Entering Research I - Research Paper

Introduction

The Chesapeake Bay has undergone major restoration efforts in order to protect and preserve all factors that are incorporated into its ecosystems, biodiversity, water quality, and sustainability. In the past 50 years, the Chesapeake Bay Foundation has made the health of the Chesapeake Bay a priority by creating awareness to all who reside in the Chesapeake Bay watershed and by enforcing a sense of responsibility when it comes to the health of the Bay. Today, the Chesapeake Bay is increasing in health at a slow and steady rate, which it has never seen before and it has become more important than ever to keep the growth of its health as exponential as it is at this point in time. The health of the Bay has come a long way from its "dangerously out of balance" rating in 1967 to the 2016 rating of 34, which is equivalent to a "C-" and is close to entering the domain of "improving". (Figure 1) The Chesapeake Bay Foundation has plans set up to facilitate the rate of improvement. With the endorsements of the states in and contributing to the watershed and several federal agencies, there are specific environmental goals that will be met by 2025, and 60% of those benchmarks will be reached in 2017. This indicates that action is being taken every day and that it is more important than ever for the 18 million people who live along the watershed and the bay to take responsibility in their actions and by living environmentally conscious lifestyles in order to save a critically important body of water.Volunteers and workers up and down the coast have been putting in countless hours to improve the state of the bay, but it is up to all citizens to take initiative in this effort in order for the health of the Chesapeake Bay to be sound once again in the future.[1]

The LIFE STEM program at Longwood University experienced a current depiction of the state of the Bay first hand in August 2017 during the Summer Bridge program at Hull Springs Farm. Students were collecting a variety of samples to run tests on and analyze on campus, one of them being sediment samples. Sediment in particular is one of the most straightforward methods of determining the health of the Chesapeake Bay.

Sediment is a key factor in analyzing the health of the Chesapeake Bay. According to previous research, sediment often contains critical information regarding the health of the body of water it is collected from. Previous studies have shown that sediments can enter a system of water like the Chesapeake Bay through means of geological erosion or construction close to shorelines.[2] Also, data collected from previous studies have stated that sediment layers that accumulate over time contain information on the history of climate in the area of the body of water over a period of up to millions of years[3]. Other studies have been done regarding the relation between runoff and rainfall on sediment content in bodies of water like the Chesapeake Bay.[4] The soil that is brought into lakes from rainfall and runoff is agreed amongst previous

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[1] Chesapeake Bay Foundation. "2016 State of the Bay Report." (2016): 1-20. Chesapeake Bay Foundation. Web.
[2] Palinkas, C., Barth, N., Koch, E. and Shafer, D. (2016). *The Influence of Breakwaters on Nearshore Sedimentation Patterns in Chesapeake Bay, USA.* Journal of Coastal Research, 320(4), pp.788-799.
[3] Mid-Atlantic Regional Council. "What Is Sediment Pollution?" N.p., n.d. Web.
[4] Coxon, T.m., et al. "*The impact of urban expansion and agricultural legacies on trace metal accumulation in fluvial and lacustrine sediments of the lower Chesapeake Bay basin, USA*." Science of The Total Environment, vol. 568, 2016, pp. 402–414.

scientific data that it brings in different nutrients from the land as it builds up on the bottom and it is often mixed together by worms and mollusks in the body of water. Depending on the season in a particular year, the nutrients in the bottom will possess different colors and elements than in an opposite season because of different agricultural patterns and different systems processing during a season.

Sediment quality is important and relevant because it is a critical element for any body of water, especially for the Chesapeake Bay. As sediment collects at the bottom of bodies of water, the layers can reveal a detailed history of nutrient, pollutant and toxin content, as well as climate fluctuations and the health of the entire water system. Sediment quality has a large span of interactions between environmental, geomorphological, and socio-economical activities. Sediment influences environmental integrity of habitats and water quality. Also, sediment influences geomorphological systems by means of floodplains, marshes, and archaeological activity. In addition, sediment plays a huge role in socio-economic activities through industrial and residential construction, recreation, maintenance and capital operations, and urban planning. Every one of these activities contribute to the contents of sediment at the bottoms of bays, lakes, and rivers. Sediment is a reflection on how human activities influence the environment and can contribute positively and negatively. The sphere of influence that sediment has prioritizes its quality management in water systems, and even more so for the Chesapeake Bay.[5]

[5] Working Group 4 (WG4 – Planning & Decision-making) of SedNet. "The Importance of Sediment and Sediment Processes for River Basin Management ." *European Sediment Research Network*

The purpose for researching and experimenting with sediment in the Chesapeake Bay is to discover how sediment content effects and contributes to the overall environmental issues pertaining to the Chesapeake Bay. Understanding patterns in sedimentation and nutrient content in sediment at the bottom of water systems can reveal greater issues regarding the health and overall state of the Chesapeake Bay. Specifically, experimenting with the proportion of warmer climates and sediment mixing by animals may reveal how the state of the bay is changing and altering its nutritional structure as climate change is becoming a hot topic in the media and in the scientific world. It would be impactful to discover any evidence between the possible link between animal behavior, sediment, and climate change. It is important to see how different factors in an environmental system can cross between sciences and be able to learn how those relations affect one another and other external factors as well.

With the sediment samples taken at the Chesapeake Bay during the LIFE STEM Summer Bridge, many hypotheses could be formed from the information collected. However, it would be beneficial to research the following hypothesis: If climate has increased over the last 50 years around the Chesapeake Bay, then it will result in more nutrients being mixed throughout the layers of sediment by animals.

Methods

To begin, the sediment samples were removed from the freezer and thawed. Then, the thawed sediment samples were homogenized and a sub sample was transferred to a pre-weighted ceramic crucible. The weight of the wet sample was recorded using an analytical balance accurate to 0.001 g. The sediment sample was dried at 50-70 ℃ for at least 48 hours. The weight of the sample was recorded before the first baking process. After being weighed, the dried sample was cooked for at least 4 hours at 550 ℃ in order to oxidize organic matter in the sediment sample. The measurement of this will be the ash mass. After this process, the weight of the ashed sample was recorded. Then, the ashed sample was cooked at 1100 ℃ for at least 4 hours in order to oxidize carbonates in the sediment sample. After the final baking process, the sample was weighed. The final measurement left for each sample will be carbonate-free mass. This was repeated for all samples taken at different locations in the Chesapeake Bay.

Results

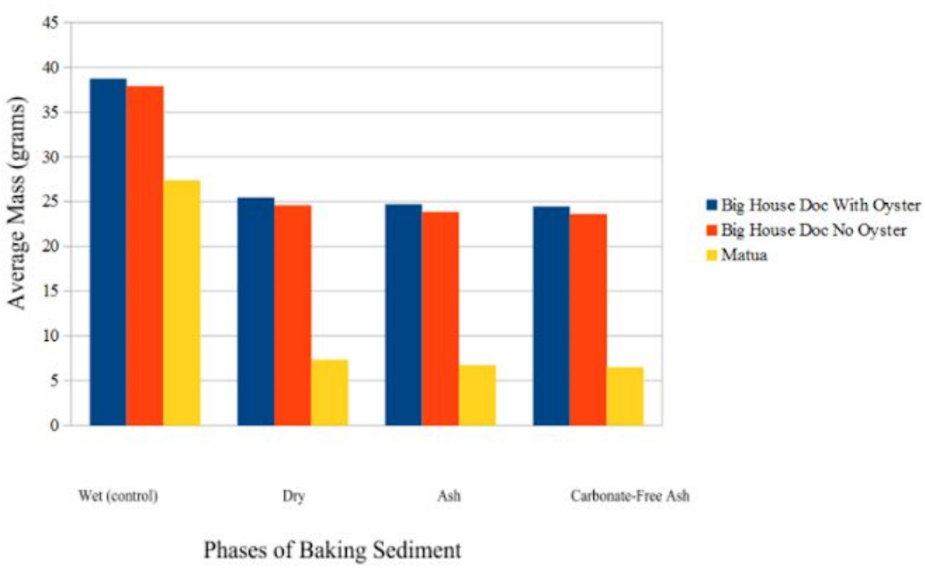

Figure 1. Average Mass of Different Sources of Chesapeake Bay Sediment Baked At Different Phases. The data shows an overall decrease in mass after each baking session. The most drastic change in mass was between the wet phase and the dry phase.

The sediment samples from the Big House Doc With Oyster began with an average wet mass of 38.75 grams. After the 48 hour drying period, the average dry mass was 25.46 grams. After baking in the oven at 550℃, the average ash mass was 24.70 grams. After baking in the oven at 1100℃, the average carbonate-free ash mass was 24.45 grams. The sediment samples from the Big House Doc With No Oyster began with an average wet mass of 37.90 grams. After the 48 hour drying period, the average dry mass was 24.60 grams. After baking in the oven at 550℃, the average ash mass was 23.84 grams. After baking in the oven at 1100℃, the average carbonate-free ash mass was 23.63 grams. The sediment samples from Matua began with an average wet mass of 27.38 grams. After the 48 hour drying period, the average dry mass was 7.35 grams. After baking in the oven at 550℃, the average ash mass was 6.72 grams. After baking in the oven at 1100℃, the average carbonate-free ash mass was 6.50 grams.

Overall, the data in the graph had a decreasing trend. In all of the samples, mass decreased from wet to dry, from dry to ash, and from ash to carbonate-free ash. The greatest decrease in all samples was between the wet phase and the dry phase. The Big House Doc With Oyster, the Big House Doc With No Oyster, and Matua mirrored each other's trends. After the drastic decrease from wet to dry, there was only slight decreases in mass in the remaining two phases. However, Matua experience the greatest initial decrease from wet to dry from 27.38 grams to 7.35 grams, which is a difference of 20.03 grams.

Discussion

Revised hypothesis: If sediment from the Chesapeake Bay is collected from the different locations, then the Big House Doc With Oyster source will reveal the most amount of organic matter and carbonates in its contents because of the presence of oysters.

"Any organic carbon assembly, large or small, dead or alive, is classified as soil organic matter.".[6] Organic matter in the Chesapeake Bay sediment samples is classified as any dead or alive organisms or living specimen of animal or plant found on the Bay floor. The average percent of organic matter content in the Big House Doc With Oyster samples is 2.99%. The average percent of organic matter content in the Big House Doc No Oyster samples is 3.09%. The average percent of organic matter content in the Matua samples is 8.57%. These calculations determine that Matua has the highest level of organic matter in its sediment. This reveals that the Matua area has a higher population of living, and in turn dying, organisms. This is a logical conclusion to make considering that the Matua area is deeper and larger than the two Big House Doc locations. However, this also could be because it has a higher amount of construction and land development contributing to the addition of nutrients in the water due to erosion and runoff from construction sites, which greatly increases the rate of accumulating organic matter. This reveals that Matua may be suffering the greatest out of all three samples from human impact because of the higher percentage of organic matter, which in turn contributes to the overall poor health of the Chesapeake Bay.

[6] Hoopes, Patricia. *Soil Organic Matter*. University of Maryland, extension.umd.edu/learn/soil-organic-matter.

Carbonates enter the water by means of runoff and erosion from limestone sedimentary rocks[7]. The percent of carbonates can determine the amount of sediment that is composed of runoff and erosion that ends up in the Chesapeake Bay. The average percent of carbonates in the Big House Doc With Oyster samples is 0.98%. The average percent of carbonates in the Big House Doc No Oyster is 0.85%. The average percent of carbonates in the Matua samples is 2.99%. According to the results, the Matua samples had the highest average percent of carbonates. This can predict that Matua is the cloudiest area of water of all of the samples due to higher amounts of erosion in the area, which decreases the amount of sunlight that reaches the bottom of the Bay. The impact of this variety of pollution damages ecosystems by limiting all processes depending on sunlight to function. The Matua sample was taken in an area of the Chesapeake Bay where there was housing development surrounding the body, which explains the higher amount of erosion. This higher amount of erosion translates that this area is a higher threat to the lives and functions of fish, plants, and other aquatic life[8].

The average percent of water within the sediment from the Big House Doc With Oyster samples is 65.70%, The average percent of water within the sediment from the Big House Doc No Oyster samples is 64.91%. The average percent of water within the sediment from the Matua samples is 26.84%. Both of the Big House Doc samples have a close average percentage of water. The Matua sample had a significantly lower composition of water because of the greater amount of organic matter and carbonates found in the sample.

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[7] Reeder, Richard J. Geosciences Program, Department of Earth and Space Sciences, State University of New York, Stony Brook, New York. "*Carbonate Minerals*". 2014. (Accessed 11/13/17).

[8] Chesapeake Bay Foundation, "*Dead Zones*." 2017, www.cbf.org/issues/dead-zones/.

The hypothesis was rejected based on the results found in the experiment. The Matua water source surpassed the average percentages of organic matter and carbonates in the content of the sample instead of the Big House Doc With Oyster. The variable was not the presence or absence of oysters, but the location. The Matua location was not only closer to the center of The Bay instead of being close to the shore, but the location had a greater depth as well. It also was more central in the most common boating waters and it is exposed to higher human traffic. The contents of the sediment samples reveal the extreme differences due to these factors.

Overall, the results determines and provides a different perspective when analyzing the health of the Chesapeake Bay. The results from the sediment analysis portray that general terms about the entirety of the Chesapeake Bay may not always translate to the state of smaller portions of The Bay. Because of the results of this experiment, it is clear that certain locations of The Bay might suffer more or less than other areas and in different ways. In addition, comparing sediment content that are from certain locations of the Chesapeake Bay may differ due to different factors, critical conditions, different severities depending on its depth, relativity to the shore, amount of exposure to human activity and recreation, biotic factors, exposure to construction, and more. The Matua samples were from a deeper part of the water that were farther from the shore. However, the samples had a greater exposure to construction and human impact than the two types of Big House Doc samples, therefore resulting in dramatic differences in organic matter and carbonates content in the sediment samples. Although there is no clear way to determine the state of the Chesapeake Bay due to a variety of components that compile to create sediment content that vary considerably by location, the data from the experiment shows how location contributes to the health of the waters and it may assist in new locational tactics to handle and reform current conditions of the Chesapeake Bay in order to make the waters healthier as a whole in the future.

Sources

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