

Water Quality Summary: Temperature

2024 Barr Lake & Milton Reservoir



Barr Lake and **Milton Reservoir**'s water quality has been sampled twenty times a year since 2003. These 440 trips to both reservoirs have produced an abundance of data and information. This is Part 4 of 8 of a water quality summary series for 2024 calendar year for both reservoirs. The first three summaries focused on pH, Chl-a, and dissolved oxygen; this one discusses water temperature.

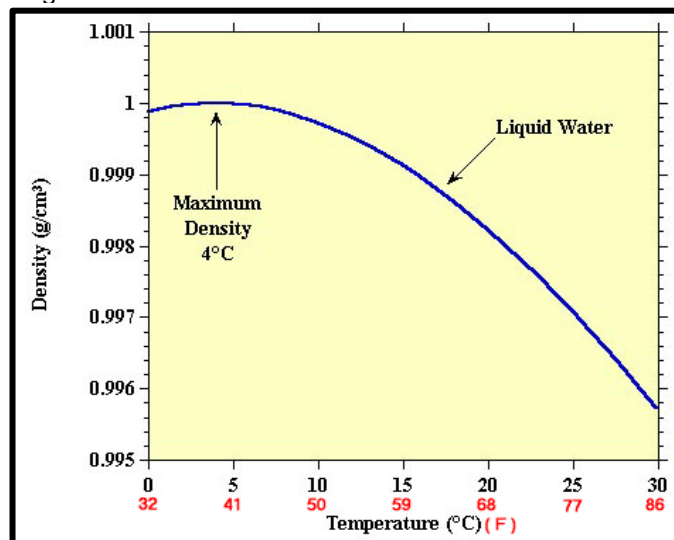
The Big Picture – Eutrophication is the addition of nutrients and sediments to water bodies resulting in algae and plant growth and sedimentation. This natural process occurs over a long geological period - 1,000's of years. Many lakes, reservoirs, ponds, and even estuaries throughout the world experience "*cultural eutrophication*". This term means that water bodies become more productive and shallower much quicker (months to years) due to increased inputs of nutrients and sediments from human activities. This unnaturally accelerated aging of lakes causes a biological response – algae growth that usually leads to blue-green algal scums. This biological response then triggers chemical and physical changes within the water – pH, oxygen, water clarity and color, fish, water safety, plants, and aesthetics.

Temperature – A unique property of water is the temperature-density relationship (Figure 1). Water changes density as it changes temperature. Water is heaviest at 4 °C. Any warmer or colder and the water is less dense and will float. This is why ice (0 °C) floats during the winter, and warm water (25 °C) floats during the summer. The bottom water temperature in many deep lakes is around 4 °C year round. Lake temperature is around 4 °C when ice cover comes off in the spring and is fully mixing. This density gradient associated with temperature defines a lake's ecology and mixing regime.

A lake's annual temperature cycle is determined by its local climate and latitude. **Barr Lake** and **Milton Reservoir** are considered *dimictic* when deeper than about 8.0 meters by mixing twice a year; once in the spring and again in the fall with thermal stratification occurring during the winter and summer months. If the reservoirs are less than 8.0 meters, they become *polymictic*; mixing multiple times when wind and wave action is strong enough to mix the entire or partial water column.

Thermal stratification is important. It is the layering of water caused by temperature differences that determines water quality. During the summer, the uppermost, warmest layer (epilimnion) is the lightest and well mixed. The middle water is where the temperature transitions to the cooler, bottom water. Each change in temperature forms a layer of non-mixing water (metalimnion). It only takes half of a degree Celsius to form stratification. The bottom layer (hypolimnion) is the coldest and most isolated.

Figure 1.



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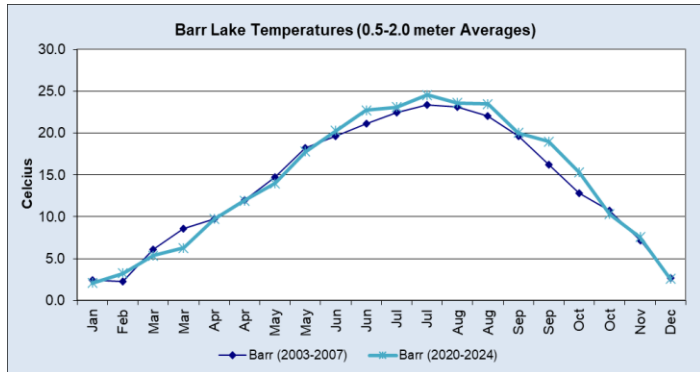
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It takes a large amount of energy to change the temperature of water. This is why the unit of energy (calorie) uses water in its definition. A dietary calorie is the amount of energy it takes to heat 1 kilogram of water by 1 °C.

Because of this thermal resistance, lakes tend to have gradual temperature cycles. This is good for aquatic organisms and explains why they have evolved to have specific temperature ranges for various life stages (e.g., spawning). The annual temperature cycle for both **Barr Lake** and **Milton Reservoir** has changed over the years (Figure 2). June through October has warmed up. The warmest water occurs during the last week of July and the coldest in December and January.

Figure 2. 5-yr Average Comparison for Barr Lake



The temperature standard for warm-water, lakes (deeper than 5 meters) only applies to the top water (0.5 – 2.0 meters). The temperature standard for **Barr Lake** and **Milton Reservoir** is 26.2 °C (chronic) and 29.3 °C (acute) between April and December and 13.1 °C (chronic) and 24.1 °C (acute) between January and March.

Table 1. Barr and Milton Temperature Data for 2024 in degrees Celsius and Ferenheit.

Month	Temperature (Barr)	Temperature (Milton)
Jan	1.9 (35.4 F)	3.5 (38.3 F)
Feb	4.9 (40.8 F)	5.0 (41.0 F)
Mar	6.3 (43.3 F)	6.6 (43.9 F)
Mar	8.6 (47.5 F)	8.4 (47.1 F)
Apr	9.9 (49.8 F)	11.4 (52.5 F)
Apr	12.2 (54.0 F)	13.1 (55.6 F)
May	13.2 (55.8 F)	12.7 (54.9 F)
May	18.9 (66.0 F)	18.9 (66.0 F)
Jun	22.0 (71.6 F)	23.0 (73.4 F)
Jun	24.2 (75.6 F)	23.3 (73.9 F)
Jul	22.6 (72.7 F)	23.1 (73.6 F)
Jul	24.5 (76.1 F)	24.0 (75.2 F)
Aug	22.5 (72.5 F)	22.7 (72.9 F)
Aug	24.5 (76.1 F)	23.1 (73.6 F)
Sep	21.3 (70.3 F)	20.8 (69.4 F)
Sep	20.1 (68.2 F)	17.9 (64.2 F)
Oct	16.5 (61.7 F)	17.0 (62.6 F)
Oct	13.0 (55.4 F)	13.5 (56.3 F)
Nov	5.6 (42.1 F)	5.0 (41.0 F)
Dec	2.8 (37.0 F)	1.9 (35.4 F)

The acute standard is a daily maximum average, and the chronic standard is the maximum average during the growing season (July 1 – September 30). A lake can exceed these temperatures as long as there is deeper water that meets both DO and temperature standards.

2024 Temperature Data – Temperature data are collected throughout the entire water column in half meter increments during each visit. Temperature data from 0.5 meter to 2.0 meters are averaged for each visit. For 2024, there were 20 temperature averages recorded for each reservoir (Table 1). For **Barr Lake** and **Milton Reservoir**, the temperature standard was achieved.

The growing season average for **Barr Lake** was 22.6 °C and 21.9 °C for **Milton Reservoir**.

Celsius to Fahrenheit = double it and add 32

$$F = (1.8 \times C) + 32$$

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Climate change can have an important effect on lakes, specifically surface water temperatures. Figure 3 shows the comparison of monthly water temperature averages for two different 5-yr periods, 2003-2007 and 2020-2024. The pattern seems to show a cooler March and May and a much warmer summer season from June to the beginning of October. Close to five continuous months of warmer water through the growing season can have a major impact on the algal community.

Figure 3.

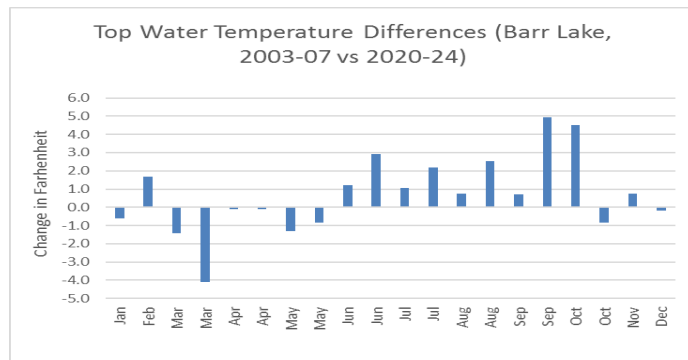


Figure 4.

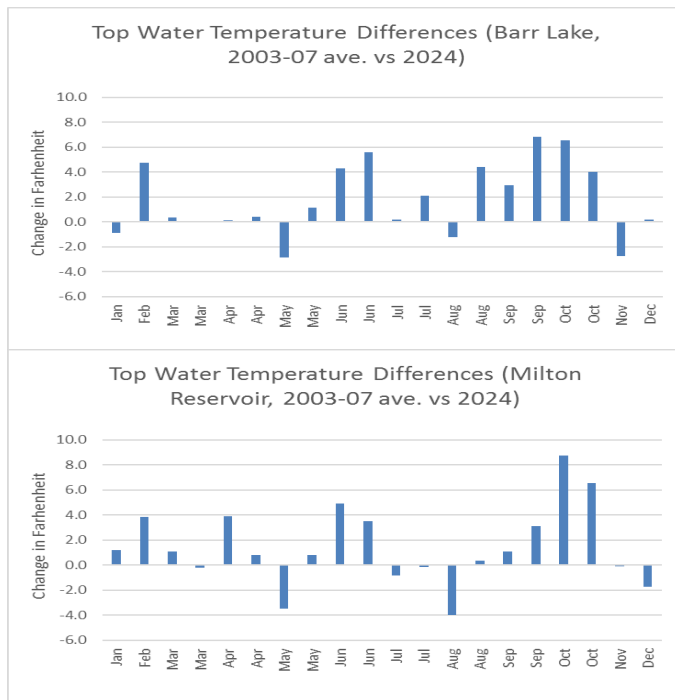


Figure 4 compares the 2024 top water temperature averages with averages from 2003-2007. This graph shows similar patterns to Figure 3 as well as some major differences. February of 2024 was much warmer causing ice off four weeks earlier. Timing of ice off can have a large impact to early season algal growth and water mixing. In 2024, the peak differences coming in June, September, and October. Normal peak water temperatures started in June and remained high through the middle of October. These higher than normal growing season water temperatures had an impact on algal growth for the second half of 2024.

Milton, similar in size and longitude as Barr Lake, is slightly farther north and can experience different weather than Barr. Milton did have colder water differences in early May, August, and December. Milton did experience warmer June, September, and October similar to Barr. Both reservoirs did have an overall warmer water patterned compared to 20 years ago.

Climate change is best described with large observations to see the larger picture. It can be difficult to see a global issue on a 1,800 acre reservoir. Overall trends are difficult to see, but isolated, severe weather can cause local impacts and alter water quality on a short temporal timeframe. For 2024 globally it was the hottest year on record and Barr Lake and Milton Reservoir showed signs of this locally.