The pH Predicament

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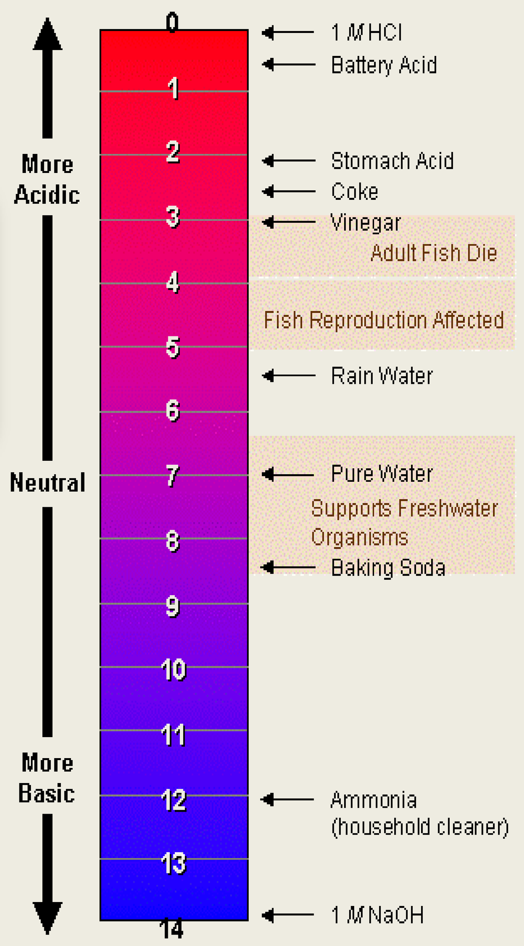
Abstract

The water contributions to the Waco wetlands contain nutrients from rainwater runoff. High levels of nutrients can cause the algae to grow at an increased rate. As the algae photosynthesize, the amount of carbon dioxide in the water is reduced. Carbon dioxide causes water to become more acidic by forming carbonic acid (TCEQ 2005). The reduced amount of carbon dioxide can have an effect on the pH of the water. Depending on the amount of algae, cellular respiration that occurs at night could lower the pH of water by adding large amounts of carbon dioxide. If the water becomes too acidic or basic, many organisms could be put in danger. The experiment involved three containers with varying combinations of algae and fertilizer. The pH of each container was measured after one week. The experiment produced data showing that, in the presence increased nutrients, the algae acts as a buffer that prevents the water from becoming too basic. The algae accomplishes this by removing the high amounts of fertilizer that would otherwise decay into ammonia (12 pH) compounds. In the control container the increased pH can be contributed to the uptake of carbon dioxide by the photosynthesizing algae. This appears to mean that the increased presence of nutrients in conjunction with augmented algae growth is a beneficial process that helps maintain the range of pH in the wetlands.

Introduction

When algae photosynthesize during the day, they use up carbon dioxide in the water. The removal of carbon dioxide prevents carbonic acid, an important water pH buffer, from forming. While not exposed to sunlight, however, cellular respiration occurs, producing large amounts of carbon dioxide. This process could have a contrary effect on the pH of water, causing it to become more acidic. The alteration of water chemistry can disrupt the natural pH balance of aquatic ecosystems. Also, many common fertilizers are likely to increase the amount of pH due to its propensity to form ammonia. This change in pH can affect many organisms in the wetlands. Due to the logarithmic nature of the pH scale, even change of +/- 1 pH is a tenfold change in H^+ ions, making the change potentially dangerous for organisms to live in. Other factors such as runoff from livestock, dairy farms or from other urban areas can also contribute to this alteration of our environment (Gui, et al. 2007) . This study will investigate how fertilizers affect algae and the water chemistry in relation to how human presence affects the wetlands and the organisms living in it. The hypothesis tested will be: If nutrient levels increase greatly, then the algae will cause pH of the wetland's water to decrease.



Materials & Method

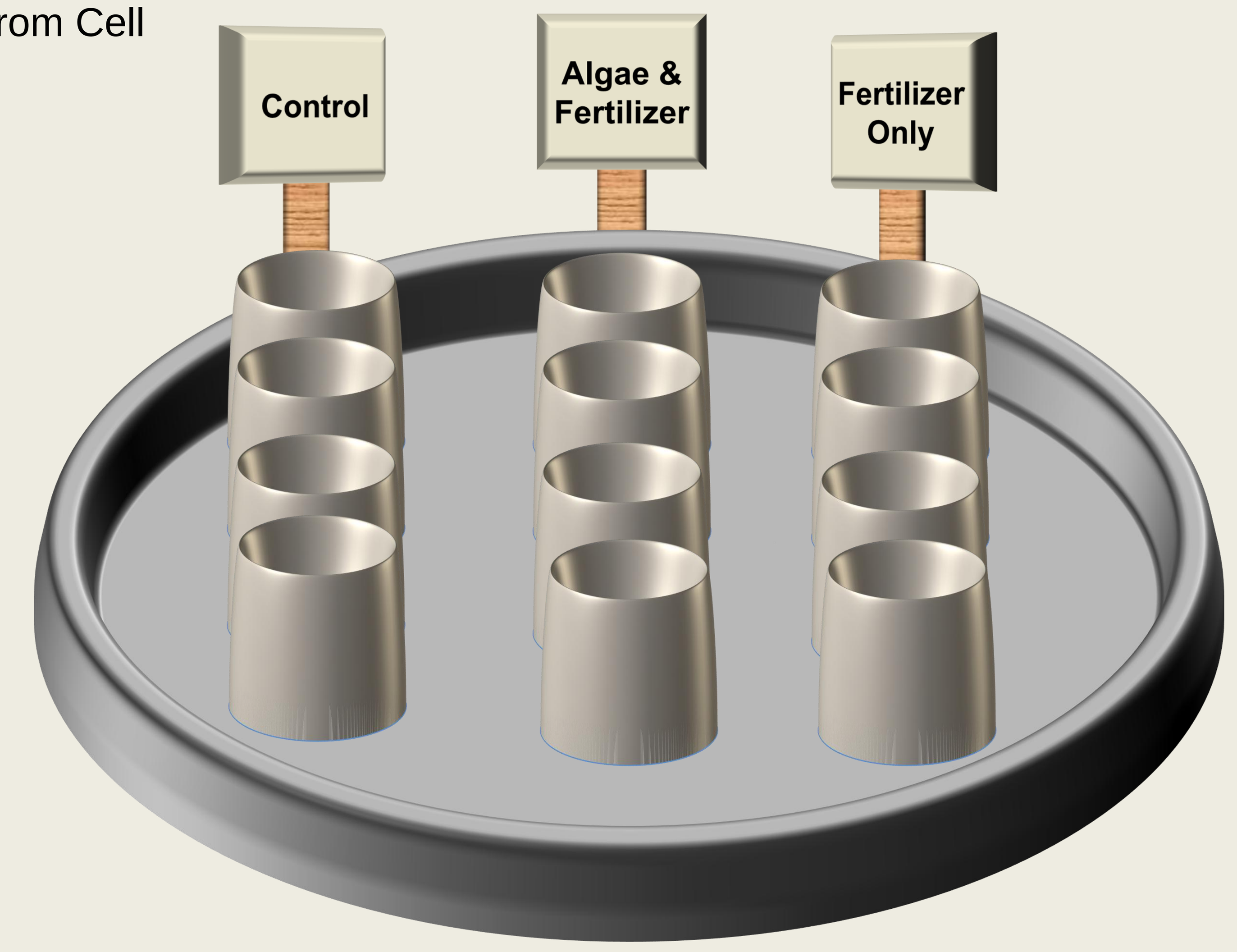
The experiment was conducted in the Baylor Experimental Aquatic Research (BEAR) outdoor facility at the Lake Waco Wetlands. The Lake Waco Wetlands features a natural filtration system separated into four cells (numbered 1-4) which the water passes through. All water used in the experiment was taken from Cell 1. All algae was taken from the channel between Cell 1 and Cell 2.

-Twelve 18.93L plastic containers
-Containers: 1. **Control**, 2. **Algae & Fertilizer**, 3. **Fertilizer Only**)
-Each container was replicated four times
-Each container contained 8L of water

1. **Control**: 20g of drained algae
2. **Algae & Fertilizer**: 2mL of liquid fertilizer (7-7-7) in addition to 20g of drained algae
3. **Fertilizer Only**: 2mL of liquid fertilizer (7-7-7)

-Initial pH was measured in order to compare average pH change
-pH was recorded after one week by 1:00 PM for three weeks using a digital pH measuring probe
-After the final pH was measured each week, all containers were reset to the above specifications

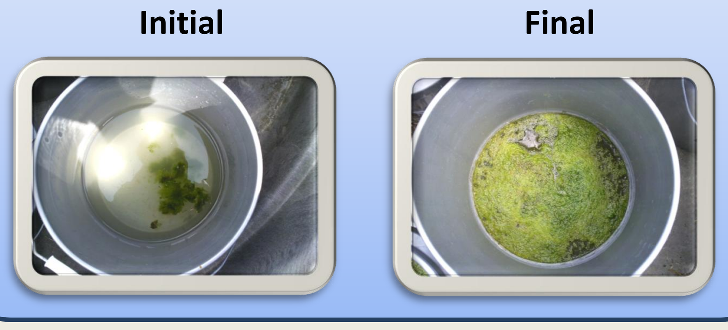
Setup Diagram



Results

After one week, the Control had little algae growth with the greatest average pH increase (+1.35). Algae & Fertilizer had a large amount of algae growth (as seen in the initial and final algae photos below) and the smallest average pH increase (+0.83). Fertilizer Only was measured to have an averaged increase in pH of 1.28.

Visual observation of algae growth from **Algae & Fertilizer** over a one week period:



Weekly Average Table

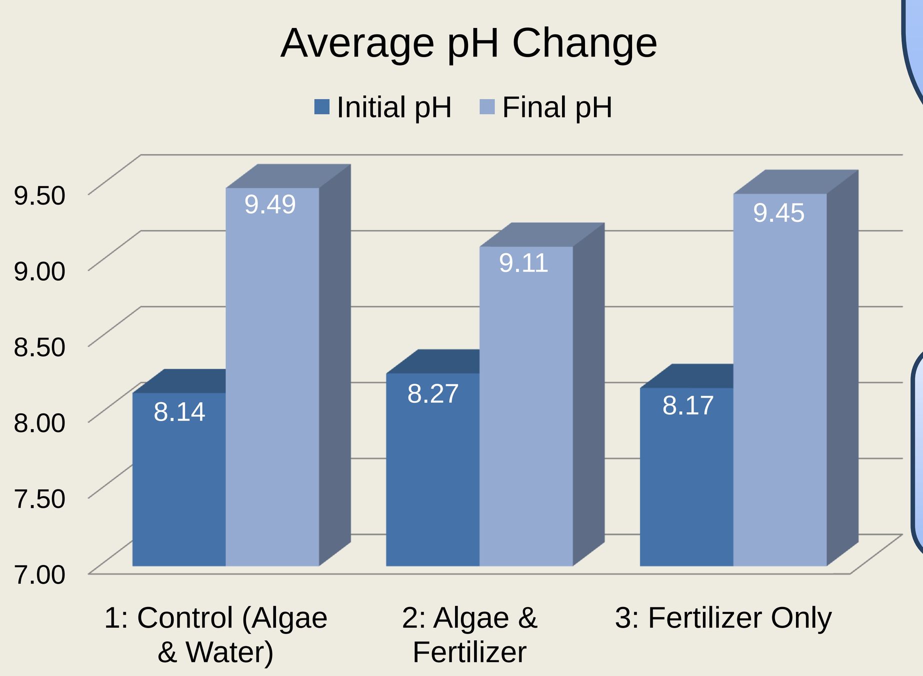
The average pH is shown separated into each week of testing. Initial Averages are the pH of each container prior to addition of fertilizer and Final Averages display the pH after a week of the experiment.

Initial Averages (**Before Fertilizer**)

	1: Control (Algae & Water)	2: Algae & Fertilizer	3: Fertilizer Only
Week 1	7.93	8.38	8.15
Week 2	8.24	8.16	8.13
Week 3	8.25	8.27	8.25

Final Averages (**After One Week**)

	1: Control (Algae & Water)	2: Algae & Fertilizer	3: Fertilizer Only
Week 1	8.29	8.66	9.27
Week 2	10.28	9.13	9.81
Week 3	9.90	9.53	9.28



The Average pH Change graph displays the averages of all three weeks of the experiment in order to depict the most general scope of change in the presented scenarios.

Conclusion

Using Welch's Test, statistical significance was found between the three experimental groups. In the Control the average pH increased. This occurred due to the reduction of carbon dioxide in the water by the algae, preventing carbonic acid from forming and decreasing the pH of the water (TCEQ 2005). The results showed that the Control and Fertilizer Only containers had an average pH increase that was greater than the increase measured in the Algae & Fertilizer containers. Due to the augmented mass of algae in the Algae & Fertilizer containers, the amount of cellular respiration that occurred over-night produced a surplus of carbon dioxide far greater than the algae in the Control. The algae's photosynthesis (reduction of carbon dioxide) was apparently not able to overtake the effects of a night of cellular respiration. The excess of carbon dioxide from cellular respiration explains the differences between the average pH change of the Control and the Algae & Fertilizer containers. In the Fertilizer Only containers, the fertilizer contained ammonium phosphate and other inorganic compounds. Because of the presence of ammonium phosphate, it was concluded that the fertilizer produced ammonia (pH of 12) therefore resulting in a more basic pH. The hypothesis proposed was disproven, suggesting that algae acts as a buffer that prevents water from becoming too basic in the presence of fertilizer.

Works Cited

Gui, P., et al. "Evaluation of constructed wetlands by wastewater purification ability and greenhouse gas emissions." Water Science & Technology 56.3 (2007): 49-55. Academic Search Complete. EBSCO. Web. 25 Feb. 2010.

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Acknowledgements

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