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Introduction

Sediment is the loose sand and other soil particles at the bottom of a body of water. While it is mostly composed of the clay and soil particles, other types of matter also settle to the bottom, from erosion and plants and animals that have been decomposed over time. “Marine sediments cover seventy percent of the Earth’s surface.” Organic matter within the sediment is found at different concentrations throughout the water and depends on the “size of the organic matter source, water depth, and sedimentation rates” (Oni 2015). As a result of the decomposition of plants and animals, organic matter is released into the sediment. Organic material in bodies of water is a large contributor to water pollution as well as erosion and human pollution. Organic matter and pollution in the sediment result in poor water quality. Contaminated sediments are harmful to the water quality because they undergo physical and chemical changes when settling to the bottom of the body of water (Lee 2018).

Sediment quality directly affects water quality. Generally, if the sediment is polluted, the pollutants from the sediment will contaminate the water. Water quality affects humans that use the water as a resource. When excess amounts of organic matter such as nitrogen and phosphorus get into the water and excess sediment can cause areas to be in poor quality and “impaired” according to the Chesapeake Watershed Agreement. Attributes such as “storm water, agriculture, air decomposition, wastewater and septic systems” are needed to reduce nutrients and sediment from entering the waterways (Chesapeake Bay Program 2014). When the water quality is low, it prevents wildlife from easily finding food causing them to exert more energy into getting it because it is difficult for the wildlife to see what they are searching for. Murky water, as a result of water pollution, also prevents vegetation such as underwater grasses from growing. Underwater grasses allow wildlife to have protection and a habitat to live in. It also provides filtration to the water. In addition to murky water, the excess organic matter in the sediment can disrupt the growing patterns of natural vegetation.

Organic matter in the sediment is mainly caused by decomposed plants and animals throughout time. As the deceased plant or animal is transported throughout the water, organic

matter such as carbon and nitrogen are transported and buried in the sediment (Lin 2019). The amount of organic matter that is deposited into the water depends on biomass, structure, enzymes, as well as additional attributes (Steinmuller 2019). During those processes, physical, chemical, and biological, processes are also happening as well, such as mineralization, decomposition, and absorption by other organisms. These processes can change the distribution of organic material in the sediments. Weather events such as typhoons, hurricanes, or high winds can cause the organic matter to be dispersed (Lin 2019).

The amount of organic matter can be different depending on the depth of where the sediment sample was extracted from. Based on Steinmuller's research, the deeper in depth a sample is taken from, the more organic matter such as carbon will appear in the sample. In the experiment where samples were taken from different depths of sediment and tested the amount of organic carbon, the depths ranged from zero to one-hundred fifty centimeters. Even though the most and least amount of carbon was extracted from those depths, the amount still varied while increasing depth. Some were higher than others and some were lower. There was not a clear, linear result increase in carbon as the depth increased. The results described the greatest amount of carbon in the depths of one-hundred thirty to one-hundred forty centimeters and the least amount of carbon being found in the depths of thirty to forty centimeters. This indicates that organic matter at greater depths are more decomposable than the organic matter at the surface and microorganisms are still present at greater depths and produce organic matter (Steinmuller 2019). Eutrophication is the excessive amount of nutrients in a body of water from the result of runoff. A common result of this process results in increased algae growth. Excessive algae growth can be detrimental to a body of water from the excess nutrients that it brings. It also causes a dense growth of plants and deprives wildlife of the oxygen it needs to survive in the water. The nutrients that enter the water "stunt algal growth and make the [bodies of water] biologically productive" (Khalil 2013).

When organic matter contaminates the water and reaches the sediment it can cause harmful effects such as algae blooms. Algae blooms occur as a result of excess nitrogen and phosphorus in the water. Nitrogen and phosphorus contaminate the water from agriculture and urban runoff, as well as sewage. These contaminants get into the water from rain washing the

products from the source into the waterways. When the pollutants get into the water, it provides additional nitrogen and phosphorus which eventually causes algae blooms. The amount of nitrogen and phosphorus that gets into the water corresponds to the size of the algae blooms; the larger the amount of pollutant, the larger the algae bloom becomes. When algae blooms occur, it covers the top layer of water and eventually dies which causes it to sink to the sediment and decompose. When it reaches the sediment, bacteria begin to decompose it. When the bacteria decompose the algae, they use oxygen in the process. The water becomes deprived of oxygen and causes dead zones. Dead zones are where wildlife cannot survive naturally as a result of low levels of oxygen. Even though the algae blooms usually occur during the warm, summer months, algae still grows and dies throughout the year which causes a continuous cycle (Chesapeake Bay Foundation 2018).

When sea grasses and algae break apart and die, they settle on the sediment and plankton and bacteria decompose it (Hicks 2007). Underwater grasses are one natural way to reduce the amount of nitrogen and phosphorus levels. Not only do they reduce organic matter pollution in the water's sediment, it provides an additional habitat for wildlife such as fish and crabs. Another natural way to reduce water contamination from pollution from run off and erosion would be planting forest buffers. Forest buffers are trees planted along the streams and shoreline of the body of water. They filter out pollution from run off and their roots absorb nitrogen from contaminating the waterway. Additionally, the microorganisms that reside in the sediment cycle the organic matter which is crucial (Oni 2015).

Considering pollutants are the main cause of organic matter in waterways around the world, it would make sense that the higher amount of organic matter would be found closer to the shorelines compared to farther away from the shore. High winds and waves result in the transportation of sediment and allows a lot of it to be spread out. In a study it was found that found that "the particle organic matter input from rivers into the ocean during typhoons is… higher than that under conditions." From that research, it was concluded that the wind and movement of water agitated the water and altered the sediment by transporting it and suspending it (Lin 2019). Often times sediment pollution continues to occur in areas because nothing is ever done to help the situation. The problem can go on for decades when the

pollution is left uncontrolled. It can also continue if the area is not dredged which eventually results in water pollution from the sediments (Lee 2018).

Global warming also has an effect on sediment in bodies of water. As a result of changing weather patterns, typhoons are becoming more common in smaller rivers (Lin 2019). In a study it was concluded that mangrove forests assisted the coastline during climate change by maintaining the sea level rise and erosion from the shore. Not only did the mangroves help with the protection of the shoreline, but it also absorbed large amounts of organic carbon (Soper 2019). The depth of the body of water also has an effect on the amount of organic matter in the sediment. Based on Zhao's research, shallow lakes have increasing algae amounts which result in increased amounts of organic matter in the sediments (Zhao 2011). Additionally, the rising temperatures of the atmosphere increases the time algae blooms occur, causing more algae to grow for a longer time period. Seasonal changes result in varying temperatures which can cause a difference in levels of organic matter in the sediment. In Khalil's research experiment, the largest amount of organic phosphate was recorded in the spring months, while the lowest amounts of organic matter were recorded in the autumn months (Kahlil 2013).

The Chesapeake Bay region is one of the waterways that is very vulnerable and susceptible to sediment pollution. With four major rivers that run into the bay including, the James River, Rappahannock River, the Potomac River, and the Susquehanna River, there are many opportunities for the water of the Chesapeake Bay to be influenced. With many farms and housing developments along the rivers that flow into the Chesapeake Bay, contaminants such as fertilizers and additional pollution from animals' waste. Smaller rivers such as the Anacostia River, which is a tributary for the Chesapeake Bay, is one that is highly contaminated with excess nutrients (Solomon 2019). This research experiment will explore the sediment in the Chesapeake Bay.

The research being conducted in this experiment will explore the location of organic matter and sediment in a body of water. It will also explore the amounts of the organic matter found at those locations. The locations tested were close to the shoreline of the Chesapeake Bay as well as father away from the shoreline to see if the amounts of organic matter are different between the locations. This research will also allow us to identify the causes of organic

matter based on the types found. Even though there has been research based on the causes of sediment pollution, the research being conducted in this study will further the other research and be able to continue it. The hypothesis if the experiment is the closer the sample of sediment is extracted, the more organic matter will be present, compared to samples taken farther away from shore.

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