The Effect of Temperature on Dissolved Oxygen Levels in Aquatic Environments

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Abstract

This study explores the relationship between water temperature and oxygen levels in aquatic environments, and focuses on the impact of temperature changes on aquatic life. As dissolved oxygen is necessary for the survival of many aquatic organisms, understanding how temperature change affects oxygen availability is crucial, especially in climate change. Through the testing of our water samples, we measured dissolved oxygen, temperature, and pH over multiple dates. The results confirmed that there is a relationship between temperature and dissolved oxygen levels–higher temperatures led to lower dissolved oxygen levels. These findings match with scientific research, showing that increased temperatures reduce oxygen solubility, possibly causing stress and habitat loss for aquatic organisms. Although there are other factors that affect oxygen levels, this study focuses on how important it is to put into account how different factors, such as temperature and dissolved oxygen, affect aquatic life.

Introduction

How does the increase of temperature affect dissolved oxygen levels, and what are the influences it has on aquatic life? If there is an increase in the temperature of a body of water, then the level of dissolved oxygen will decrease, because high temperatures reduce the solubility of oxygen in water, which then makes aquatic life difficult to be supported. When making the decision to choose the topic of *The Effect of Temperature on Dissolved Oxygen Levels in Aquatic Environments*, we felt that it was an important subject that needed to be examined. Most people don't know about this topic as a whole, so we wanted to look at it more closely. The study of how temperature affects dissolved oxygen levels in aquatic environments was mostly driven by the concerns that were made of climate change, pollution, and aquatic ecosystem health in all.

Clearly, oxygen is essential for fish and other aquatic organisms, so its depletion could lead to an increase in the death of fish, and a loss of diversity in aquatic life. Understanding how temperature and dissolved oxygen relate is also important in predicting the impact of climate change, which helps water quality and to utilize resources in an efficient manner. So, when researching the topic of *The Effect of Temperature on Dissolved Oxygen Levels in Aquatic Environments*, it was important to examine the subject more closely in order to make it more clear.

Aquatic ecosystems rely heavily on dissolved oxygen to help support life in them, which runs from fish and invertebrates all the way to microorganisms. There are many factors that depend on the level of dissolved oxygen in water; temperature itself is one of the major factors affecting the solubility of oxygen in water. With temperatures rising all over the world, there has been speculation as to how this could affect aquatic life, because it is said that warmer waters reduce the solubility of oxygen. Therefore, this project will consider and discuss dissolved oxygen levels of change resulting from temperature changes in aquatic freshwater environments and, particularly, how increased temperatures could result in oxygen use and their connection to aquatic organisms. The relationship between temperature and dissolved oxygen is necessary in understanding the connection relating to the change in aquatic life. Comprehending how these ongoing changes will impact future aquatic ecosystems is also critical in the preservation of diverse aquatic life and good water quality. Currently, oxygen use is already a concern in many regions, especially in areas with influences from pollution and agricultural runoff, along with other environmental harms. According to the U.S. Environmental Protection Agency (2009), the possibility of the worsening of oxygen conditions with increasing temperatures is very serious for many aquatic species. Changes in oxygen levels not only affects life forms directly, but also leads to disruptions of food webs and ecological interactions. For example, fish that are dependent on high oxygen waters would be compelled to migrate, so local biodiversity would then be altered. Once again, the oxygen consumption might promote other organisms such as algae that form harmful algae blooms, to contribute to oxygen consumption and then the development of dead zones in water bodies (U.S. Geological Survey, 2018). The result of this study is another piece of writing that adds to the knowledge on the dependence of temperature and dissolved oxygen. Temperature has been one of the considerable determining factors for the dissolved oxygen level in water. With increased temperature, less oxygen is carried by water. According to the U.S. Geological Survey (2018) , with increased temperatures, the gases become less soluble in water since the speed at which molecules move is higher in warm water; so, they are not able to carry as much of the dissolved gas. This then makes this oxygen less soluble, particularly for shallow bodies of water, where the change in temperature is greater compared to deep waters. The pattern of temperature's relation to dissolved oxygen in general is known. With a rise in water temperature, the oxygen solubility in water goes down. With global warming driving temperatures upwards, oxygen availability to aquatic organisms may lower and create stress for species that are adapted to low-temperature environments. In general, aquatic life is sensitive to oxygen levels and requires a sufficient amount of oxygen to maintain life. Aquatic organisms digest foods at higher rates with the increase in temperatures, which results in increased demands for the production of oxygen (pHionics, 2021). However, low oxygen solubility of warm water creates a separation between the oxygen requirements and the oxygen available for the organisms. These result in physiological stress, reduced growth rates, and sometimes deaths, which The U.S. Environmental Protection Agency (2009) wrote. Cold-water fish like salmon and trout are susceptible to reduction in oxygen content. They only exist in waters that have been highly oxygenated; when such waters record an oxygen level reduction, it creates a potential migration for the organisms.

Methods and Materials

Materials:

- Dissolved Oxygen Kit: Used to measure dissolved oxygen levels.
    - Manufacturer: CHEMetrics
    - Model: CHEMets Kit
- pH Meter: Used to measure pH.
- Thermometer: Used to measure water temperature.
- Protective gear: Safety goggles, apron, close toed shoes.

Methods:

The data collection site was chosen based on the closest body of water to the school. Water samples were collected from the Ottawa River, in Toledo, Ohio. Our first test was taken on November 7th, 2024. A water sample was collected from the stream and tested on a few different variables. First, we tested dissolved oxygen levels using the CHEMets Kit and got a dissolved oxygen level of 5 mg/L. Then, the temperature of the water was measured using a digital thermometer, which recorded the value of 14.65 degrees celsius. Lastly, the pH of the water was measured using a calibrated pH meter, and it read 7.8.

Our second test was taken on November 13th, 2024. We collected another sample on this day and then ran the same tests. We started with taking the dissolved oxygen level, which was 9 mg/L. Then we took the temperature of the water, which came out to be 10 degrees celsius. Lastly, we tested the pH of the water, which read 6.4

Our third test was taken on November 25th, 2025. A third sample was collected on this day and we started off by measuring the dissolved oxygen, which was 7 mg/L. Next, we tested the temperature of water, which was 13 degrees celsius. Lastly, we tested the pH, which was 7.

For our last test, it was taken on December 5th, 2024. We started by testing the dissolved oxygen, which came out to be 10 mg/L. Next, we tested the temperature, which was 1.1 degrees celsius. Lastly, we tested the pH, which was 6.9.

When performing this experiment, it is important to use the same kit to test the dissolved oxygen and pH, because these are variables that should stay constant. After we collected our data, we looked at each variable and tried to figure out if any variable increasing or decreasing had an effect on one another. The data that we took eventually answered our hypothesis.

Presentation of Data and Results

Figure 1: Relationship Between Temperature and Dissolved Oxygen :

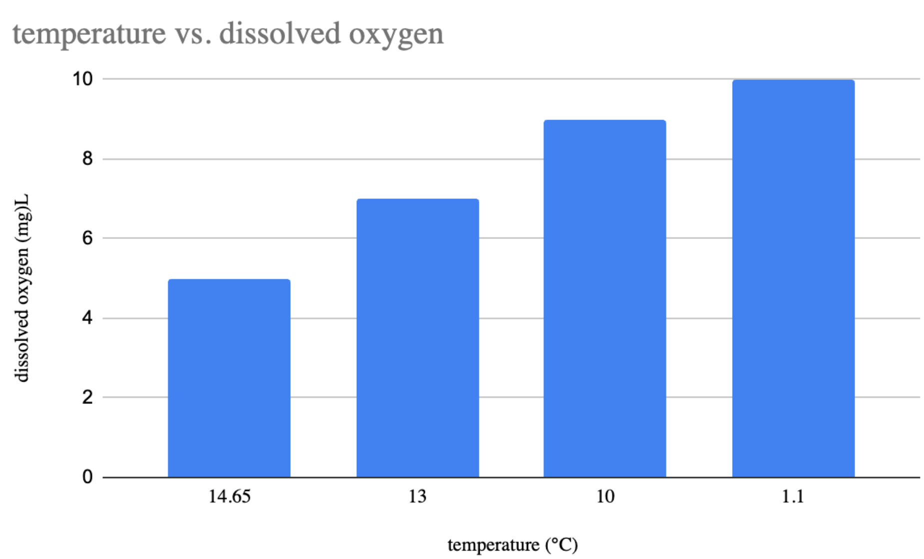

Figure 2: Dissolved Oxygen, Temperature, and pH Levels Over Time

	Date	Dissolved Oxygen (mg/L)	Temperature	pH
Test 1	11/7/24	5 mg/L	14.65°C	7.8
Test 2	11/13/24	9 mg/L	10°C	6.4
Test 3	11/25/24	7 mg/L	13°C	7
Test 4	12/5/24	10 mg/L	1.1°C	6.9

On November 7th, the maximum temperature (14.65°C) was correlated with the minimum dissolved oxygen level (5 mg/L). On December 5th, the minimum temperature (1.1°C) was correlated with the maximum dissolved oxygen level (10 mg/L). This is in accordance with the established scientific principles, as cold water holds more dissolved oxygen due to lower molecular activity, which decreases gas diffusion out of the water.

An interesting exception occurred on November 13th. The dissolved oxygen level reached 9 mg/L, even though the temperature was 10°C. This was higher than what we usually expect. Possible reasons could include more water movement, increased photosynthesis by water plants, or recent weather changes. The study also found that pH levels varied from 6.4 to 7.8. Interestingly, the lowest pH of 6.4 occurred on the same day as the unexpected rise in oxygen, hinting at possible chemical or biological changes in the water.

Analysis and Results

Our findings suggest that temperature and dissolved oxygen have a negative relationship in water environments. The findings of the Ottawa River depict that water temperature drops with increased levels of dissolved oxygen. The lowest temperature of water (1.1°C) was accompanied by the highest concentration of dissolved oxygen (10 mg/L), while the highest water temperature (14.65°C) was accompanied by the lowest concentration of dissolved oxygen (5 mg/L). This follows the established scientific fact that the solubility of gases decreases with a rise in temperature.

A statistical analysis of the data also supports this conclusion. Dissolved oxygen levels and temperature have a negative relationship with one another, where one rises while the other falls. The equation that models this relationship also follows Henry's Law, which was derived as an inverse relationship between temperature and the solubility of a gas in a liquid. Our data also follows the general curve of oxygen solubility in freshwater, further supporting our measurements.

One outlier in the dataset was observed on November 13th, where dissolved oxygen was 9 mg/L despite a moderate temperature of 10°C. This deviation may be attributed to environmental factors such as increased water turbulence or biological activity that could have introduced more oxygen into the system. The pH levels fluctuated between 6.4 and 7.8, suggesting that minor chemical variations occurred throughout the study, potentially affecting dissolved oxygen levels.

Overall, these results support the hypothesis that warmer water holds less dissolved oxygen, which has serious implications for aquatic ecosystems.

Conclusion

The results of our experiment verify the hypothesis that an increase in water temperature leads to a decrease in dissolved oxygen levels. As a result of looking at our data, it is clear that colder water held higher dissolved oxygen levels. With an understanding of the fact that higher temperatures lower the solubility of gases in water, this is consistent within our data. The results we found matchup with those of which are published by the U.S. Geological Survey (2018), and the U.S. Protection Agency (2009). These sources state that an increase in temperature contributes to lower oxygen levels in aquatic environments.

The variation in pH levels throughout the study also shows that other factors, such as biological activity and chemical reactions in water, have a role in the dynamics of dissolved oxygen. A change was observed on November 13th, when the dissolved oxygen levels were very high, even with the moderate temperature. This shows that there are factors other than temperature that could have contributed to the results. Overall, the results of this experiment show the importance of monitoring temperature changes and the effect it has on both aquatic ecosystems and dissolved oxygen levels, especially relating to climate change, as well as other factors.

Discussion

This study gives more in depth details of the relationship between temperature and dissolved oxygen levels in water, but there are many ways the research could have been better. If we were to do this study again, we could have used a larger data set collected over a longer period of time to put into account the different seasonal effects. Also, if we used different sampling sites with different conditions environmentally, this would provide more accurate results of factors influencing dissolved oxygen levels.

Beyond the classroom, the discoveries that were made have deeper meaning into environmental changes in aquatic environments. Having a more in depth understanding of the impact of temperature on dissolved oxygen is necessary for predicting the negative effects of the change in temperature on aquatic life overall. This data could be relevant for industries that rely on aquatic environments.

Further studies could look into other variables that have an effect on dissolved oxygen, such as algae blooms, pollution levels, and the roles that aquatic plants play in oxygen being produced. Comparing the results of this experiment with data from other climate zones could give us a further insight of the impact of rising temperatures on water life. Lastly, it could be helpful to look into challenges that are created based on declining dissolved oxygen levels.

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