Hypoxia in a Freshwater Ecosystem related to Varying Levels of Nutrients

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Abstract

There is evidence that nutrient pollution and eutrophication of water result in hypoxia, with levels of dissolved oxygen below 2ppm. The goal of this preliminary study was to provide data on the maximum levels of nutrients that will result in positive effects on an environment that do not lead to hypoxia. This was tested by adding gradually increasing levels of fertilizer to six separate, identical microenvironments. Measures of carbon dioxide, dissolved oxygen, pH, and nitrate were taken weekly. The results demonstrated high levels of fertilizer cause dramatic fluctuations in DO, while even a relatively low level still leads to hypoxia. Future studies in this area are advised to use lower increments of fertilizer.

Introduction

Hypoxia is an increasingly emerging problem in many areas destroying the natural habitat of many fresh and saltwater organisms and causing fish kills (Fig. 1). Several causes contribute to this, including climate and topography. It is suspected that nutrient pollution leads to a cycle that causes hypoxia to a greater extent than these other factors. The addition of nutrients in the form of fertilizers, animal waste, and sewage cause algal blooms that decay and consume the oxygen in the water system (NWRC, 2000).

Eutrophication has been a significant part of initiating the hypoxic cycle (EPA, 2002). The question addressed by this study is this: What level of nutrients will enrich an environment without eventually causing hypoxia?

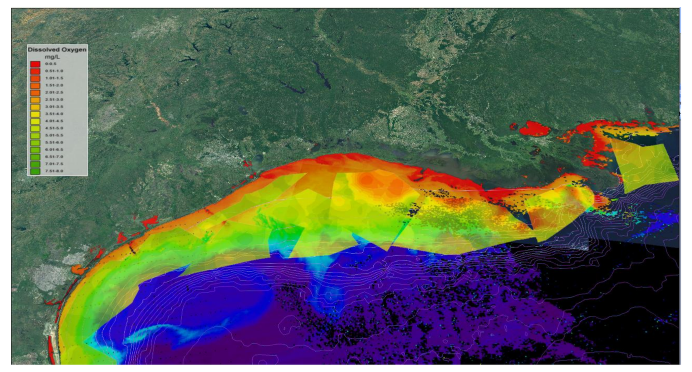


Figure 1. The hypoxic zone or "Dead Zone" in the Gulf of Mexico is mainly due to excessive nutrients brought in by the Mississippi River.

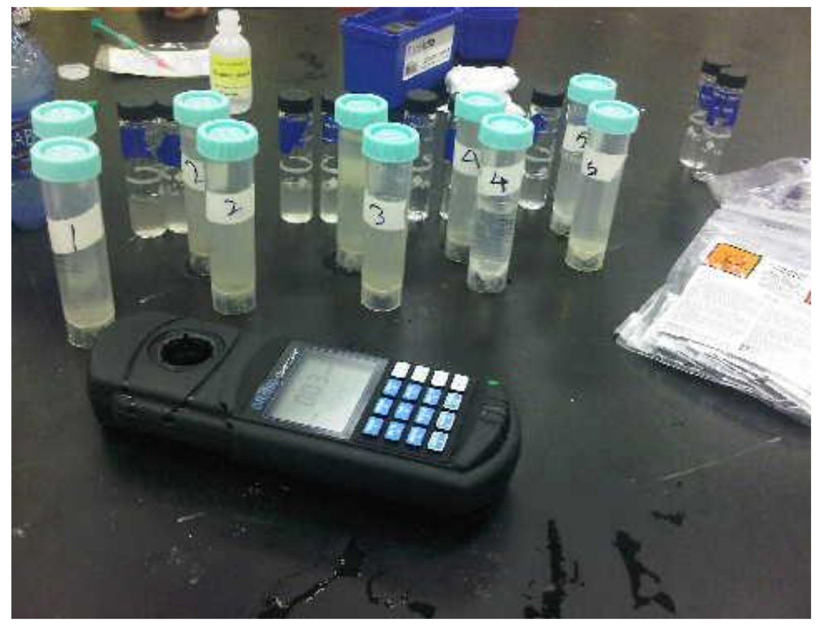
Figure 2. The Lake Waco Wetlands consists of five connected cells which water flows through. As the water progresses through each cell it is filtered.

Materials and Methods

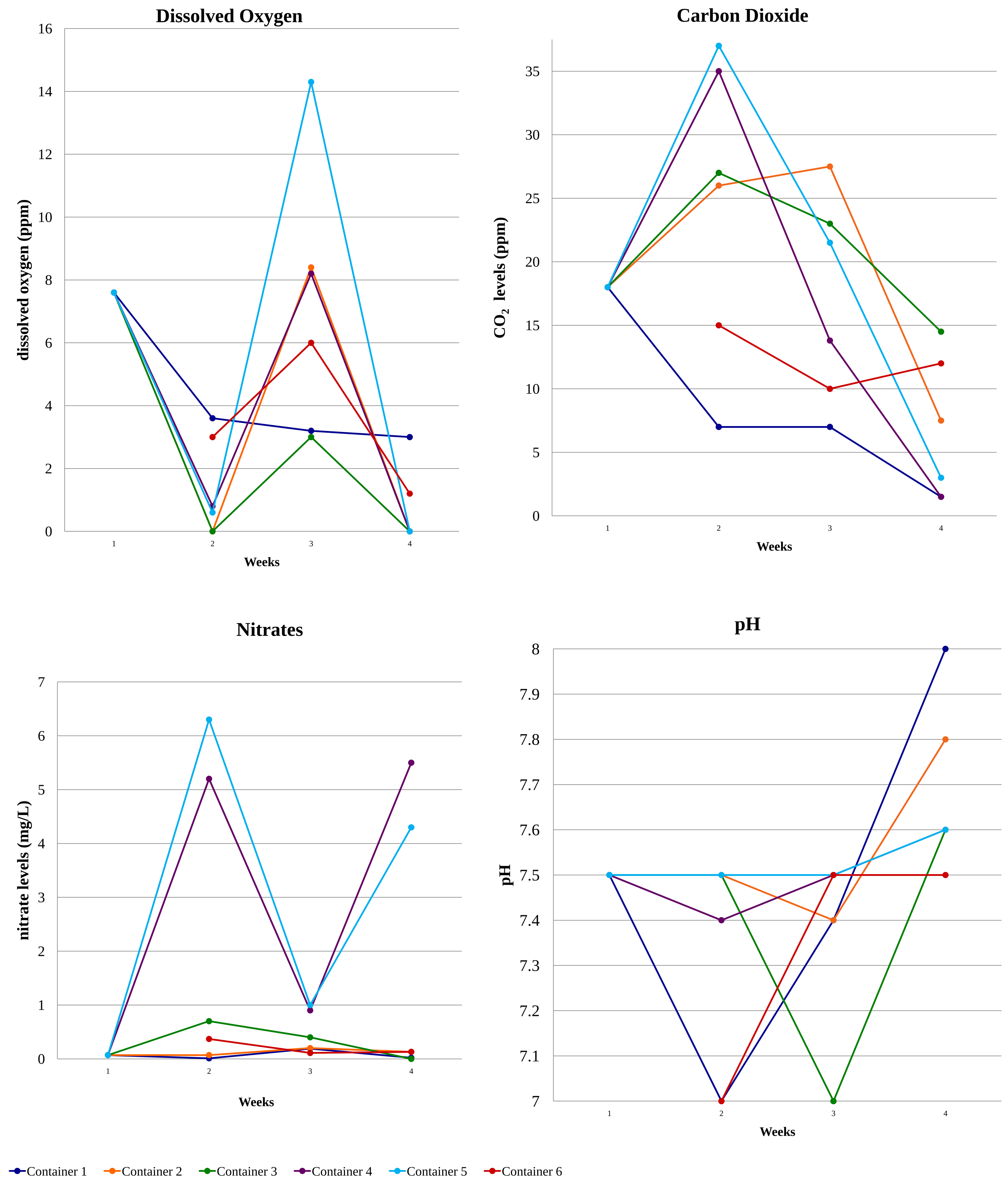
Five containers served as identical microenvironments. Sediment and water were collected from the first cell at the Lake Waco Wetlands (Fig. 2). 2kg of sediment, 5.5L of water, 30g of green algae were added to each container, and nutrients in the form of fertilizer were added in graduated increments of 5mL. Container 1 served as a control to which no nutrients were added. Containers were kept in the lab, with a12-hour artificial light cycle.

Measurements of dissolved oxygen, carbon dioxide, and pH were taken weekly using of LaMotte test kits. A HACH DR/890 colorimeter was used to measure nitrate (Fig. 3). Samples were collected over a 3 week period. An additional container was added after week 2 to which only 1 mL of fertilizer was added.

Figure 3. The picture on the left shows nitrate testing and the device used. The picture on the right is a sample with 0 mg/L of dissolved oxygen and the kit used.



Results (Figure 4)



Based on the data collected in the preliminary experiment, the relationship between dissolved oxygen and nitrogen had confirmed our hypothesis. As the level of nitrates increased, the levels of dissolved oxygen decreased. The trend can be concluded in the opposed measurements taken for nitrates and dissolved oxygen in four consecutive weeks tested. Carbon dioxide also played a role in the data. During the second week the levels increased to the maximum amount, and then gradually decreased. This fluctuation can also be seen in the pH measurement fluctuation between 7 and 8. This trend evaluated in dissolved oxygen, carbon dioxide, pH, and nitrates can be attributed to photosynthesis and nitrification (Sprent, 1990; Burns, 1975).

Conclusions

An inverse relationship is shown between nitrogen and dissolved oxygen consumption and breakdown. A hypothesis was formed that the nitrate levels in Containers 4 and 5 would be extremely high and cause hypoxia rapidly. This was clearly shown in the results (Fig. 4). After week 2, there was an algal bloom that caused depletion in nitrogen levels and an increase in dissolved oxygen levels. After week 3, bacteria began to consume the decomposed algae which caused nitrification, which in turn, caused another spike in nitrate levels in week 4. As algae was photosynthesizing it used CO_2 causing a gradual increase in dissolved oxygen. The dissolved oxygen was then consumed by the bacteria causing the CO_2 to increase after week 2.

Literature cited

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