Update on the Old Inlet Breach and Great South Bay

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As those who have ventured over to the Old Inlet breach recently have undoubtedly noted, there have been major changes in the breach over the past few months. We have kept up with the monthly aerial photography and Great South Bay observations, and recently conducted another of our bathymetric surveys of the breach area and approaches. The oblique shots and photo mosaics as well as the realtime and delayed-mode water property data are available on the project website (http://po.msrc.sunysb.edu/GSB). Here we summarize some of the recent observations and present status of the breach.

Over the past couple of years since the formation of the breach there has been a cycle of erosion and deposition within the breach. While steady erosion took place along the western shoreline, there was deposition of sand along the northwestern corner. This deposition along the northern area, which we have referred to as the "spit", would close off or restrict the western channel during the spring and summer months and then be eroded during the fall and winter. The northern extension of this spit generally ranged from 100 to 300 meters to the north and always left a channel of more than 100 meters between the spit and Pelican Island. On the eastern side of the breach the shoreline remained remarkably static after some initial accretion and then erosion during the first year after the breach formation.

This year something different happened. Starting in May the spit started to grow as before but this year the eastern side also began to move out. And unlike in past summers, the spit kept growing until by the end of June the spit was within ~20 meters of Pelican Island. By mid-July. the spit had made contact with the island and by the end of July the spit had wrapped around the eastern side of Pelican Island and the previous connection to the western channel was completely cut off. This progression is shown in Figure 1 below.

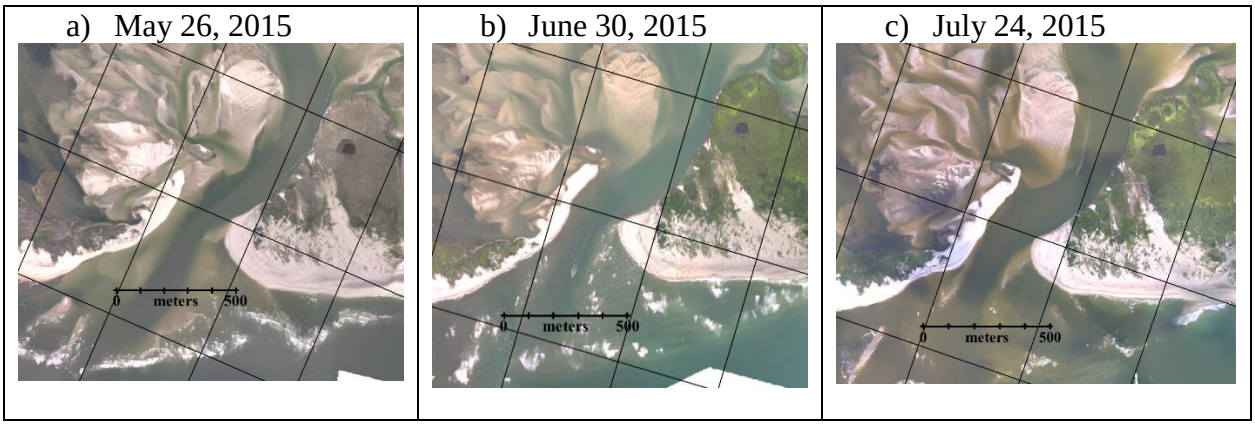

Figure 1, Photo mosaics of the Old Inlet Breach this spring showing the development of the western spit and the accretion of sand along the eastern shoreline. The scale at the bottom of each figure indicates 500 meters. Larger versions of these figures are available on the project website.

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The mosaics also show that the width of the breach opening has decreased over the past few months due to the extension of the spit but mostly as a result of the sand accretion along the eastern shoreline. The minimum width now is around 200 meters, substantially less than it has been in the past. Also of note are the along-channel shoals that have formed extending out to the outer ebb shoal. The shoal to the southwest is particularly prominent and is occasionally above water at low tide. These shoals form the edges of the main offshore channel reducing the width of the channel by roughly 50% compared to the distance between the east and west shores. This channel which started out nearly perpendicular to the original shoreline has since early 2014 run nearly north-south, some 15^{o} clockwise from the large-scale Fire Island shoreline.

On July 22nd we conducted a complete bathymetric survey of the breach and the approaches from the north. (Much of the flood delta is too shallow even for our small skiff and measurements in that area await permission from the Park Service to use a jet ski.) The entrance to the area is through a well-defined NW-SE channel with maximum depths of around 4 meters. The channel shoals and turns off to the northeast as one approaches Bellport Bay. In the area leading to the breach the main channel is along the north shore of Fire Island with depths approaching 5 meters. Within the breach itself, the maximum depth of about 6 meters is found farther south and west than previously in the narrowest part of the channel which is now formed by the shoal extending from the eastern shoreline visible in Figure 2, and the western shore.

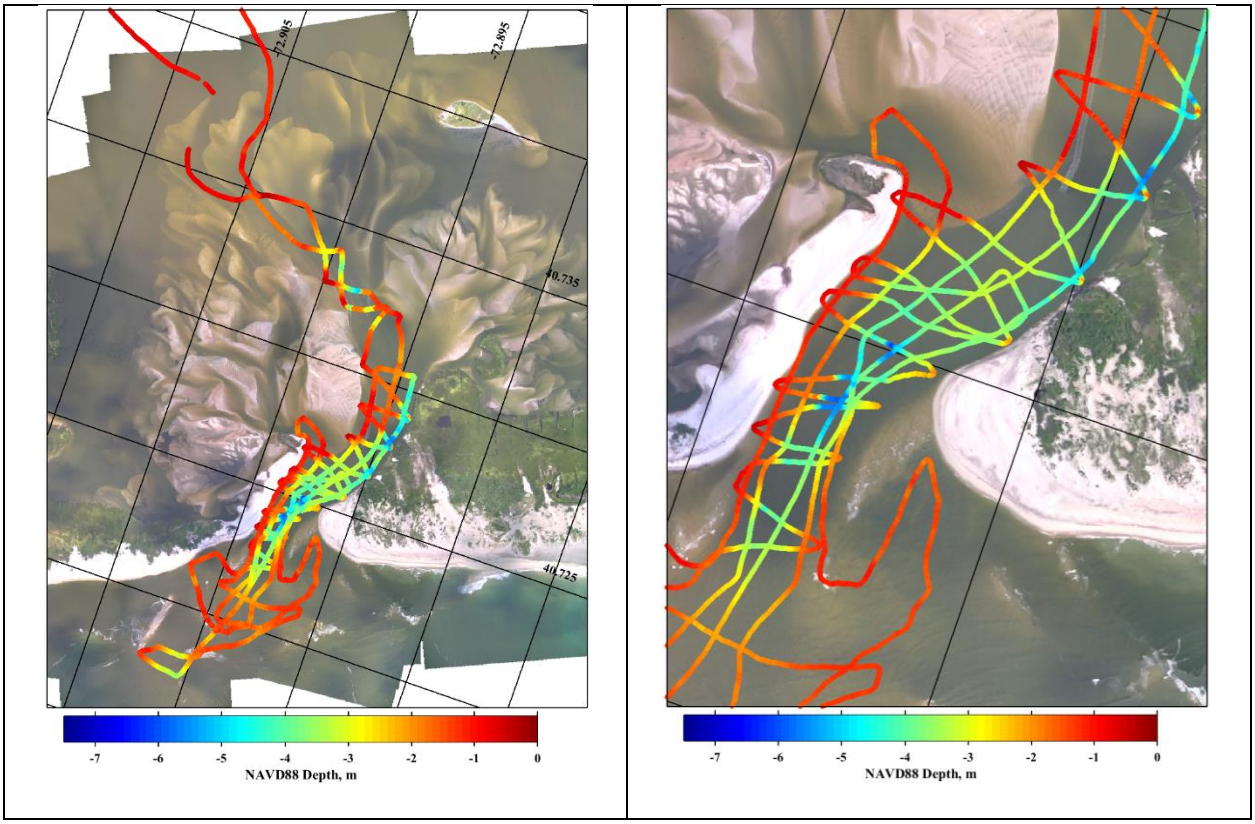

Figure 2. Track and depth plot of July 22, 2015 bathymetric survey on the July 24, 2015 aerial mosaic of the Old Inlet breach area. Depths are relative to the NAVD88 geoid.

The other notable observation about the changes in the channel is that the cross-sectional area has decreased compared to our measurements in 2014 as shown in Figure 3. During the first

year after the formation of the breach the minimum cross-sectional areas quickly ramped up to between 300 and 400 m^2, shown in Figure 3b. The number of surveys decreased in 2014 but those we did do suggested that the cross-sectional areas had increased by 50% to 500 to 600 m^2. This increase coincided with disappearance of the Old Inlet dock and the development of the NE-SW channel to the Bay. This latest survey on July 22nd suggests that the minimum cross-sectional area has decreased to roughly 450 m^2. The narrowing of the channel is quite evident in the profiles shown in Figure 3a. Since we do not have any recent velocity measurements it is unclear whether this decrease in cross-sectional area has led to a decrease in the ocean-Bay tidal exchange.

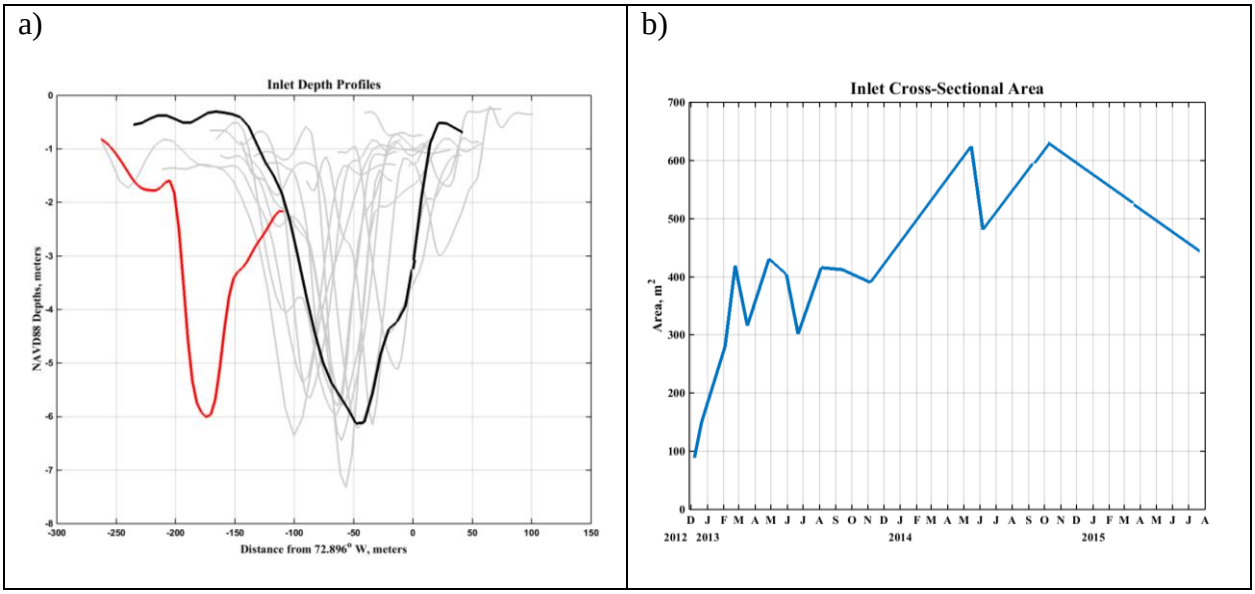

Figure 3. a) Cross-section profiles of the breach from the 15 bathymetric surveys. The October 2014 profile is shown in black, the July 2015 profile is shown in red where the change in cross-sectional areas is clearly visible. b) Time series plot of the minimum cross-sectional areas for each of the surveys.

The rather sudden changes in the character of the breach this spring and summer relative to previous years naturally lead to speculation as to their cause. Despite the unusual amount of cold and snow, this past winter was not subject to as strong nor'easters as we have seen in the past, especially the winter/spring of 2013. That would lead to less erosion than we have seen in past winters. But less erosion does not account for the extra sand we see in the spit and along the eastern shoreline. A potential source for the large increase in sand deposition in the breach is the beach restoration project east of Smith Point that took place in the fall of 2014. Large amounts of sand were pumped from offshore to the area just west of Moriches Inlet. Natural wave and current processes along the south shore of Long Island serve to redistribute beach sand through a generally westward drift. And any man-made alteration of the beach system must undergo some adjustment as a result of larger scale ocean action. It thus seems quite likely that the beach restoration along Smith Point Park is the source of the extra sand introduced into the breach system. Whether the sand remains in the breach, is carried farther into the flood delta, or gets entrained again in the alongshore drift, remains to be seen.

The other aspect of the Great South Bay project is to keep track of what is happening to the water properties of the Bay. Salinity is the best indicator of mixing between ocean, Bay and fresh water sources; whereas fluorescence gives us an indication of biological activity. Both these parameters at the Bellport dock and GSB1 buoy south of West Sayville are plotted in Figure 4 for the period March 1st through August 5, 2015. Salinities at Bellport were around 30 psu during the late winter and spring with substantial variations during periods of fresh water outflow from the creeks. Then in late May/early June salinity at Bellport dropped noticeably to less than 29 practical salinity units (psu) and has tapered off to around 28 psu by the end of July. By the end of the record the salinities at Bellport are essentially the same as those record at the GSB1 buoy, something that has not happened since after a huge rain storm in June of 2013. These lower salinities are not unusual at Bellport but not for this extended a period and not without a large rain storm. It is tempting to ascribe these salinity changes to the changes we have seen in the breach bathymetry. Presumably, a smaller opening to the ocean should reduce the ocean Bay exchange. However, throughout 2013 the breach had cross-sectional areas similar to or smaller than the recent survey with much higher salinities, 30 to 31 psu, than we are seeing now. So exactly what is going on to change the salinity over the last couple of months and whether this trend will continue is unclear at this point.

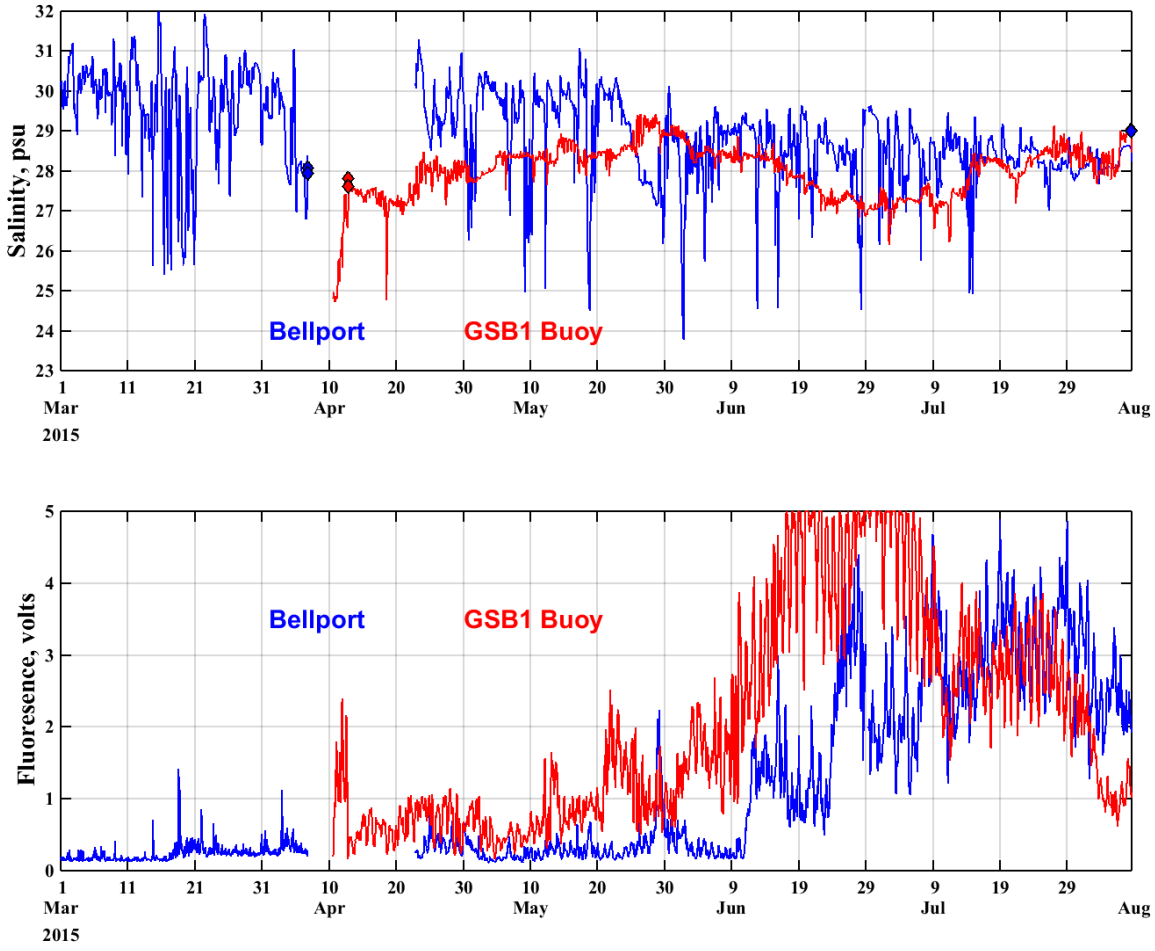

Figure 4. Time series of salinity, upper panel, and chlorophyll fluorescence, lower panel, from Bellport and the GSB1 buoy. Salinity calibration samples in April and August are shown as solid diamonds.

The lower panel in Figure 4 shows the record of chlorophyll fluorescence during this spring/early summer period. This instrument works by flashing a high intensity light at a small volume of water which causes the chlorophyll molecules to flash back, or fluoresce, at a different wavelength. The intensity of the return flash is proportional to amount of chlorophyll, hence algae, in the water. The records show that at Bellport there was very little plant matter in the water until the second week of June at which point the brown tide bloom started in Bellport Bay. This bloom was delayed at Bellport by nearly a month relative to the waters to the west where the bloom got quite intense by mid-June. By the beginning of July the bloom over the western portions began to dissipate but remained significant in Bellport Bay. And by the end of July the bloom seemed to be largely over in the west. On a purely qualitative basis, on July 7th the waters in Bellport Bay had a definite greenish color while those in Patchogue Bay remained brown. The fluorometer does not distinguish between the myriad algae species in the Bay so it is quite possible that we are seeing a different algal succession in Bellport Bay relative to that in Patchogue Bay and farther west. As noted above, the salinity in Bellport Bay is less than it has been in recent spring/summer periods suggesting a reduced ocean/Bay exchange resulting in high nutrient levels. In this way, the lower salinities might be related to the recent strength of the brown tide bloom in Bellport Bay.

To summarize, there have been significant changes in the breach over this past winter and spring. Fewer large storms, more littoral sand drift from the east, deposition in the breach and the expansion of the both the east and west shorelines, a decrease in salinity within the eastern Bay, and a substantially larger brown tide/algal bloom this year. Whether these changes represent a new trend is unclear. During the rest of the summer and early fall when the south shore beaches tend to accumulate sand, it is unlikely that there will be substantial erosion and opening of the breach. So we will just have to wait to see whether the fall/winter storms remove the extended spit and open up the breach as has happened in the past, or whether the recent build-up of sand is sufficient to resist those forces.