Changes in Chemical Properties of Surface Waters in Dunn County

Bryanna Hoffman, Madeline Candline, Riley Strobush, Ana M.Q. Vande Linde, Ph.D.

Department of Chemistry and Physics

University of Wisconsin-Stout

INTRODUCTION

The chemical properties of surface water are some of the indicators used to assess the health of lakes and rivers. They provide valuable information that can be used to understand how natural and man-made activities affect the aquatic ecosystem. Monitoring the changes in chemical properties can assist local communities and environmentalists on how to respond to any developing or on-going problems in the body of water. The chemical properties of rivers and lakes are influenced by numerous factors which include hydrological processes, climate and anthropogenic activities.

Parameters including pH, conductivity and concentrations of compounds containing sodium (Na), potassium (K), calcium (Ca), and magnesium (Mg) are used to assess water quality. pH is a measure of the acidity or basicity of water and conductivity is an indicator of the concentrations of dissolved ions in the sample. The concentrations of compounds of Na, K, Ca, and Mg are used to assess the suitability of the use of a given body of water.

OBJECTIVE

The objective of this project is to determine the changes in pH, conductivity, and concentrations of compounds of Na, K, Mg, and Ca in Lake Menomin, Tainter Lake and the Red Cedar River. These properties were measured from three sites in Lake Menomin and two sites in both Tainter Lake and the Red Cedar River. Samples were collected from each site from June to September 2022.

METHODOLOGY

Figure 1 shows the locations of the sites where water samples were collected. In Lake Menomin, samples were collected at the Cemetery Island (Site 1), at the Highway 12 Boat Launch (Site 2), and the Wakanda Boat Launch (Site 3). In Tainter Lake, samples were collected at the Champney Park Boat Landing (Site 1) and Northwest Boat Landing (Site 2). In the Red Cedar River, the collection sites were upstream from the treated wastewater dump area at the River Road Boat Landing (Site 1) and downstream from the dump area at the Riverside Park near the Red Cedar Trail (Site 2).

The pH and conductivity were measured using Vernier Technology Go Direct pH and conductivity sensors, respectively.

Concentrations of Na, K, Mg, and Ca were determined using a Perkin Elmer Analyst 400 Atomic Absorption Spectrometer (AAS). Prior to the AAS analysis (Figure 3) water samples, in triplicates, were digested (Figure 2) using concentrated, trace metal grade HNO_3 solution, filtered and diluted appropriately. Analytical grade reagents containing compounds of Na, K, Mg, and Ca were used to prepare the standard solutions for AAS analyses.

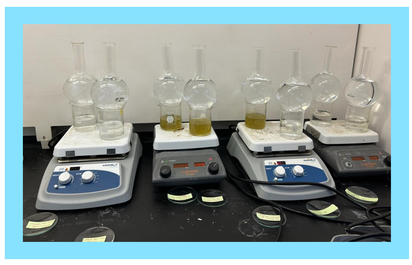

Figure 2: *Digestion of Samples*

Figure 3: *Atomic Absorption Spectrometer*

Table 1 – Data From Lake Menomin		
	pH	Conductivity (µS/cm)
Site 1	6.79 – 9.07	224 – 1545
Site 2	6.86 – 9.54	244 – 271
Site 3	8.19 – 8.90	225 – 251
	$\pm s$ Na (ppm)	$\pm s$ K (ppm)
Site 1	8.19 ± 0.84 – 11.52 ± 1.49	3.32 ± 0.19 – 18.00 ± 0.00
Site 2	8.16 ± 0.26 – 12.14 ± 1.60	3.21 ± 0.04 – 4.03 ± 0.18
Site 3	8.07 ± 1.60 – 9.05 ± 0.71	3.32 ± 0.33 - 3.97 ± 0.49
	Mg (ppm)	$\pm s$ Ca (ppm)
Site 1	15.86 ± 0.56 – 16.12 ± 0.35	6.50 ± 0.70 – 20.56 ± 1.49
Site 2	16.57 ± 0.56 - 17.79 ± 0.10	20.48 ± 1.49 - 28.34 ± 1.08
Site 3	16.69 ± 0.16 – 16.72 ± 0.18	22.06 ± 1.02 – 24.45 ± 0.71

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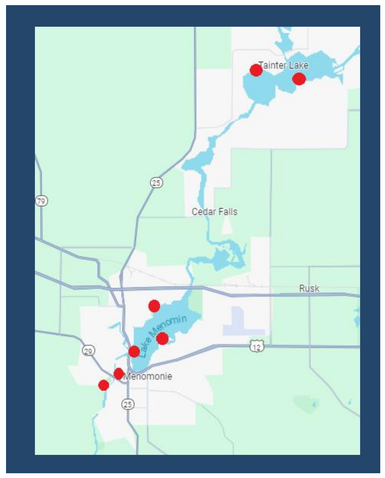

Figure 1: *Water Sample Collection Sites*

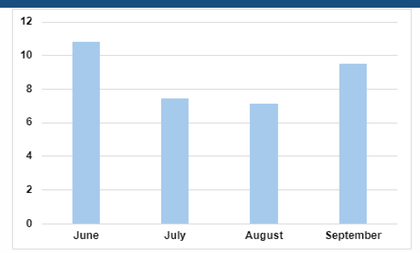

Figure 5a – pH, Site 1, Tainter Lake

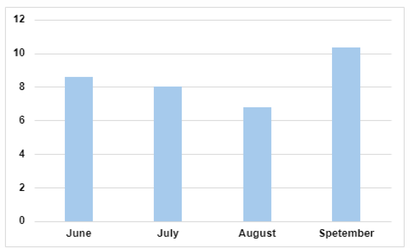

Figure 5b – pH, Site 2, Tainter Lake

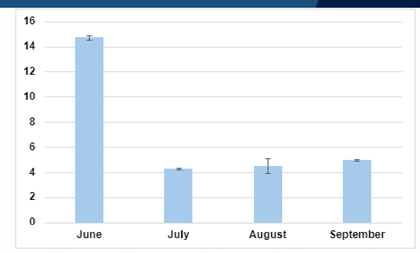

Figure 5c – K, Site 1, Tainter Lake

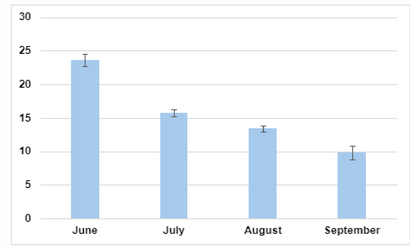

Figure 5d – Ca, Site 2, Tainter Lake

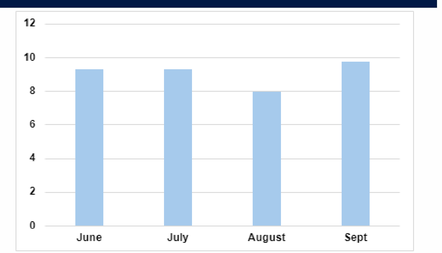

Figure 6a – pH, Site 1, Red Cedar River

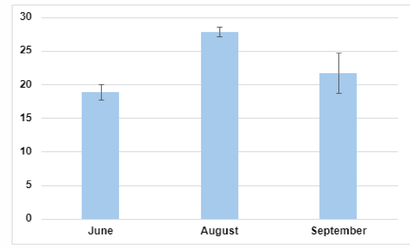

Figure 6b – Ca, Site 1, Red Cedar River

Table 2 - Data From Lake Tainter	
pH	
Site 1	7.15 – 10.77
Site 2	6.77 – 10.34
Conductivity (µS/cm)	
Site 1	254 – 277
Site 2	189 – 233
$\pm s$ Na (ppm)	
Site 1	9.49 ± 0.60 – 14.68 ± 10.15
Site 2	7.38 ± 0.75 – 7.77 ± 0.56
s K (ppm)	
Site 1	4.27 ± 0.09 – 14.70 ± 0.20
Site 2	3.00 ± 0.09 – 4.39 ± 0.11
$\pm s$ Mg (ppm)	
Site 1	12.72 ± 1.325 – 15.411 ± 0.23
Site 2	12.68 ± 0.22 – 17.62 ± 0.44
$\pm s$ Ca (ppm)	
Site 1	12.73 ± 0.53 – 22.99 ± 2.41
Site 2	9.84±0.99 – 23.66±0.87

Table 3 - Data From Red Cedar River	
pH	
Site 1	7.93 – 9.72
Site 2	9.27 – 10.29
Conductivity (µS/cm)	
Site 1	191 – 269
Site 2	205 – 225
$\bar{x} \pm s$ Na (ppm)	
Site 1	8.56 ± 0.09 – 9.46 ± 0.65
Site 2	7.75 ± 0.36 – 9.94 ± 2.81
$\bar{x} \pm s$ K (ppm)	
Site 1	2.91 ± 0.02 – 3.37 ± 0.09
Site 2	2.62 ± 00.38 – 3.26 ± 00.09
$\bar{x} \pm s$ Mg (ppm)	
Site 1	19.75 ± 00.12 – 19.80 ± 00.08
Site 2	18.45 ± 00.13 – 20.02 ± 0.28
$\bar{x} \pm s$ Ca (ppm)	
Site 1	18.88 ± 01.15 – 27.84 ± 0.67
Site 2	12.07 ± 01.15 – 21.72 ± 00.47

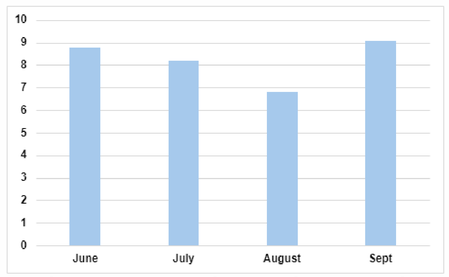

Figure 4a – pH, Site 1, Lake Menomin

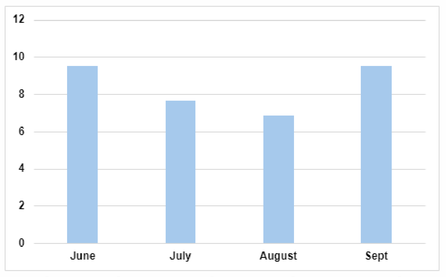

Figure 4b – pH, Site 2, Lake Menomin

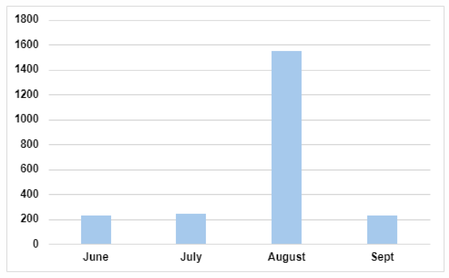

Fig 4c – Conductivity, Site 1, Lake Menomin

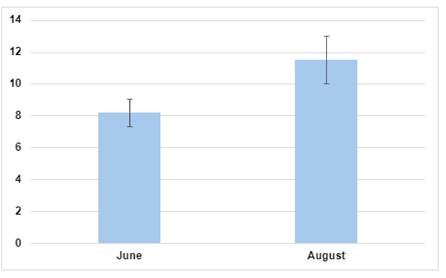

Figure 4d – Na, Site 1, Lake Menomin

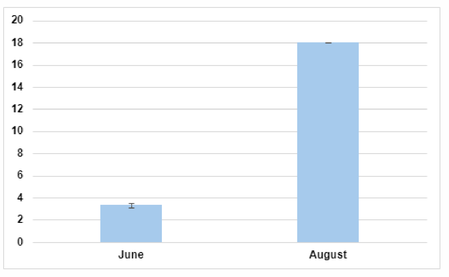

Figure 4e – K, Site 1, Lake Menomin

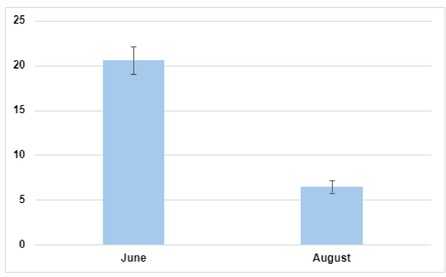

Figure 4f – Ca, Site 1, Lake Menomin

RESULTS & DISCUSSION

Tables 1, 2 and 3 show the ranges of pH, conductivity, mean and standard deviations ($\bar{x} \pm s$) of Na, K, Mg and Ca obtained in this study. Figures 4a to Figure 6b show chemical parameters with the most significant change between the initial sample collection in June and the final sample collection in September.

Declining trend in pH from June to August was observed in two sites in Lake Menomin (Figs. 4a & 4b) and in both sites in Lake Tainter (Figs. 5a & 5b). This decline in pH can be attributed to the production of CO_2 from the respiration of fish, plants, and other aquatic organisms and the breakdown of organic materials. Fluctuations in pH are within the EPA water quality criteria in fresh water (EPA, 2024). Elevated pH (above 9.00) recorded in Lakes Menomin and Tainter Lake maybe due agricultural lime runoff.

Based on EPA guidelines (EPA, 2012) the conductivity readings obtained in this study are within the expected values for fresh water (150 – 500 µS/cm) and rivers (50 – 1500 µS/cm). The only site that experienced a significant increase in conductivity was the Cemetery Island in Lake Menomin (Figure 4c). This can be attributed to the increasing concentrations of Na^+ and K^+ ions (Figs. 4d & 4e).

In freshwater, the typical level of calcium is between 4 – 100 ppm (LEO 2000). The concentration of Ca observed in this study are within this range. Although, a significant decrease was observed in water sample from Lake Menomin (Cemetery Island) collected in June compared to the sample collected in August (Fig. 4f). Ca level of 6.50 ± 0.70 ppm is close to the lower end of the acceptable range. Continued decline in calcium can endanger many aquatic species that require calcium for their shells. This decline in Ca level may be attributed to decline in pH observed in Lake Menomin. Studies have shown widespread diminishing of calcium due to acidification in freshwater (Weyhenmeyer et al, 2019). This relationship was not observed in the Red Cedar River, where Ca level increased while pH decreased (Figs. 6a & 6b). In Lake Tainter, Ca level continues to decrease when pH increased in September (Figs. 5d & 5d).

The higher levels of potassium in Lakes Menomin and Tainter (Figs. 4e & 5c) may be attributed to fertilizer runoff from neighboring farms.

This discussion is a simplified explanation of the changes observed in Lakes Menomin, Tainter Lake, and the Red Cedar River. It does not cover the complex nature of the chemistry in these water systems which are affected by numerous factors including climate, atmospheric inputs, underground rocks and soils in the watershed, physiography, land use, anthropogenic impact and morphometry (USGS, 2018).

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