The Continuing Evolution of the Old Inlet Breach

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The Great South Bay Project group has continued the monthly aerial surveys, finally repaired and deployed the GSB1 buoy south of Sayville, completed 1a bathymetric survey of the breach and approaches, and continued the maintenance of the observatory's SeaCats. Below is a discussion of some of the recent results.

From the aerial photos we can see that the processes governing the build-up of sand deposits along the west side of the breach that took place in 2013, also occurred this year. Below are two photo mosaics from September 2013 and 2014 showing a similar formation of a spit off the northwestern corner. (Larger versions of these photos are on the GSB Project website, http://po.msrc.sunysb.edu/GSB/.) However, the development of the western spit which only appeared in early September, was delayed by several months this year as compared to last when a substantial spit had already formed by May. The western channel is largely cut off in the recent photo and when we were in the breach two weeks later for the bathymetric survey, it appeared that the spit extended farther north and further reduced the flow west. Also obvious from the

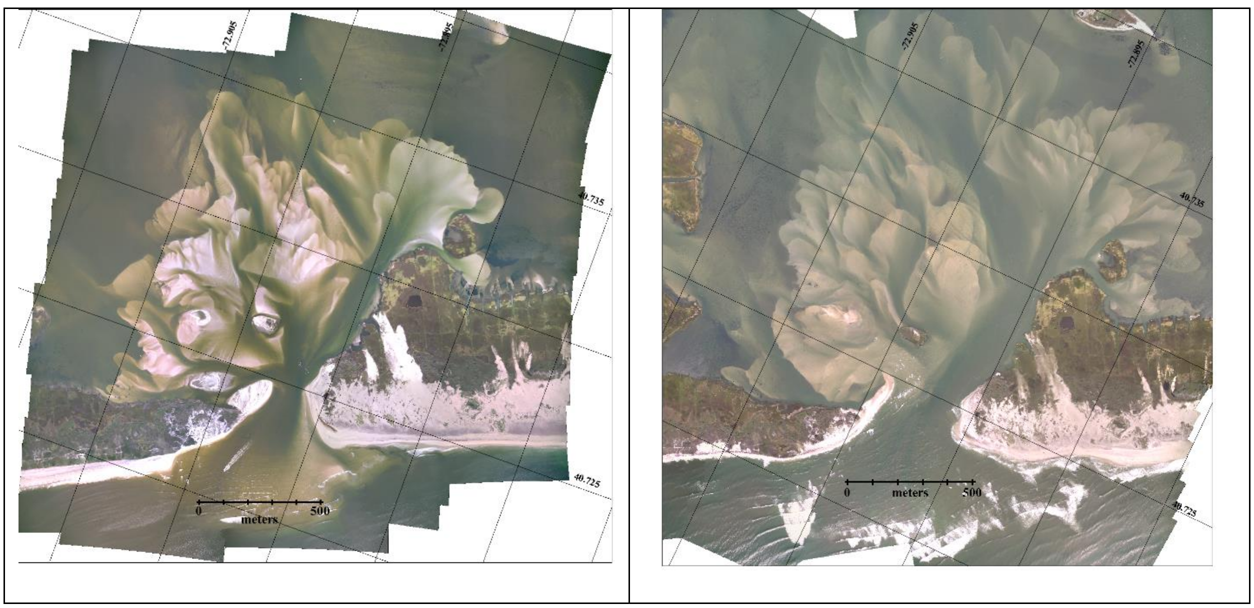

Figure 1, Photo mosaics of the Old Inlet breach area from September 15, 2013 on the left, and September 26, 2014 on the right.

photos is that the western shore of the breach has retreated westward about 100 meters over the past year and the minimum width of the inlet has also increased, from about 200 meters to 350 meters, or so. The minimum width can be variable depending upon the status of the northwestern spit. Another thing of note in these photo mosaics is the northward spread of the flood delta. Last September the flood delta extended north to about 40.735º N. This year the flood delta extends 300 to 400 meters farther north as well as, to a lesser degree, farther east and west. And with the spread of the flood delta, the northwest-southeast channel to the Great South Bay has become much more developed. In a few locations along this channel water depths have reached 4 meters or so, see below. There is still a relatively shallow fan-shaped shoal at the northern end of the channel but this is slowly spreading out and getting deeper. Clearly the access to the Bay through the breach and flood delta has increased and this is shown in the most recent bathymetric survey of the breach itself.

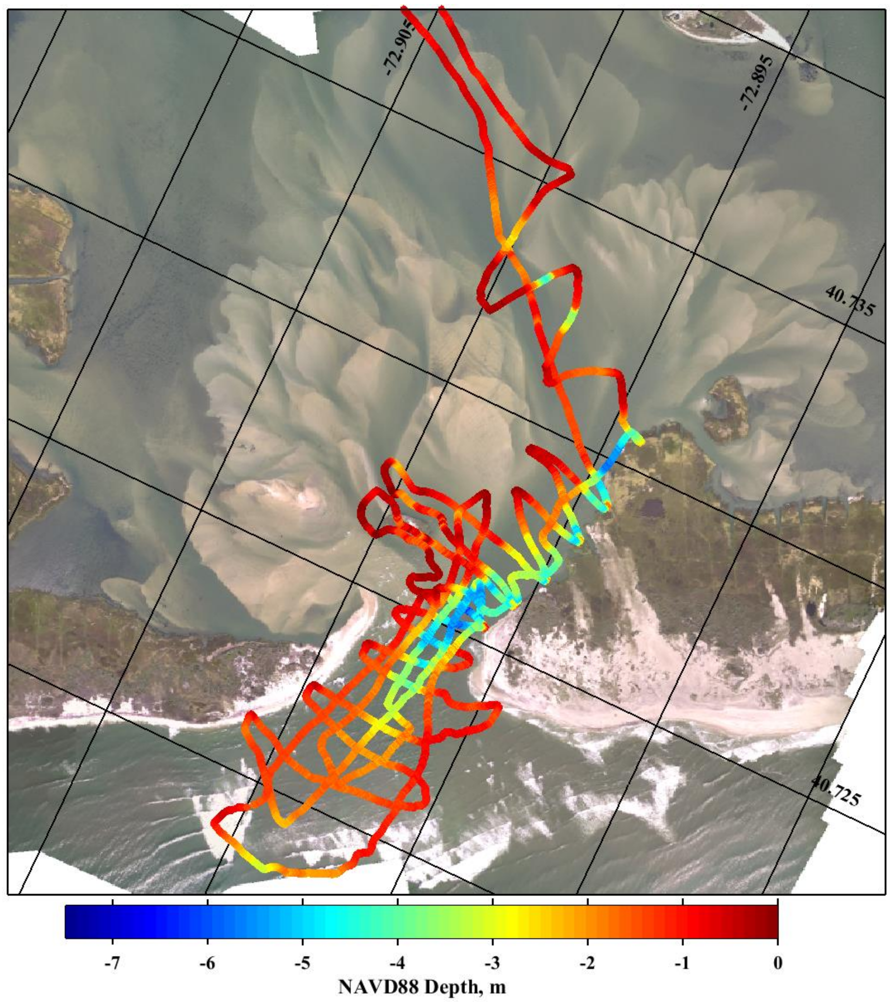

Figure 2, Bathymetric survey data from October 9, 2014 plotted on the aerial photo mosaic obtained on September 26, 2014.

On October 9th we completed our 14th bathymetric survey of the inlet and approaches to document developments that had occurred during the summer and to compare present conditions with the previous year's data. Figure 2 shows the survey track and depths relative to NAVD88 covering the main channel into the area north of the breach, in and around the remains of Pelican Island, and through the inlet almost out to the ebb delta. The data were taken around local high tide which allowed us to venture farther into some of the shallow areas. The deepest depth observed was 6.3 meters at the narrowest part of the breach, Figure 3. This depth is in line with observations of maximum depths we have seen over the past two years. And as Figure 3 also shows, the alongshore position of the narrowest and deepest section has remained remarkably constant, within 50 meters or so, for the two years of the breach's existence. The major development over the past spring and summer is that the cross-sectional area of the inlet has increased from around 400 m^2 characteristic throughout the first year, to about 600 m^2 now, Figure 4. The opening of the breach appears to coincide with the expansion and consolidation of the east channel's connection to the Bay to the north. However it is unclear whether the size of the breach is related more to the increased access to the Bay or whether the expansion of the breach due to the storms forces an increased carrying capacity on the channel to the Bay.

Given that there has been a significant change in the breach's size, the question now is what has happened, if anything, within the Great South Bay as a result of the changes seen over the past 6 to 8 months. There are two issues, first, has the presumed increase in exchange because of the widening of the breach been sufficient to alter the tides in the Bay and second, has this exchange altered, ie increased, the mean salinity of the Bay. Another important question is whether there has been a change in the response of the Bay to storm events since Sandy and the opening of the breach. We have data presented below on the first two questions and are working on the third.

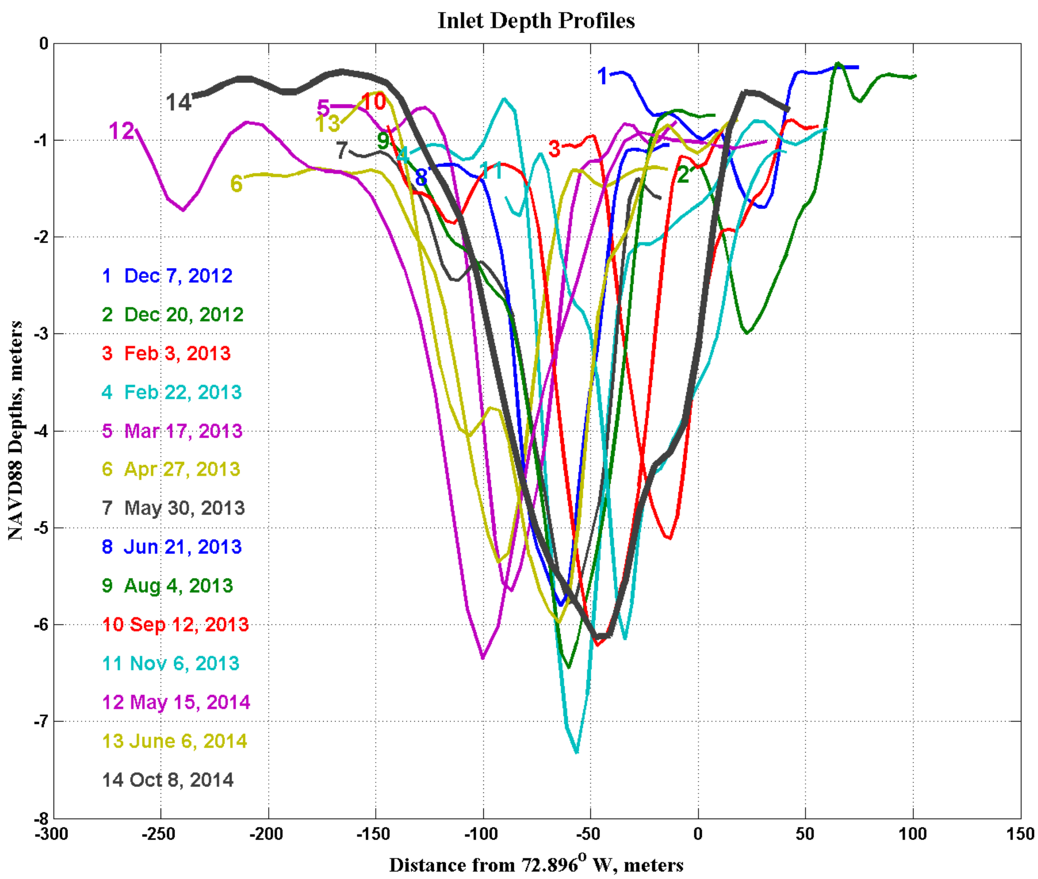

Figure 3, Depth profiles across the breach at its deepest and narrowest section. The October 8th profile is shown bold.

In terms of the Bay salinity, this is a highly variable quantity especially at Bellport which is subject to local run-off from the nearby shore and creeks. And since Great South Bay is so shallow, average depth on the order of 2.5m, the salinity in the Bay reflects not just the usual balance between surface and subsurface fresh water inflow and exchange with the ocean, it is also responds to large rain events. And there have been two major rain events within the past two years, one in June 2013 with ~9" of rain, and another recent but highly localized event in

August 2014 with ~10" of rain. The 2013 event effected the entire Bay which took quite awhile to recover to more usual salinities. The 2014 event was largely restricted to the western portion Bay and did not effect Bellport to any large extent. With these caveats, if we look at the average salinties for the first 9.5 months of 2013 and 2014 we can get some idea of whether or not there has been an increase in exchange with the ocean as a result of the increase in the breach's cross-sectional area. The mean salinities at the Bellport SeaCat for 2013 and 2014 were 28.57 psu and 28.59 psu, respectively, with standard errors of ±0.08 psu assuming a 1-day decorrelation time. So statistically, these results suggest that there has not been a noticeable increase in salinity in Bellport Bay this year as compared to the first year that the breach was open. However, the day to day variation in salinity is such that this is not a very robust result.

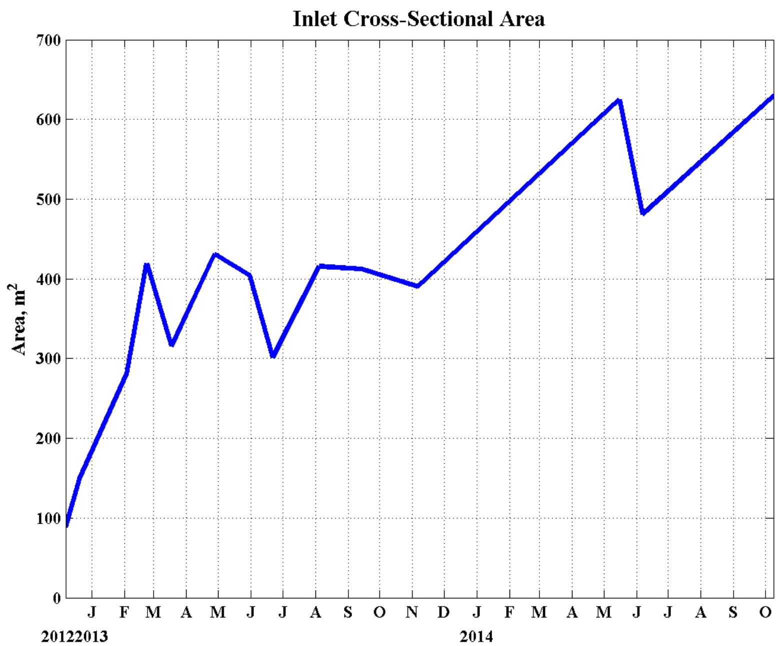

Figure 4, Plot of the cross-sectional area of the narrowest and usually deepest section of the breach.

Tides on the other hand are more easily diagnosed and a summer student, Ryan Capps, has looked at the changes in the tidal constituents since before the breach was opened. The procedure used the water level record from our site at Bellport, corrected for atmospheric pressure, and the USGS tide data from Lindenhurst. These records were divided into approximately 40-day segments and the Matlab routine, t-tide (Pawlowicz, Beardsley and Lentz, 2001) was used to estimate the primary tidal parameters. The main tidal constituent in this area is the M_2 lunar semi-diurnal tide with a period of 12.42 hours and a typical amplitude (half the range) of around 0.15 meters. The other important tidal constituents have amplitudes generally less than 0.03 meters.   The Figure 5 shows the changes in M_2 amplitude and phase for the two stations. The plots show that there has not been a significant change in tidal amplitude at Bellport since before Sandy while there has been an increase of perhaps 5 cm at Lindenhurst. The change in the M_2 amplitude at Lindenhurst occurred around March/April 2013 which is the time when dredging of Fire Island Inlet started. Since then, the M_2 amplitude at Lindenhurst has been remarkably stable. So it does not appear likely that the breach has caused a change in tidal amplitude. However, at Bellport there has been a fairly steady decrease in phase since Sandy amounting to about 10 degrees over 18 months. Each degree of the M_2 tidal phase corresponds to about 2 minutes so it appears that high tide at Bellport has advanced by about 20 minutes over this time. The phase change at Lindenhurst seems to be variable and does not exhibit a significant trend. The reason for the gradual phase change at Bellport is unclear.

A major accomplishment over the past few months has been the resurrection of the GSB1 buoy and its re-deployment south of Sayville. During the previous two winters the ice sheets had dragged the buoy back and forth between Islip and Sayville but last winter's ice movement dragged the buoy south into shallow water, rolled it over and destroyed the electronics. The ice finally rafted the injured buoy ~10 miles east to the breach's flood delta. After pondering various clever ways to get the buoy ashore for repairs, near the end of March Walter Martens of the Park Service just towed it into Beaver Dam creek and loaded onto our trailer. Simple. The damage was extensive and some sensors, the tower and the electronics had to be replaced. Thanks to the combined funding from the National Park Service and NY DEC the buoy was rebuilt by early September and redeployed. We had a short term problem with the telemetry but that has been fixed and the buoy is now on station and delivering data to the GSB Project website.

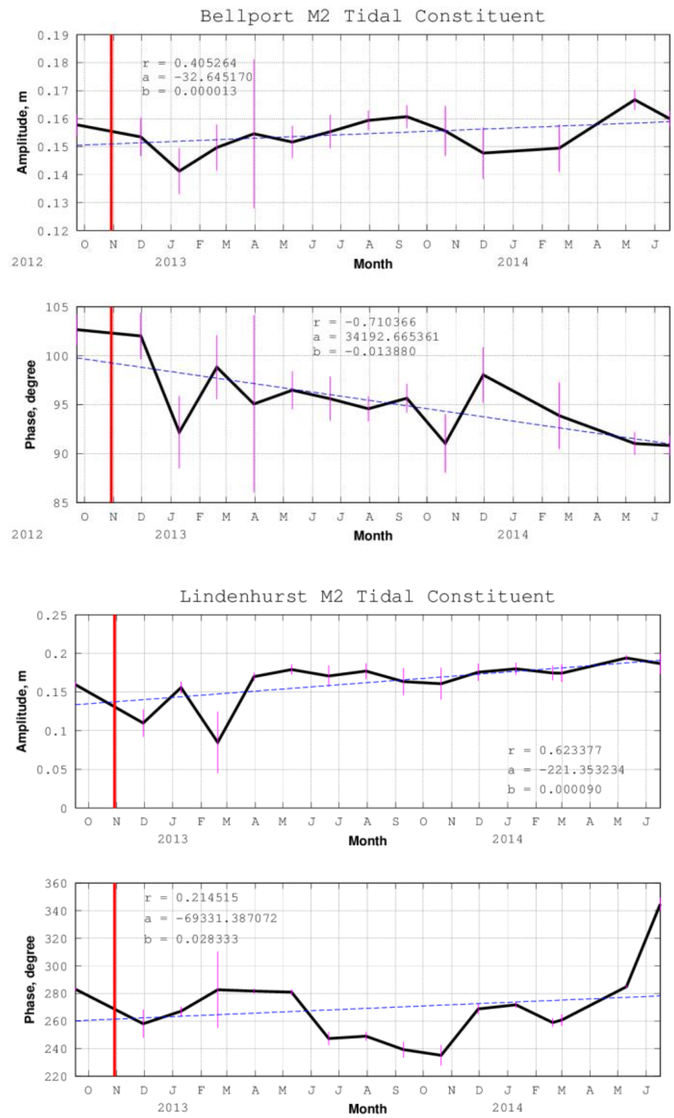

Figure 5, Temporal variation in the M2 tidal amplitude and phase since prior to the opening of the breach at Bellport, top, and Lindenhurst, bottom. The red line indicates the passage of Sandy, the vertical pick lines show the 95% confidence interval for the estimates while the linear least-squares fit to the data is shown by the dashed line. a and b are the fitting parameters and r is the regression coefficient of the fit. The 95% confidence level for the regressions is 0.53.