Update on the Status of the Old Inlet Breach

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We are coming up on the four-year anniversary of Sandy and the formation of the breach near Old Inlet. So this is a good time to see how things have progressed in recent months, and during the recent visit by the remnants of Hurricane Hermine. These events give us an interesting perspective on the stability of the system.

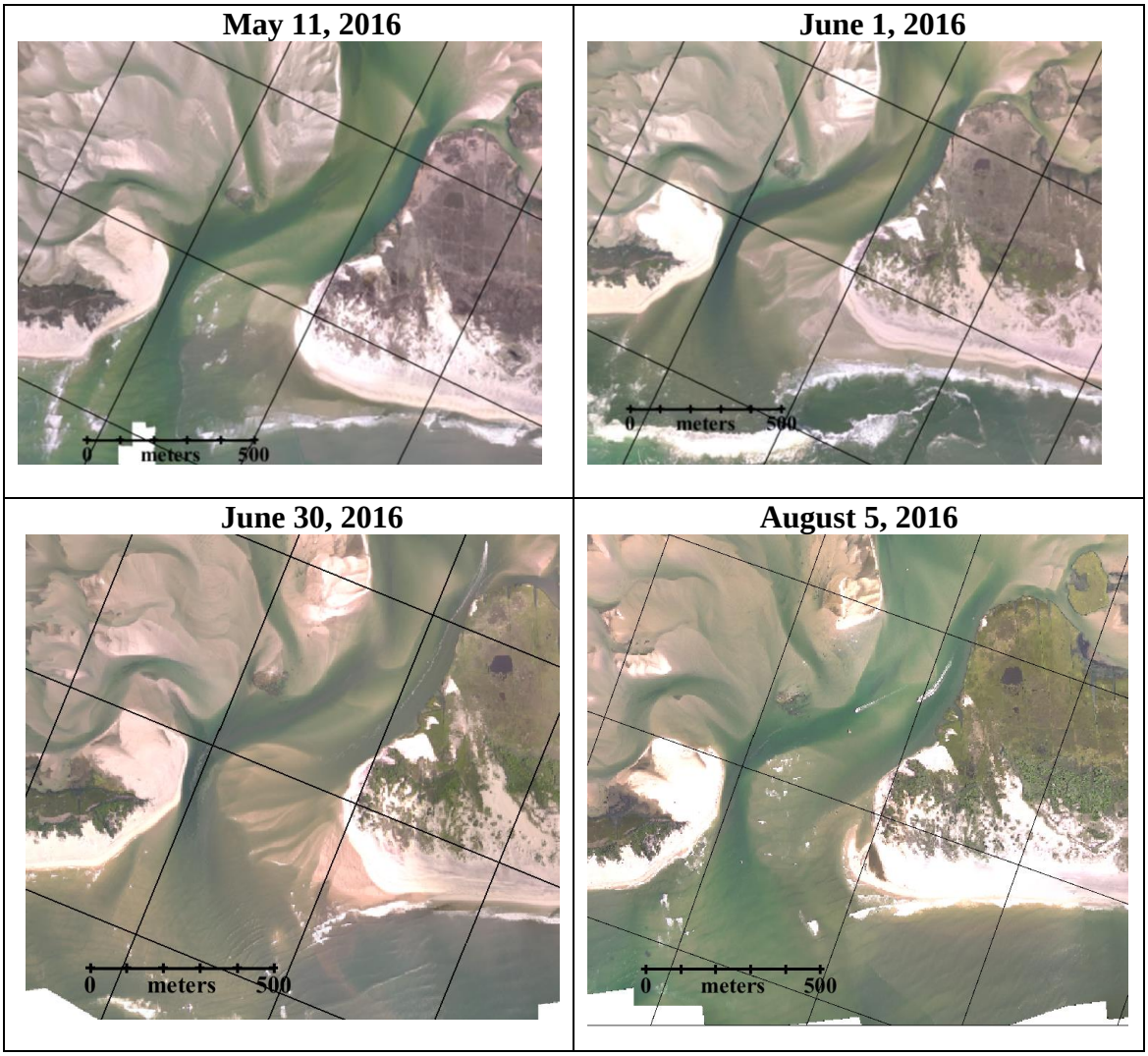

Figure 1, Photo mosaics of the Old Inlet breach through the spring and summer of 2016.

A phenomena that has repeated itself through the springs and summers of 2014 and 2015 was the buildup of a sand spit that extended north from the western shore of the breach reaching as far as Pelican Island in 2015. The fall storms would then remove the spit, sending the sand into the flood delta to the north and west. This spit was quite extensive in the summer of 2015, had a lot of sand that reached and surrounded Pelican Island. As in previous years, an early fall storm removed the spit, but this time there was such a large amount of sand that it was not moved entirely into the flood delta but instead formed a large plume of sand just north of the western

shore, **Figure 1**. With this large pre-existing plume of sand, we expected that this spring an even larger sand spit would form that would extend at least as far as the remains of Pelican Island. As **Figure 1** shows however, that did not happen. In fact, the western shoreline of the breach has remained remarkably stable since December 2014.

While the western shore has remained relatively stable over the past year, there has been a gradual change in the overall structure of the breach with the development of a large shoal, which has built out from the east and pushed the main channel both to the west and north. Earlier and through the summer of 2015, the main channel had flowed along the northern edge of the eastern Fire Island. Then with the development of the western spit, the main channel crossed over the breach to flow along the western shore. The early October storm of 2015 that removed the large western spit also brought in a lot of sand, depositing it along the eastern shore to form an eastern spit. That spit did not last long, disappearing by December 2015. However, quite a bit of sand had been brought into the breach, which added to a persistent shoal that had existed along this eastern shore for a long time. One of the results of this larger eastern shoal was the diversion of the main channel north to a position just south of Pelican Island so that the main channel makes a more serpentine path through the breach.

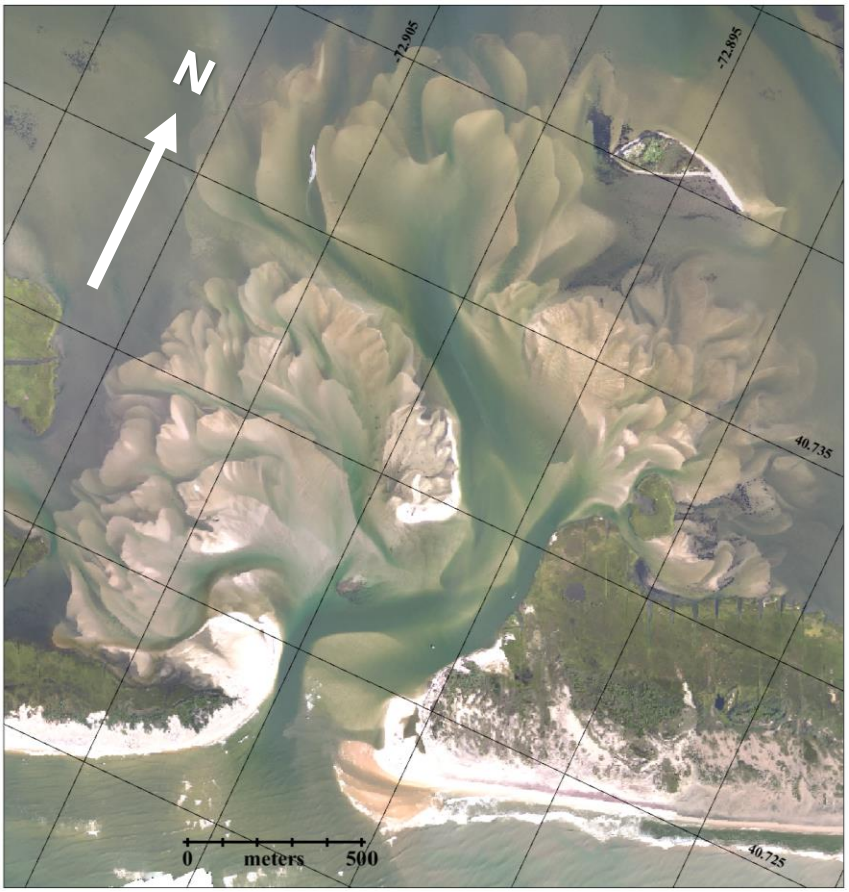

Figure 2, Photo mosaic from September 8, 2016 taken around 0900 EDT during ebb tide. This mosaic was collected two days after the remnants of hurricane Hermine left the area.

More recently there have been other important developments along the eastern shore of the breach. In August there was an expansion of the Fire Island beach to the east and the

development of a ridge and runnel system that extended into the breach, **Figure 1**. This ridge and runnel has expanded considerably over the past month and survived and/or was augmented by the remnants of hurricane Hermine, **Figure 2**. Locally, the hurricane produced winds out of the north and northeast while waves at the offshore NODC buoy, ~20 miles south of Jones Inlet, recorded 3 meter waves from the east and southeast. Water levels at Bellport were approximately 0.3 meters above normal. These conditions were similar to an early October 2015 nor'easter that also deposited a lot of sand along the eastern shore. The spit that formed then lasted less than two months but it did result in more sand in the eastern shoal area. A ridge and runnel system similar to that which we are seeing now, developed in the spring of 2013 when the breach was much narrower. The 2013 ridge and runnel system was gone by the summer. The conditions were different in 2013, so the ultimate fate of this new 2016 ridge and runnel system is unclear. It may vanish or it may be the beginning of the long expected extension of the eastern shoreline as the breach reaches some level of "maturity" and continues its clockwise rotation typical of natural inlets along the south shore.

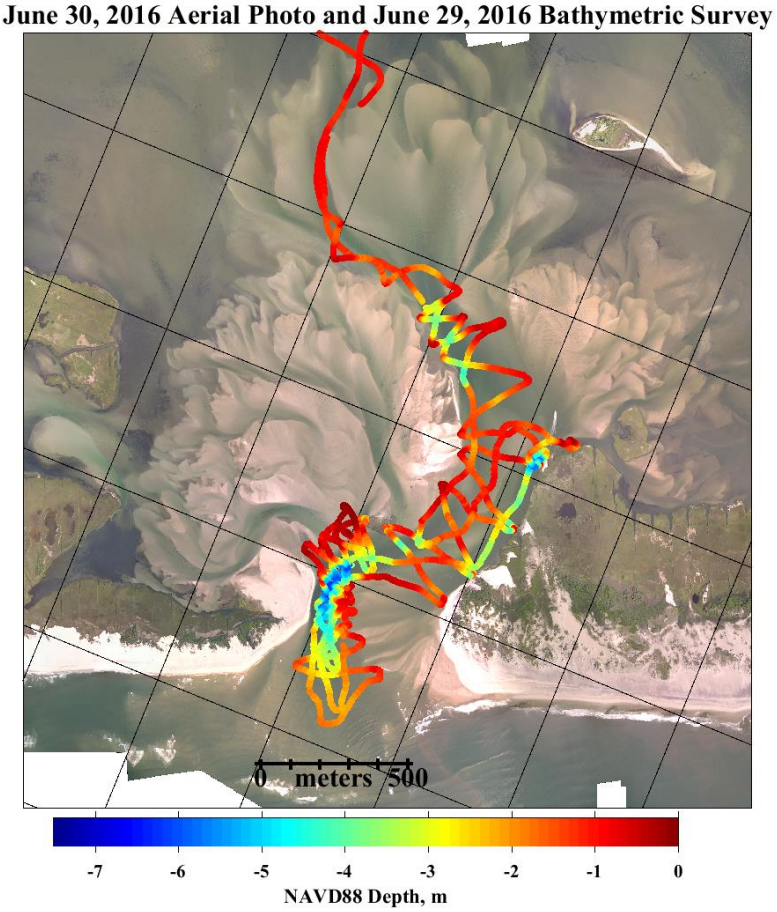

Figure 3, June 29, 2016 Bathymetric survey of the Old Inlet breach.

There was a long hiatus in our monitoring of the breach bathymetry, and so an important question was whether or not there had been a significant change in the size and location of the breach. The aerial overflights suggested that the main channel had moved west, and that is clearly the case. But what was unknown was whether the cross-sectional area had changed. On

June 29th we conducted the 16th in the series of breach bathymetric surveys with the results shown in **Figure 3**. One very noticeable thing was that with the decreased size of Pelican Island, the area just north of the breach is much more open than it had been a year earlier. Also the shoal off the eastern shore of the inlet was very pronounced with breaking waves that prevented us from surveying it in our 14 ft skiff. **Figure 3** shows that the deepest depths were about 6 meters as the main channel turned to the south along the western shoreline. In the channel to the north, there was a broad area of 1 to 2 meters depth and then some areas of more than 4 meters farther northward and right along the north shore of Fire Island. In determining the minimum cross-sectional area of the main channel, we again chose a section through the deepest portion; but because of the shallowness of the shoal, we could not carry the section all the way to the eastern shore. The section is shown in **Figure 4** where the westward migration of the main channel that had started a year earlier had progressed more than 100 meters. The breadth of the channel, not including the shallows to the east, is about 100 meters, while the cross-sectional area of the channel at this narrowest location was just over 400 square meters. The history of the cross-sectional area is that it quickly grew to 300 to 400 square meters where it stayed through 2013, increased to 500 to 600 square meters in 2014 before returning to roughly 400 square meters during the summer of 2015. So the combination of the ebb and flood deltas and the resistance of the western shore to further erosion seems to have set a limit on both the width and depth of the breach.

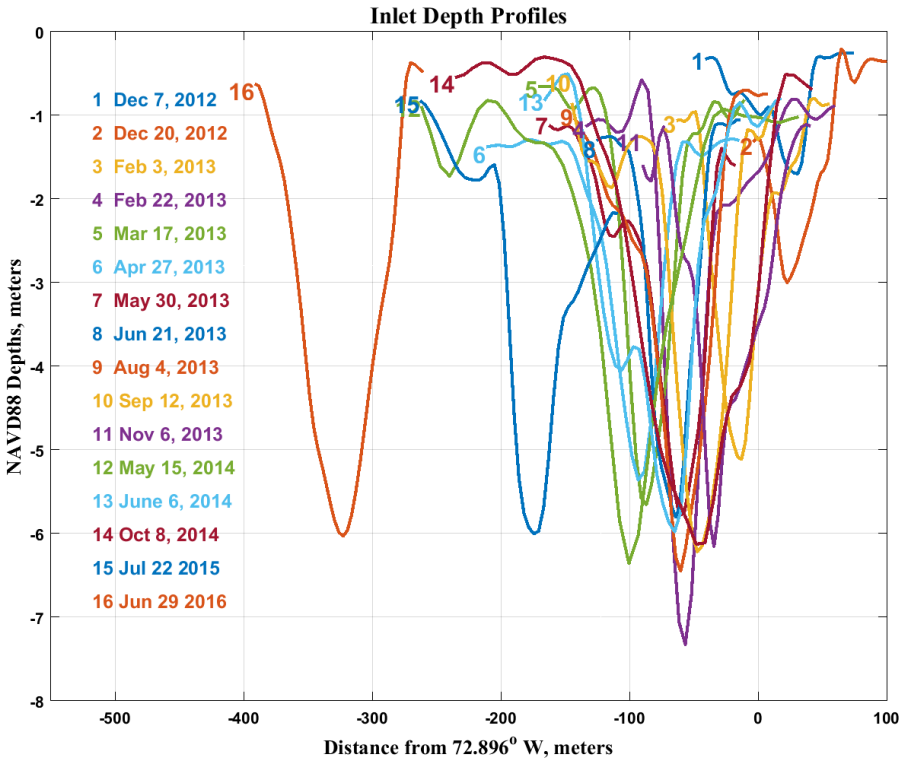

Figure 4, Depth profiles across the narrowest part of the breach channel from bathymetric surveys. Position of the profiles are relative to 72.896°W which was near the center of the initial breach location.

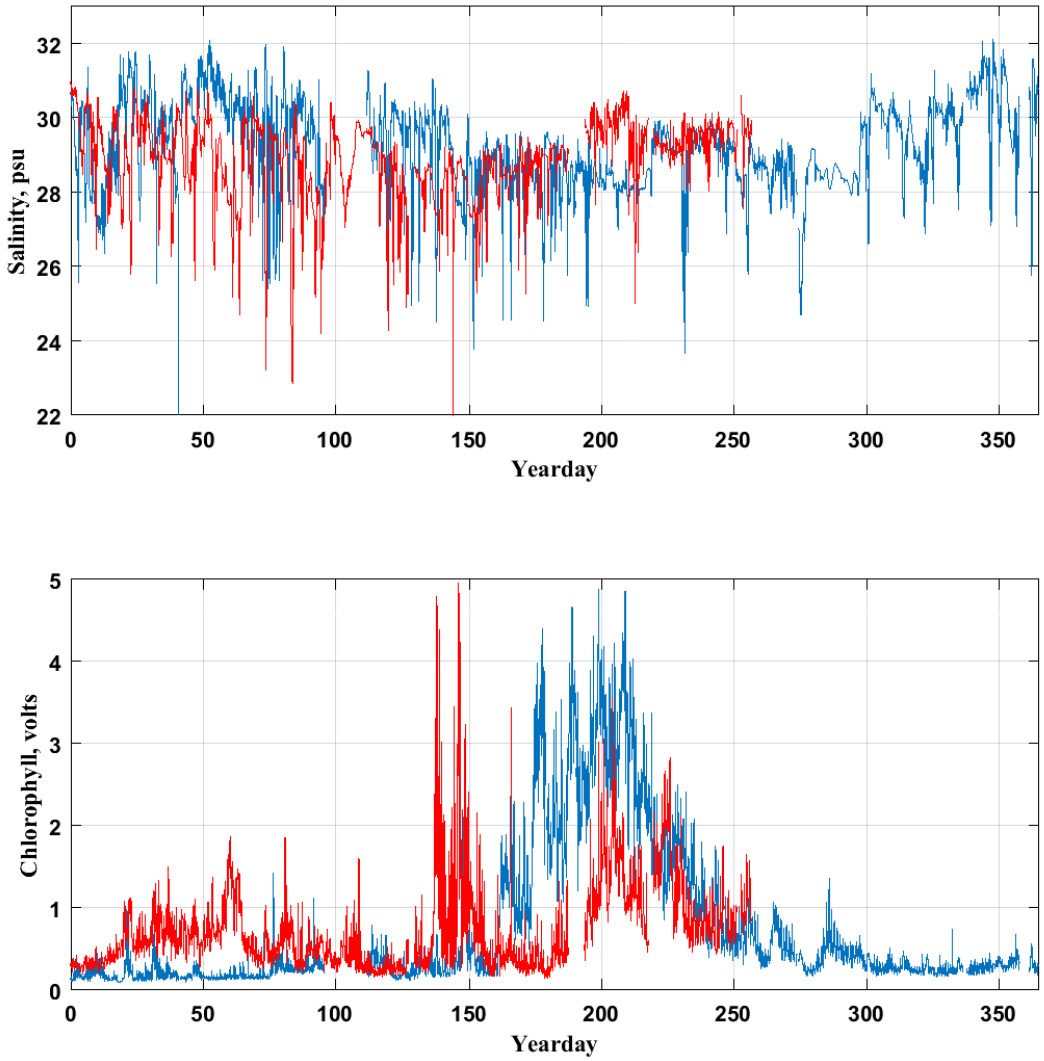

Figure 5, Comparison of salinity and chlorophyll records between 2015 (blue) and 2016 (red), versus yearday.

The above observations of the breach indicate that things are more or less stable and that the exchange of ocean and bay waters should be about the same as in the past couple of years. So does that mean that the water properties and biological responses should also be about the same? **Figure 5** shows the salinity and fluorometer/chlorophyll time series from the Bellport SeaCat for 2015 and 2016 as a function of yearday. The salinity record from Bellport is highly variable because every time there is a wind or rain event fresh water flows into the bay past the sensor from the creeks and storm drains. Nevertheless, the general pattern of the maxima shows that salinities remain much higher than before the breach when salinities were around 25 psu, but for the first half of 2016 the Bellport salinities were about 1 psu lower than during 2015. Since yearday 150 (May 30th) the salinities for the two years have been pretty similar despite the summer of 2016 being rather drier than 2015.

The chlorophyll records for the two years are markedly different. In 2015 there was a short-lived brown tide bloom starting in early June, which gave way in Bellport Bay to a stronger and longer

lasting endemic green alga bloom that gradually tapered off by yearday 250 (Sept 10th). The chlorophyll record for 2016 has been completely different. There was a very intense but short-lived Mahogany alga bloom in May, after which the waters in the Bay were clear until about yearday 190 (July 9th) when a lesser green alga bloom started. (The green alga, Brown Tide and Mohogany alga are the result of different alga species with differing impacts on the other resident fauna.) The cause for the differences between the years is not clear at this time. The winter of 2016 was noticeably warmer through March than the previous year. This plus the relatively dry spring and summer, which probably reduced the supply of nutrients from streams and ground water, may have set conditions against the Brown Tide and allowed the Mahogany alga to flourish.