Source Tracking Along Island Beach State Park and Seaside Park, New Jersey

Research Report Submitted to the Committee of the Barnegat Bay Student Grant Program

by

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Abstract

The barrier islands that form Barnegat Bay are dynamic in that they are composed of sand and are on the first line of exposure to the Atlantic Ocean. On the barrier islands, there are a number of towns that serve are year-round residences and an important part of tourism. Water quality is a concern for recreational swimming activities along the shore and its barrier islands. Inland, freshwater swimming areas are testing on a weekly basis; however there are limited means to test areas along the bay side of the estuary, especially in those areas that are not officially designated for swimming. We monitored four sites from late June through early August along the Island Beach barrier island ranging from Seaside Park (5th Ave) to the kayak launch at A-21 on Island Beach State Park. We tested for fecal coliform bacteria, chlorophyll, suspended solids, turbidity and other basic field parameters. Our results indicate that significant rainfall events cause runoff into some of these areas that could cause bacteria levels well above the maximum allowable swimming values; however during most light rainfall events and dry intervals, all of the sites tested below the maximum allowable level.

Introduction

The Barnegat Bay has already faced ecological trouble, and the arrival of Hurricane Sandy only added to the destruction of the bay. The Jersey Shore hasn't seen a storm this bad since the Storm of 1962 which swallowed the shore and had almost the same death toll. Current focuses are on restoration of businesses, dunes, and homes but what about the quality of the bay's water? This is why we went on the initiative to take on the water quality project in Island Beach State Park through Save Barnegat Bay and the Marine Academy of Technology and Environmental Science.

Barnegat Bay is approximately 1.5 meters deep at mean low water with restricted circulation caused by the shallowness and the lack of ocean breaches (Kennish et al. 2007). The semidiurnal bay has a tidal range from <0.5 to 1.5 meters and is well mixed (Kennish et al. 2007). The flushing time is approximately 70 days allowing eutrophication to easily take over the bay and create the right conditions for algal growth (Kennish et al. 2007). With these algal blooms there is an expected increase in the level chlorophyll-a concentration.

In late October 2012 when Sandy hit, it tore across the barrier islands. It washed houses, cars, and boats into the bay. The aftermath left chemical, pollutants, and toxins in

the bay as a result of the storm surge and flooding that followed. It damaged sewers, gas lines, and roadways. Some of the sand was washed into the bay and was exposed to contaminants as well. With bays like the Pensacola in Florida, it only takes a few weeks to flush out and start returning to normal (Huang et al. 2011, Figure 1). However, with Barnegat Bay's slow flushing rate, there still may be adverse remnants from Sandy still lingering.

With the additional sand, it is expected for turbidity to increase and visibility to decrease as a result of finer particles that settle on the bay floor. Barnegat Bay is a popular location for water recreation. Boating is historically a popular activity of both residents and tourists alike. In fact, there are estimates of hundreds of thousands of boats that frequent the Bay at some point over the course of a summer season (Wnek, pers. comm.). However, boat motors can kick up bottom sediment since the Bay is shallow. This material, considered mostly sand, can be comprised of differing particle sizes from course to very fine particle sizes, adding to the Total Suspended Solids (TSS). These include anything from organic particles to sediments. Another major contributor to TSS is phytoplankton, which contains chlorophyll-a. Chorophyll-a is essential for the growth plants and algae; it is also essential for further plant production. However, with increased turbidity, the visibility of the water would decrease, thus sunlight would not be able to penetrate the water for plant production, especially submerged aquatic vegetation (SAV) including eel grass (*Zostera marina*) and widgeon grass (*Ruppia maritime*), both predominant estuarine SAV types found in Barnegat Bay.

Furthermore, like most Mid-Atlantic estuaries, Barnegat Bay rarely deals with a hurricane. Little to no data is recorded on the subject of hurricane effects on lagoon type

estuaries of the Mid-Atlantic. The record rainfall events associated with tropical systems could provide information of runoff patterns within tributaries leading into Barnegat Bay and suspended material caused by the runoff in the bay. It could provide data on storm water runoff directly into the bay and components the water carries with it. Bacteria levels could be measured to determine sources and types of bacteria that are caused by runoff or discharge. Fecal coliform bacteria is an indicator of warm-blooded animals and possible human sources (which is more difficult to determine in an estuary). There may have been compromised sewer connections as a result of the storm, which could cause contamination of runoff into the Bay during a rain event.

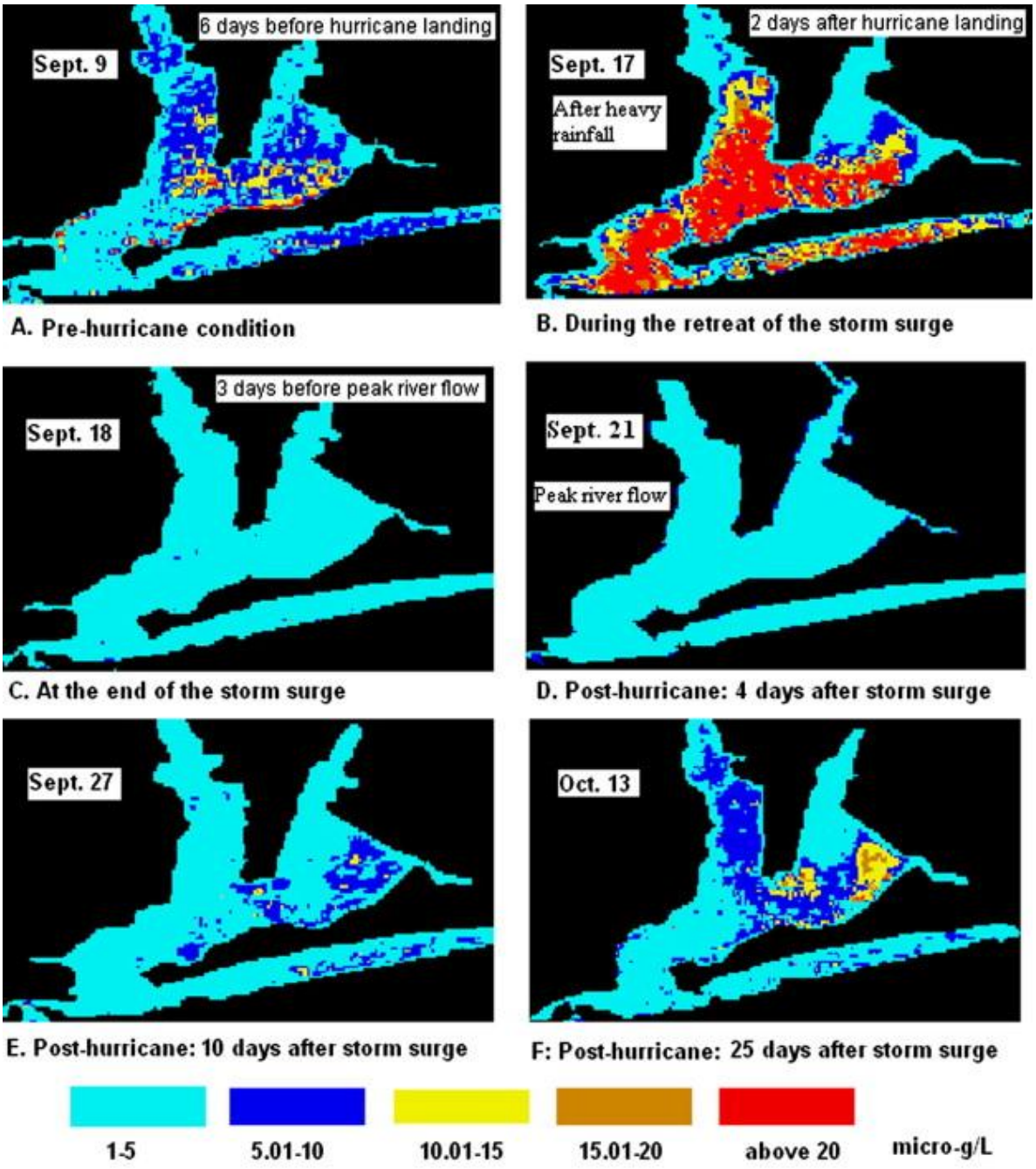

Figure 1. Recovery of Pensacola Bay, Florida, after a hurricane event.

The purpose of our project is to provide an understanding for the continuing affects of Hurricane Sandy. This study also corresponds to Governor Chris Christie's 10-Point Plan for Barnegat Bay. Our project will help set a "base line condition of the Bay" and determine areas of "water quality impairment" (Martin 2011). The team project

consists of sites along island beach picked for its use. Site one (Seaside Park) is in close proximity to houses, drainage pipes, and parks. Site two is adjacent to a primary bathing beach access along with the park office and lot with maintenance vehicles and trash containers (Bath House One trail). The third site is a popular "cove"for boaters with estimates of over 500 boats at one time (Tice Shoal, Sullivan report 2012). The fourth site is a kayak launch near the southern end of the Park which is closest to Barnegat Inlet (A-21).

Methodology

Field Procedures

Sampling was conducted weekly at four sites between Seaside Park and Island Beach State Park, New Jersey (Figure 2). Site 1 was located at the outfall pipe in the bay on 5th Avenue in Seaside Park; the rest of the sites are within Island Beach State Park. Site 2 was on the bay side of the Bath House 1 parking lot, site 3 was located at the end of the Fisherman's Walkway, more commonly known as Tices Shoal, and site 4 was at the A-21 kayak launch. Plastic bottles were triple-rinsed with sample water and filled at a depth of one foot below the surface. Additional 100-mL samples were taken in sterile WhirlPak® Thio-Bags for use

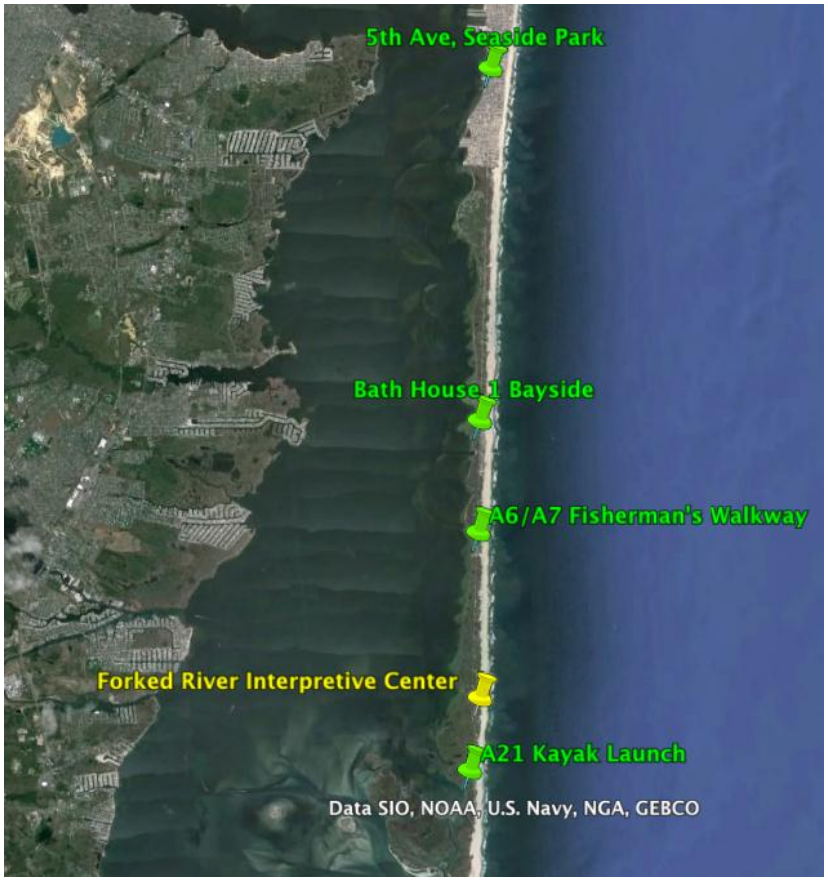

Figure 2. Map of sampling locations.

in bacterial testing. WhirlPak® samples were collected with a sampling pole at the same depth and twist-tied shut. All samples were kept on ice at approximately 4^{o} C until the samples were brought back to the lab for further analysis after all samples were collected. We took field measurements at each site using a YSI 556 and an Oakton pH meter, with backup ExTech® meter used to verify pH. A list of water quality parameters collected at each site can be found in Appendix A. Each week, one location at random was selected for a duplicate sample to comply with NJDEP Quality Assurance/Quality Control (QA/QC) standards (Appendix A). Time, weather conditions, tidal stage, recent rainfall events, and on-site observations were recorded at each location as well.

Special interest Tices Shoal

In response to NJDEP interest in the Tices shoal site due to heavy human usage and a presence of fecal coliform colonies in the July 9^{th} bacterial analysis, we began taking two samples at that location each week in addition to the duplicate. Double-sampling of Tices shoal began on July 16^{th}. A second sample was taken in the both plastic bottles and WhirlPaks® at a distance of fifty yards from the original sample. More detailed observations of the site and an estimate of the number of boats present at the time were recorded to determine possible anthropogenic and natural causes of increased bacterial presence.

Lab Procedures

Turbidity. Turbidity measurements were taken using a LaMotte 2020WE Turbidimeter. After rinsing with distilled water, a glass cuvette was filled to the 10 mL line with sample water from the plastic sample bottles. A blank was also prepared with distilled water. The outside of the cuvettes was wiped with a KimWipe to clear the surface of fingerprints and other obstructions to the reading. The blank was scanned first, followed by the sample, to obtain the turbidity value in Nephelometric Turbidity Units (NTUs). This process is repeated three times from each sample in accordance with NJDEP QA/QC.

Chlorophyll. Chlorophyll measurements were taken using an AquaFluor® fluorometer. The plastic cuvettes used for this test were rinsed three times and were prepared the same way as the turbidity test, with a sample cuvette and a blank with distilled water. The cuvettes were wiped with a KimWipe and scanned on the meter's channel B to obtain Chlorophyll A values. The results were unit-less and therefore relative, but a chlorophyll curve was created using various known concentrations (Figure 3) to obtain Chlorophyll A values in ug/L. The process was repeated three times in the same manner as turbidity for quality control.

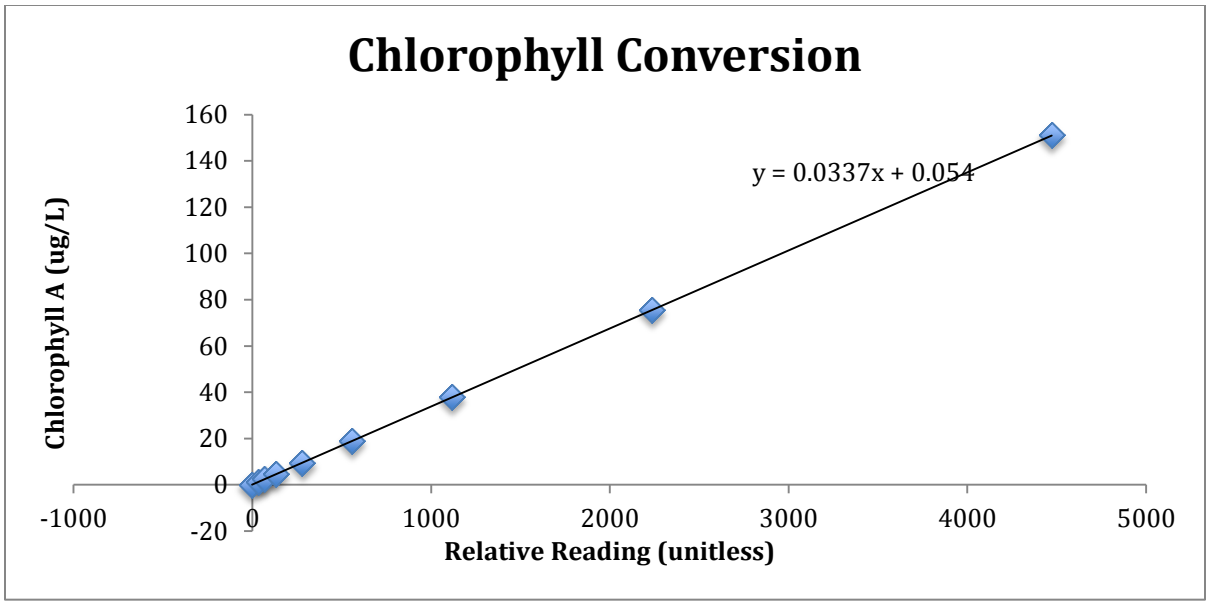

Figure 3. Known chlorophyll A concentrations and approximate linear relationship between relative readings and chlorophyll levels in ug/L.

Total Suspended Solids. Total suspended solids were measured for each sample using an Erlenmeyer flask fitted with a Buchner funnel and a small vacuum (Figure 4). Filter paper was cut to the size of the Buchner funnel and an initial mass of the paper was recorded using an analytical balance. We used 100 mL of sample water from the plastic bottles to pour over the filter paper and the vacuum filter the water through the funnel and into the flask. Once the water was filtered through, the filter paper was rinsed with distilled water to flush out any remaining salt ions that could interfere with the

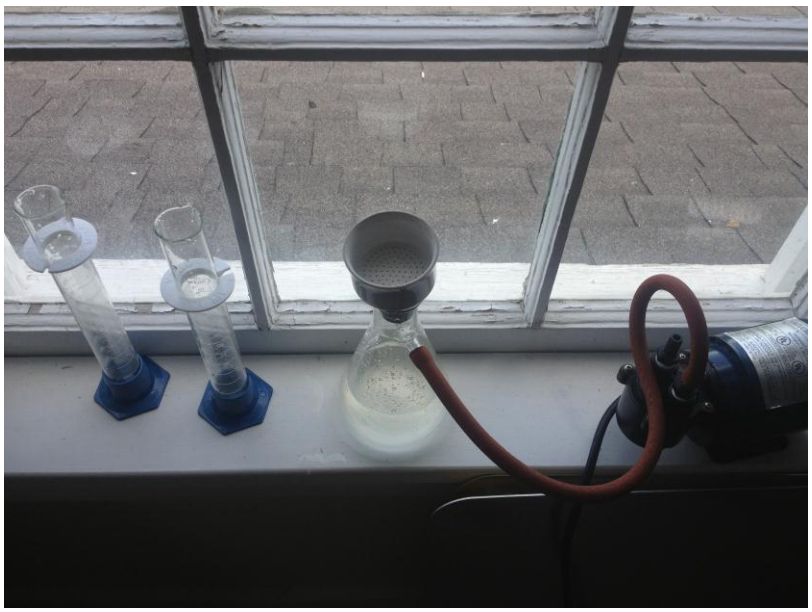

Figure 4. Vacuum filtration system used to obtain total suspended solids.

final mass reading. The filter paper was then removed from the funnel using forceps and left to dry on a plastic tray for 24 hours. After it completely dried, the final mass was recorded on an analytical balance (g). The initial mass subtracted from the final yields total suspended solids in g/100 mL of water.

ColiScan® EasyGel Bacterial Analysis. Coliscan® EasyGel was the chosen method of bacterial analysis because the procedure and values accepted by the NJDEP and comply with NJDEP QA/QC standards (for freshwater). Sterile latex gloves were worn throughout the entire procedure. The EasyGel was prepackaged in small plastic bottles, to which 1 mL of sample water from the WhirlPaks® was added. After shaking the bottle to mix the contents, the gel was poured into a sterile petri dish and left to solidify for approximately thirty minutes. The petri dish was then capped, inverted and incubated at 37^{o}C for 24 hours. After the incubation period has ended, the number of colonies were counted and separated by color. The ColiScan® procedure identifies purple and blue colonies as fecal coliform bacteria. Pink colonies were considered total coliform bacteria and are not of harmful strains. The number of colonies in each category is adjusted to yield a result in Colony-Forming Units (CFU) per 100 mL of water. It is important to note that the NJDEP swimming standard for fecal coliform presence is 200 CFU/100 mL.

IDEXX Enterolert® Bacterial Analysis. After finding fecal coliform bacteria on several occasions, we added an enterococcus test to supplement the ColiScan® procedure by verifying the results. The IDEXX Enterolert® procedure was relied on by the

Environmental Protection Agency as the federal standard for water quality at public saltwater beaches in place of fecal coliform because of a possible stronger correlation between enterococcus bacteria and human pathogens. To determine the concentration of enterococcus in CFU/100 mL, we created a 10% dilution using 10 mL sample water from the WhirlPaks® and 90 mL distilled water. In accordance with the procedure, one packet of Enterolert® medium was added to the dilution and shaken until fully dissolved. The solution was then poured into the sterile well plate and sealed using an IDEXX Quanti-Tray® Sealer. Gloves were worn throughout this procedure as well. The sealed wells were incubated for 24 hours at 41^{o} C and then examined under a blacklight. The number of large and small wells that glow is recorded and converted using the Enterolert® conversion table to obtain a result in CFU/100 mL water. The federal swimming standard for enterococcus bacteria is 104 CFU/100 mL water.

Meter Calibration.

YSI 556. The YSI 556 was calibrated weekly to abide by NJDEP QA/QC standards. NJDEP-issued solution standard was used to calibrate for conductivity. A sponge saturated with distilled water, representing 100% saturation, was used for dissolved oxygen calibration. The conductivity and dissolved oxygen were tested using solutions of known conductivity and oxygen content, respectively, before the meter was used for sampling each day.

Oakton 110 pH meter. The pH meter was calibrated using a

three-point calibration with standards of pH 4.0, 7.0, and 10.0. The meters were tested in a 7.0 solution at each site in accordance with a 0.1 allowable pH variation from the buffer for proper function.

Results and Discussion

Bacterial Analysis

Location. Each of the four sites exceeded the NJDEP swimming standard for the ColiScan® test one or more times. Out of the 28 samples collected in total throughout the project not including duplicates, 12 of them exceeded the allowable levels. A map of bacterial spikes by location is shown in Figure 5. The Seaside Park site at 5th Avenue and Tices Shoal exceeded the most times (Figures 6 and 7). These two sites also have the highest amount of human activity; Seaside Park contains an outfall pipe as well. It is unclear as to the specific source of the bacteria, but in general lower bacteria levels were found at sites with little or moderate human interaction with the water.

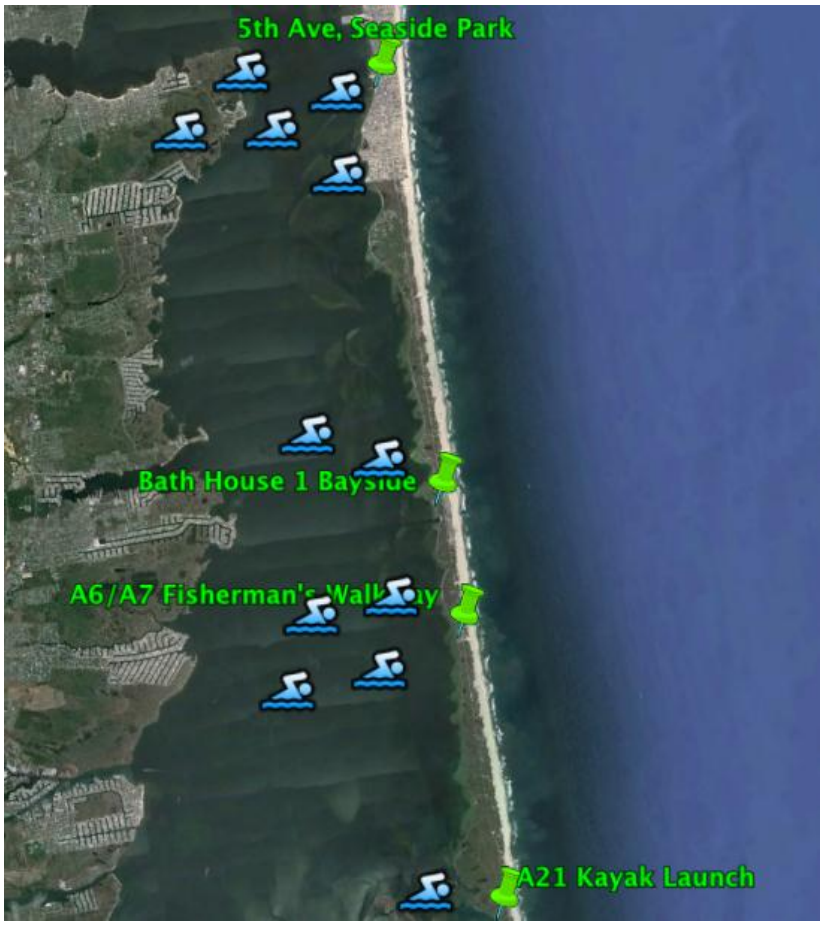

Figure 5. Each blue graphic corresponds to one day of sampling where the bacterial levels exceeded the NJDEP swimming standard.

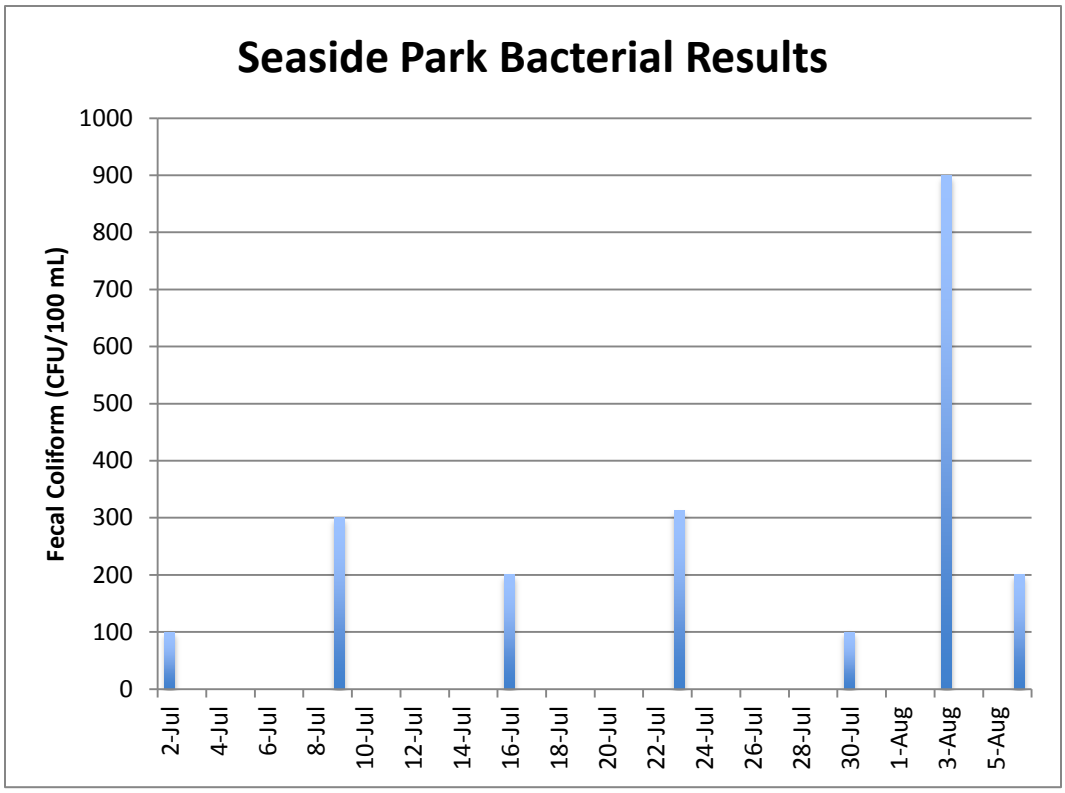

Figure 6. Bacterial results from Seaside Park at 5th avenue. Note that the NJDEP limit for swimming is 200 CFU/100 mL water.

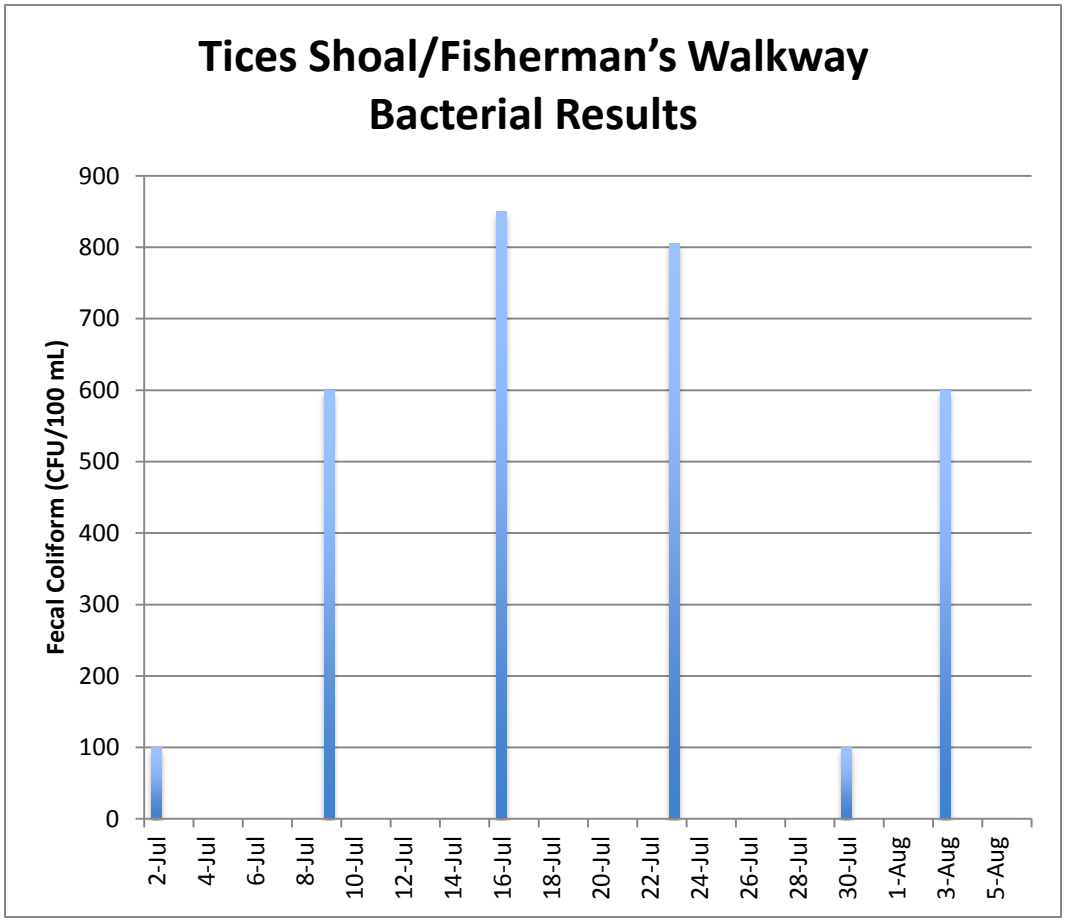

Figure 6. Bacterial results from Tices Shoal.

Rainfall. Bacterial results were also analyzed with respect to rainfall events to determine if higher bacterial levels correlated with rainfall events. On the days with heaviest rainfall in the past 24 hours, some or all of the sites exceeded the allowable levels. Seaside Park and Tices Shoal samples exceeded levels during every rainfall event but one. The A21 kayak launch samples were generally not affected by rainwater and only exceeded one time, and the Bath House 1 site exceeded only on two days. Bacterial levels were exceeded on days of no rainfall at several sites as well, but the reason for these spikes is still unclear.

Table 1. Describes which sites exceeded allowable swimming levels on each date and specifies any rainfall events within the preceding 24 hours.

Date	Seaside Park	Bath House 1	Tices Shoal	A21 Kayak Launch	Rainfall (past 24 hrs)
July 2	No	No	No	No	Yes, light
July 9	Yes	No	Yes	No	Yes, moderate
July 16	Yes	No	Yes	No	Yes, moderate
July 23	Yes	Yes	Yes	Yes	Yes, heavy
July 30	No	No	No	No	No
Aug 3	Yes	Yes	Yes	No	No
Aug 6	Yes	No	No	No	No

Turbidity, TSS, and Chlorophyll

Samples analyzed for Turbidity, TSS, and Chlorophyll were inconclusive. There was a general trend of average turbidity and TSS reading lower on days with no rainfall but taken as a whole there was no statistical correlation between turbidity or TSS and rainfall. The highest turbidity levels were seen at Seaside Park because of a higher concentration of fine sand, as opposed to the more coarse sand that is found at the other three sites (through general observations).

Conclusions

In response to the higher bacterial levels that were found, especially at 5th Avenue and Tices Shoal and after some rainfall events, we recommend that more sampling be done at these two sites and after it rains in order to determine whether the water is for boaters and swimmers on any given day. We also recommend that an advisory be issued to visitors to these two sites on days where the bacterial levels do exceed the safe swimming standard. Or, a general announcement be made that "if, within 24 hours of a rainfall event, be advised that any water recreation in this areas may pose a health problem as this location is prone to a higher level of bacteria". We recommend that more methodical bacteria bacterial testing be conducted at Seaside Park (5th Avenue) and along the Tice Shoal areas to further pinpoint the source of higher bacterial levels.

Acknowledgements

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