The Continuing Evolution of the Breach at Old Inlet

Charles N. Flagg and Roger D. Flood
School of Marine and Atmospheric Sciences, Stony Brook University

The Great South Bay project (http://po.msrc.sunysb.edu/GSB/) gathers data from a variety of sources to gain an understanding of the Bay dynamics and its ecology. Since superstorm Sandy, periodic reports to the National Park Service and NY Sea Grant have focused on the impact of the new Old Inlet breach utilizing data from sensors in Great South Bay, aerial overflights and bathymetric surveys of the inlet. The locations of some of the sensors deployed in Great South Bay are shown in Figure 1.

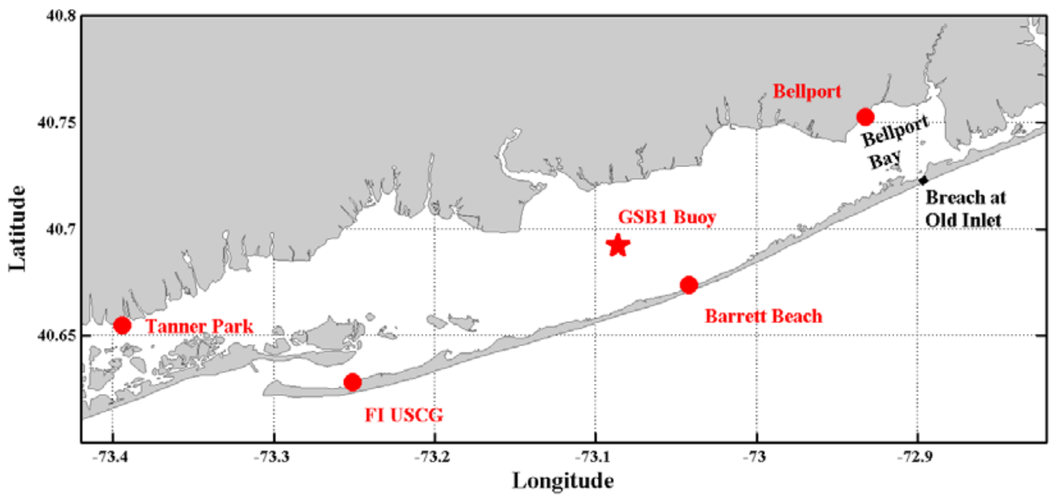


Figure 1, Chart showing the location of the Breach at Old Inlet and sensors deployed in Great South Bay.

The last report was published nearly 3 months ago and while there have not been any major changes in the breach at Old Inlet there has been a steady evolution. This report brings the discussion up to date. The collection of water property data has continued at the locations shown in Figure 1 while the aerial over flights and bathymetric surveys of the inlet have proceeded at about monthly intervals.

Figure 2 below shows the wind history from the GSB1 buoy to provide an overview of the events that first opened the inlet and then caused episodic modifications to it. The red dots mark times with wind speeds greater that 25 kts. As one would expect the frequency and intensity of the winter storms have abated but not completely disappeared this spring. Of particular note this spring was the mini-nor'easter that took place on June 8th which caused some alterations to the inlet and also dropped about 9 inches of rain.

In this report we present the photo mosaics from the last five over flights, from March 29 through June 16, showing the changes in the morphology of the inlet and back bay sand shoals. (Red diamonds along the top panel of Figure 2 show the times of the over flights.). Then we present the results from the series of bathymetric surveys showing the changes in the location and depth of the inlet's throat area. (The timing of those surveys is shown by the black diamonds in Figure 2). And lastly, we show the changes in the salinity of the bay that have taken place in the last few months.

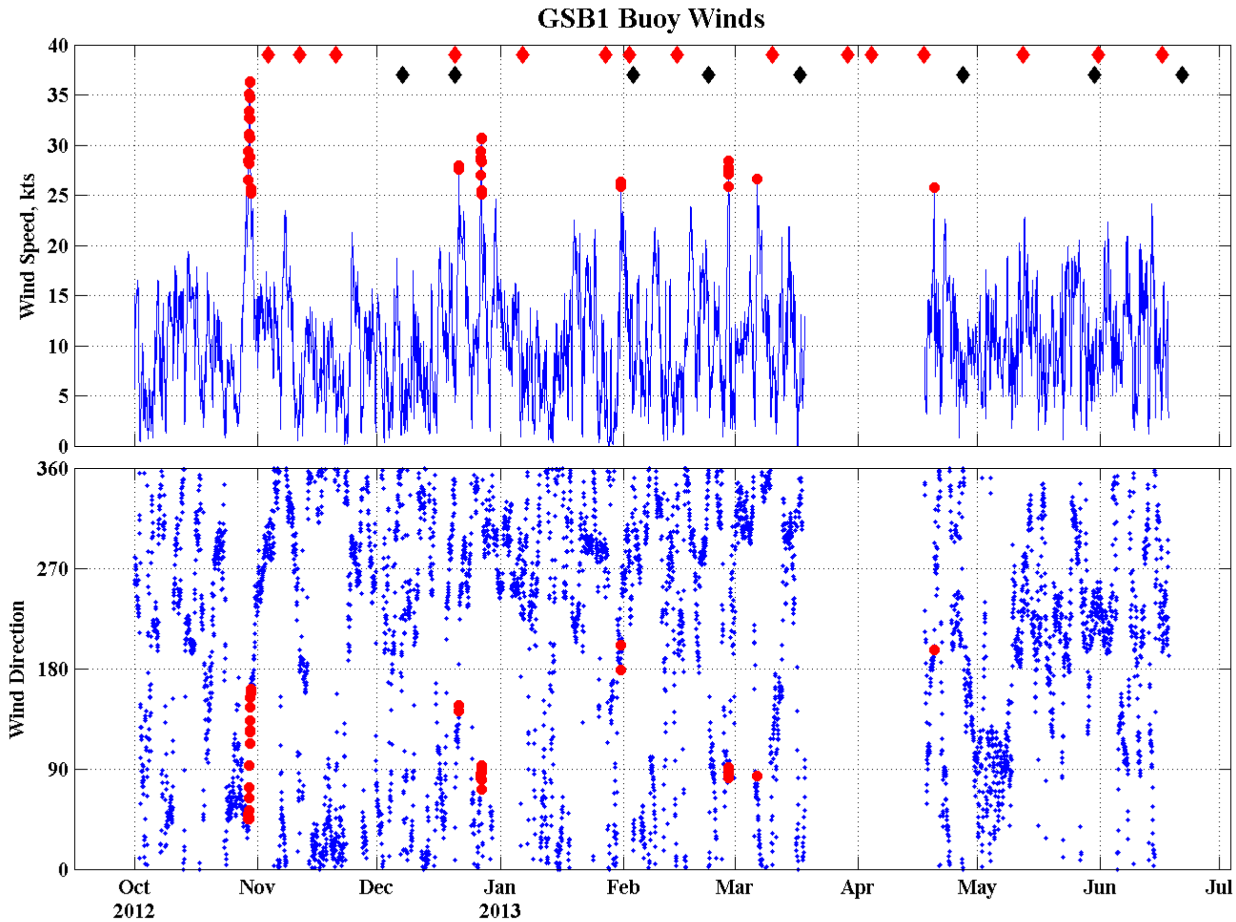


Figure 2, Plot of the wind speed and direction from the GSB1 buoy in the central Great South Bay south of Sayville. The buoy was down for repairs from mid-March until mid-April. Wind direction indicates the direction from which the wind blows. The red dots show periods when the 15-minute averaged winds speeds were greater than 25 kts. The red diamonds along the top of the upper panel show the dates of the 15 aerial over flights while the black diamonds show the dates of the 8 bathymetric surveys.

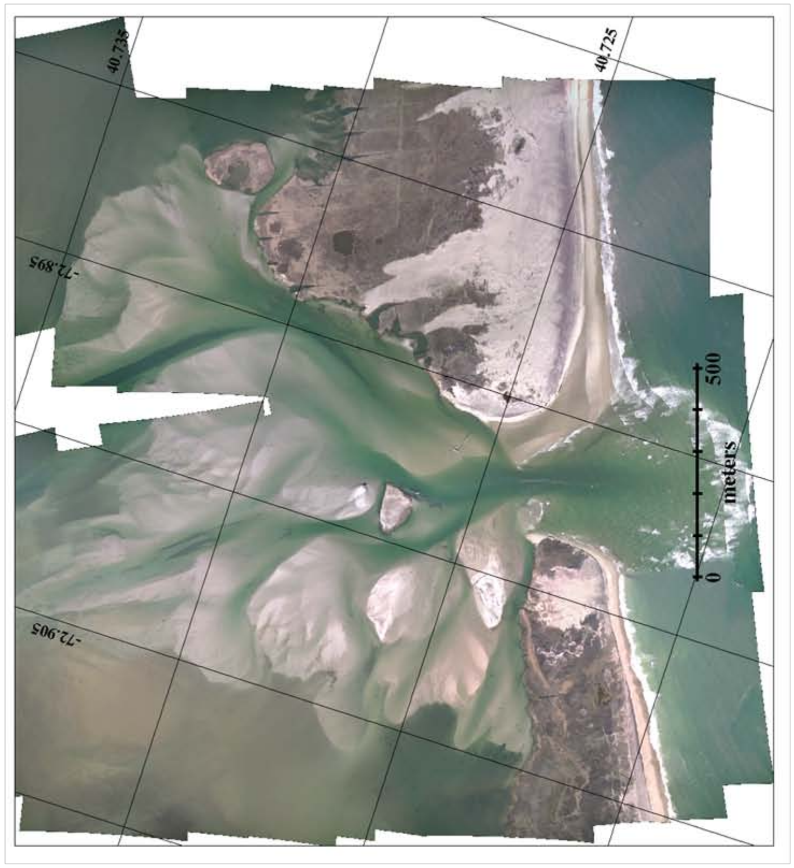
Figures 3-5 show the photo mosaics obtained since the end of March and after the major storm events of this past winter. The previous report, Inlet Report 8, showed that the storms on February 27th and March 6th and 7th were responsible for a significant retreat westward of the west side of the inlet. The March storm also caused high water levels in the inlet area which rearranged much of the back bay sand shoals and resulted in the deposition of a broad area of sand along the eastern edge of the inlet. Since then, the overall location of the inlet has remained fairly steady, although there has been considerable movement of sand in the inlet and the formation and retreat of a spit off the western edge.

The photo mosaic taken on March 29, Figure 3, is quite similar to that of March 10 in the previous report, although the shoaling in the channel to the west just north of Fire Island has increased. Also by the end of March the sand bar that had moved into the inlet along the eastern side had increased in size and consolidated. Evident in the March 29 and subsequent photos is a runnel area between the eastern sand shoal and Fire Island to the east. This runnel area has waxed and waned over the past three months indicating that while the eastern sand shoal remains low enough to be flooded at times, it has not been accessible to overwash for enough sand to be deposited to fill the depression.

The major alterations to the inlet since the end of March involve the development of a sand spit off the northwest corner of the inlet. On March 29th there was just a small indication of a sandy area at the tip of the island. The spit grew noticeably by April 17th and the shoal at the entrance to the westward channel had grown as well essentially cutting off the channel along the north side of the island. By a month later on May 12th the spit had grown to an area of about 200 meters by 100 meters and reduced the western channel even further. At the end of May, the enlarged sand spit remained and one can see that flow to the west had formed a new channel north of the spit. The evolution of the spit continued into June when a small nor'easter on June 8th caused the erosion of the northern end of the spit evident in the June 16 photo, Figure 5. Some erosion of the spit had taken place on the west side, but most of it occurred in the inlet area. The sand however was not washed out of the inlet but rather built up an extensive shoal along the spit to the east. When we were out in the inlet for another bathymetric survey on June 21st during an ebb tide, the water was boiling over this shoal and it was quite shallow. While the spit on the west was eroded as a result of the June storm, an extensive shoal area formed along the east side of the inlet extending from the northeastern corner of the inlet southward highlighted by the breaking waves in that area in Figure 5.

The changes in the back bay sand island, shoals and channels have not been as dramatic as the changes in and along the inlet, but the evolution of that area continues. In particular, the channels and shoals off to the northeast keep changing. Since the storm at the end of February when the gun club house on Pelican Island moved about 100 meters to the north, the area under the house's previous location has been part of a major channel to the north and east. The channel on the west side of Pelican Island heading off to the north has also increased in size. Early on in the development of the inlet, the main channel to the east skirted along the north shore of Fire Island. That channel has varied in size and location. Initially it was south of the Old Inlet dock about which a sand shoal had formed. But later that shoal shifted and spread out to the east, and there is now considerable flow through the old dock. Much of the flow to the north and east is now funneled into an area along the Fire Island shore near Hospital Island, the little round island located at 40.732^{o}N, 72.892^{o}W. From there the flow splits, some of it spreads out and flows off toward the Smith Point Channel and some flows to the northwest, west of John Boyle Island.

Also notice that by the end of May the ocean beach to the west of the inlet had built up considerably and that this sand accretion extended along the west side of the inlet and has remained.



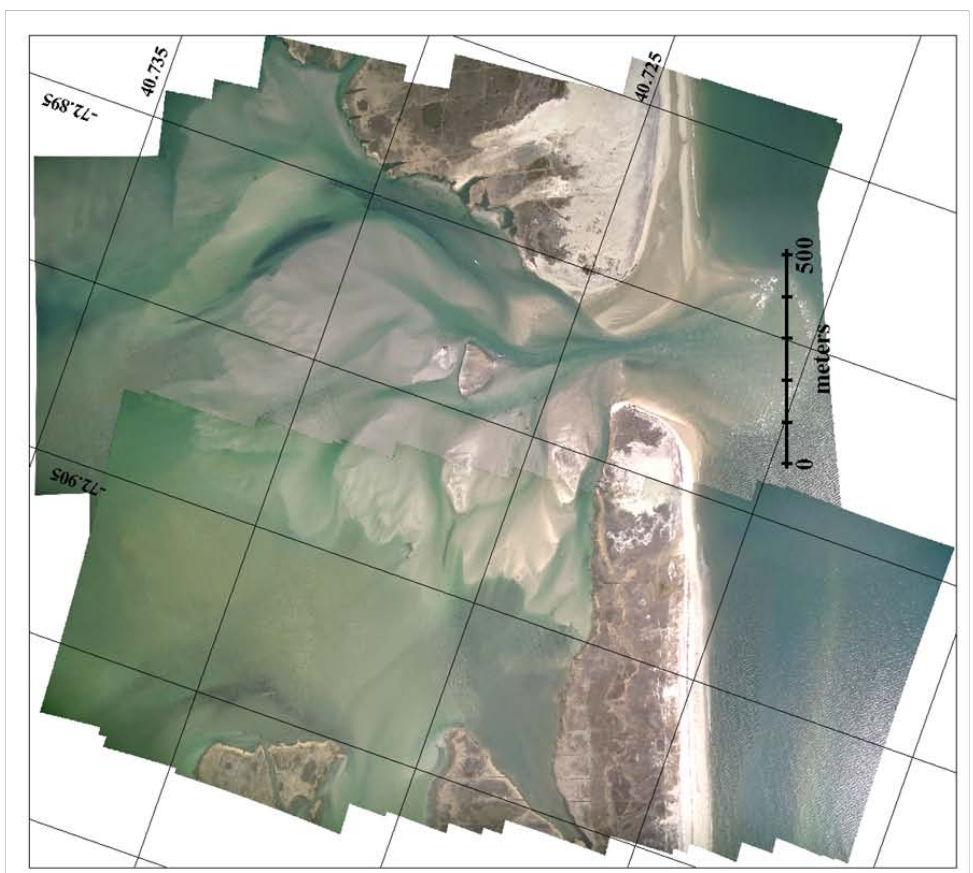
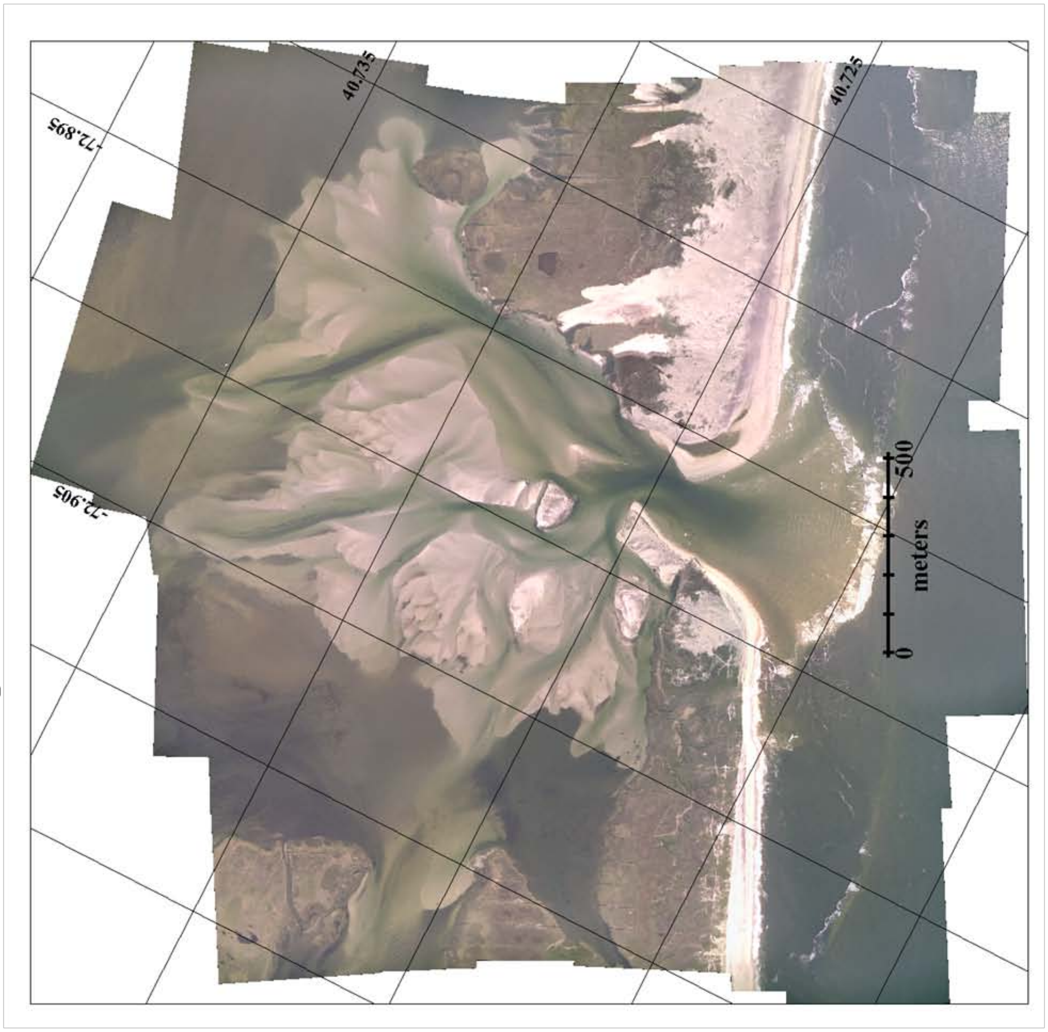


Figure 3, Photo mosaics from March 29 and April 17, 2013

May 31, 2013



May 12, 2013

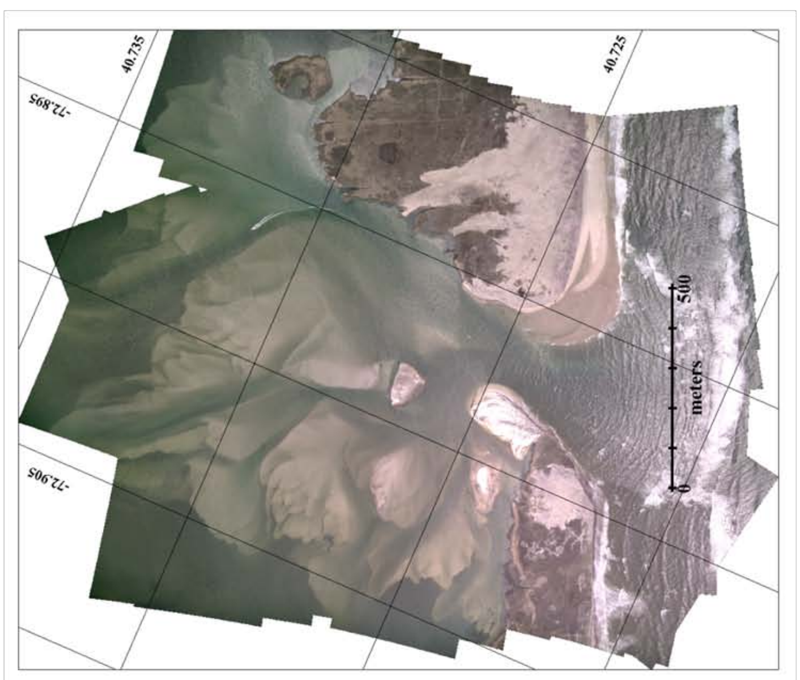


Figure 4, Photo mosaics from May 12 and May 31, 2013

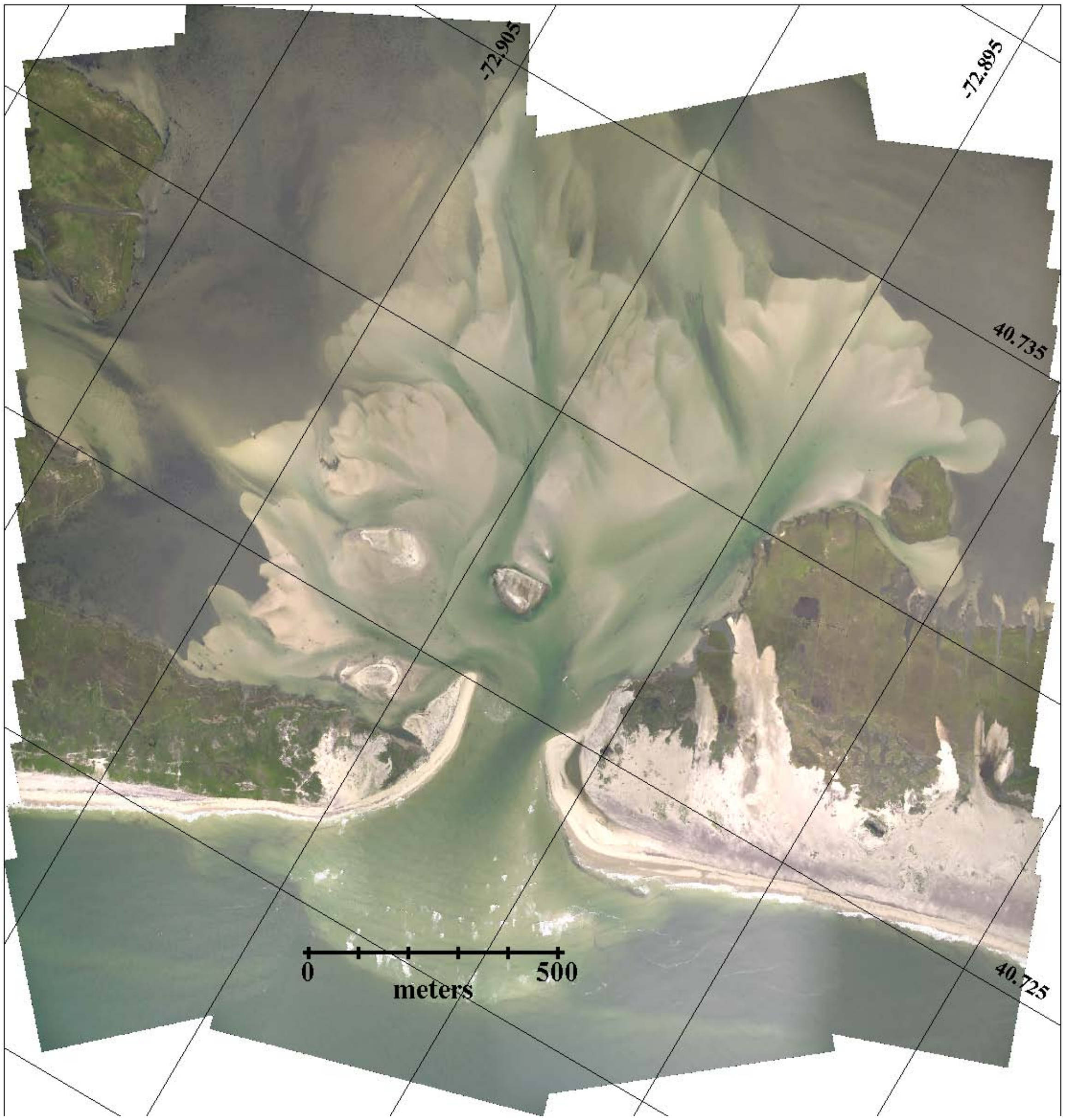


Figure 5, Photo Mosaic from June 16, 2013

On June 15th the remains of the displaced gun club house were removed. When it moved off the island on February 28th it sank in several feet of water and caused the flow in that area to slow down and deposit sand around the house. So a shoal and sand island formed around the house which is visible in all the photos since then. However the photo taken on June 16th, Figure 5, the day after the house was removed, already shows that the sand shoal around the house was beginning to erode away.

Since December 7, 2012 we have conducted eight bathymetric surveys of the inlet to define the depth of the area from the ebb-tide delta to the back bay shoals and channels. At this time the data from first seven surveys have been processed. The surveys were conducted from a small skiff equipped with an echo sounder and precision RTK GPS system that allowed us to explore the narrow channels and get pretty close to shore. But the boat is small enough that we cannot deal with the breaking waves over the ebb shoal which restricts the coverage offshore. The dot-plot in Figure 6 shows the observations from the May 30, 2013 survey and shows the coverage typical of the surveys.

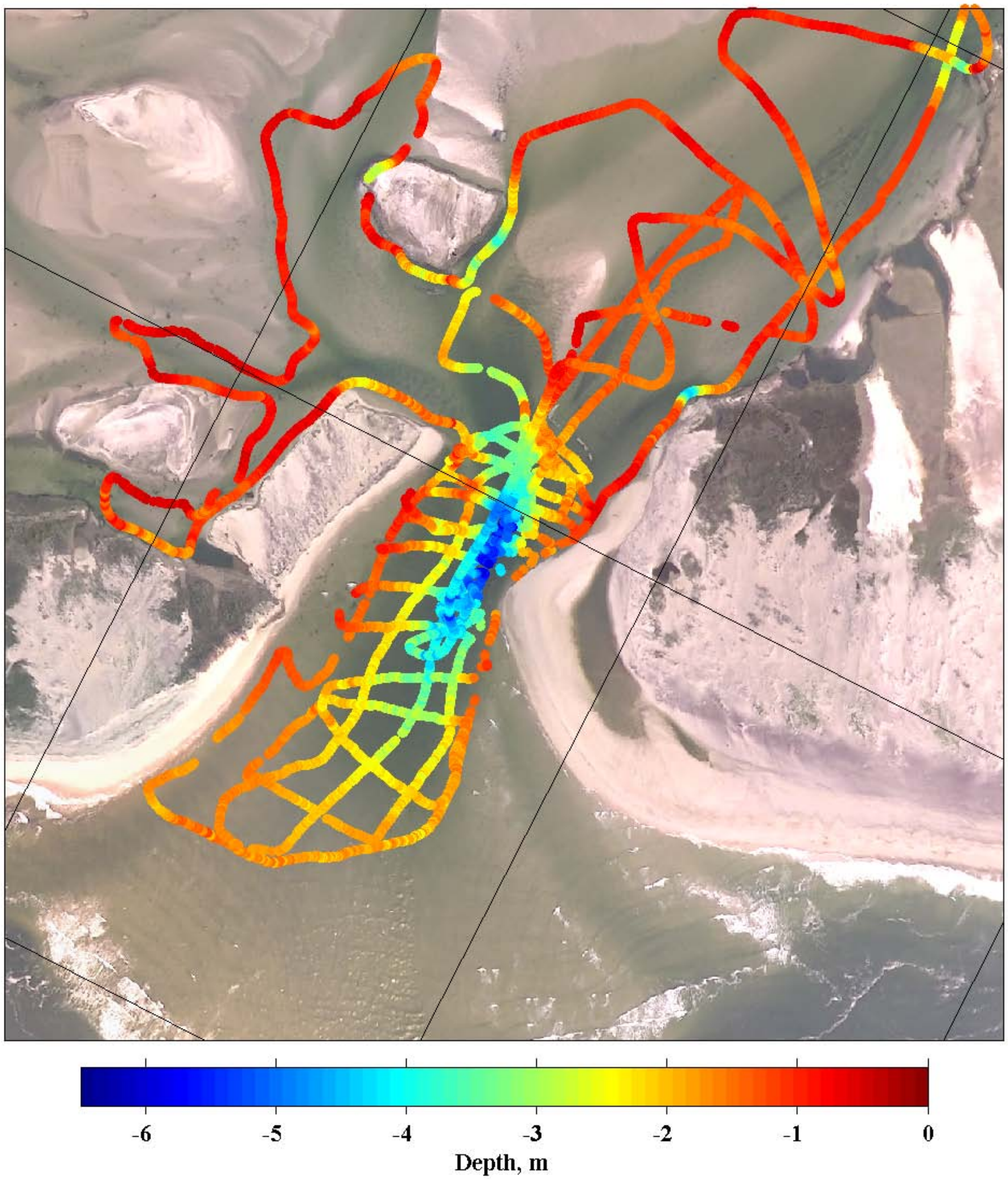


Figure 6, Bathymetric data collected on May 30, 2013 plotted on the photo mosaic of the area from May 31.

The bathymetric data in Figure 6 is characteristic of all the surveys we have done so far. There is a narrow throat region of the inlet where the depth is the deepest and the current the strongest. This throat area has moved generally westward since the inlet was formed while at the same time rotating from a cross-island orientation to lately, a more north-south orientation. The increasing northeast – southwest orientation of the inlet is characteristic of the progress of a natural breach as the combination of erosion on the west side and deposition on the east slowly rotates the inlet clockwise, as can be seen in the remnants of Old Inlet shown in the March 29th photo in Figure 3. To both the north and south of the throat area the flow spreads out, the erosion is less and the deposition greater so that the water depths become shallower. Water depths in those areas vary from 2 to 3 meters, to less than a meter. There now appears to be permanent islands to the west of the inlet while the shoals to the north and east often become dry at low tide.

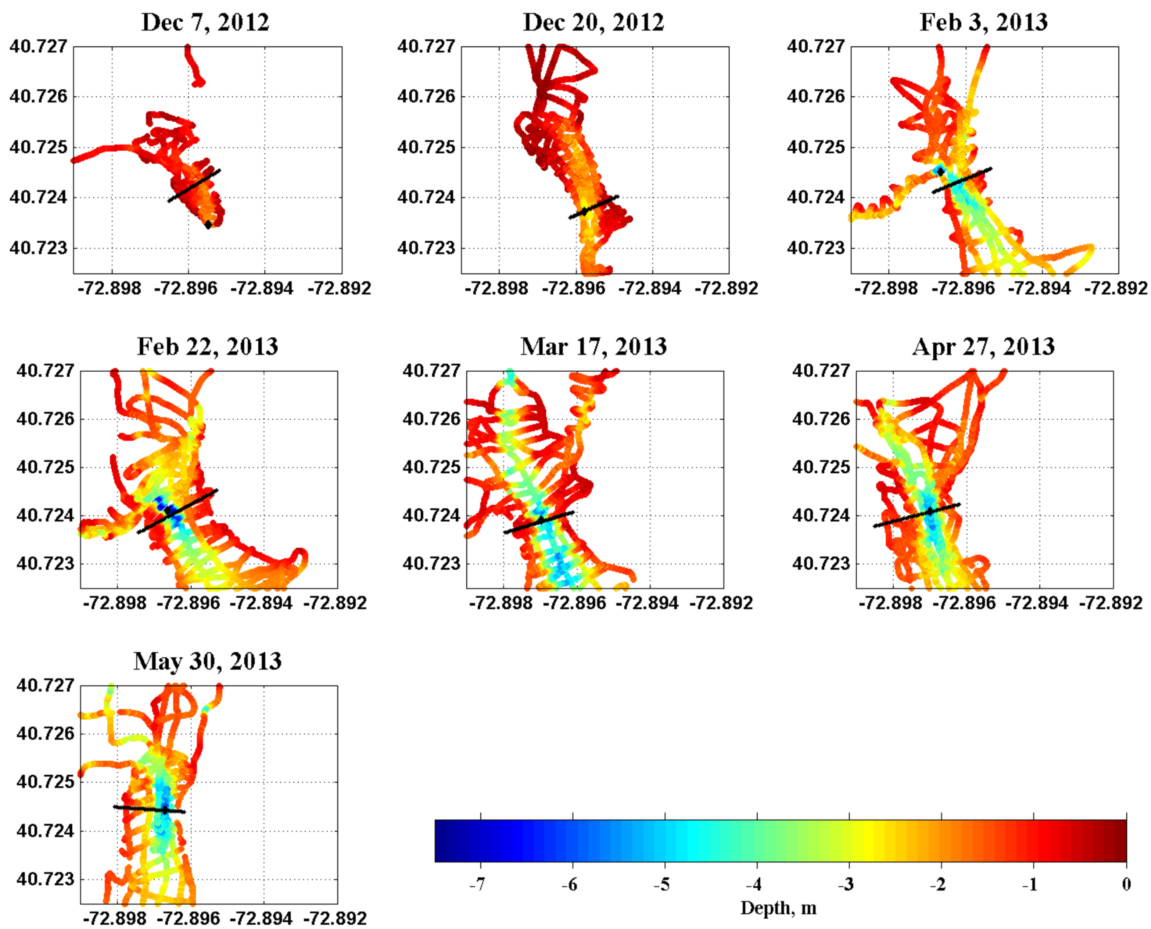


Figure 7, Bathymetric data from the first seven surveys. The boundaries for each subplot are the same as is the depth scale thus showing the lateral movement of the inlet as well as the changes in maximum depths. The black line through the throat area in each subplot indicates the location of the cross-sections shown in Figure 8.

A summary plot of all the bathymetric data is presented in Figure 7 and it shows the early expansion of the inlet as well as the changes in its location and orientation. Through April, the orientation of the inlet remain pretty much directly across the island along a northwest to southeast line. The orientation changed in May, apparently as a result of sand entering the inlet along the east side forming a prominent shoal that is visible in the May 31 photo mosaic and even more clearly so in the June 16 photo. The north-south location of the deepest portion of the inlet has remained within about 50 meters of 40.724^o N latitude, a position that seems to be related to the configuration of the east side of the inlet. Notice also that the deepest portion of the inlet generally extends less than 100 meters along the axis of the inlet.

Figure 8 shows the cross-inlet depth profiles at the locations of the deepest depths. The temporal progress of the inlet is clear in this view, showing both the westward movement and depth changes. The maximum depth increased from the initial ~2 meters to what appears to be a fairly stable 5 to 6 meters, although deeper depths occurred briefly in mid-February when somewhat more than 7 meters was observed. The plot shows that the throat of the inlet has moved about 100 meters to the west and was farthest west in mid-March. Since then the location of maximum depth has retreated back to the east by ~50 meters.

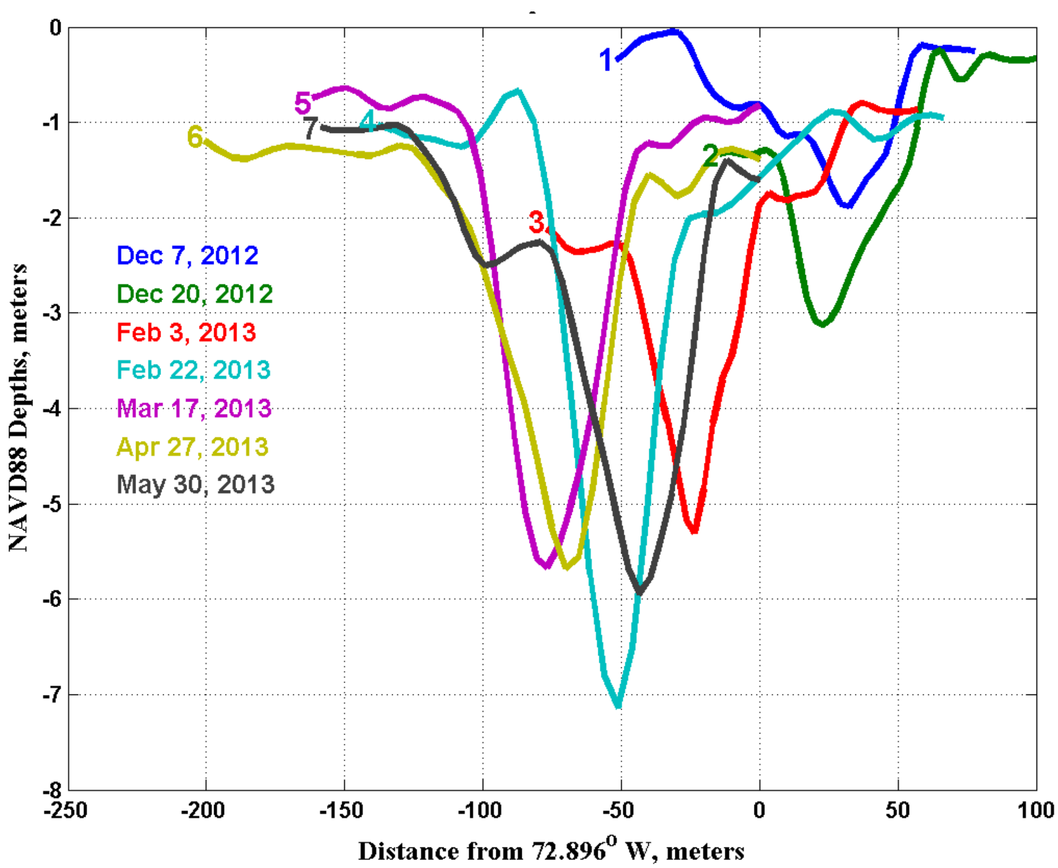


Figure 8, Cross-inlet profiles at the across the deepest portion of the inlet for each cruise.

Table 1 shows the data from the cross sections at the locations indicated by the black lines in Figure 7. The cross-sectional areas are determined from the profiles of Figure 8 up to the approximate mean water elevation. It should be noted that these profiles do not extend up the beach on either side to the height of mean water so there is a triangular area on either side that is not included in these estimates. We hope to add those data when we do the next survey. Despite this limitation the cross-sectional areas are useful because they show the initial expansion of the inlet to the point where the cross-sectional areas have remained fairly constant at about 400 meters^2 since February. This suggests that a near equilibrium has been reached between the tidal scouring and the deposition of sand as the sand is moved back and forth through the inlet. If more sand becomes available through an increase in the alongshore sand transport, then the inlet may constrict some, on the other hand, if more of the sand skirts the inlet around the ebb shoal, then the inlet may deepen. Another point to make about these area estimates is that the 400 meters^2 is roughly 10% of the total cross-sectional area of Fire Island and Moriches Inlets combined. And the contribution of the inlet to letting in the ocean's storm surges is probably of the same order.

Table 1, Maximum depth and cross-sectional areas across the inlet observed during each survey

Survey Date	Maximum Depth Meters	Cross-Section Area Meters^2
Dec 7, 2012	**2.4**	**98**
Dec 20, 2012	**3.3**	**162**
Feb 3, 2013	**5.8**	**324**
Feb 27, 2013	**7.4**	**429**
Mar 17, 2013	**5.8**	**319**
Apr 27, 2013	**6.0**	**442**
May 30, 2013	**6.1**	**418**

The last item to be addressed is the continuing changes in water properties in the Bay as a result of the new inlet and alterations that have taken place in the other inlets. Figure 9 shows the wind, water level and salinity records from Bellport and the GSB1 buoy. The plot extends from a couple of months before hurricane Sandy to mid-June. The wind record is similar to that shown in Figure 2, while the water level record from Bellport shows that the storms and storm surges of the winter and early spring have abated since about the beginning of April. The salinity plot shows that before the opening of the new inlet salinities at Bellport were typically between 24 and 25 psu ("practical salinity units" or psu), while those at the GSB1 buoy were a couple of psu higher. With the advent of the new inlet salinities at Bellport jumped to between 28 and 30 psu and occasionally reached near oceanic values of 31 to 32 psu. The GSB1 buoy salinities seemed to settle down to nearly their earlier values after about a month of higher values.

The interesting feature is that at the beginning of March the buoy salinities began to increase over a period of a couple of weeks to values that were nearly the same as those at Bellport even though there was no marked increase in salinity at Bellport. This anomalously high salinity at the buoy continued for more than two months causing some worry that the sensor had lost calibration. So a calibration sample was taken at the buoy near the end of May, as indicated by the red diamond, which showed that the sensor was giving the correct readings. So what happened? Without detailed study of the changes, it is worth noting that dredging in Fire Island Inlet began on February 15 and lasted until March 15. So it is possible that there has been an increase in ocean/Bay exchange as a result of an opening of that Inlet. The problem with that explanation is that there does not appear at the moment to have been a commensurate increase in the tidal range in the Bay. So at this point we do not have a clear cut explanation for the abrupt increase in salinity in the western Bay during those months.

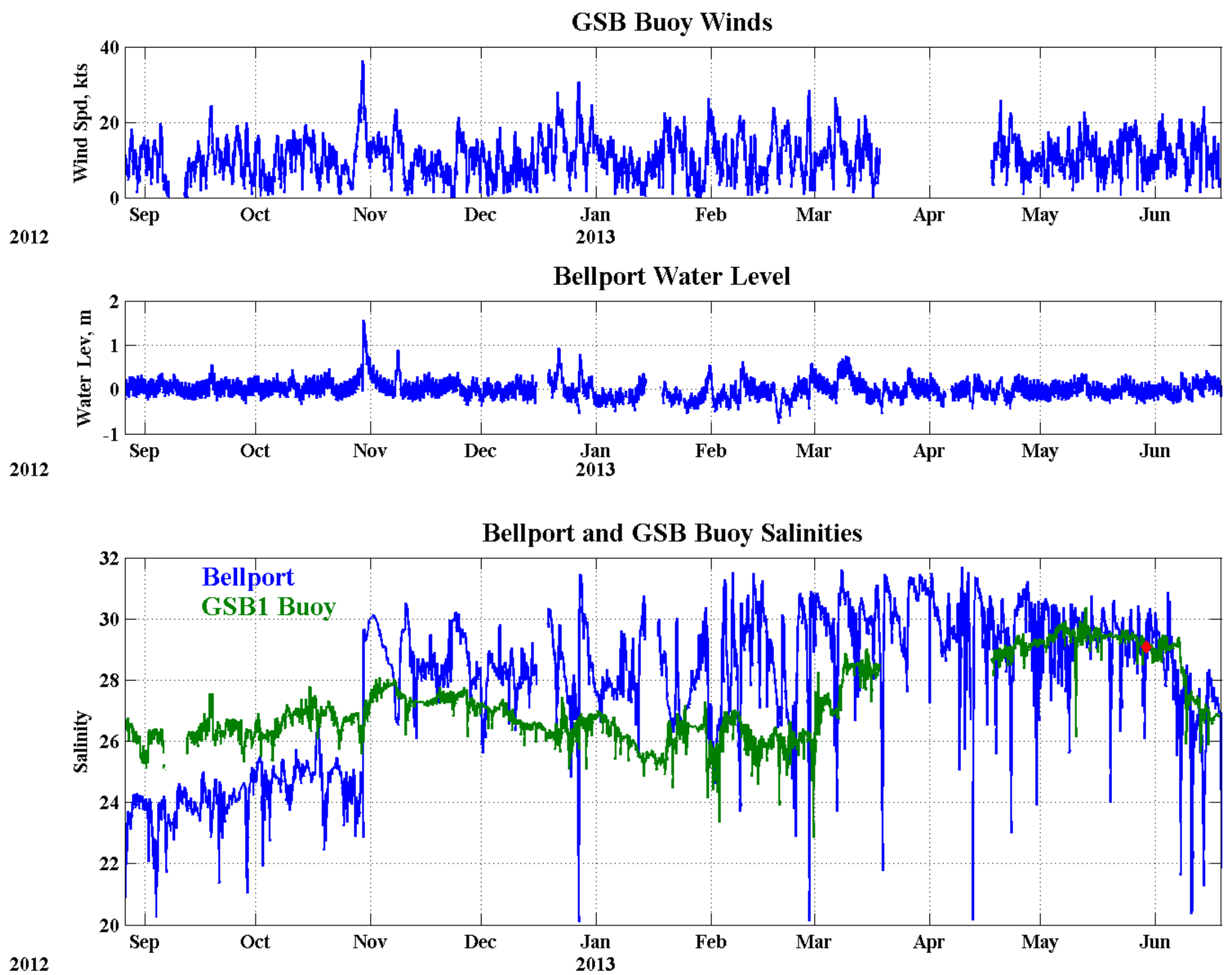


Figure 9, Plots of water level and salinity at Bellport together with the wind speed and salinity at the GSB1 buoy.

Note that following the increase in Bay salinity in March there was an even more abrupt decrease in salinity throughout the Bay in early June. For that we have a good explanation and that is shown in Figure 10. This figure includes the salinity records from Figure 9 together with the cumulative rainfall measured at Islip since the first of the year. From the beginning of the year through the first week in June, the precipitation was fairly steady at a rate of about 0.75 inches per week. The on June 7 through June 10 a substantial rain event dropped about 9 inches (0.23 meters) of rain on Long Island and Great South Bay. Given an average water depth for the Bay of about 2 meters, this rain event would lower the Bay salinity everywhere by about 2 psu and that is just what was observed. Although it is not shown in the salinity plot of Figure 10, the low salinities in the Bay have persisted through much of the month of June, rather longer than one would expect given the increased exchange with the ocean since Sandy and since the dredging of Fire Island Inlet. One possible explanation is that there has been an extended period since the rain event during which the fresh water that fell on the Great South Bay watershed has continued to flow into the Bay. Given that the fresh water supply will eventually taper off, it is expected that the salinity of the Bay will gradually return to the 28 to 30 psu range it had earlier.

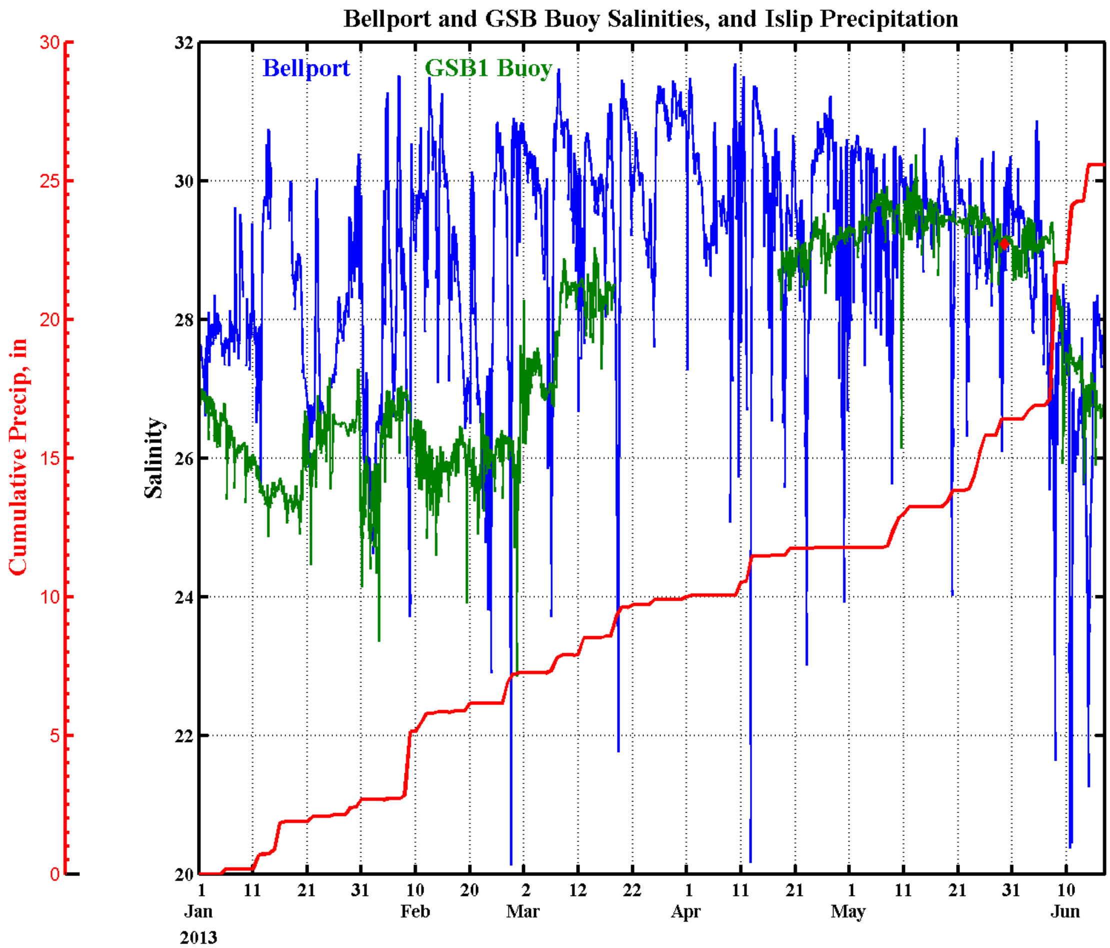


Figure 10, Salinities from Bellport and the GSB1 buoy together with the cummulative rainfall from the Islip rain gauge.