How do different levels of detergent and fertilizer affect the process of eutrophication in Ell Pond (Melrose, MA) and Spot Pond (Middlesex County, MA)?

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Abstract

The process of eutrophication has been an environmental issue in bodies of water in a range of places, largely since the 1900s. Previous research showed that after the Industrial Revolution more runoff occurred increasing nutrients in the water, leading to algae blooms. Algae blooms cause a decrease in dissolved oxygen (DO) leading to population loss. This study looked at Spot Pond and Ell Pond, both local to our school. This study used titration to measure DO levels from pond samples. The pond samples are enriched with Miracle-Gro and Borax. Miracle-Gro has a high nitrogen level which is associated with eutrophication. We found that the Miracle-Gro had a similar trend while the Borax had no pattern. In this study we found that different chemicals created differing results including different DO levels.

Introduction

In both Ell Pond and Spot Pond, oxygen levels differ creating algal blooms caused by eutrophication. Eutrophication is overwhelmed with nutrients causing algae blooms and an increase in activity (BYJU'S). This is a problem because too much oxygen can "choke" the water therefore causing oxygen levels to drop. The science currently tells us that in the Massachusetts area algae levels went up after the Industrial Revolution. Sediment studies in White and Walden Ponds, two other local bodies of water, found that around 1900 (industrial revolution), the organic contents in the sediment changed to show a greatly increased diatom population (Stager 11). Clearing land for industrial activities or land development causes runoff into bodies of water, which is associated with increased diatom populations. (Beck). Runoff often contains nitrogen, which adds nutrients to the water. Increased nitrogen has specifically been associated with algal blooms" (Saros 1687).

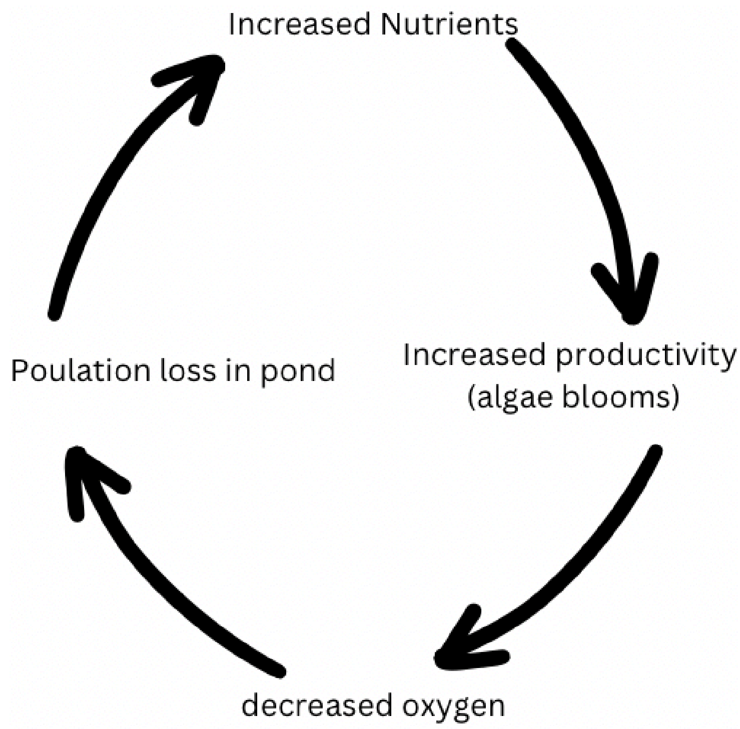

Image 1. The cycle of eutrophication

Ell Pond's history is full of pollution and invasive species. It is infested with European Water Chestnuts. The main problem however was. sewer leakage into the water which included metal. The transparency is currently murky and full of weeds covering the surface of the pond. The average depth is 10-12 feet and the area is 23 acres. Spot Pond is a home for many fish and is a reservoir. In 1845 the area became industrialized. The water is now flat and the transparency is poor. The average depth is 11 feet and the area is 254 acres.

Prior research on this issue in the area has been conducted at Walden Pond in Concord Massachusetts with the first relevant change in the diatom record when *D. stelligera* occurred. In the mid-1800s around the start of the Industrial Revolution, the clear water started producing a green color. Around the same time, Walden's settlements started to lack organic content. A prominent amount of eutrophication started in 1960 when *A. formosa*, increased *D. stelligera*. The cycle of lots of oxygen leads to an increase in productivity leading to little oxygen and repeating.

The reason eutrophication is a problem is because the oxygen levels go down which damages productivity. When this happens the water is “choked.” Algal blooms form and are a problem because they can release toxins that can negatively affect surrounding wildlife. The wildlife will become sick if they drink the toxins and in extreme cases can die. The reason it is important to measure oxygen levels is that wildlife can be severely hurt by this. When stopped the water’s oxygen levels can return to normal. It is important because when algal blooms occur it poorly affects not just the aquatic life but surrounding plants and animals as well.

Research Questions

Do different amounts of detergents affect the levels of oxygen in Spot and Ell Pond?

Do different amounts of fertilizer affect the levels of oxygen in Spot and Ell Pond?

How did ponds’ levels of oxygen relate to eutrophication?

Methods

The first part of the experiment was to collect water samples from two ponds, Ell Pond, and Spot Pond. Once collected the water was divided into 14 jars, using seven jars for each pond. I put ½ cup pond water and ½ cup spring water into each In three of the Spot pond jars and three of the Ell pond jars I put in varying levels of borax. I put ¼ tsp, ½ tsp, and 1 tsp of borax. For the other jars I used the same levels but instead of borax, I used Miracle-Gro. Afterwards, I made two control jars for each pond which were ½ cup pond water and ½ spring water. One day I would measure Ell Pond and the next day I would test Spot Pond. I measured the dissolved oxygen by using a dissolved oxygen test kit from the Monitor Aquarium. This kit used titration to determine dissolved oxygen contents. When the oxygen levels drop wildlife can be harmed because a lack of productivity means a lack of food. As I tested I would put the results into a spreadsheet. The total experiment spanned around two weeks. After the data was collected we put the information into a line graph because it shows progression over time.

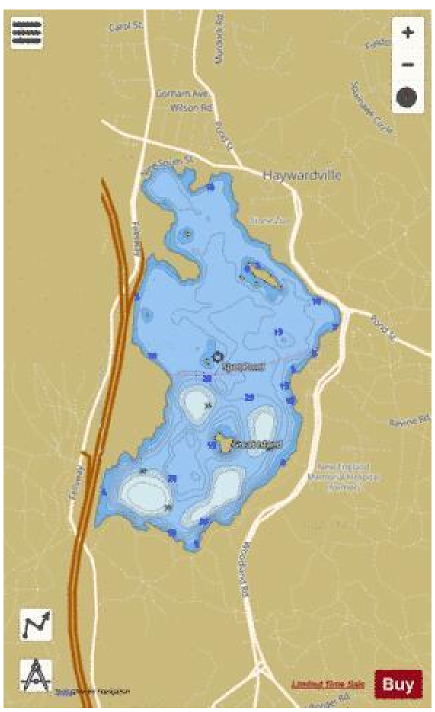

Image 2. Map of Spot Pond

Spot Pond is part of the Middlesex Reservation in Stoneham leaving it protected. The pond is home to many fish and other wildlife, both in and surrounding the pond. Little to no runoff enters the pond

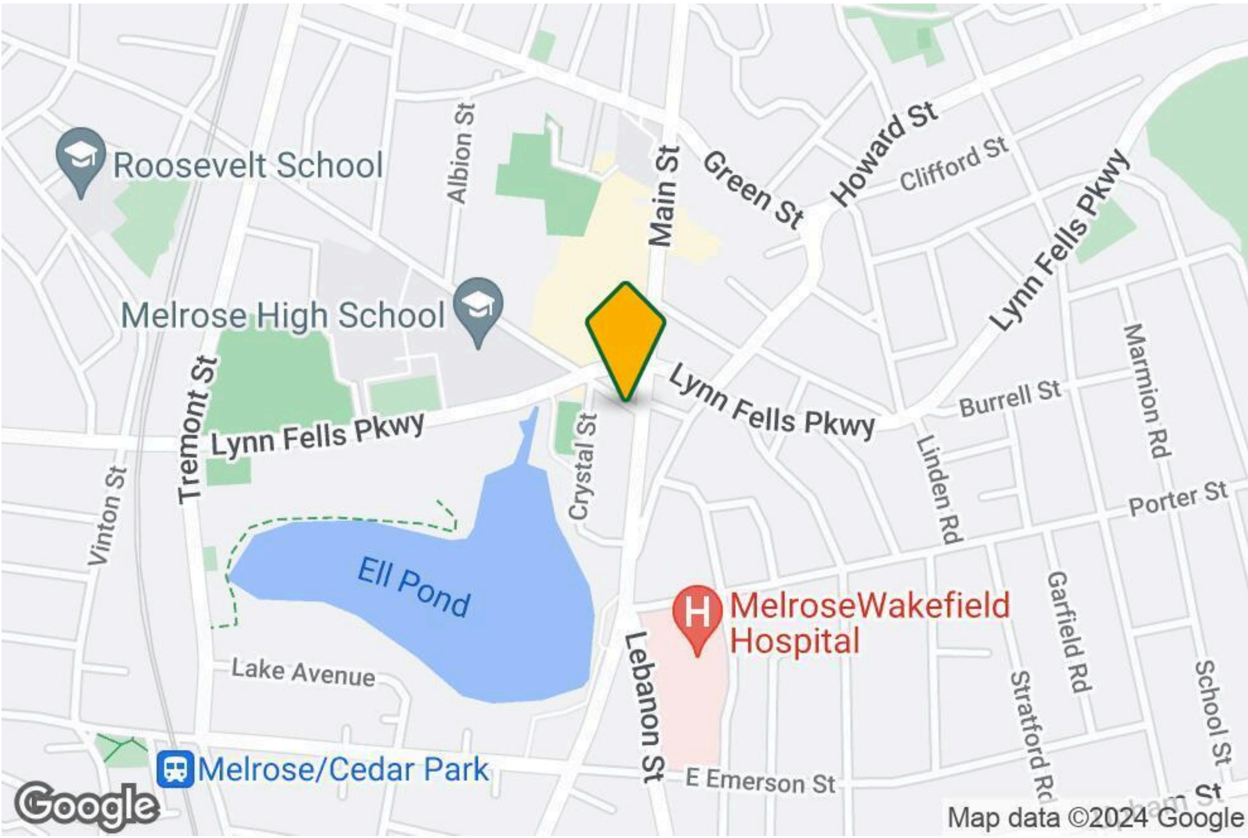

Image 3. Map of Ell Pond

Ell Pond is located in the middle of a town, surrounded by much industrialization. The pond is surrounded by invasive animals and plants. Runoff is normal for the pond.

Results

The results for Ell pond's dissolved oxygen levels show how detergent and fertilizer affect the pond water. Both of these were chosen because they contain nutrients commonly associated with eutrophication. For the detergent, the ¼ tsp level stayed low maxing at a dissolved oxygen level of four. The levels stayed steady throughout the period with a steady descent with one spike towards the end. When the ½ tsp level was tested there were two spikes with the same highest point. The lowest point of the dissolved oxygen arc was one. The detergent at 1 tsp stayed above the limit that was reachable with the testing chemicals. At the end of the experiment, there was a quick drop. During the last two days, the ½ tsp and 1 tsp overlapped.

For Spot Ponds results on detergent vs fertilizer, the results varied more often. The detergent levels showed 1 tsp drop on the final days of the reading. As displayed on the detergent chart 1 tsp and ½ tsp follow the same path on days eleven to fifteen. The ¼ tsp had a steady decline throughout the readings. The fertilizer shows the 1 tsp level stayed fifteen and above the majority of the time. For the ½ tsp starts at 11 DO and declines the rest of the way. Similar to the ½ tsp the ¼ tsp started at 7 and declined the rest of the way.

The charts all show that 1 tsp had the highest do with most staying above the limit of fifteen. The ¼ tsp stayed low except for the levels from the fertilizer in Ell Pond. When compared the ½ tsp in both Ell and Spot Pond's fertilizer stayed low in DO levels barley spiking. Overall the data shows that different tsp levels across the charts are more relatable than fertilizer is to fertilizer or detergent to detergent.

The range of error of the experiment was high. Not being able to test both pond's jars on the same day left space for misreading. The chemical readings occasionally had differing water samples due to the droppers being used rather than a scale. Having to retest the same sample led to varying water levels causing some samples to run out faster. The range of error most likely affected the results but gave more data on eutrophication by being able to compare lt varied data.

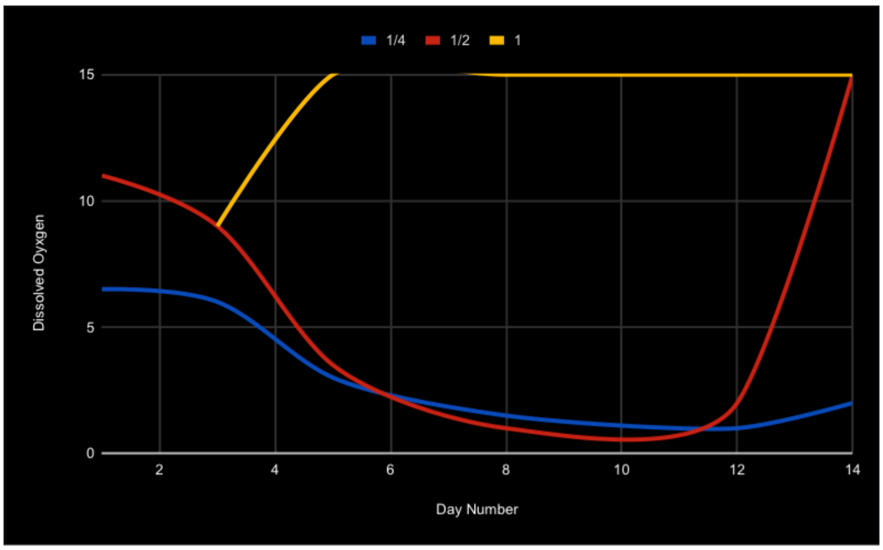

Fig 1. Spot ponds DO levels with fertilizer

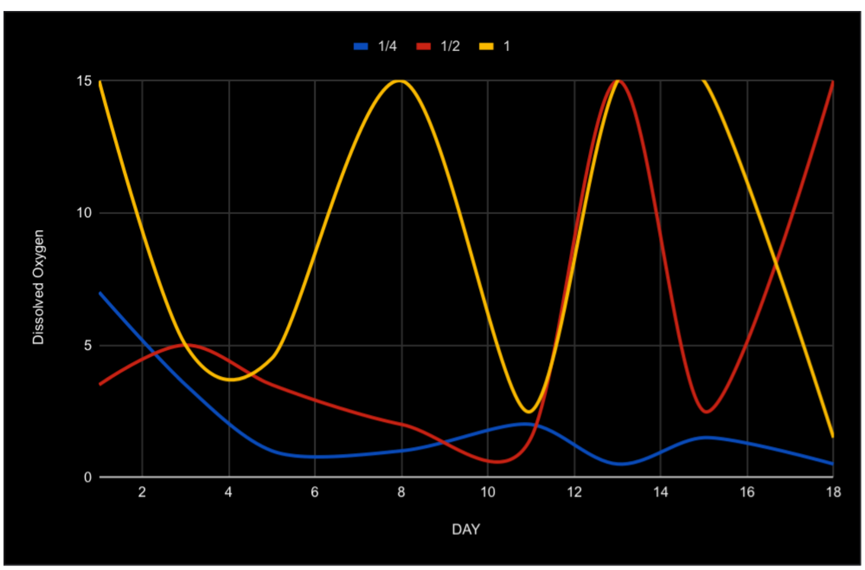

Fig 2. Spot Ponds DO levels with detergent

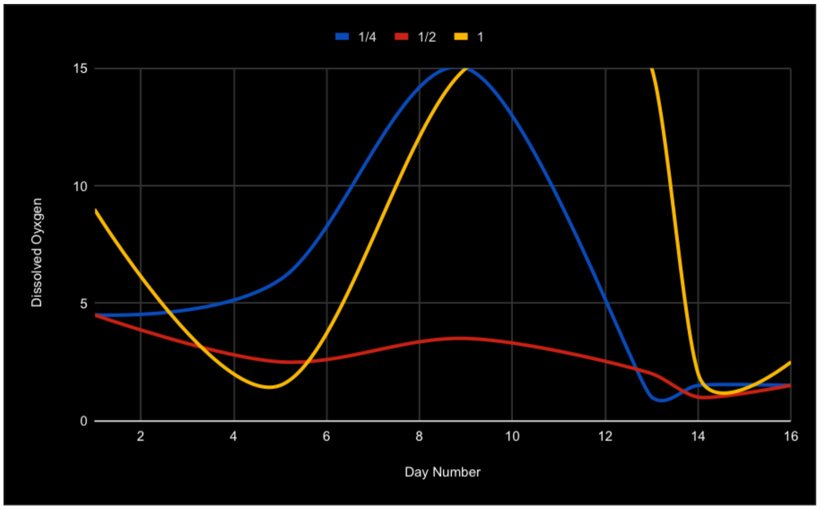

Fig 3. Ell ponds DO levels with fertilizer

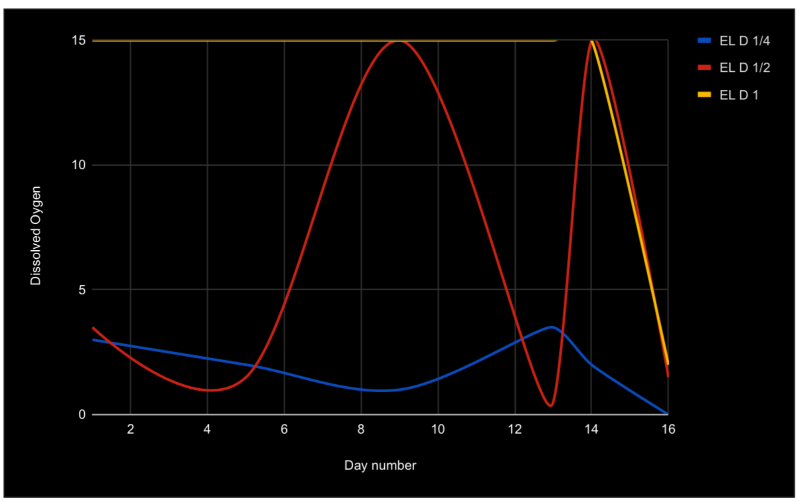

Fig 4. Ell ponds DO levels with detergent

Discussion

In the experiment, we found that Spot Pond and Ell Pond's DO levels of ½ tsp and ¼ tsp had similar trends. Towards the end, the ½ tsp starts to look like the 1 tsp level. The DO level for the

¼ stays low in both graphs. For the most part, there was no pattern. This level of detergent had little effect on the DO level. For Ell Pond, the 1 tsp line was steady then dropped showing that overtime the detergent level drops in DO. The ¼ tsp has shown to have little effect on the DO level. On the graph, it shows ½ tsp has a wave pattern. The ½ tsp and 1 tsp lines on the last three days had the same levels of DO. In summary, different levels of detergent affect DO levels differently.

In the experiment with different levels of fertilizer, the differing amounts showed different levels of DO. Spot ponds ½ and 1 ⁄ 4 had a similar pattern until ½ spikes of DO in the final two days. The 1 ⁄ 4 line was a downward trend throughout the experiment. The 1 tsp level went up the entire time passing the upper measurable limit of DO. In summary, the fertilizer in Spot Pond had different effects on the DO level with similar trends of the ¼ and ½ until ½ spiked. 1 was different the whole time. For Ell Pond ½ had lower levels and is consistent with the number of days difference. In the graph, ¼ and 1 had the same upward curve and downward trend. This result differs from Spot Pond's result being unexpected. In the end, the levels are in the same range of DOs.In summary, different levels of fertilizer affect DO levels differently but his graph shows the most prominent pattern

Eutrophication occurs when too many nutrients are in the water. The different pond waters normally have 5 to 10 DO. Our levels started at 10 and 12. In the ponds we studied there was slight eutrophication. The effect of the fertilizer for this experiment was that there is no pattern so it is unclear how it would affect eutrophication. For Ell Pond, there was a decrease and in Spot

Pond, there was an outlier. Further experiments are needed to elucidate the true effect of fertilizer/detergent on DO levels.

When comparing studies dealing with eutrophication, the papers displayed how nitrogen and land clearance affected the DO levels in different ponds. During land clearing where railroads and ores were being smelted made it so nitrogen entered the bodies of water. (Beck 8). The runoff from factories also puts toxins into the ponds leaving DO levels askew. When there is too much nitrogen the study done by Saros, Wolfe, and Interlandi says when enhanced, diatom levels rise with it. White and Walden Ponds had similar histories with both being inhabited by indigenous tribes before the 1900s and the Industrial Revolution. All four ponds are located in Middlesex County, Massachusetts, leaving similar runoff patterns.

Conclusion

To summarize when combining pond water with different amounts of fertilizer and detergent the DO levels start to change. The detergent charts had a similar wave trend but lacked a common pattern. For the fertilizer data, there was no common pattern. The data trends show that with a lack of pattern across all charts the DO levels are truly affected very differently in each reading. To conclude, the titration used to measure the levels of DO showed us that eutrophication acts differently with nitrogen or without it.

Citations

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