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Introduction

The focus of this research experiment was to measure and analyze the water quality of the Chesapeake Bay. The Chesapeake Bay is an estuary located between Maryland and Virginia on the East Coast of the United States of America. An estuary is a coastal body of water that is fed by one or more rivers and flows freely into the ocean. The Chesapeake Bay serves as a transition zone between rivers such as the James and Potomac Rivers and the Atlantic Ocean and is composed of a mixture of freshwater and seawater known as brackish water. The watershed of the Chesapeake Bay is fed by rivers and streams from Virginia, Maryland, Delaware, New York, Pennsylvania, West Virginia, and Washington D.C. While the Chesapeake has an area of about 11,000 square kilometers, the Chesapeake Bay watershed covers an area of over 150,000 square kilometers (Jeremy et al, 2017). This makes the Chesapeake Bay the largest estuary in the United States and, as a result, one of the most productive in the country (Da et al, 2018). Due to its size and proximity to several states, the Chesapeake Bay provides much value to the East Coast.

The Chesapeake Bay is vital to the ecosystem of plants and animals that inhabit the Bay. Because the Chesapeake Bay is able to provide food and protection to a wide variety of flora and fauna, the Bay is home to thousands of species of plants and animals such as oysters, ospreys, and underwater sea grasses (Zhang et al, 2018). Along with the various plants and animals that the Bay supports, the Chesapeake Bay also supports many people who live, play, and work along or near the Bay's shores. The Chesapeake Bay Watershed provides water, seafood, and a place for people to enjoy the natural world for over 18 million people living in the watershed (Jeremy et al, 2017). For example, Tangier Island, the last offshore fishing community in the United States, is located in the middle of the Chesapeake Bay. Tangier Island is well known for their

fishing industry, especially their blue crab and oyster fisheries. The Chesapeake Bay is the economic foundation for the marine industries of Virginia and Maryland, such as the fishing and shipping industries. The economy of coastal cities such as Norfolk, Newport News, and Baltimore depend on the Chesapeake Bay. All of these factors give the Chesapeake Bay much cultural, economic, and environmental value. However, the large numbers of people living along the Chesapeake Bay has created some environmental problems.

Currently, the health and water quality of the Chesapeake Bay is facing many issues. Many of these issues are caused by unsustainable human activities of the people in the Bay's watershed. Water pollution, overharvesting, and rising sea levels are just some of the issues that are affecting the water quality and overall health of the Chesapeake Bay. Dissolved oxygen is one of the main issues in terms of the Chesapeake Bay's water quality. Dissolved oxygen is a measurement of the concentration of oxygen that is dissolved in water. Dissolved oxygen also measures how much oxygen is available to aquatic life. The dissolved oxygen concentration in the Chesapeake Bay has been constantly monitored and recorded. Historically, the concentration of dissolved oxygen in the Chesapeake Bay was measured by using the Winkler Dissolved Oxygen Method (James, 1965). However, today the concentration of dissolved oxygen can be measured by using more sophisticated machines and probes.

Aquatic life, such as fish, shellfish, and sea grasses, depend on a high concentration of dissolved oxygen in order to survive and thrive. When the concentration of dissolved oxygen becomes reduced to the point that aquatic life is not able to be supported, water becomes hypoxic. Hypoxia occurs when the concentration of dissolved oxygen in water is below 2 mg/L (Bever et al, 2018). Hypoxia occurs in coastal waters as a result of eutrophication. Nutrients, such as nitrogen and phosphorus, enter the Chesapeake Bay through agricultural and industrial waste. These nutrients cause algae populations to grow rapidly. When these large amounts of algae die and sink to the bottom of the Chesapeake Bay, they are decomposed by bacteria and microbes which uses up the dissolved oxygen in the water (Tomasetti et al, 2018).

As a result of eutrophication, the concentration of dissolved oxygen in the Bay have decreased, causing hypoxic zones in the water.

Climate change is the rise of the Earth's surface temperatures caused by the burning of fossil fuels by humans. It is predicted that climate change will cause changes in temperature, sea level, and precipitation in the Chesapeake Bay. Changes in these three factors will all affect the concentration of dissolved oxygen in the Chesapeake Bay. Henry's Law dictates that gases are more soluble in water at colder temperatures and less soluble in water at warmer temperatures. Warming waters in the Chesapeake Bay as a result of climate change will decrease the solubility of gases in water and increase the amount of oxygen being used for respiration, therefore decreasing the concentration of dissolved oxygen in the Bay. Rise in sea levels in the Chesapeake Bay will stimulate water circulation, causing more water to be mixed and moved around. Therefore, dissolved oxygen concentrations in the bottom waters of the Bay are expected to increase while dissolved oxygen concentrations at mid-depths will likely decrease. An increase in precipitation will cause more winter and spring freshwater flow and an increase in nutrient pollution into the Chesapeake Bay. Increased nutrient pollution will result in an increase in eutrophication, therefore decreasing the concentration of dissolved oxygen in the Bay (Da et al, 2018).

Based on data from the article *Ecological Forecasting and the Science of Hypoxia in Chesapeake Bay*, there were more than 6 cubic kilometers of hypoxic water in the Chesapeake Bay in 2015 (Jeremy et al, 2017). Overall, it seems that although large portions of the Chesapeake Bay are hypoxic, the overall dissolved oxygen concentration of the Bay is increasing. Hypoxic waters can cause the stunt of growth or development of aquatic life, can cause impairment in ability and mobility, and can cause mass deaths of aquatic plants and animals. As dissolved oxygen concentration decreases, the chances of survival for the plants and animals of the Bay also decrease.

In the research project, the concentrations of dissolved oxygen in the Chesapeake Bay were measured in order to compare the results to other areas of the Chesapeake Bay. By comparing the results to data collected from hypoxic and

non-hypoxic zones, the overall health of the Chesapeake Bay can be analyzed and determined.

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