2016 Water Quality Summary Series – Phosphorus

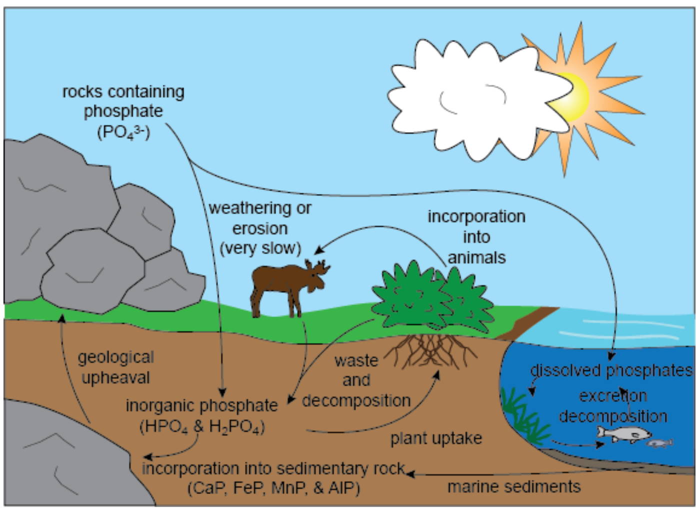
Twenty times a year since 2003, **Barr Lake** and **Milton Reservoir** have been observed and sampled for many water quality parameters. These 240 trips to both reservoirs have produced an abundance of data and information. This is Part 5 of a continuing series summarizing the 2016 water quality data. The first four summaries focused on pH, chl-a, dissolved oxygen, and water temperature; this one discusses phosphorus.

The Big Picture – 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 impacts in the watershed. Eutrophication is a natural process, but it generally occurs over a much longer geological period. This 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 column – pH, oxygen, water clarity, water color, and aesthetics.

Phosphorus – Phosphorus is a chemical element that is required by all living organisms. Phosphorus can be attached to soils (inorganic), dissolved in water (organic or inorganic), or be in the form of biomass (organic) (Figure 1). Phosphorus cannot be a gas. The most common form of phosphorus is the oxidized state, *phosphate* (PO_4^{-3}). Phosphates exist in three forms: orthophosphate, polyphosphate, and organically-bound phosphate. Orthophosphate is the compound that is available for algae uptake.

Total phosphorus (TP) is the analysis that sums all of the phosphorus in a water sample (organic, inorganic, particulate, and dissolved). Soluble Reactive Phosphorus (SRP) or Orthophosphate is the analysis that includes all of the soluble, inorganic phosphates.

Figure 1.



Phosphorus is a key nutrient that determines how much algae can grow in a lake. Concentrations are typically expressed in units of micrograms per liter (µg/L) or parts per billion (ppb). The two forms that are analyzed are: TP and SRP. Concentrations below 10 µg/L are considered low and values greater than 20 - 50 µg/L are considered high in general terms.

Excessive nutrients are the main cause of *cultural eutrophication*. Too many nutrients leads to aesthetic issues, odor problems, cyanotoxins, large dissolved oxygen fluctuations, and lower water clarity. The TP goal that has been determined for **Barr Lake** and **Milton Reservoir** is 100 µg/L or less in the epilimnion during the growing season.

2016 Phosphorus Data – Phosphorus data are collected from the one meter depth and one meter from the bottom depth during each visit. For 2016, there were 40 phosphorus samples analyzed for each reservoir. Only top water data is shown in Table 1.

Table 1. Barr Lake and Milton Reservoir 2016 epilimnion phosphorus data (µg/L). Bold values exceed water quality target.

Barr Lake (µg/L)				Milton Reservoir (µg/L)		
Month	**TP**	**SRP**		**Month**	**TP**	**SRP**
Jan	110	30		**Jan**	120	160
Feb	270	160		**Feb**	190	160
Mar	300	100		**Mar**	180	70
Mar	270	90		**Mar**	150	40
Apr	300	<30		**Apr**	150	120
Apr	200	<30		**Apr**	160	110
May	200	40		**May**	100	70
May	210	180		**May**	90	40
Jun	180	140		**Jun**	90	60
Jun	200	280*		**Jun**	120	60
Jul	**860**	490		**Jul**	**180**	130
Jul	**300**	950*		**Jul**	**150**	80
Aug	**300**	210		**Aug**	**170**	<30
Aug	**220**	130		**Aug**	**160**	<30
Sep	**290**	90		**Sep**	**200**	<30
Sep	**280**	190		**Sep**	**180**	<30
Oct	330	70		**Oct**	250	<30
Oct	330	310		**Oct**	310	<30
Nov	260	190		**Nov**	660	<30
Dec	220	50		**Dec**	1,120	1,100

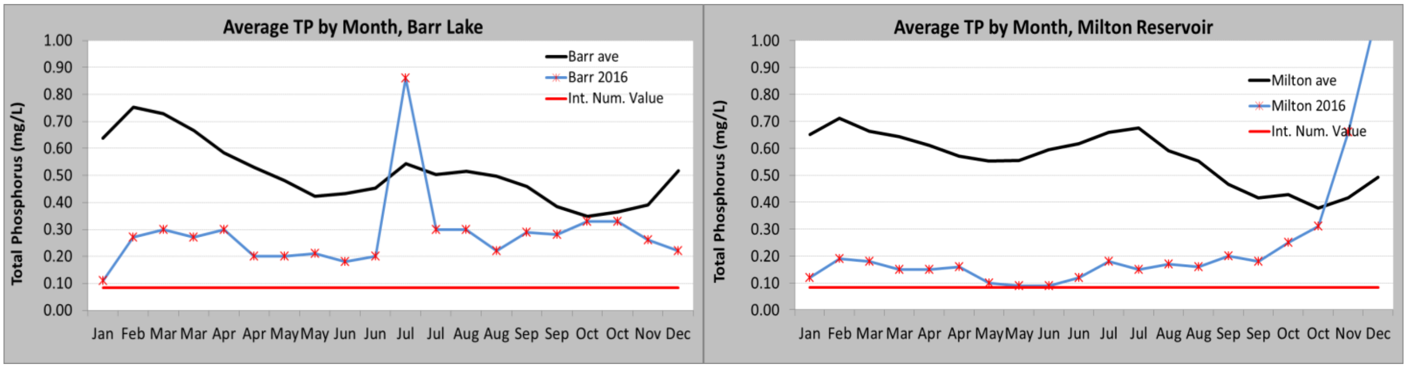
*SRP cannot be greater than TP

The average TP for **Barr Lake** in 2016 was 282 µg/L and 237 µg/L for **Milton Reservoir**. Barr Lake had a narrow concentration range for most of the year except for one outlier in July. TP can increase in July but this value might be a sampling or laboratory error. The TP value would not have dropped so fast. Milton also had a steady TP concentration until the drawdown and refill in the fall.

The growing season (July – September) average for **Barr Lake** was 375 µg/L and 173 µg/L for **Milton Reservoir**. Typically, the growing season average is lower than the annual average. Barr Lake growing season average without the outlier would have been 278 µg/L.

Figure 2 shows the annual TP cycles, TP target, and 2016 data for both lakes. Both reservoirs had below average TP for most of the year. **Barr Lake** TP was lower because no effluent was pumped to the lake during the winter months. **Milton Reservoir** was also lower than normal and the reservoir was completely refilled from a large drawdown in the fall of 2015. Clearly, there has been a major reduction in TP loading into both reservoirs in 2016.

Figure 2.



Internal Loading – Another way that phosphorus can enter lakes is from the bottom sediment. This typically happens when the bottom of a lake is anoxic. No dissolved oxygen allows for a chain reaction to occur that results in a release of dissolved phosphorus from the sediments. This can happen during the winter or spring when the reservoirs are deeper than 7 meters. The other way is for sediments to be physically stirred up. This happens when the reservoirs are shallow in the late summer and winds can re-suspend phosphorus-rich sediments. Carp and other bottom feeders can also stir up the sediments. Carp are known to dig up to a foot in the sediments to get food. This is called bioturbation – when aquatic animals disturb the sediments.