Water Quality Summary: Chlorophyll-a

2019 Barr Lake & Milton Reservoir

Twenty times a year since 2003, **Barr Lake** and **Milton Reservoir** have been sampled for water quality. These 340 trips to both reservoirs have produced an abundance of data and information. This is Part 2 of 8 of a water quality summary series for 2019 calendar year for both reservoirs. The first summary focused on pH; this one discusses chlorophyll-a (Chl-a).

The Big Picture – Eutrophication is the addition of nutrients to water bodies resulting in nuisance algae growth and sedimentation. This natural process usually occurs over a long geological period of time. Many lakes, reservoirs, and even estuaries and bays throughout the world experience "*cultural eutrophication*". This term means that water bodies tend to become more productive and shallower over relatively short periods of time due to increased inputs of nutrients and sediments from human activities. Accelerated aging of lakes causes a quick biological response – severe algae growth. This response then leads to other chemical and physical changes within the water – pH, oxygen, water clarity and color, fish, plants, and aesthetics can all change.

Chl-a around 85 ug/L at Barr Lake (07/15/03)

Chl-a – This is the measurement of how much green pigment is in the water. Algae, like trees and grasses, produce Chl-a through photosynthesis causing the plant to be green. Chl-a is essential in the plant's process of transforming sunlight into biomass. By measuring how green the water is, one can get a relative understanding about how much algae are in the lake. Chl-a concentrations are expressed in units of micrograms per liter (µg/L) or parts per billion (ppb). Chl-a is not an exact measurement of biomass, but it is close. Some algae (e.g. diatoms) don't produce as much Chl-a as others (e.g. blue-green algae) and can change their rate of Chl-a production throughout the day. Chl-a is not the same as the rate of productivity or an indicator of how fast the algae are growing. Concentrations below 5 µg/L are considered low and values greater than 25 µg/L are considered high.

Too much algal growth is the main observable symptom resulting from *cultural eutrophication*. Too much growth leads to aesthetic issues, odor problems, cyanotoxins, large dissolved oxygen fluctuations, and lower water clarity. Typically, more algae mean more zooplankton and more fish. However, there can be a point where too much algae harms fish and zooplankton. The water quality standard for Chl-a for warm water reservoirs is 20 µg/L averaged over the growing season (July 1 – September 30). The

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2019 Chl-a Data – Approximately 1 liter of 1-meter depth water is collected and filtered in the boat during each site visit. The filter paper collects the algae contained in that one liter of water and is analyzed for Chl-a. For 2019, there were 20 Chl-a concentrations recorded for both Barr and Milton (Table 1).

Table 1. Barr and Milton 2019 Chl-a data (ug/L). Bold values exceed the water quality target of 20 µg/L.

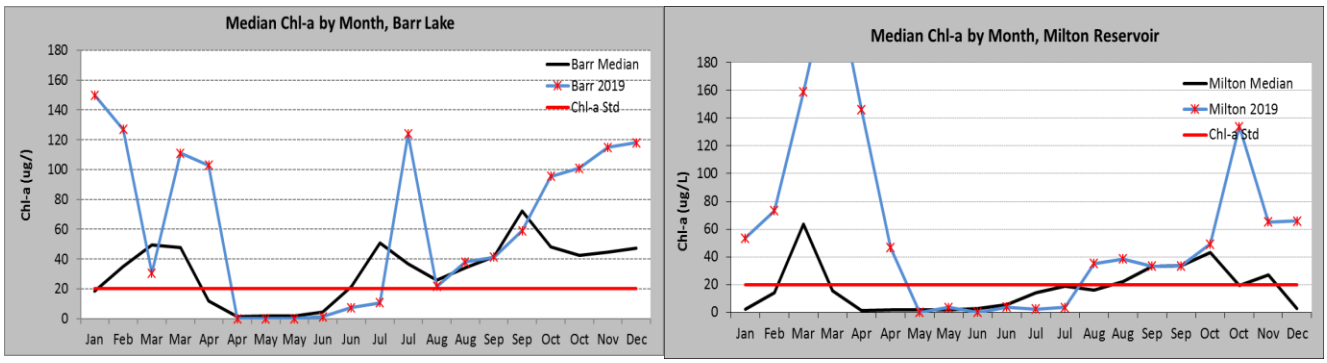
Month	Chl-a (Barr)	Chl-a (Milton)
Jan	150.0	53.4
Feb	127.0	73.3
Mar	30.6	159.0
Mar	111.0	252.0
Apr	103.0	146.0
Apr	<1.0	46.5
May	<1.0	<0.0
May	<1.0	3.4
Jun	1.2	<1.0
Jun	7.3	3.7
Jul	10.7	2.3
Jul	**124.0**	3.6
Aug	**21.6**	**35.2**
Aug	**38.0**	**38.5**
Sep	**41.3**	**33.3**
Sep	**58.9**	**33.5**
Oct	95.4	49.3
Oct	101.0	134.0
Nov	115.0	65.2
Dec	118.0	65.8

The median* Chl-a for **Barr Lake** in 2019 was 50.1 µg/L and 42.5 µg/L for **Milton Reservoir**. The large algal community that occurred in both reservoirs in the winter and fall not only caused an increase in pH but also an increase in Chl-a. As with the pH, the Chl-a decreased by May before the warmer growing season. Barr did have a major bloom in late July that caused recreational closures for a few weeks.

The growing season median for **Barr Lake** was 39.7 µg/L and 33.4 µg/L for **Milton Reservoir**. With large fluctuations in values, the median is a better estimate of the middle when it comes to Chl-a. In April, Chl-a changed by 103 µg/L in just two weeks.

Figure 1 shows the annual cycle, goal, and 2019 results for Chl-a. **Milton Reservoir** had low Chl-a between May and July. This was followed by moderate growth during the summer and then an increase during the refill. **Barr Lake** had two large diatom blooms in Jan/Feb and Mar/Apr. Barr did experience a lake-wide cyanobacteria bloom in July. What triggered this bloom? One possibility is that 2019 had a larger snowpack in April that caused Barr to remain full longer into the summer. Isolated bottom waters allowed for lower oxygen at the bottom causing higher than normal internal loading. This loading might have fueled the bloom.

Figure 1. 2019 Chl-a data compared to WQ target and 2003-2019 annual average



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Photosynthesis – This important biochemical process has a major impact on Barr Lake and Milton Reservoir. The process of photosynthesis converts CO_2 into organic matter (sugar) by using energy from the sun. An evaluation of Chl-a provides a good representation of the primary biomass in a lake. Photosynthesis helps determine the balance between pH (changes in CO_2), organic matter (Chl-a or algae), nutrients, and dissolved oxygen.

$$6CO_2 + 6H_2O + Nutrients \underset{\text{(Respiration/Decomposition)}}{\overset{\text{(Photosynthesis)}}{\rightleftharpoons}} C_6H_{12}O_6 + 6O_2$$

** median is used instead of average because Chl-a data has a large range of values and can change quickly. Median does a better job of representing the middle of a data set that has extreme high values along with extreme low values. The state standard applies the average between July 1 and September 30.*