Effects of Nitrogen and Phosphorus Input on Lake Louise, Dallas, Luzerne County, PA

Hailey Kubiski & Dr. Cosima Wiese

Department of Biology, Misericordia University

Introduction

The runoff of nitrogen and phosphorus can be detrimental to a lakes health and ability to support life (Baker, et al. 2007). Eutrophication is a product of large amounts of nitrogen and phosphorous in lakes (Rice and Horgan, 2017). Eutrophication is when there are large amounts of algal blooms, causing there to be lower amounts of dissolved oxygen content in the water (Baker, et al. 2007). The low oxygen content causes many organisms that live in the lake to die and sink to the bottom of the lake (Baker, et al. 2007). Eventually, the dead organisms in the lake will build up at the bottom and cause the lake to fill up with sediment and decomposed organisms (Baker, et al. 2007). Eutrophication will also lead to lower biodiversity; high biodiversity is an indicator of a healthy ecosystem (Vonlanthen, et al. 2012). The purpose of this study is to examine if large amounts of nitrogen and phosphorus are present in Lake Louise. The goal is to determine if there are different amounts of nitrogen and phosphorus at a variety of locations at the lake and to compare them. The proposed research question is: Are there high concentrations of nitrogen and phosphorus in and around Lake Louise? The null hypothesis of this study is that **there will be no significant difference in nitrogen and phosphorus concentrations in areas in and around Lake Louise.**

Figure 1. Map of sites at Lake Louise.

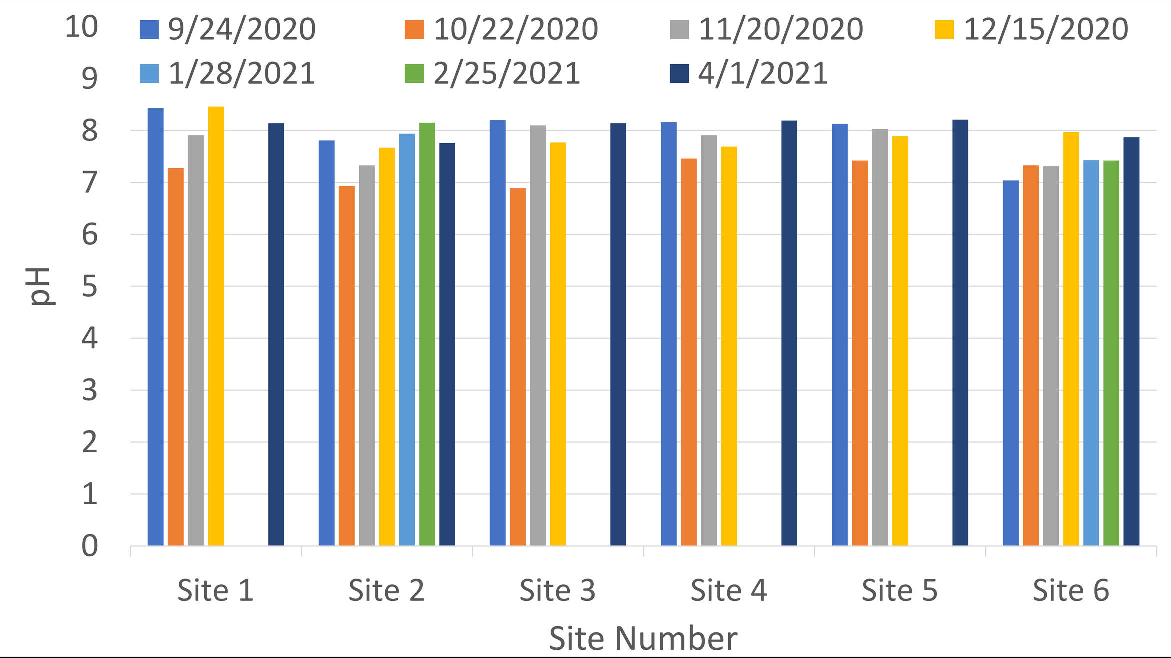

Figure 2. pH measurements in Lake Louise.

Methods and Materials

The lake that was sampled is Lake Louise, Dallas, Luzerne County, PA (41.3824° N, 75.9137° W). There were various points of water sampling near the lake, in the lake, and around the lake. Water samples were also taken from the inlets that are located near or in a golf course (Figure 1). There was a total of six sample spots. Water samples were collected using VWR TraceClean HDPE Wide Mouth Containers, Leakproof, Natural that were then submerged into the water in order to be filled. The water sample bottle was then be capped, labeled, and taken back to the lab for farther analysis. At each sampling site, the YSI ProDSS Multiparameter Water Quality Meter was used to measure water temperature, pH, dissolved oxygen, conductivity; and later in the lab chloride, nitrate (NO_3), and ammonium (NH_4). The sampling took place once a month at roughly the same date and time. In the lab, the samples were tested for total phosphorus and reactive phosphorus using the HACH Total and Reactive Phosphorus Kit. The samples were then be preserved in a Lugol's solution (North Carolina Department of Environmental Quality, 2016). The samples were observed under a microscope in order to locate any algal species present. Some of the algal species were identified using Kannan and Lenca (2013) and Wehr and Sheath (2002).

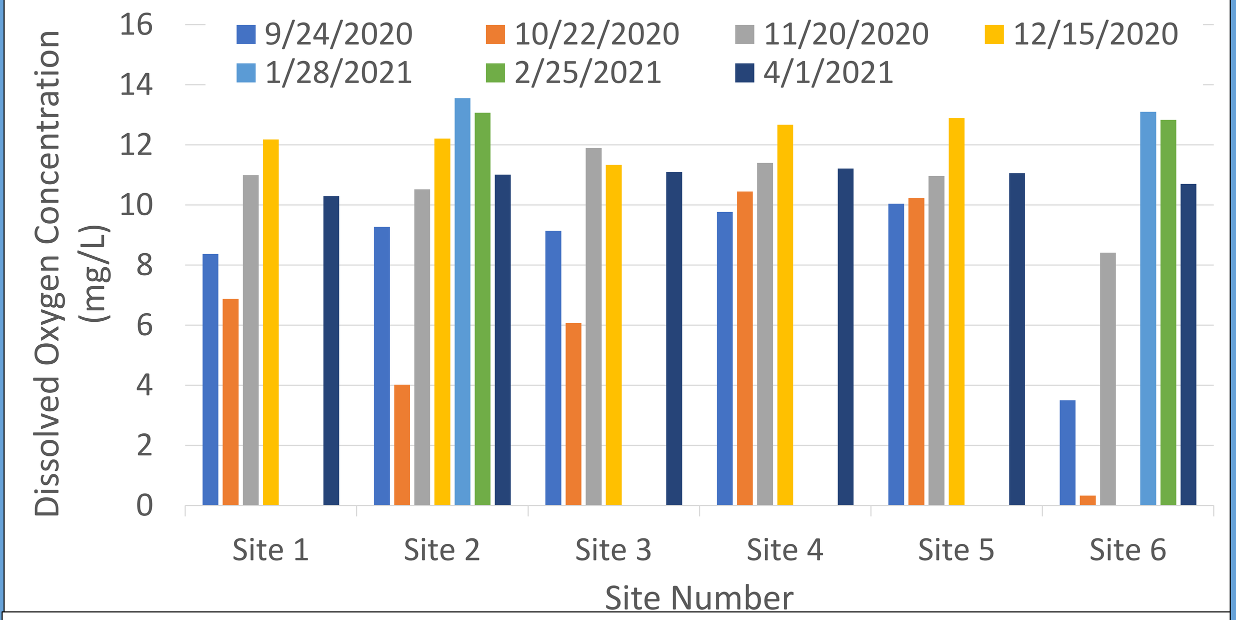

Figure 3. Dissolved oxygen concentrations in Lake Louise.

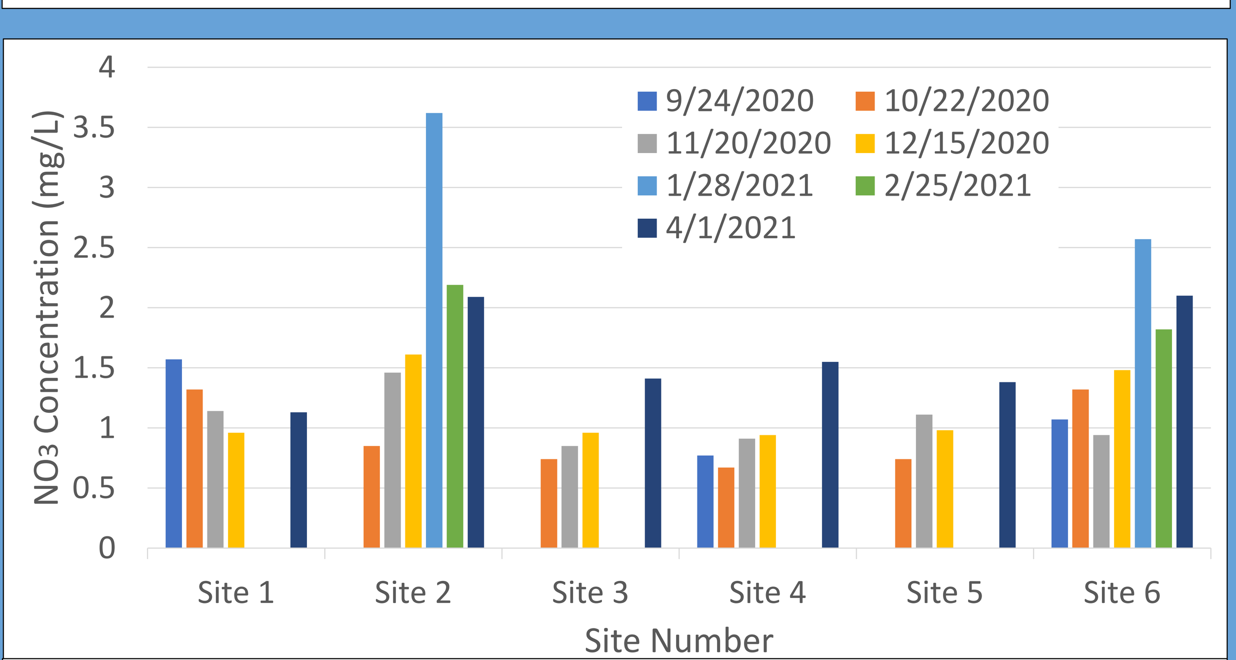

Figure 4. Nitrate concentrations in Lake Louise.

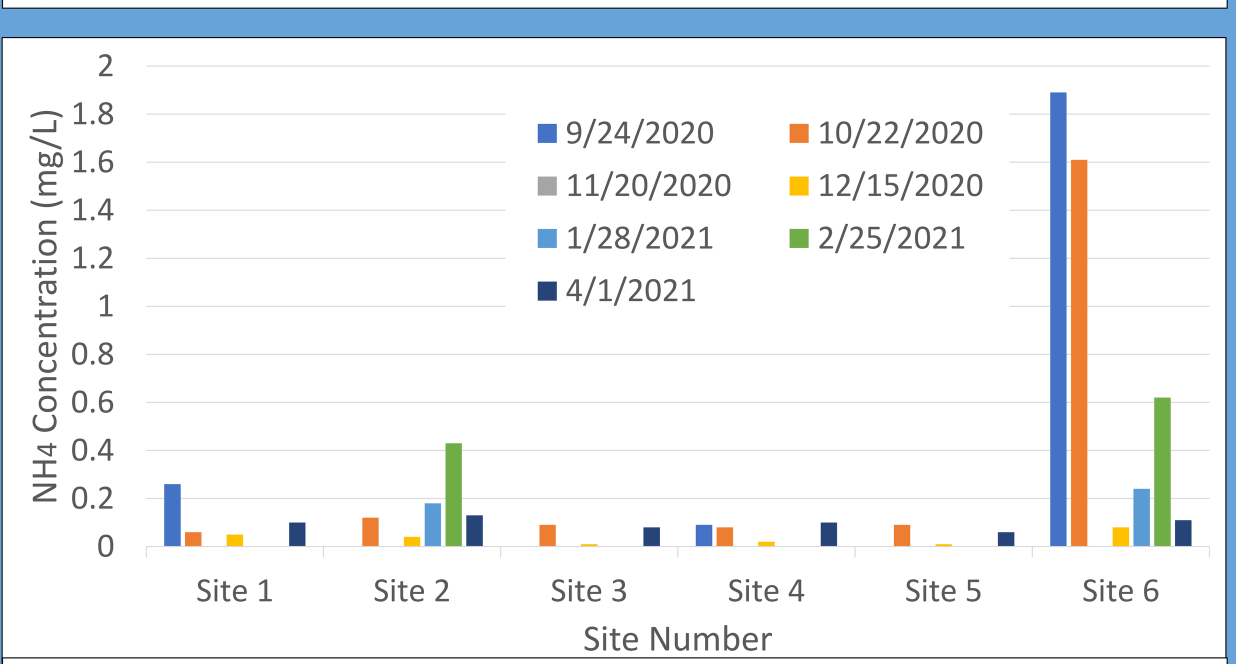

Figure 5. Ammonium concentrations in Lake Louise.

Results

pH measurements ranged from 6.89 to 8.46 throughout 24 Sept 2020 to 1 Apr 2020 at the different sites (Figure 2). pH measurements remained consistent (Figure 2). Dissolved oxygen (DO) content ranged from 0.33 mg/L to 13.55 mg/L throughout 24 Sept 2020 to 1 Apr 2020 at the different sites (Figure 3). Sites 1, 2, 3, and 6 had lower dissolved oxygen concentrations on 22 Oct 2020 (Figure 3). Site 6 had the lowest dissolved oxygen concentration of 0.33 mg/L on 22 Oct 2020 (Figure 3). Nitrate (NO_3) concentration ranged from 0.67 mg/L to 3.62 mg/L throughout 24 Sept 2020 to 1 Apr 2020 at the different sites (Figure 4). The highest nitrate concentrations were at Site 2 and 6 on 28 Jan2021 (Figure 4). On 1 Apr 2021, nitrate concentrations were relatively consistent between all sites (Figure 4). Ammonium (NH_4) concentration ranged from 0 mg/L to 1.89 mg/L through 24 Sept 2020 to 1 Apr 2020 at the different sites (Figure 5). Sites 2 and 6 have corresponding concentrations on 15 Dec 2020, 28 Jan 2021, 25 Feb 2021, and 1 Apr 2021 (Figure 5). Site 6 had the highest concentrations on 24 Sep 2020 and 22 Oct 2020 (Figure 5). The various algae species identified were consistent between sites. The abundance of the algae species depended on the time of year. Site 1, 3, 4, and 5 values are absent during the sampling dates of 28 Jan 2021 and 25 Feb 2021 due to ice over the lake, making the site inaccessible. Site 6 data from 15 Dec 2020 is absent due to a sampling mistake in the field. Phosphorus data is absent due to restrictions and complications regarding COVID-19.

Figure 6. Orange sludge at Site 6.

Literature Cited

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Conclusion

The data gathered allowed us to reject the null that **there will be no significant difference in nitrogen and phosphorus concentrations in areas in and around Lake Louise.** The data shows a trend that the fluctuations in pH, DO, NO_3, and NH_4 are affected by the time of year, rather than the site. The month of October had generally lower amounts of in pH, DO, NO_3, and NH_4; apart from the Site 6 measurement of NH_4. The ideal pH for aquatic organisms is between 6.5 to 8.0 (Definition of Water Quality). Although the pH of Lake Louise is slightly higher than the ideal range, the pH is consistent throughout the seven months sampled. Dissolved oxygen concentrations below 4 mg/L is harmful to aquatic life (Definition of Water Quality). Sites 2 and 6 had DO concentrations below or very close to the 4 mg/L cutoff. On 22 Oct 2020, both Sites 2 and 6 had low concentrations of DO (Figure 3). It is important to note, Site 6 is the same stream input as Site 2; Site 2 is closer to Lake Louise. Therefore, there are trends between Site 2 and 6; the sites had corresponding data. On 22 Oct 2020, Site 6 had very little water flow, a smelly odor, an oily film on top of the water, and thick chunks of orange sludge at the bottom of the stream (Figure 6). Nitrate concentrations over 10 mg/L have a negative effect on freshwater aquatic environments (Definition of Water Quality). There were no sites that had a concentration of nitrate over 3.62 mg/L, thus falling into the acceptable standard. Although, on 28 Jan 2020, Site 2 and 6 both had the two highest nitrate concentrations (Figure 4). Ammonium, what is measured in this study, is not toxic to aquatic life; ammonia is toxic (Surface Waters: Ammonium is Not Ammonia - Part 1). However, the pH and ammonium concentrations can give an idea to the ammonia concentrations (Surface Waters: Ammonium is Not Ammonia - Part 1). At a pH less than 6.0, the proportion of ammonium as ammonia is very low (Surface Waters: Ammonium is Not Ammonia - Part 1). At a pH of 8.0, the proportion as ammonia is 10% or less (Surface Waters: Ammonium is Not Ammonia - Part 1). The data shows multiple times that the pH went slightly above 8.0 (Figure 2). Many of the low ammonium concentrations correspond with the higher pH measurements. This could be indicating that the reaction, $NH_3 + H_2O \leftrightarrow NH_4^+ + OH$, is being favored to the left, forming more ammonia (Surface Waters: Ammonium is Not Ammonia – Part 1). To have a clearer understanding of ammonia concentrations, a test to measure ammonia directly is needed. The algae species that were identified showed that there was no difference in species among the sites. Based on the time of year and algal blooms, determined the abundance of algae. These data trends can lead to the suggestion that the time of year is a greater factor than the location of the site. The reasoning may be because of the timing of the application of fertilizers in the area; at places such as a golf course and small developments. More sampling and gathering of data must be done to properly conclude why Lake Louise is having algae and sediment issues.

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