Analysis of Anthropogenic Effects at Tices Shoal

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Abstract

Tices Shoal on the Barnegat Bay side of Island Beach State Park is commonly used as an anchoring spot for watercraft. Human usage, the effect of watercraft, and pets in the water can make a vast difference in water quality, which in turn can be a problem for people who conduct activities along the Tices' bay shoreline. Water quality tests were performed to indicate whether there was a correlation between boat densities and water quality parameters. Bacteria, such as fecal coliform at levels 200 colonies or greater per 100 ml (threshold level) of sample indicate levels that are not safe for humans to swim. Fecal coliform levels were noted on three separate occasions to be higher than the allowable swimmable limit, both on days with high and low traffic. While levels were not found to be high at all times and in all areas, it raises several questions about future water-based activities at Tices and the problems with managing this popular anchoring location.

Introduction

There is a commonly inhabited "area located on the bay side of Island Beach State Park, just East of Buoy #40" ("About"). This area is known as Tices Shoal and is a frequent hangout of people of all ages. Tices is reached via watercraft through Barnegat Bay and is directly east of Lacey Township, New Jersey. From the shoal, there is access to Island Beach State Park through a path known as Fisherman's Walkway. This path allows people to travel from their boats on the bay side to the beach on the Atlantic Ocean in just a few short steps. Tices Shoal is also home to an annual event known as "Bay Bash" in which local radio stations host shows on the water and people 'park' their boats in the shoal to enjoy the festivities. There have been occasions where boats have been counted "in excess of 1000" ("About").

Barnegat Bay is one of 28 estuaries in the United States designated as part of the National Estuary Program. It is considered a highly eutrophic system (Barnegat Bay Characterization Report) which is a result of anthropogenic effects. Understanding human activity and how it relates to habitat quality is important. In other words, what are effects of boat traffic in Barnegat Bay to submerged aquatic vegetation (SAV) beds, bottom sediment, and the presence/absence of fauna. This study focuses on the density of boats along the Tices Shoal shoreline and effect on water quality. If there is an effect, this study quantifies such effects.

Figure 1: The image above depicts a typical weekend day at Tices, shown by aerial view. Photo taken August 25, 2013. (Justin Auciello)

Due to the high concentrations of boats, people, and pets (mainly dogs) that spend time at Tices, it was deemed important to see how these parameter effect the water quality.

Figure 2: The image above shows the six sampling sites at Tices Shoal and which numbers correlate to which locations.

Methodology

Field Procedure

On scattered weekend days throughout the summer of 2014, samples were taken and tests were run to analyze the effects. Six sample locations were chosen around Tices Shoal as well as control points outside of Tices to the north and south. On each sampling day, a team member took readings using a YSI 556 meter (called “YSI” throughout) at the north control point, the base of Tices, and the south control point. The YSI meter was used to determine water temperature (C), specific conductivity (uS/cm), total dissolved solids (TDS, g/L), salinity (PPT), dissolved oxygen (DO, mg/L or ppm), and pH. The specific conductivity of the water is the ability of the water to conduct electrical current; this helps to detect contaminants in the water and can help determine how pure the water is. In addition to meter testing, water samples were taken at the six Tices locations and both control locations each day of sampling. These water samples were used to test the levels of chlorophyll, turbidity, total suspended solids (TSS), and coliforms (ug/L). Chlorophyll is measured to detect if there are algal blooms as well as to determine phytoplankton concentrations. Turbidity tells us the clarity of the water and can indicate how deep one can see. All tests performed were indicators of the quality of the water.

In order to take samples, the team handled two different sampling activities each sampling day. One group took the YSI meter to the North control, Tices control, and South control locations and recorded the readings. To obtain proper readings, the team ensured the probe was completely submersed and rapidly moved the probe through the water stream to provide a fresh and active reading to the meter. Equipment was used in accordance with the NJ DEP in-field analysis used during the June 27, 2014 training that passed the NJDEP Office of Quality Assurance-required Performance Tests. Equipment used to perform the sampling and in-field analysis were maintained and operated according to the "Regulations Governing the Certification of Laboratories and Environmental Measurements", N.J.A.C. 7:18. Approval to continue using said equipment, referenced above, shall expire on June 30, 2015.

This group also used sterile WhirlPak® bags to obtain water samples from the North and South control sites for bacterial testing. Samples were collected by opening the seal of the bags and opening the mouth of the bag to retrieve the sample roughly "two feet" under water. The samples were then sealed by tightly folding over the tab and securing the aluminum wire shut, ensuring the samples would not leak and no contaminants could get into our samples before they were run. The sample bags were stored on ice until they were brought to the lab to be tested. The second team took WhirlPak® bags to Tices Shoal and took samples following the same procedures at six predetermined sample locations around the shoal. In addition to taking the samples around Tices, the second team counted the number of boats and dogs at Tices during the sampling period.

Lab Procedure

Upon returning to the lab, several tests were performed. In the lab, there were two AquaFluor® Handheld Fluorometer/Turbidmeters. One meter was preset to measure turbidity and the other to measure chlorophyll. All meters were calibrated using a certified standard through the NJDEP Bureau of Marine Water Quality. More specifically, a plastic cuvette was rinsed using distilled water prior to each test and then filled and rinsed with sample water. After being rinsed with the sample water, a sterile pipette was used to fill the cuvette with sample water and the cuvette was wiped down using KimWipes. The cuvette was then inserted into the machine set to read chlorophyll and the values were recorded. The cuvette was then transferred to the other AquaFuor® and the turbidity read was taken. This procedure was repeated with each water sample.

The AquaFluor® Handheld Fluorometer produced a chlorophyll value that was unit-less and needed to be converted into a measurable value. Figure 3 below was used to complete the conversion and returns values in ug/L. The values received were also compared to the Rutgers University flyover data to ensure accuracy in our readings. The values found once converted aligned with the values shown in the flyover data, showing that the samples were properly obtained and run and the testing instrument was properly calibrated.

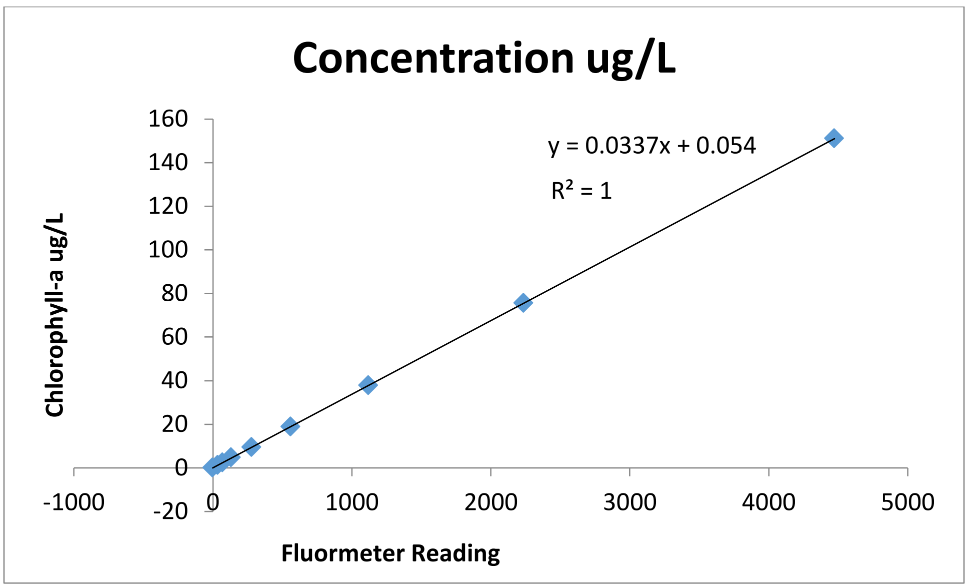

Figure3: The graph above shows the chlorophyll concentration conversion between the reading given by the fluorometer and ug/L. The formula in the top right was used to convert all values.

The next test run was the ColoScan EasyGel®. For each water sample, one ml of sample water was added to a proportioned EasyGel bottle using a sterile pipette. The mixture was then carefully shaken, avoiding aerating the sample and causing bubbles to appear. This mixture was then poured into a pre-labeled, sterile petri dish and left uncovered to solidify. This process was repeated with each water sample obtained. Once all gels had fully solidified, the tops to the petri dishes were placed back on and the dishes were inverted and put into an incubator set to 35°C for 24 hours.

In addition to these tests, a fourth test was run to fine the total suspended solids found in the water. For this test, 100ml of sample water was measured using a graduated cylinder (rinsed using distilled water prior to each new sample). Filter paper was cut to fit into a Buchner Funnel and was weighed prior to each test. This initial weight was recorded. The Buchner Funnel was placed into an Erlenmeyer flask and a vacuum was attached to the flask via a hose. For each test, the filter paper was placed in the funnel and the vacuum was turned on. The sample was then slowly poured into the funnel and stayed on until all water was sucked through the funnel and into the flask by the vacuum. The filter paper was then removed using tweezers and placed onto a pre-labeled board to finish drying overnight (Figure 3). This procedure was repeated with each sample.

Figure 4: The image above is an example of a set of filtered TSS samples drying on the label board.

On the day after sampling, 24-30 hours after these tests were completed, one member of the team would return to the lab and reweigh each of the filter papers used in the TSS tests.

They would then take the weight for each sample and subtract the initial filter paper weight from the new weight to determine the weight of TSS in 100 ml of sample water. In addition the finishing the TSS test, the team member would then remove the ColiScan EasyGels from the incubator and record all growth shown for each sample site. Once all data was recorded and pictures were taken, the filter papers were discarded and the ColiScan EasyGels were sanitized using Lysol Disinfecting Spray and properly disposed of.

Results and Discussion

In Appendix A, all data is compiled by date. The data collected was analyzed to compare a variety of parameters and see what correlations were present. Results were recorded on site in lab notebooks and were later transcribed into an excel spreadsheet.

Figures 5 and 6 below both represent the Chlorophyll data that was measured during testing. When viewing chart 2, it appears that the levels of chlorophyll are relatively uniform except for a few spikes in values on the 26^{th} of July and a few at the North control location. Figure 6 removes the abnormally high value on June 28^{th} at the North control site and allows more visibility to the change in chlorophyll levels at the different locations on the different dates.

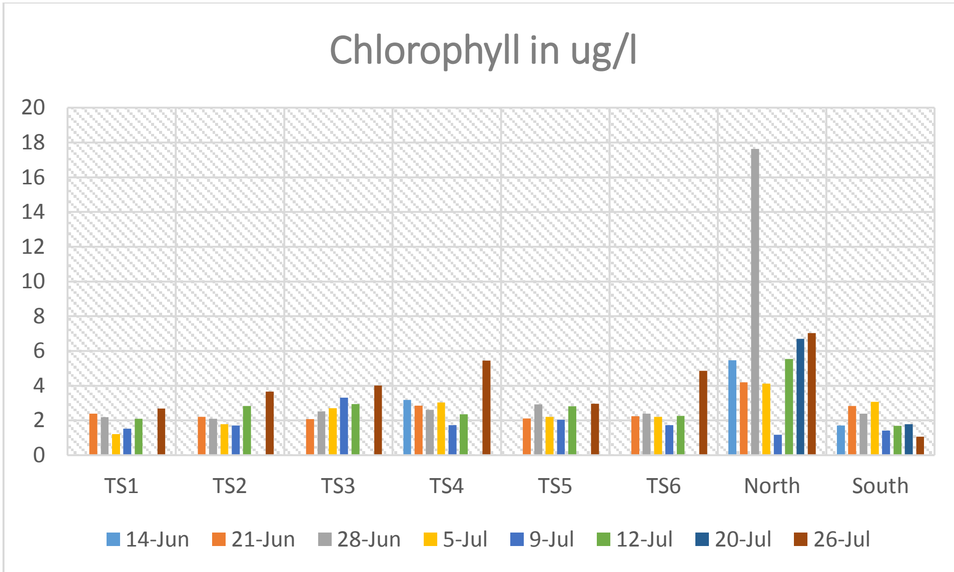

Figure 5: Chlorophyll data in ug/l for all locations on all dates recorded.

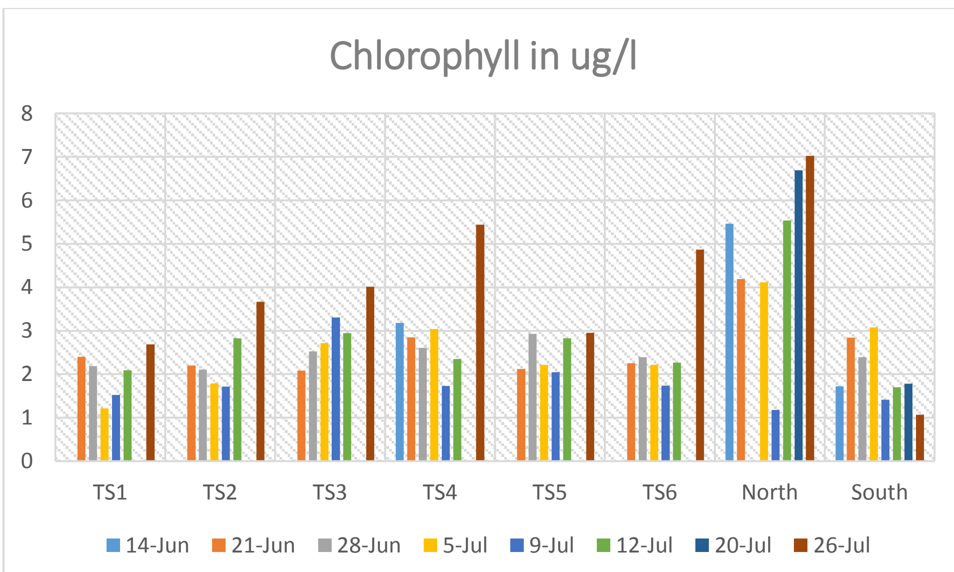

Figure 6: Chlorophyll data in ug/l for all locations on all dates. Except for the North control point on June 28, 2014. This gives a more in depth view of the changes in chlorophyll levels.

There does not appear to be a steady change in the chlorophyll levels in the same location on different dates. TS3 appears to have steadily increasing chlorophyll levels over the course of the summer while TS4 seems to be on more of a decline for the first few weeks (Figure 6).

In addition to the chlorophyll levels, we took a look at the turbidity of the water at Tices Shoal and if there seemed to be any correlation between the turbidity and the number of boats present. In Figure 7 below, it is clearly visible that TS4, North, and South all have higher turbidity values. These three locations are those closest to the shoreline and can be heavily affected by the tides. Figure 8 compares the turbidity data for June 21st with July 12th. June 21st, there were only three boats recorded at Tices during the time of testing. On July 12th, we had the highest boat population recorded during the course of our study with over 600 boats reported. As seen in chart 5, there is not much change in the turbidity values, showing that the boats are not appearing to affect the turbidity of the water.

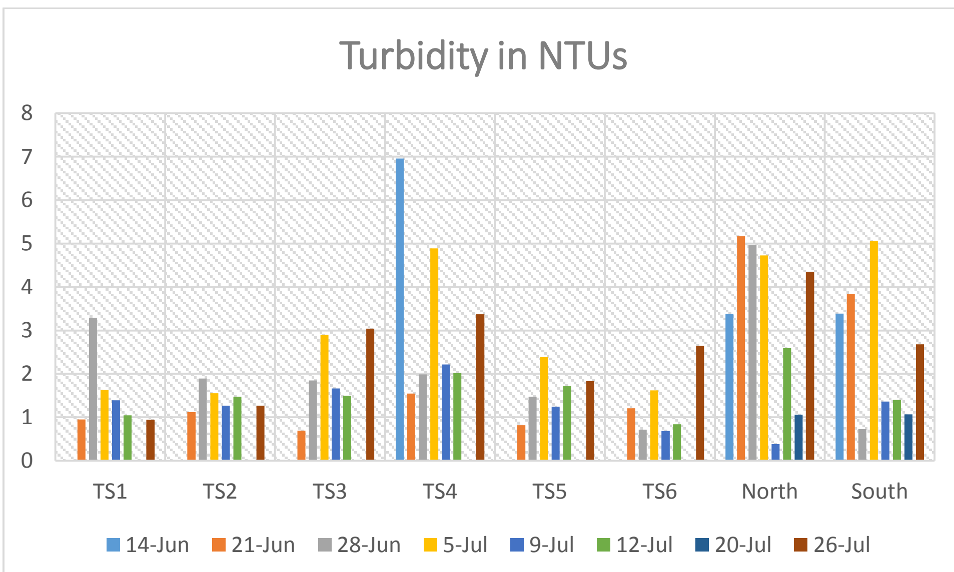

Figure 7: Turbidity data in NTUs for all locations on all dates recorded.

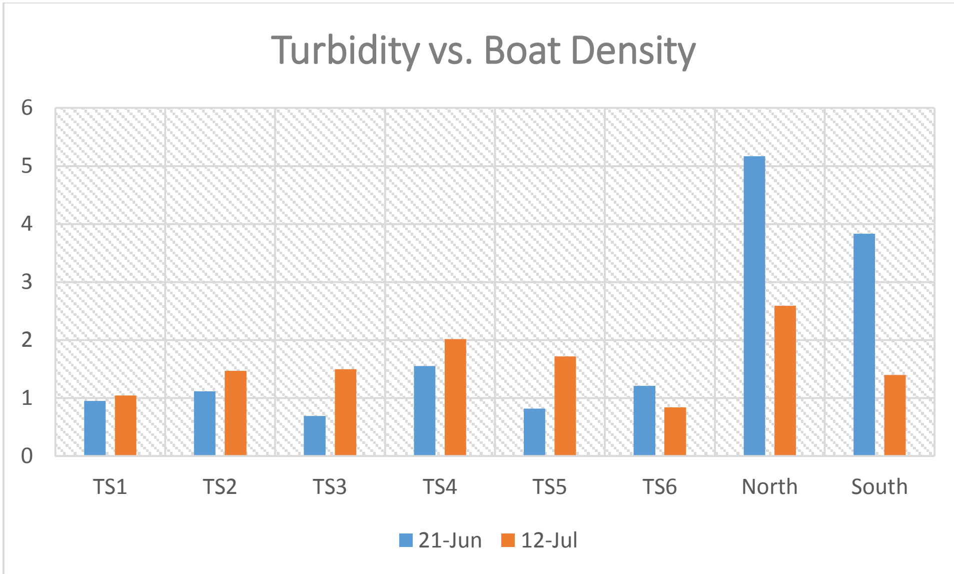

Figure 8: Comparative turbidity data for a date with the lowest recorded boat count (June 21st – 3 boats) with the highest recorded boat count (July 21th – 600+ boats). There does not appear to be a significant chance due to boat density.

Testing was also done to determine the levels of fecal coliforms in the level. It is mandated that anything over 200 organisms per 100 ml (or two colonies) is not safe and above the swimmable limit. While on majority, the water did have a concentration of 200/100ml or less, there were a few instance when the levels were very high and unsafe for swimming. There were four instances of fecal coliform levels being between 500/100ml and 800/100ml (Figure 9). June 21st, June 28th, and July 12th all had abnormally high levels of fecal coliforms at Tices Shoal found at data points TS3, TS4, and TS5. These points encompass areas close to the shore and to the south. Amongst these dates there were occasions where the tide was incoming and as well as occasions where the tide was outgoing. On July 12th, there were 600+ boats present and on June 21st there were only three boats present; this raises the question whether the boats and their occupants are causing the spikes in fecal coliform levels.

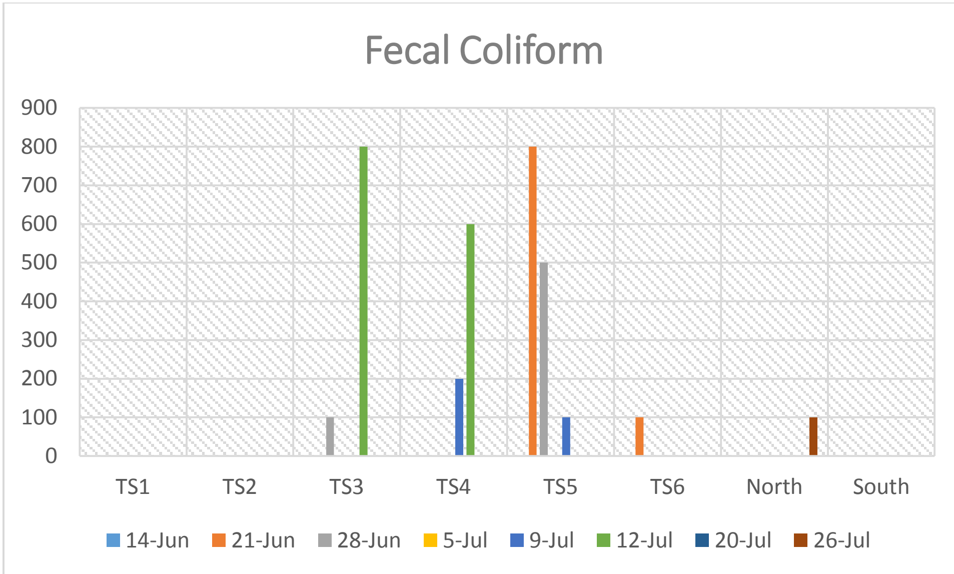

Figure 9: Fecal coliform data in organisms/100ml for all locations on all dates recorded.

Conclusion

There does not appear to be a true correlation between the boats and their occupants and the turbidity or fecal coliform levels. June 21st and July 12th were two dates used heavily in the comparisons due to their drastic differences in boat counts. Both dates exhibited similar turbidity values as well as abnormally high levels of fecal coliforms. More investigations need to take place to determine the cause of the spikes in fecal coliform levels. Both dates did however show that multiple canines were present on both dates which could cause the elevated levels of fecal coliforms. Less than 50% of the dates tested showed unsafe levels; therefore, at this time, I do not believe it is critical to shut down Tices.

References Cited

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Appendix A

	Tices Shoal							
	TS1	TS2	TS3	TS4	TS5	TS6	North	South
Chlorophyll Reading				92.73			160.4	49.45
Chlorophyll Concentration (ug/L)	x	x	x	3.179001	x	x	5.45948	1.720465
Turbidity	x	x	x	6.957	x	x	3.378	3.384
TSS								
Fecal Coliform								
Other Coliforms								
Water Temp (C, add 0.15 C to correct the meter)						19.76	19.37	19.83
Spec. Cond. (mS/cm)						32.17	30.33	41.66
TDS (ppt)						20.92	19.72	27.07
Salinity (ppt)						20.14	18.87	26.75
DO%						86.3	74.3	97.4
DO ppm						7.02	6.11	7.57
pH						6.64	6.57	6.72
YSI test time							11:00	
Boat count:	3 boats and 1 dog							
high tides:	12:27							
Notes: Tide coming in during testing. We were only able to do coliform samples at control south due to the lab not being opened. Also due to the lab not being opened we were told to only do TS4 which is the closest to the shore.								

Table A1: The above table displays all data recorded on 6/14/14.

	Tices Shoal							
	TS1	TS2	TS3	TS4	TS5	TS6	North	South
Chlorophyll Reading	69.64	63.83	60.17	82.91	61.27	65.22	122.7	82.76
Chlorophyll Concentration (ug/L)	2.4009	2.2051	2.0817	2.8481	2.1188	2.2519	4.189	2.843
Turbidity	0.949	1.116	0.693	1.55	0.818	1.208	5.166	3.834
TSS	0.015	x	x	0.015	0.013	0.011	0.013	0.015
Fecal Coliform	0	0	0	0	800	100	0	0
Other Coliforms	2 other	0	3 other	4 other	35	15	33	0
Water Temp (C, add 0.15 C to correct the meter)						24.9	25.91	23.95
Spec. Cond. (mS/cm)						38.75	38.43	43.74
TDS (ppt)						25.31	24.62	28.43
Salinity (ppt)						24.77	24.01	28.21
DO%						95.6	41.7	107
DO ppm						6.9	2.97	7.67
pH						8.11	7.46	8.06
YSI test time						10:50	10:30	12:00
filter paper								
Boat count:	3 boats, 2 dogs							
high tides:	6:24	19:02						
Notes: Tide going out while testing								

Table A2: The above table displays all data recorded on 6/21/14.

	Tices Shoal							
	TS1	TS2	TS3	TS4	TS5	TS6	North	South
Chlorophyll Reading	63.2	60.82	73.36	75.73	85.28	69.48	521.8	69.48
Chlorophyll Concentration (ug/L)	2.18384	2.103634	2.526232	2.606101	2.927936	2.395476	17.63866	2.395476
Turbidity	3.292	1.891	1.847	1.985	1.47	0.713	4.97	0.732
TSS								
Fecal Coliform	0	0	100	0	500	0	0	0
Other Coliforms	5	12	7	17	1	6		
Water Temp (C, add 0.15 C to correct the meter)						25.95	26.64	21.79
Spec. Cond. (mS/cm)						35.74	34.84	40.6
TDS (ppt)						23.97	22.63	26.37
Salinity (ppt)						22.35	21.85	25.98
DO%								
DO ppm						7.2	7.87	7.27
pH						8	8.2	8.1
YSI test time						10:50	10:30	11:20
Boat count:	95-100							
high tides:	12:25							
Notes: Tide coming in while testing. Chlorophyll data for the North end seem overly high. If decimal point was off it would be too low. Skewed results could be due to difficult sampling location. Will have sampling pole for future use. This would also attribute to the high turbidity, etc. YSI values for the North data point seem normal, only data from the whirl pack sample taken seem off.								

Table A3: The above table displays all data recorded on 6/28/14.

	Tices Shoal							
	TS1	TS2	TS3	TS4	TS5	TS6	North	South
Chlorophyll Reading	34.47	51.39	78.92	88.54	64.18	64.16	120.6	89.65
Chlorophyll Concentration (ug/L)	1.215639	1.785843	2.713604	3.037798	2.216866	2.216192	4.11822	3.075205
Turbidity	1.628	1.557	2.901	4.89	2.384	1.62	4.728	5.06
TSS		0.014	0.015	0.015	0.006	0.049	0.026	0.026
Fecal Coliform	0	0	0	0	0	0	0	0
Other Coliforms	0	1 white	0	1 white	0	0	4 pink	0
Water Temp (C, add 0.15 C to correct the meter)						24.18	25.52	23.76
Spec. Cond. (mS/cm)						39.22	36.81	22.67
TDS (ppt)						25.49	23.92	14.73
Salinity (ppt)						24.99	23.26	13.68
DO%						107.7	83.8	108.6
DO ppm						7.83	60.1	8.49
pH						8.09	7.83	6.32
YSI test time						12:30	12:50	1:05
Boat count:	500 on 6th							
high tides:	4:36	17:52						

Notes: North end had a high snail population. Tices appears boat count has doubled at YSI testing since samples were taken. There were two people clamming at the south testing location. Low tide was at 11:22 AM. When YSI test was taken, tide was beginning to come in. When samples were taken at TS1-6, the tide was going out and approaching low tide.

Table A4: The above table displays all data recorded on 7/5/14.

	Tices Shoal							
	TS1	TS2	TS3	TS4	TS5	TS6	North	South
Chlorophyll Reading	43.66	49.41	96.49	49.7	59.09	49.89	33.26	40.36
Chlorophyll Concentration (ug/L)	1.525342	1.719117	3.305713	1.72889	2.045333	1.735293	1.174862	1.414132
Turbidity	1.391	1.267	1.661	2.216	1.243	0.688	0.383	1.359
TSS								
Fecal Coliform	0	0	0	200	100	0	0	0
Other Coliforms	1	8	26	16	15	4	0	0
Water Temp (C, add 0.15 C to correct the meter)						25.53	26.09	22.89
Spec. Cond. (mS/cm)						43.77	43.14	45.8
TDS (ppt)						28.45	28.04	29.77
Salinity (ppt)						28.2	27.74	29.72
DO%						111.8	91.2	112.9
DO ppm						7.8	6.31	8.18
pH						6.8	6.6	6.86
YSI test time						10:55	10:40	11:10
Boat count:								
high tides:	8:27	21:01						
Notes:								

Table A5: The above table displays all data recorded on 7/9/14.

	Tices Shoal							
	TS1	TS2	TS3	TS4	TS5	TS6	North	South
Chlorophyll Reading	60.54	82.33	85.7	68.19	82.26	65.69	162.8	48.81
Chlorophyll Concentration (ug/L)	2.094198	2.828521	2.94209	2.352003	2.826162	2.267753	5.54036	1.698897
Turbidity	1.043	1.471	1.498	2.016	1.715	0.838	2.591	1.398
TSS								
Fecal Coliform	0	0	800	600	0	0	0	0
Other Coliforms	0	1 other (1 pink)	6 other (6 pink)	2 other (2 pink)	0	7 other (5 pink, 2 white)	23 other (11 pink, 12 white)	0
Water Temp (C, add 0.15 C to correct the meter)						26.33	28.6	21.16
Spec. Cond. (mS/cm)						42.46	42.17	45.55
TDS (ppt)						27.6	27.41	29.6
Salinity (ppt)						27.25	26.98	29.55
DO%						108.5	33.3	111.8
DO ppm						7.53	2.16	
pH						6.88		6.81
YSI test time								
Boat count:	600+	5 dogs						
high tides:	11:18	23:39						
Notes:								

Table A6: The above table displays all data recorded on 7/12/14.

	Tices Shoal							
	TS1	TS2	TS3	TS4	TS5	TS6	North	South
Chlorophyll Reading							197.1	51.3
Chlorophyll Concentration (ug/L)	x	x	x	x	x	x	6.69627	1.78281
Turbidity	x	x	x	x	x	x	1.057	1.066
TSS							0.012	0.01
Fecal Coliform	0	0	0	0	0	0	0	0
Other Coliforms	0	0	1 pink	0	0	0	2 teal, 11 white, 9 pink	3 white, 1 teal
Water Temp (C, add 0.15 C to correct the meter)						22.58	22.37	20.57
Spec. Cond. (mS/cm)						41.17	40.54	43.98
TDS (ppt)						26.76	26.35	28.59
Salinity (ppt)						26.4	25.95	28.43
DO%						85.3	52.9	48
DO ppm						6.33	3.95	5.93
pH						6.64	6.52	6.69
YSI test time						10:25	9:55	10:10
Boat count:								
high tides:	6:02	18:36						
Notes: After weights: T1=0.203 T2= 0.221 T3=0.221 T4=0.220 T5S=0.203 T6M= 0.224 Dup= 0.205								

Table A7: The above table displays all data recorded on 7/20/14.

	Tices Shoal							
	TS1	TS2	TS3	TS4	TS5	TS6	North	South
Chlorophyll Reading	78.24	107.1	117.4	159.9	86.12	142.8	206.8	30.08
Chlorophyll Concentration (ug/L)	2.690688	3.66327	4.01038	5.44263	2.956244	4.86636	7.02316	1.067696
Turbidity	0.945	1.264	3.041	3.371	1.83	2.643	4.352	2.682
TSS	0.022	0.018	0.038	0.023	0.023	0.019	0.015	0.018
Fecal Coliform	0	0	0	0	0	0	100	0
Other Coliforms	0	0	3 other (1 pink, 2 white)	13 other (10 pink, 1 teal, 2 white)	0	6 other (3 pink, 3 white)	127 colonies (5 teal, 13 white, 109 pink)	0
Water Temp (C, add 0.15 C to correct the meter)						24.58	24.27	23.44
Spec. Cond. (mS/cm)						43.21	41.78	45.95
TDS (ppt)						28.08	27.15	29.87
Salinity (ppt)						27.82	26.8	29.82
DO%						101.7	42.7	99
DO ppm						7.23	3.07	7.1
pH						7	7	7
YSI test time								
Boat count:	170	3 dogs						
high tides:	11:19	23:29						
Notes:								

Table A8: The above table displays all data recorded on 7/26/14.

Appendix B

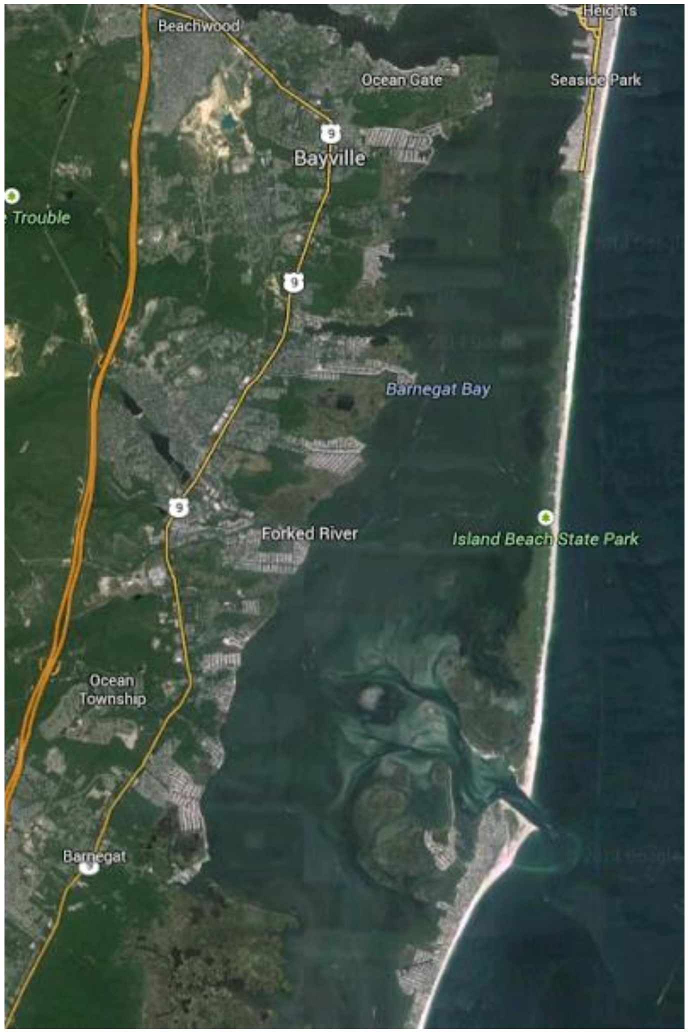

Figure B1: The above image shows an aerial view of Island Beach State Park in reference to parallel locations on the west side of the Barnegat Bay.

Figure B2: The above image shows an aerial view of Tices Shoal and the relative path and beach that are accessed by persons traveling to IBSP via boat.

Figure B3: The above image is a close up of figure B2 and shows the path that leads from the beach to the main road, the crosswalk designated for those traveling from Tices Shoal to the beach, and the boardwalk from the road to the beach.