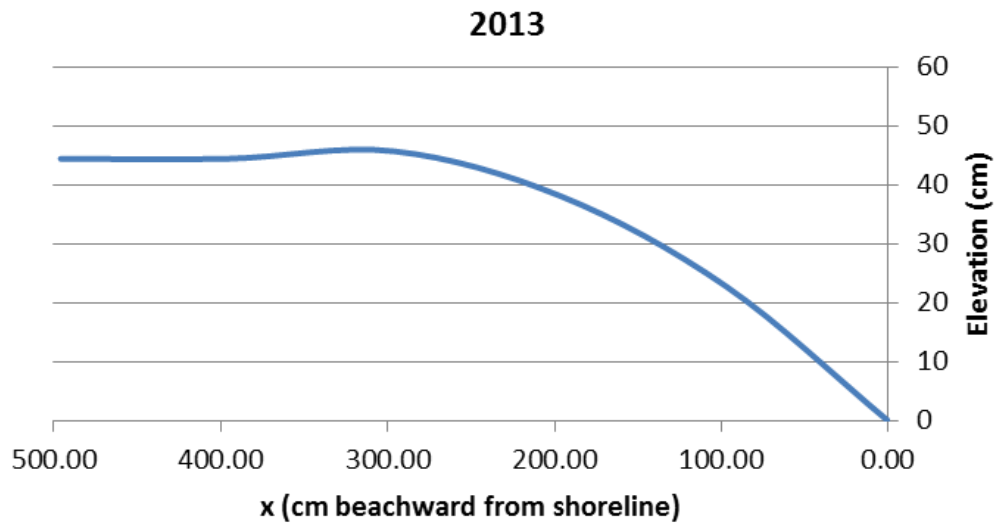
Station 9



Station 9 in 2013 showed a steeper slope and higher elevation compared with the profile from 2011.



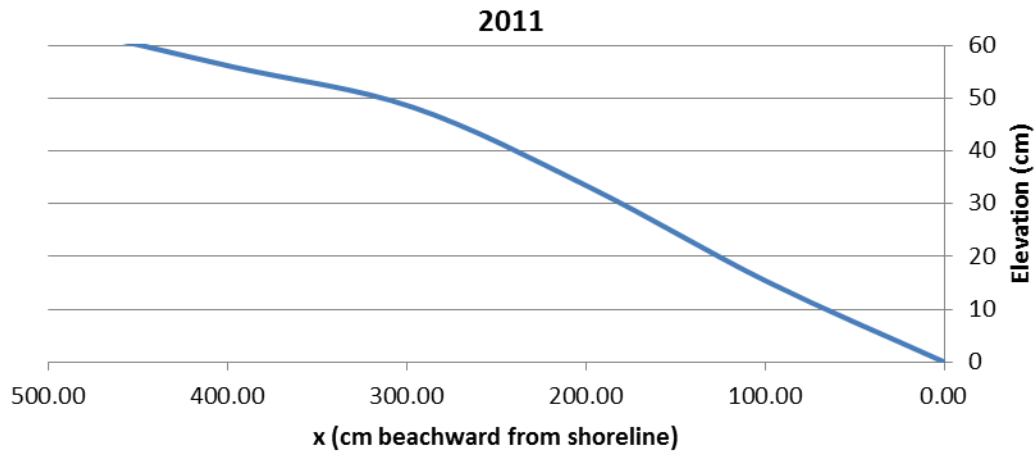
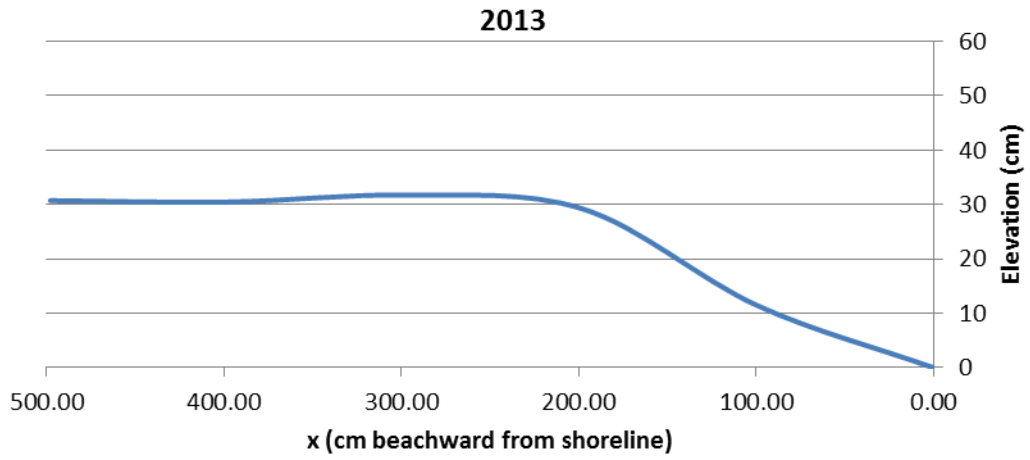
Station 10



Station 10 had no counterpart in 2011. The profile is similar to Station 9: fairly steep slope, and higher elevation.



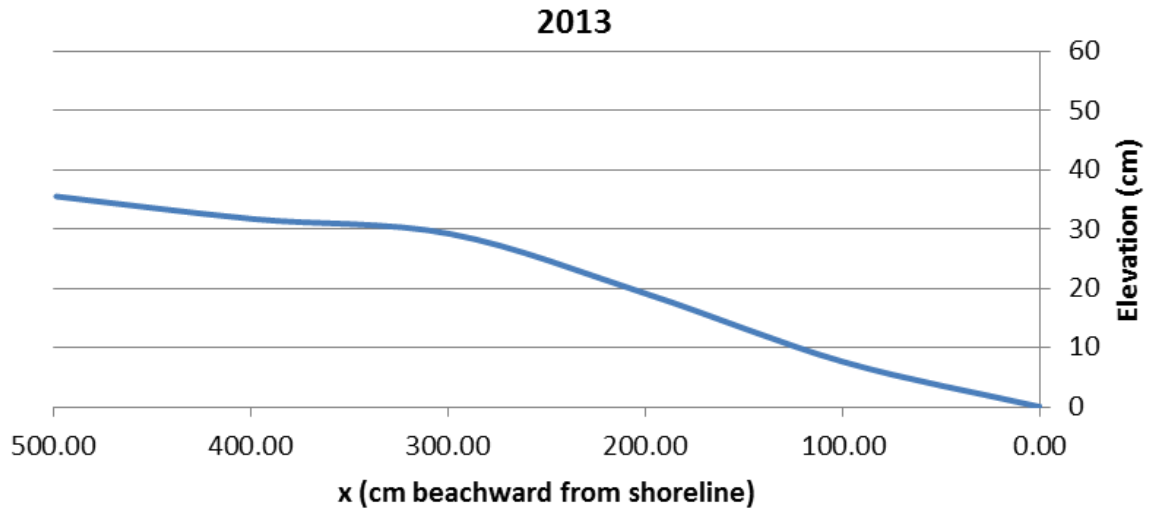
Station 11



The 2013 profile at Station 11 is more concave and has less elevation, suggesting a more eroding shoreline in 2013.



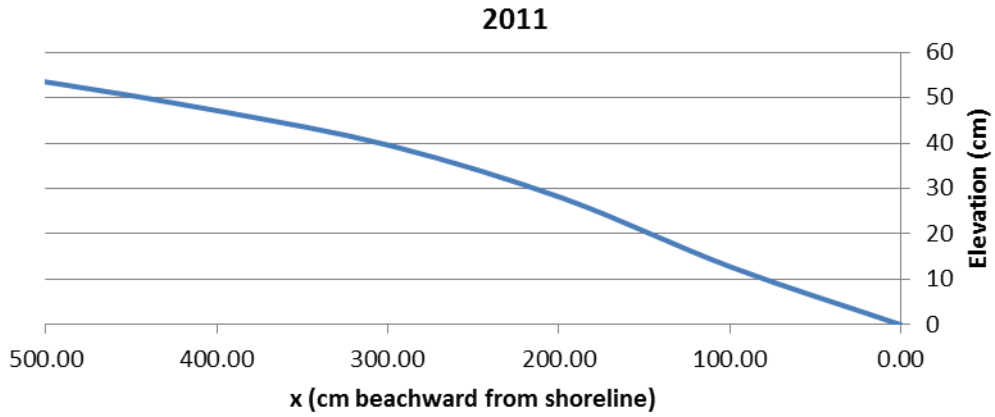
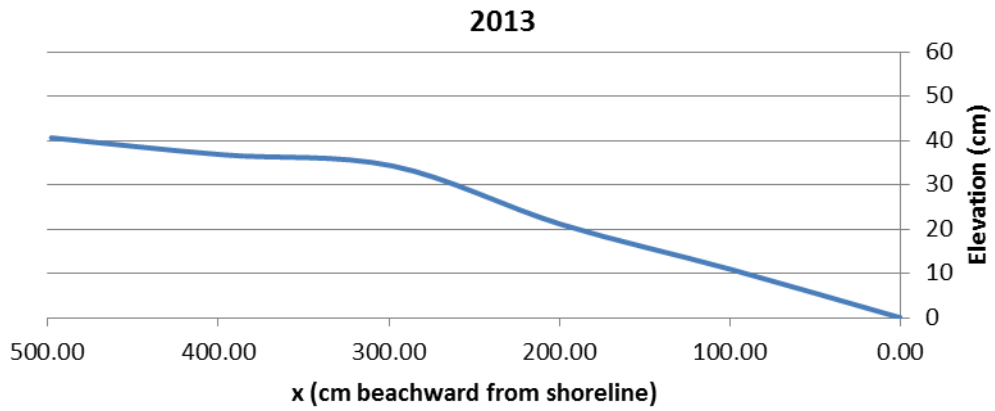
Station 12



Station 12 has no 2011 counterpart. A concave slope and low elevation suggest an eroding shoreline.



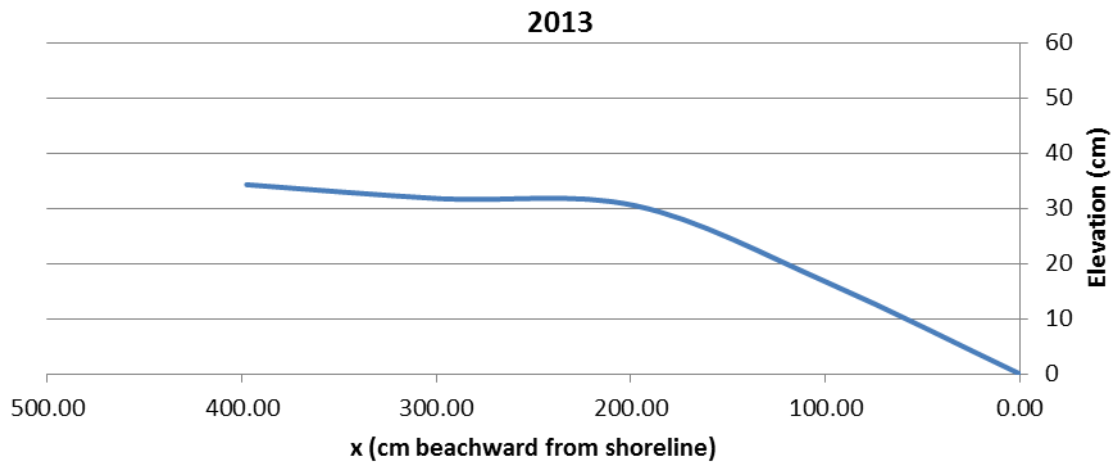
Station 13



Although both profiles are similar, Station 13 in 2013 has less elevation and a slightly concave shoreline, suggesting greater erosion in 2013.



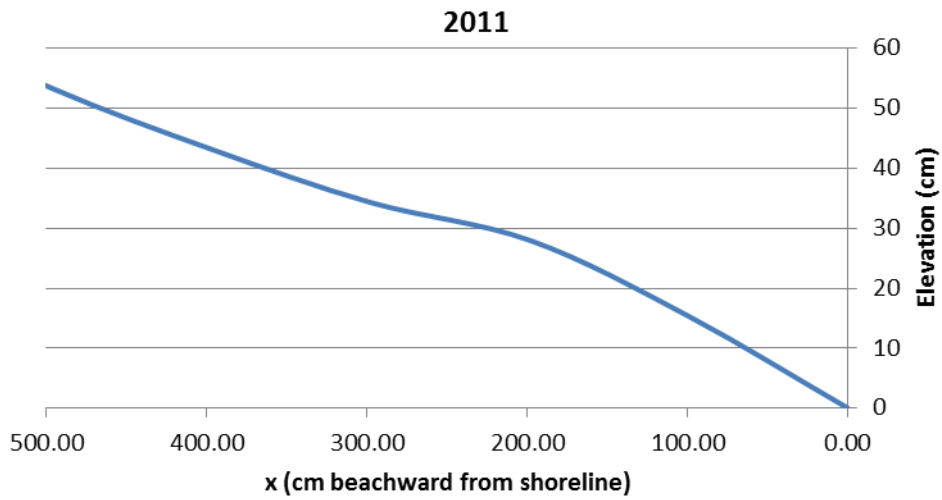
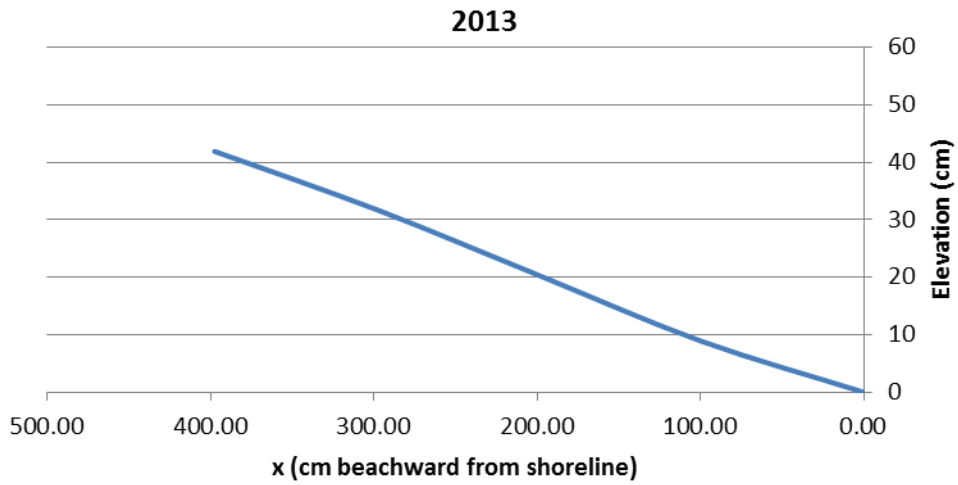
Station 14



Station 14 has no 2011 counterpart. Low elevation and a short distance between the water and the end of the beach show an eroding shoreline.



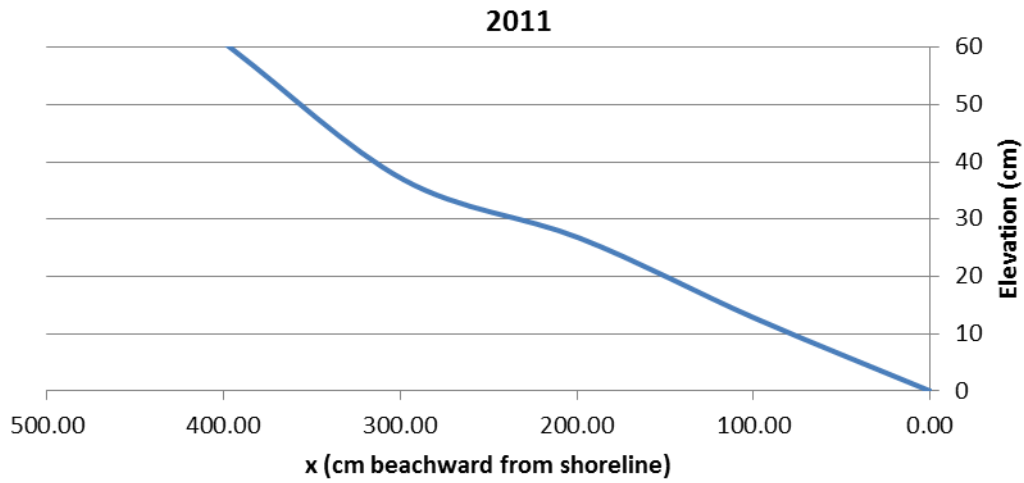
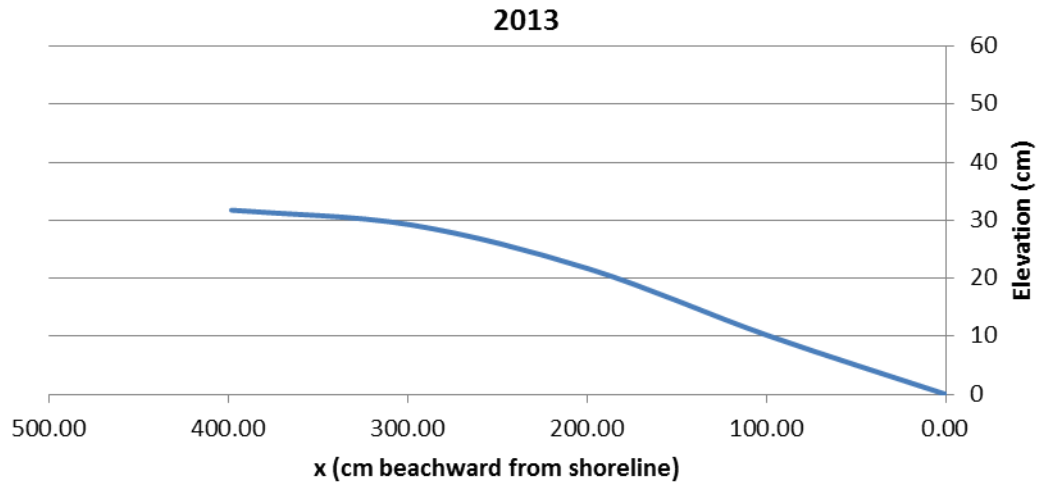
Station 15



Although the station 15 profile shows an eroding shoreline in both years, the concave slope and short distance to the end of the beach suggests greater erosion in 2013.



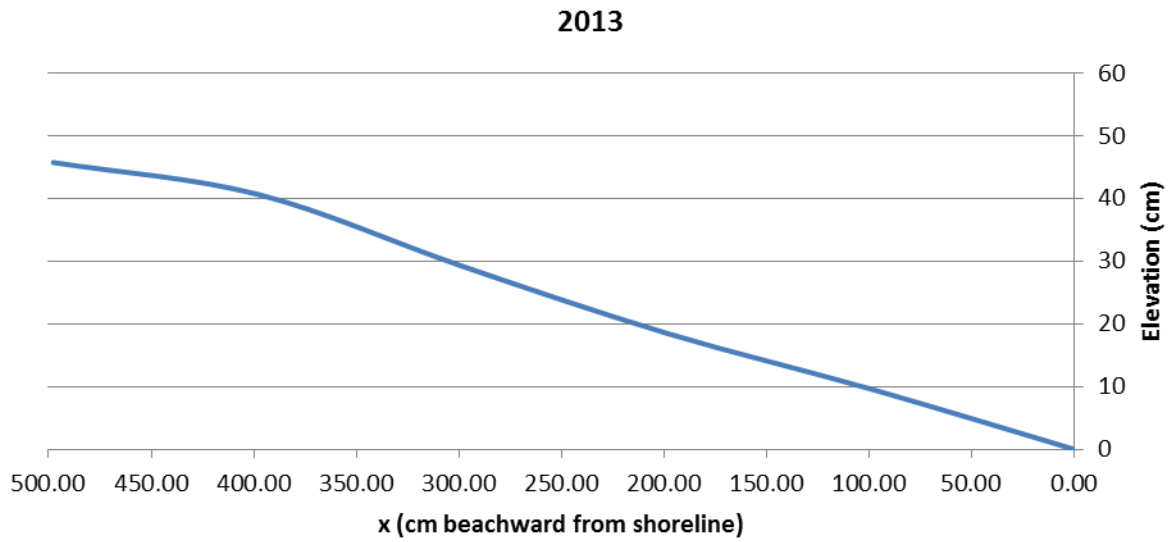
Station 16



The station 16 profiles for both years show straight or concave slopes and a short distance to the beach end, suggesting an eroding beach.



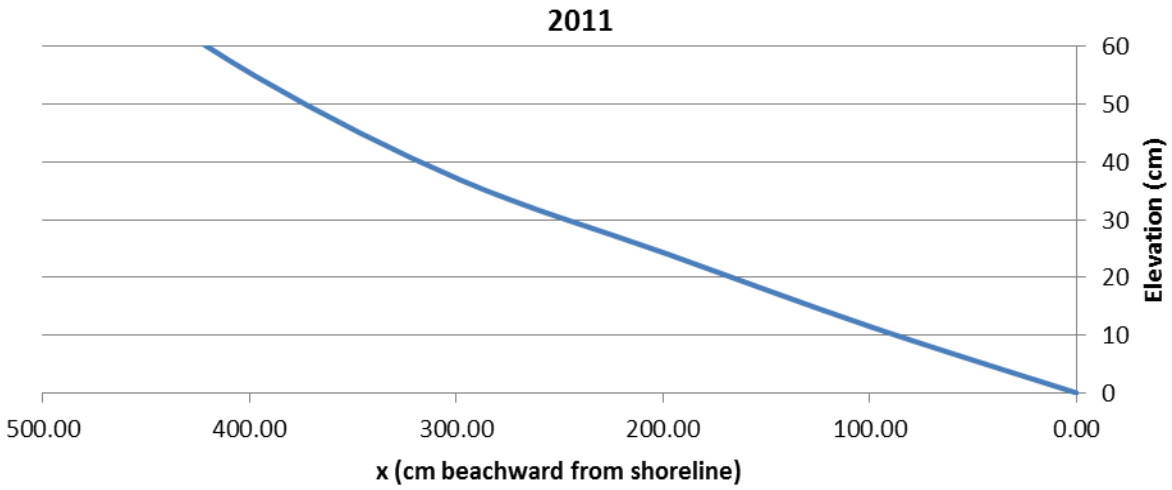
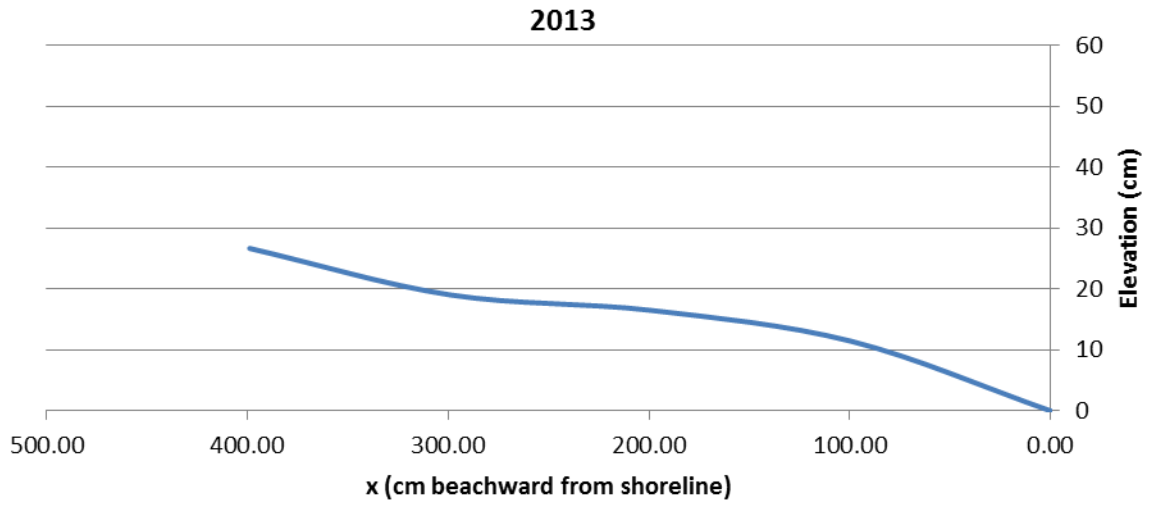
Station 17



Station 17 has no 2011 counterpart. A wider beach and straighter slope suggest less erosion compared with stations in the middle beach area.



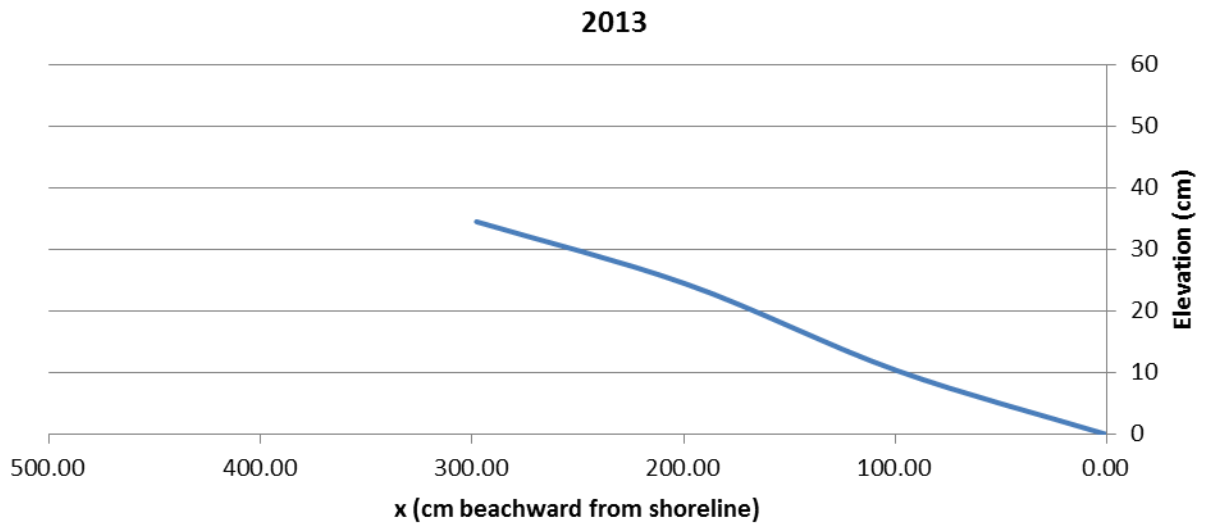
Station 18



Station 18 in 2013 shows lower elevation and a shallower slope compared with the 2011 profile.



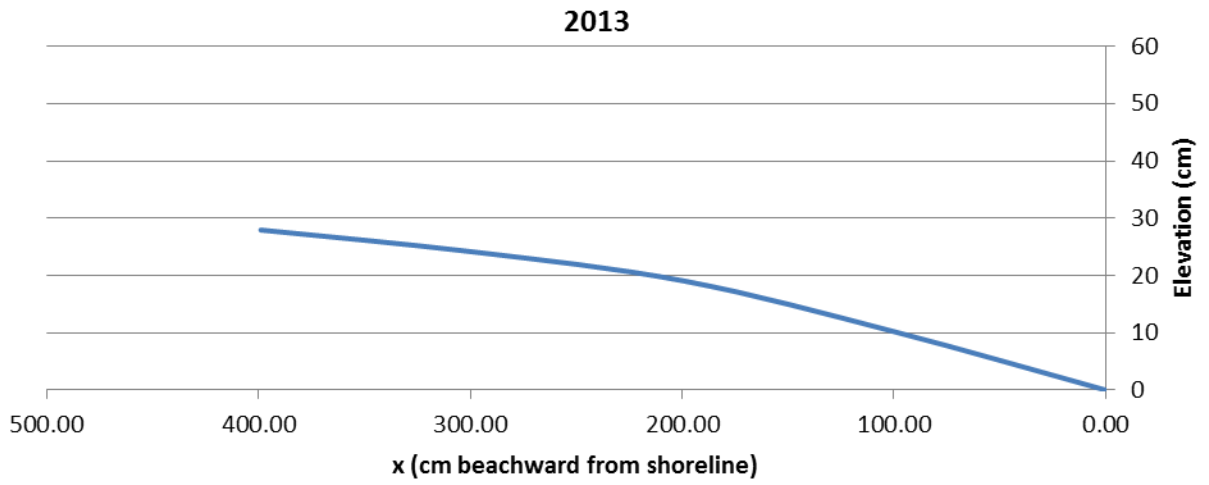
Station 19



Station 19 has no 2011 counterpart. The chart shows a short beach with less elevation and some concavity.



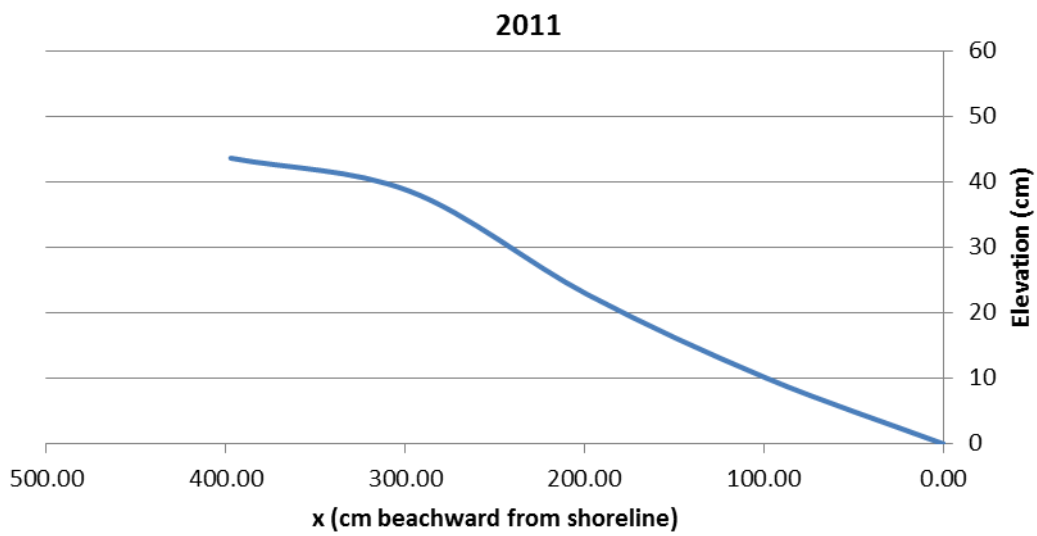
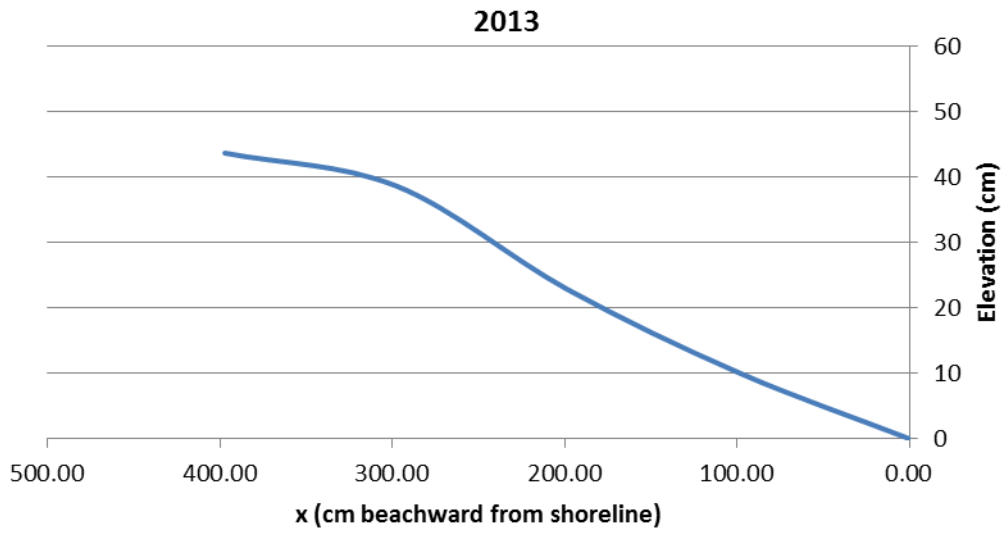
Station 20



Station 20 has no 2011 counterpart. The profile shows a beach with a shallow slope and low elevation.



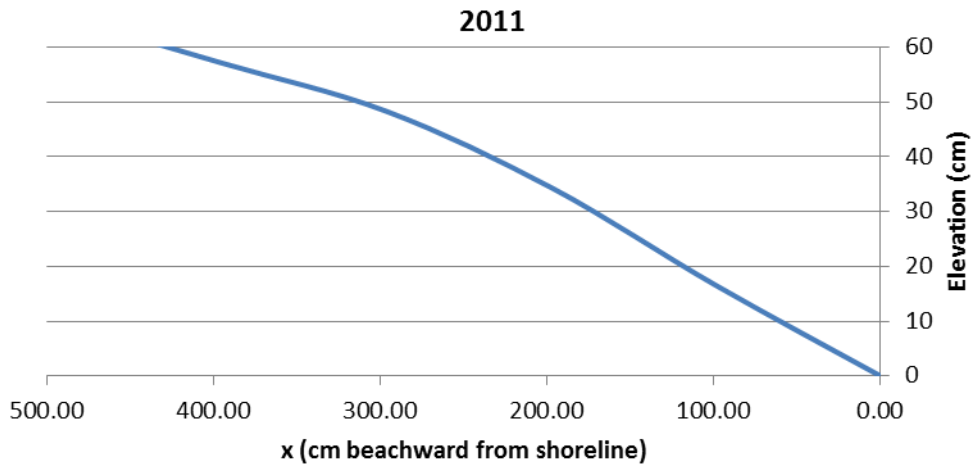
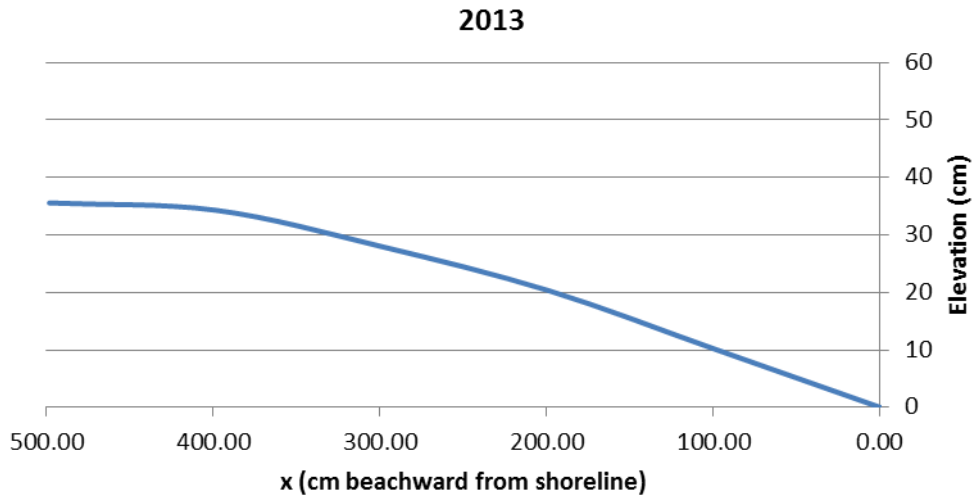
Station 21



Station 21 profiles from 2013 and 2011 were similar – a moderate sloping beach with some concavity,



Station 22



Station 22 in 2013 shows a beach with shallower slope and lower elevation compared with the 2011 profile.



Literature Cited

Botton, M.L., R.E. Loveland and T.R. Jacobsen. 1988. Beach erosion and geochemical factors: influence on spawning success of horseshoe crabs (*Limulus polyphemus*) in Delaware Bay. *Marine Biology* 99:325-332.

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