The Impact on Great South Bay of the Breach at Old Inlet

Charles N. Flagg and Roger Flood

School of Marine and Atmospheric Sciences, Stony Brook University

Since the last report was issued on January 31st there have been two significant wind events, one on January 31 with winds from the west to northwest and a second storm, which was the blizzard of February 8-9 with winds from the north to northeast. The first of these storms had relatively little impact whereas the blizzard caused significant alterations to the inlet and back bay sand shoals. The data available to document these events come from the sensors at Bellport and the Old Inlet dock, two aerial overflights and two bathymetric surveys of the inlet. The locations of the sensors deployed in Great South Bay are shown in Figure 1.

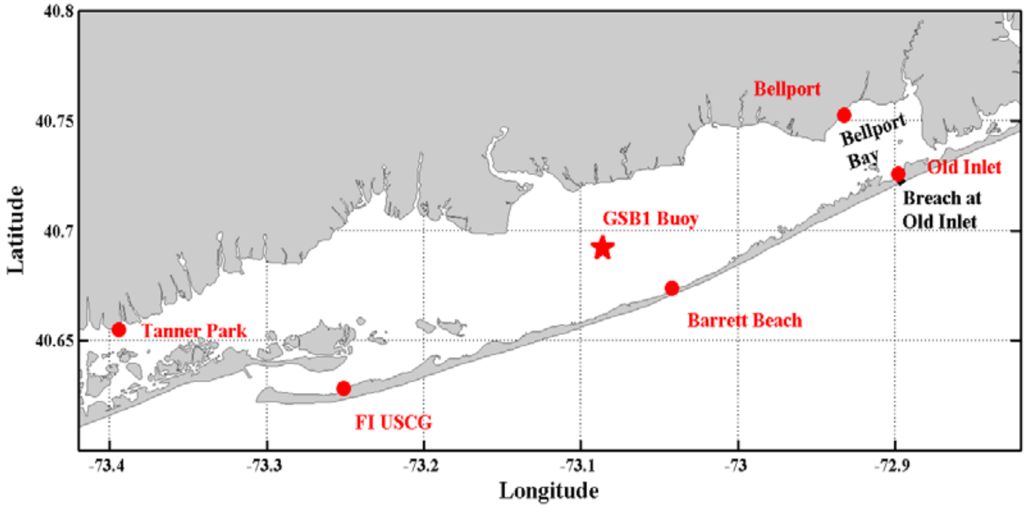

Figure 1. Map showing the location of the breach at Old Inlet, the GSB1 buoy and the sensors deployed around the perimeter of the Bay included in this report.

Figure 2 shows the water level records from all the available sensors and the wind speed and direction from the GSB1 buoy. The sensors at Tanner Park, Fire Island Coast Guard Station and Barrett Beach were all retrieved and re-deployed in late December and early January leaving only Bellport and Old Inlet sensor data available over the last month. The Old Inlet sensor was retrieved on February 14 and not redeployed because the Old Inlet dock appeared to be breaking up. The water level records are all plotted relative to their long-term means. Also shown in Figure 2 are the times of the bathymetric surveys and aerial overflights.

The two high water periods in the last month were produced by different wind histories. The January 31 event with water levels reaching just short of 1 m was characterized by a prolonged period of west to northwest winds averaging over 20 kts. While the peak elevation occurred at the same time as the peak winds, the water levels dropped much faster than did the winds. Thus it appears that the initial surge in Bellport Bay was a result of the local along-bay winds driving the waters of the bay eastward, which then receded as the ocean waters offshore were set down against the island allowing the bay waters to drain through all the inlets.

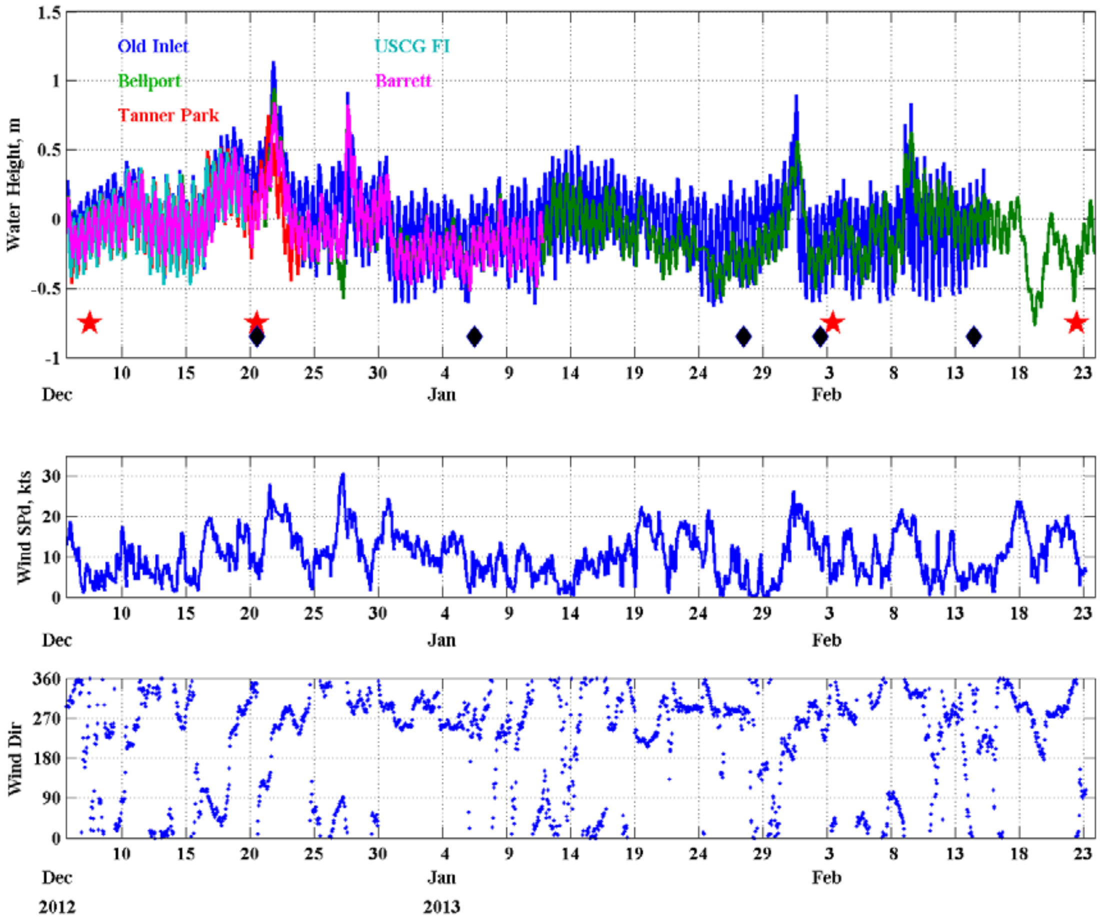

Figure 2, Time series plots of water levels and winds in Great South Bay. Also shown are the times of the bathymetric surveys of the inlet (red stars) and the aerial overflights (black diamonds).

Figures 3 a and b show aerial mosaics of the Old Inlet breach area, courtesy of Mark Lang, before and after the late January event. It does not appear that there were significant alterations to the inlet's inner portion from the January 31 wind event. Even the offshore bar and runnel structure and offshore bar had changed but little. (Better resolution photos are available on the Great South Bay Project web site: http://po.msrc.sunysb.edu/GSB .)

It was a completely different story as a result of the February 8-9 blizzard during which winds were initially out of the east before rotating to the north and northwest. Water levels in the bay again reached fairly high values of around 0.75 m above the long-term mean before retreating. This time it appears that the setup against the island caused by the east wind was responsible for the increased water level, overcoming the local downwind setdown in the bay. As the photo mosaic taken on February 14 shows, Figure 4, this storm caused significant alterations to the shape of the inlet, in particular to the inlet's western shore. The eastern tip of the western shore lost 30 to 50 m, and more of the western shore facing the ocean was eroded as well. With the disappearance of the eastern bar, ocean waves were able to impinge directly on the western shore of the inlet and may have been an important factor in the sudden erosion there. The bar and runnel visible in Figure 3a and 3b along the western shore had also disappeared. On the bay side, there now appears to be an larger eastern channel south of the old dock which has extended farther into the Bay. And one can see that the middle of the old dock is missing. Subsequent visits to the area show that a large piece of the dock trails in the water and a few pilings have been pulled out. The remainder of the dock seems secure enough although the currents running past it are quite high, about 3.5 kts during flood on February 22. The western channel close to Fire Island appears to be about the same as before.

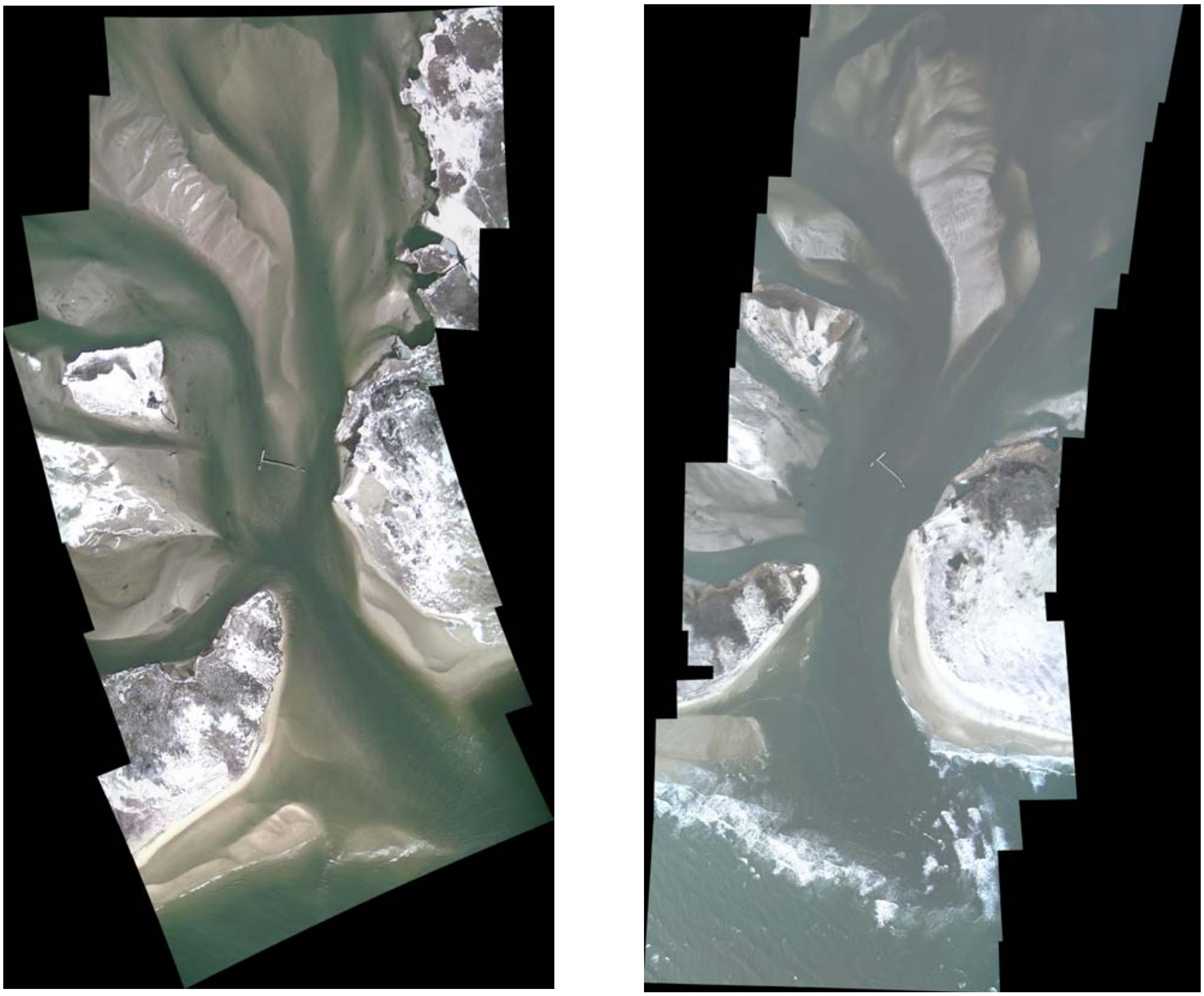

Figure 3a and 3b, Photo mosaics of the inlet taken on January 27 (left) and February 2 (right). For scale, the remains of the Old Inlet dock is about 50 m long.

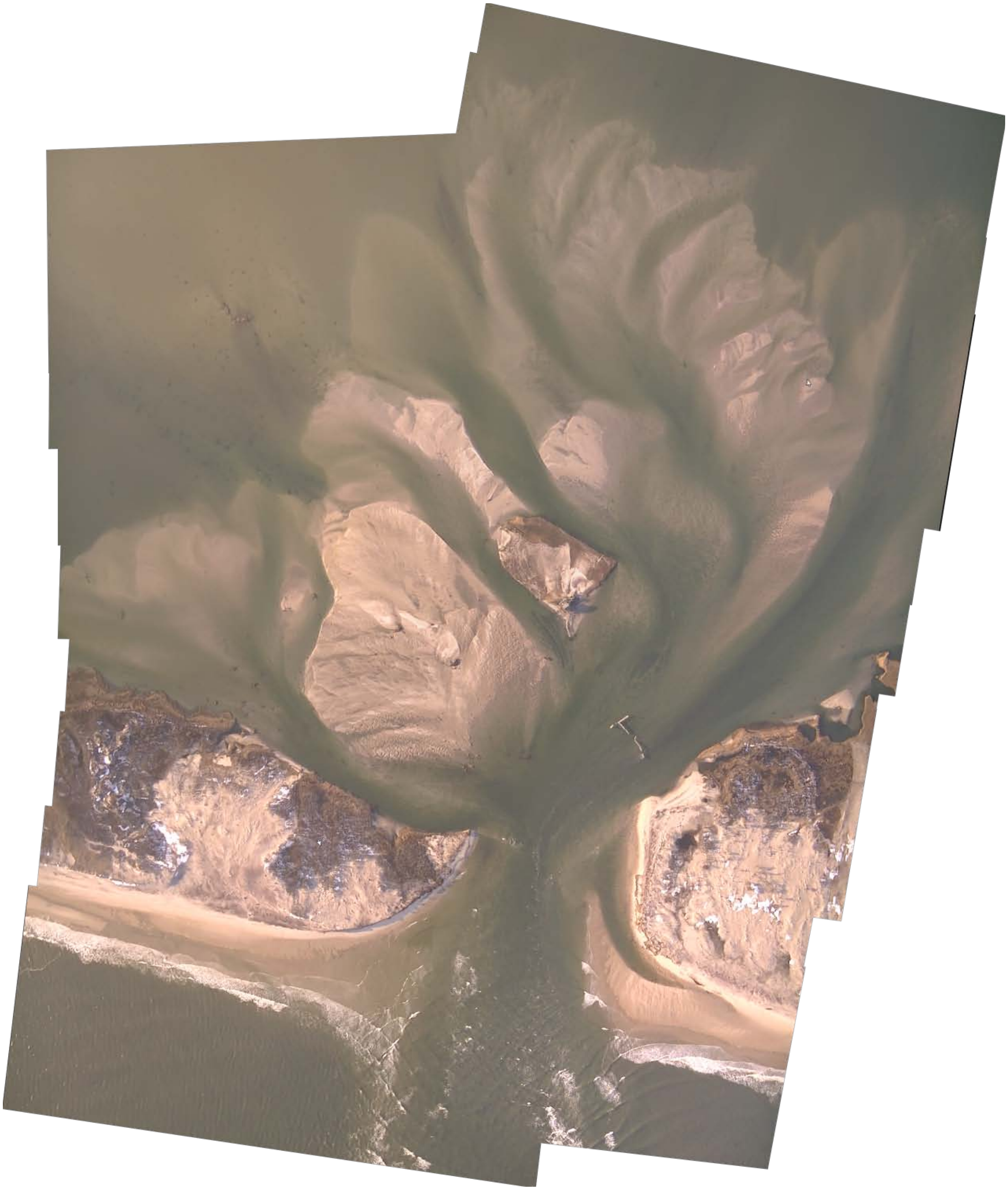

Figure 4, Photo mosaic taken on February 14 about an hour before sunset near low tide.

With the alterations to the morphology of the inlet and presumed increase in transmittance between the Bay and ocean, an important question is whether there have been any obvious changes in Bellport Bay's tides and salinity. Figure 5 shows the entire two and one half months of the Old Inlet dock record together with that from Bellport. In the last report, we showed that there was almost no change in the amplitude of the major semi-diurnal tidal constituent (M2) at Bellport through most of December compared to conditions before Sandy, and that appears to still be the case. Table 1 shows the amplitude and phase of the M2 tide for three periods, one before Sandy and two after. The post Sandy time periods were chosen to avoid major storms as they would significantly affect the calculation for these short record lengths. The M2 tidal amplitude in January appears to be somewhat less than earlier periods but given the shortness of the record that probably is not significant. The same can be said about the small differences in phase. (One degree in phase for the M2 tide corresponds to slightly more than 2 minutes.) The tide range in the inlet remains substantially larger than that at Bellport, and this has been the case since the late December storms, suggesting that tides in the inlet area are driven by the ocean rather than by what is happening in the Bay. It is also notable that the amplitudes and phases of the tidal constituents are constantly changing in the inlet as the inlet's connection to the ocean and Bay respond to more erosion and deposition.

Table 1. M2 tidal analysis for Bellport before and after the formation of the breach at Old Inlet. The 95% confidence limits are indicated.

Dates	Duration, days	Amplitude, meters	Phase, Degrees
Aug 26, 2012 – Oct 26, 2012	**61.39**	**0.160 ± 0.004**	**102.8 ± 1.19**
Nov 10, 2012 – Dec 15, 2012	**35.76**	**0.156 ± 0.006**	**93.8 ± 2.36**
Jan 1, 2013 – Jan 30, 2013	**29.04**	**0.139 ± 0.011**	**96.1 ± 3.94**

An interesting feature of the water level record in Figure 5 is the period of extremely low water, about 0.75 m below the mean water level, starting on February 18 that lasted about two days to be followed by a second period of low water a day later. This event was initially accompanied by strong winds out of the northwest, but that alone does not explain what was going on since the duration was too long to be supported simply by local winds. This low water period also shows up in the ocean and can be seen in tide records from Atlantic City and Chesapeake Bay.

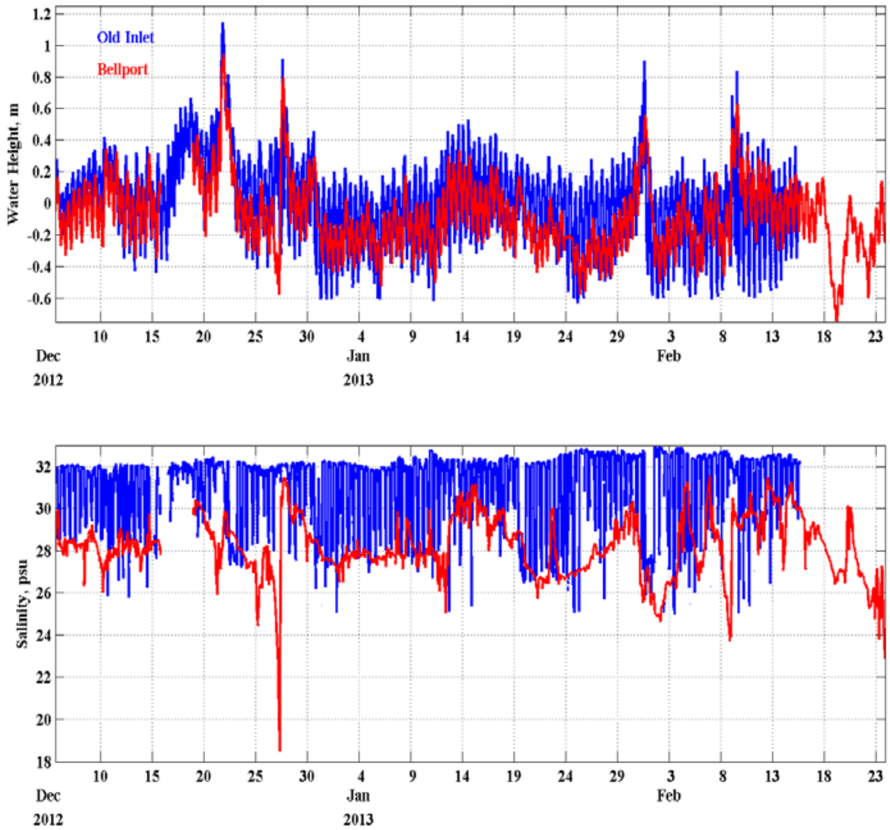

Figure 5, Time series of water level and salinities at the Bellport marina and Old Inlet dock.

The last item of interest is the salinity records from the inlet and Bellport. Ocean salinity has been slightly more than 32 psu for a long time and that is reflected in the Old Inlet record during flood tides. During ebb tides, the salinity in the inlet drops to Bay salinities, which are quite variable at Bellport as winds and local runoff alter the inner Bay conditions. Soon after hurricane Sandy, salinities at Bellport reached values of around 30 psu but gradually the salinities settled to fluctuate around 27 to 28 psu. In the last month or so, the salinities at Bellport seem to have increased somewhat and now quite often reach values greater than 31 psu. The seems to indicate that there is more exchange with the ocean through the inlet even though the tide range at Bellport has not increased. At the end of the plotted record the salinity at Bellport has dropped way down to around 25 psu and appears associated with the wide spread drop in water level and may be due to a drainage of the local fresh water creeks and river. In the last day or so the salinity Bellport has recovered to nearly 30 psu so the drop in salinity was a temporary phenomena.

Bathymetry surveys were conducted on February 3 and February 22, 2013 using a survey-grade echosounder and GPS navigation. Depths are referenced to the vertical datum NAVD88 which is about mean sea level in this area. Figure 6 shows the track lines and water depths recorded during the surveys.

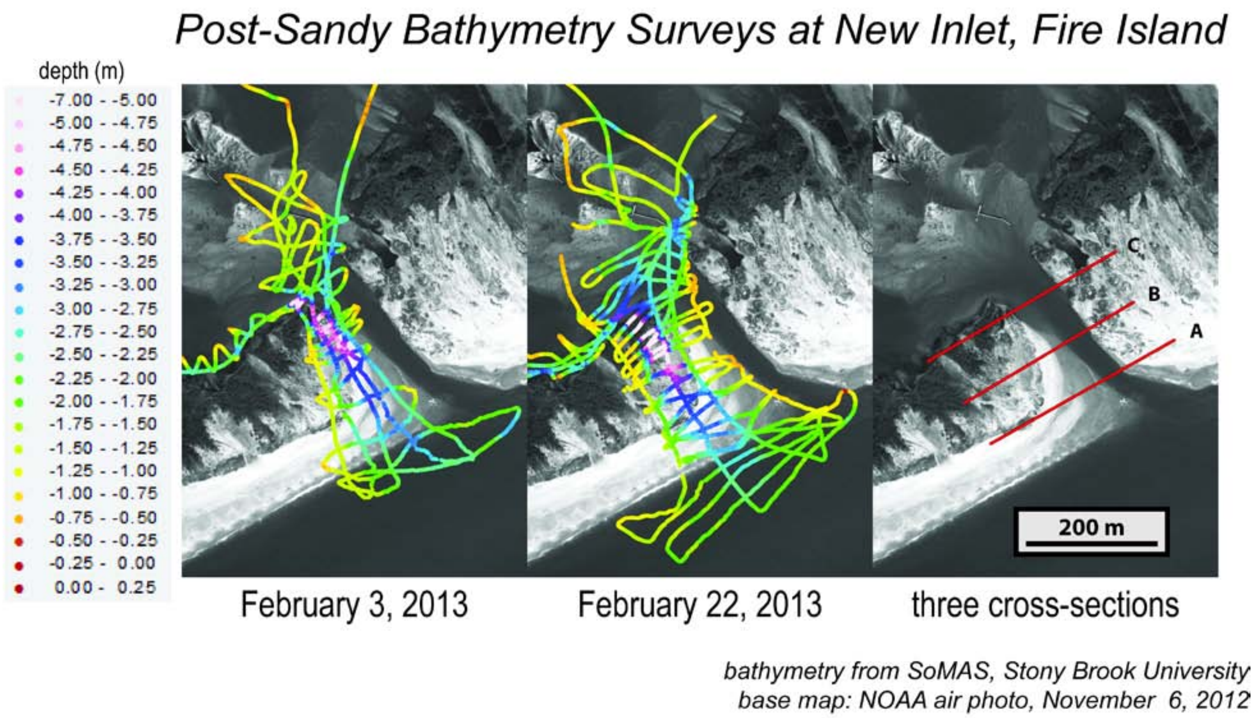

Figure 6. Results of bathymetric surveys conducted on February 3 and February 22, 2013. The color of the track varies with the water depth, and water depths are referenced to NAVD88.

The air photos in Figures 3 and 4 show that there is a flood tidal delta on the bay side of the channel and an ebb tidal delta on the ocean side of the channel. We surveyed primarily in the main channel of the inlet and had a primary interest in characterizing the shape and size of this flow conduit. We also collected bathymetric data in some of the channels on the inshore flood tidal delta, but we were generally unable to survey near the offshore ebb tidal delta in our small boat because this area is often characterized by breaking waves. There appeared to be a well developed shoal on the ebb tidal delta during the Febuary 3 survey but not during the February 22 survey.

Our bathymetric surveys show that there is a central deep channel and that the channel shoals both towards the bay and towards the ocean. On February 3, the central channel (defined here by water depths greater than 1.5 m) had a width of about 80 to 100 m with a maximum depth of about 5.8 m. The maximum depth was recorded where the channel makes a sharp turn to the west when entering the bay. The flow was very fast at this corner during the time of our survey. On February 22, the central channel had moved about 50 m to the west, had a width of about 80 to 120 m with a maximum depth of about 7.3 m. The maximum depth was recorded at the inner (bay) end of the central channel.

Cross-sectional areas were computed along three lines across the channel. Section A is near the ocean end of the channel, section B is at about the center of the channel, and section C is near the bay end of the channel. The locations of the cross sections are shown on Figure 6 and the sections are plotted on Figure 7. The cross-sectional areas for areas deeper than 1.5 m are shown in Table 2.

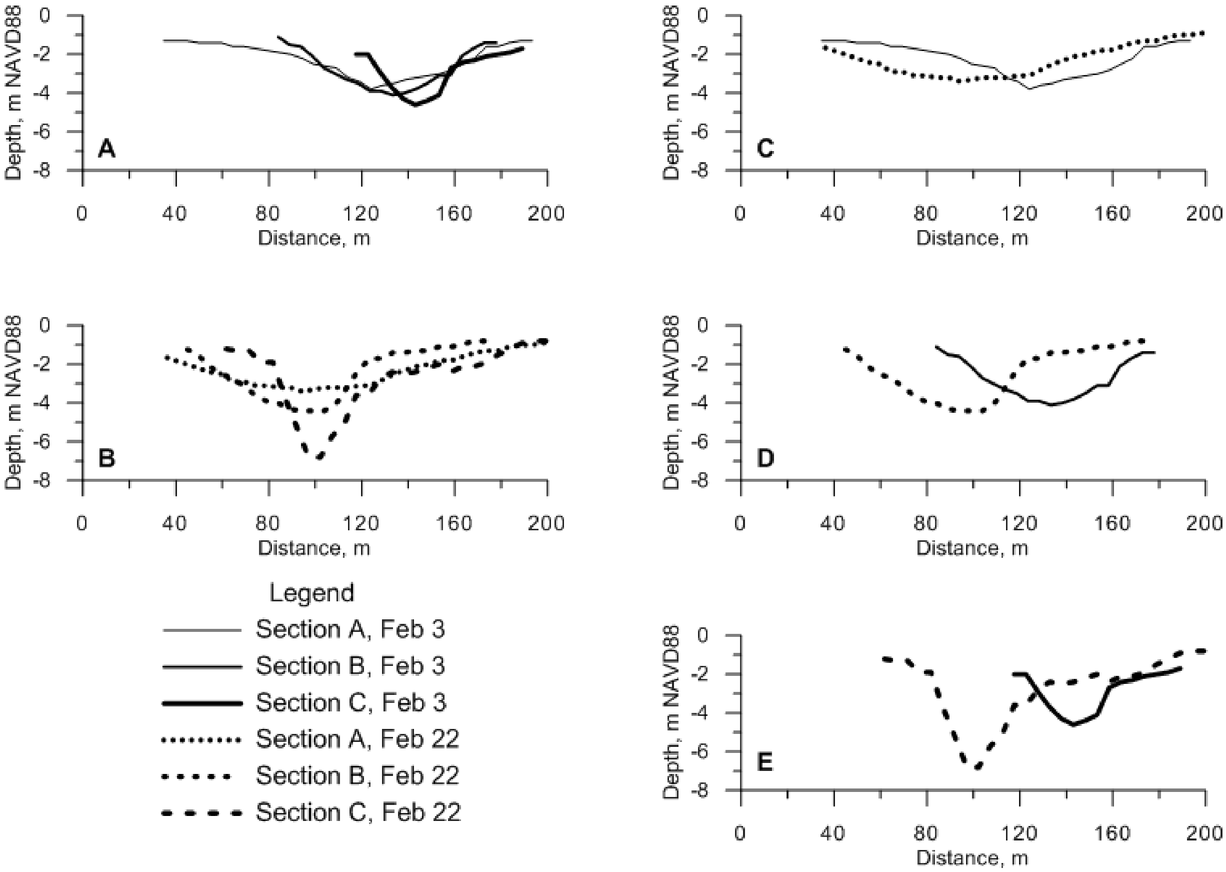

Figure 7. Bathymetric profiles plotted for sections A, B and C. A: All profiles for February 3, 2013. B: All profiles for February 22, 2013. C: All profiles on Section A. D: All profiles on Section B. E: All profiles on Section C. Horizontal distance increases towards the east.

Table 2. Cross-sectional areas along sections A, B and C for February 3 and February 22. Areas are calculated for the portion of the channel deeper than 1.5 m.

Section	February 3, 2013	February 22, 2013
A	63.0 m^2	73.9 m^2
B	62.7 m^2	70.1 m^2
C	52.6 m^2	94.8 m^2

The profile plots for February 3 and February 22 show that the inlet generally narrows and deepens towards the bay. For both surveys, the cross-sectional area deeper than 1.5 m is about the same on sections A and B, but it decreases at section C on February 3 while it increases at section C on February 22. The profiles at sections A and B are quite similar for the two surveys, although the channel is displaced to the west and the cross-sectional areas deeper than 1.5 m are 10% to 20% larger on the later survey. The lateral migration of the channel suggests that, for this time interval, sands are filling in the channel on the east side while the channel is being cut into new material on the west side.

The profile at section C on February 22 extends much deeper than the profile on February 3, and as a result the cross-section area for C on February 22 is about 80% larger than that on February 3. The increase in cross-sectional area from sections A and B to Section C on February 22 should result in a decrease in flow velocity at section C which is inconsistent with the increased apparent erosion at section C. The larger area and deeper channel at section C on February 22 could occur if the deeper part of the channel was being cut into finer-grained sediments, for example back-bay muds or peats, rather than sands. There is some anecdotal evidence from our survey for fine-grained sediments underlying coarser sediments in the survey area, including (1) echosounder profiles often show vertical edges where depth suddenly changes by 0.5 to 1 m and such edges would be consistent with erosion through a sandy veneer into a muddy layer, possibly followed by more sand deposition in the eroded area, (2) echosounder profiles in some areas show regular features, possibly sand waves, lying on a flat reflector which would be consistent with sand being transported over pre-existing muddy sediments, and (3) one can often punch through a somewhat resistant surface layer with a pole or on foot suggesting again sand over mud.

If indeed there is sand overlying mud, it would be consistent with the general understanding of the structure of a barrier island in which sandy beach, dune and overwash deposits build on pre-existing back-bay sediments as the barrier island retreats. However, with existing observations it is hard to know if or where there are local pockets of mud overlain by sand and how that might affect the evolution of the inlet's morphology. As we continue to monitor the inlet's bathymetry and the general response of the bay we will gain a fuller understanding of the hydrodynamics and geo-dynamics controlling the inlet.