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Macroalgal Blooms

Right now, Narragansett Bay is one of the cleanest estuaries on the East Coast thanks to the work done by local Rhode Islanders, but for years this wasn’t the case. As the human population expanded on and around the coast over time, waste being dumped into our bays and oceans skyrocketed. For years after the industrial revolution these acts went unnoticed and unregulated, having immense negative impacts on our underwater communities. One of the most significant environmental impacts is eutrophication. Eutrophications is when access nutrients such as nitrogen and phosphorus are released into the ocean from a number of sources. The main source of these nutrients is from waste, which is what this particular ongoing study focuses on, but can also be from precipitation runoff as well. The addition of these access nutrients into the ecosystem induces the growth of algae creating an algal bloom. Significant algal blooms can cause something called water hypoxia, which is when the oxygen in the water in depleted. This event can cause massive negative impacts on an environment, potentially killing all of the fish and invertebrates in a community. Over the years, wastewater treatments facilities were put in place in an effort to reduce the input of waste into the bay, and in turn reduce the amount of eutrophication as well as many other negative effects that go along with it..

This study, started in May 2006, set out to document the changes in nutrient levels, the frequency and severity of algal blooms (specifically macroalgae), and many other factors related to eutrophication since the wastewater treatment facilities were put into place. The data has been collected using two main methods, aerial surveys and ground surveys. The aerial surveys were done using oblique digital photographs around low tide to determine the cover of macroalgae in certain areas around the bay. As for the ground surveys, 9 sites were chosen in total with seven being inside of greenwich bay and two additional sites, one further north at Conimicut Point, and another one south of greenwich bay at Sandy Point. In addition to the 9 sites, there were also ground surveys done in the locations involved with the aerial surveys, with additional photographs being taken and the dominant species were recorded. With runoff being a potential factor, precipitation was recorded as well.

As an undergrad, I have been lucky enough to help out in Dr. Thornber’s lab with Dr. Green on a few of their projects. I mainly worked on organizing the algae herbarium, but also measured and weighed algae for various projects they were working on as well. Because of this, I was not able to come up with the my own study, with my own plan, methods, and goals, so I had to choose a data set that was involved with the lab. No scientific study is perfect, but looking at the methods and hypothesis that they had in mind when starting this research, it seemed like something that I would like to have been a part of from the start. Because of this fact, I decided to use this opportunity to see what I could find in an exploratory analysis. There were many things at play in this research, but the main hypothesis was simple. With waste water treatment facilities potentially reducing the input of access nutrients into the bay, then the nitrogen levels, and in response the macroalgae blooms, should decrease over time as the bay starts to adapt to more normal levels. With my minimal knowledge of R Studio, I set out to see if this was evident in the data collected. The first problem I ran into was that much of the data was input into excel in a way that was not friendly to R. Months and Years were separated into different columns, there were spaces and characters in the column titles, and some files were completely unusable because of their layout with the minor R skills I have.

I started out by comparing the obvious questions, if the nutrient levels were higher, was there more algae collected in the transects? What about if the precipitation levels were high? Nutrient levels in relations to the amount of algae collected was the basis of this whole data set, and according the R-squared value and p-values, there was no correlation. The next question I tried to answer was whether precipitation was significantly affecting the nitrogen levels in the bay, as this would make it difficult to see how the wastewater treatment facilities were really affecting the algae growth. This had no correlation as well, so the first good news was seeing that according to this data, precipitation was not a major factor in the levels of nitrogen over a given month. I then created a graph of how the mass of Ulva in these sites changed over the years, and discovered that this too came up with an unexpected result. Ulva blooms actually increased overtime, but many factors could contribute to this, such as the possible decline in populations of other species that would normally outcompete Ulva. So comparing all of the species would be necessary to answer this question. The comparison of dissolved nitrogen overtime showed that in the areas collected, the dissolved nitrogen did not appear to decrease like expected.

To conclude this exploratory analysis, the point of a scientific study it to create a hypothesis, a plan to collect the relevant data, and analyze that data for trends and correlations. You will not always get the data that is expected, but there is no such thing as failure. All data collected can be used to further research in one way or another, and in this case there certainly is more information that can be taken out than I was able to with a simple analysis using my little knowledge in R Studio. While the questions I started with were not fully answered, if I were to repeat this study on my own with the knowledge gained from this one, I would certainly be much more successful than without it. There are many questions to keep in mind going forward, and as to why my simple analysis, and seemingly simple questions, came out the way that it did. How could have the methods for collecting the data been affecting the results? What about the locations of the sites? Spending more time digging through data like this could provide the answer, but for now we can only build off of what we know for sure.