Delaney McMahon

Introduction

Humans contribute to detrimental effects of waterways that they inhabit. As a result of increased human population, there has been an increased number of people residing near or on the coastal shores. In addition, as a result of increased human populations around coastal areas, there is an increase in poor water management which causes the water quality to decrease significantly. Pollution is a main cause of water contamination. The main types of pollution that are a contributor to bodies of water as a result of human interactions include industrial waste, agricultural run-off, and human litter. (Ralf 2006). Humans can directly and indirectly affect marine ecosystems. Fishing, infrastructure, tourism, and pollution are direct examples and recreation or climate change being indirect examples of how humans affect marine ecosystems. These factors put stress on the marine ecosystems, especially when the direct and indirect factors are present in the same area at the same time. Also, as a result of human impacts on waterways, marine biodiversity often declines. Both human activities and stressors are detrimental to ecosystems in the water (Anderson 2019).

Eutrophication is a main effect of human pollution and is caused when nutrients in the water are in excess and an increased number of photosynthetic organisms increase in population, causes an overall trend of decreased animal life. It is caused by the pollution of coastal waters as a result of human populations increasing by the shores, which increases the amount of nutrients in specific areas of the water. Chemical fertilizers used by humans are also a cause of the increase in eutrophication. Nitrogen and phosphorus are the main nutrients that are in excess in eutrophication. When the excess nutrients are not distributed throughout the water, it causes specific areas to have too much nutrients and cause the aquatic life in those areas to decrease in quality of life. Eutrophication is one of the main contributors to habitat change and the expansion of algae blooms (Gilbert 2005). As a result of eutrophication, hypoxic zones form. Dissolved oxygen levels decrease in areas with high eutrophication. When the dissolved oxygen levels go below 0.5 mL of oxygen per liter, the survival of the ecosystems within that area dwindle; the marine structure and diversity of the area decreases. In a recent study, hypoxia is mainly caused by fertilizer runoff from agricultural systems along the shore (Diaz 2020).

The Chesapeake Bay is the largest and most productive estuary in North America, which is one of the reasons why when detrimental events occur in the Bay, it is very important to find

the cause of the problem and fix it as soon as possible without causing major harm to the entirety of the Chesapeake Bay. During the summer months, oxygen levels in the Bay are depleted and are caused by excess organic matter within the water. During the spring and summer months, algae is more prominent and as the algae dies, it sinks to the bottom to decomposes. As the algae decomposes it uses oxygen and releases other nutrients, replacing the other nutrients such as nitrogen and phosphorus, instead of additional oxygen (Bratton 2003). When oxygen is depleted, organisms that thrive under these conditions will survive and become more favorable compared to the aerobic organisms. When the nutrients are increased in areas of bodies of water, it changes the overall structure of the water including the ecosystems that inhabit the body of water. The increased nutrient input, as a result of humans, can cause bodies of water to age faster than it would if it did not have the excess amounts of harmful nutrients (Khan 2020). In a study the succession as a result of eutrophication goes from a natural body of water, to a marsh, then settling into a dry terrestrial area. In that specific location, over the course of many years as a result of increased algae blooms, no aquatic animals were able to live in the area and the aquatic plants did not have enough oxygen or sunlight to survive. Therefore, the body of water that was studied, eutrophication and dead zones caused the once thriving body of water to turn into an inhabitable area. Over 80 tons of nutrients such as phosphates enter various bodies of water per day from human processes such as fertilizers and other forms of pollution. In contrast, in some cases, an increased amount of nutrients in the water can cause an increase of aquatic plants but reduce the amount of dissolved oxygen that is released into the water, which eventually causes those plants to decrease in populations and reduce their diversity (Khan 2020).

Dead zones are the main result of eutrophication. As a result of excess nutrients and decreased amount of oxygen in these hypoxic zones, there is a decreased amount of aquatic life that is able to thrive in said environment. Hypoxia, the loss of oxygen in bodies of water, most frequently occurs in enclosed bodies of water such as bays, lakes, estuaries, and seas. Hypoxic zones reduce the ability to thrive in natural environments for aquatic ecosystems. The extent of the severity of responses to the new environment varies among each species. However, a general trend shows a favor for organisms that do not require as much oxygen, therefore reducing the diversity of the marine ecosystems (Joyce 2000).

The effects of dead zones in bodies of water are studied to examine how ecosystems in the water adapt to a new environment. The increase in nutrients cause mass die offs from aquatic

plants. As a result from increased human activities and their effects on the waters, it causes an increase in algae blooms. The algae blooms that form reduce that amount of sunlight that is able to reach the aquatic plants which will ultimately reduce that amount of chemical energy they are able to produce during photosynthesis (Chislock 2013). In the Chesapeake Bay, there has been a decreased amount of benthic plants due to an increased turbidity, as a result of decreased oyster populations being there to filter the water. Also, over the past 50 years, there has been a trend of decreased diversity of plant species because of the favored species being able to survive is more harsh environments (Kemp 2005).

Dead zones also affect the aquatic animals that inhabit the affected waters. As a result of algae blooms, it limits the light being able to penetrate throughout the water. That causes predators to be unable to successfully find food. Also, the increased amount of pollution and fertilizers that enter the water result in the pH of the water to be changed. The increased pH turns the organisms blind and have to solely rely on receptors to survive (Chislock 2013). In the Chesapeake Bay, as a result of hypoxic conditions, a species of copepod produces fewer eggs when the dissolved oxygen levels were low. Overall, the species population declined under hypoxic conditions due to smaller eggs clutches, slow growth, and increased mortality (Slater 2020).

The Chesapeake Bay is a very important resource for North America, and especially the states that directly are surrounding it. It is hypothesized that if dead zones occur in the Chesapeake Bay as a result from human activities, then aquatic animals and aquatic plants will be negatively affected. We know that eutrophication and dead zones are occurring in the Bay, however, it is not known how these phenomena directly affects specific species of plants and animals that live in those areas. There are studies that mention the effects of dead zones, however, do not go in depth on how the aquatic plants and animals are affected and how the affected ecosystems can cause related events to happen to the resources that humans use from the Chesapeake Bay. By investigating the effects dead zones on aquatic life, it will provide additional information about the Bay and how humans can change their actions to make a better impact. We will be going in depth on how specific locations in the Chesapeake Bay are affected by dead zones. We chose aquatic life, specifically aquatic plants and aquatic animals, to study because both of them are essential for marine flourishment. Marine plants provide nutrients, food, and shelter, while aquatic animals recycle said nutrients and provide other resources.

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