Guide to Interpreting Total Phosphorus and Secchi Depth Data from the Lake Partner Program

The following information will assist with interpreting Lake Partner Program total phosphorus and Secchi depth data. These results are posted each year in separate tables on the Lake Partner Program webpage (www.Ontario.ca/LakePartner). Since 2002, total phosphorus (TP) analyses have been conducted at the Dorset Environmental Science Centre (DESC) chemistry laboratory. TP data based on DESC analytical methods are approximately ten times more precise than data collected before 2002.These data can be found in the **Pre-2002 TP Means** table and are expressed as annual means of all data collected. By averaging several years of these data, we can describe average concentrations prior to 2002, but the data should not be used to examine trends through time.

Chemistry Technician at the Dorset Environmental Science Centre performs total phosphorus analyses on Lake Partner Program water samples.

Total Phosphorus

TP concentrations are ideally used to interpret lake nutrient status since phosphorus is the element that controls the growth of algae in most Ontario lakes. Increases in phosphorus may decrease water clarity by stimulating algal growth. In extreme cases, algal blooms will affect the aesthetics of the lake and/or cause taste and odour problems in the water.

Many limnologists place lakes into three broad categories with respect to nutrient status. Lakes with less that 10 µg/L TP are considered oligotrophic. These are dilute, unproductive lakes that rarely experience nuisance algal blooms. Lakes with TP between 10 and 20 µg/L are termed mesotrophic and are in the middle with respect to trophic status. These lakes show a broad range of characteristics and can be clear and unproductive at the bottom end of the scale or susceptible to moderate algal blooms at concentrations near 20 µg/L. Lakes over 20 µg/L are classified as eutrophic and may exhibit persistent, nuisance algal blooms.

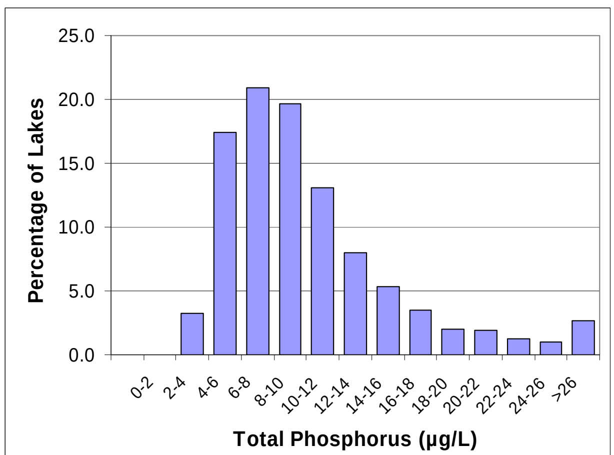

Figure 1. Distribution of total phosphorus concentrations in 1421 of Ontario's inland lakes. Lake concentrations are based on the lake-wide averages of spring turnover concentrations.

Note: Tea stained lakes, with high dissolved organic carbon (DOC), are called dystrophic lakes and do not share the algal/TP relationships described above. Generally there can be more TP in a dystrophic lake without the occurrence of algal blooms. The chemistry of these lakes is quite complex.

The Lake Partner Program database contains TP data from over a thousand of Ontario's inland lakes. Figure 1 shows the distribution of TP concentrations in over 1400 of Ontario's inland lakes based on data from the Lake Partner Program. You may find this useful in understanding how the TP concentrations of your lake compare to other lakes in the province. This figure shows that more than 50% of the lakes in this dataset have TP concentrations of 4-10 µg/L.

Water Clarity – Secchi Depth readings

As we know, increases in phosphorus may decrease water clarity by stimulating algal growth. However, water clarity cannot generally be used to infer nutrient status in Ontario's inland lakes. Light penetration in the lake can be controlled by dissolved organic carbon (DOC) or by non-biological turbidity, which influences the colour of the lake. Water clarity can also be altered by invading species such as zebra mussels. It is always best, therefore, to use TP to evaluate the nutrient status of the lake. Water clarity readings nonetheless are valuable to track changes in the lake that might be occurring that would not be noticed by monitoring TP concentrations alone, e.g. zebra mussel invasions or watershed disturbances.

A Lake Partner Program volunteer uses a Secchi disk to measure water clarity in a lake.

Between-year differences in TP concentrations

Once there are several years of data, volunteers may want to examine their results for trends through time. Three years of data are required to establish a reliable, long-term average to measure the current nutrient status of the lake. However, three years of data are not enough to examine trends. There are some lakes that show relatively large differences in TP between the years (e.g., Austin Lake, Figure 2) but unless there are tangible reasons for these differences (e.g. large differences in rainfall between years or a large watershed area compared to lake area), it is more likely that further data collection will identify these years as data anomalies. Most lakes do not usually show large, between-year differences, but this is the reason why we collect annual data, so that we can identify what the normal between-year differences should be. Although the three years of data may show distinct increases or decreases, the trends are probably due to normal between-year variability. It is interesting to note that once there are several years of high quality TP data, it is possible to identify long-term trends (trends that maintain

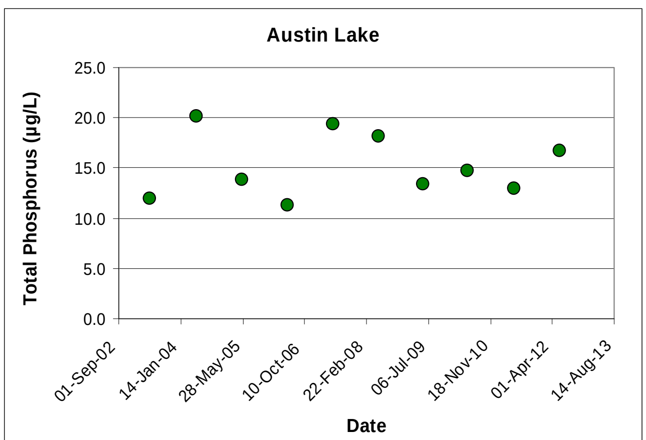

Figure 2. Between-year variation in total phosphorus (TP) concentrations for Austin Lake.

themselves through time), such as the slight downward trend noted for Runnings Bay in Charleston Lake (Figure 3).

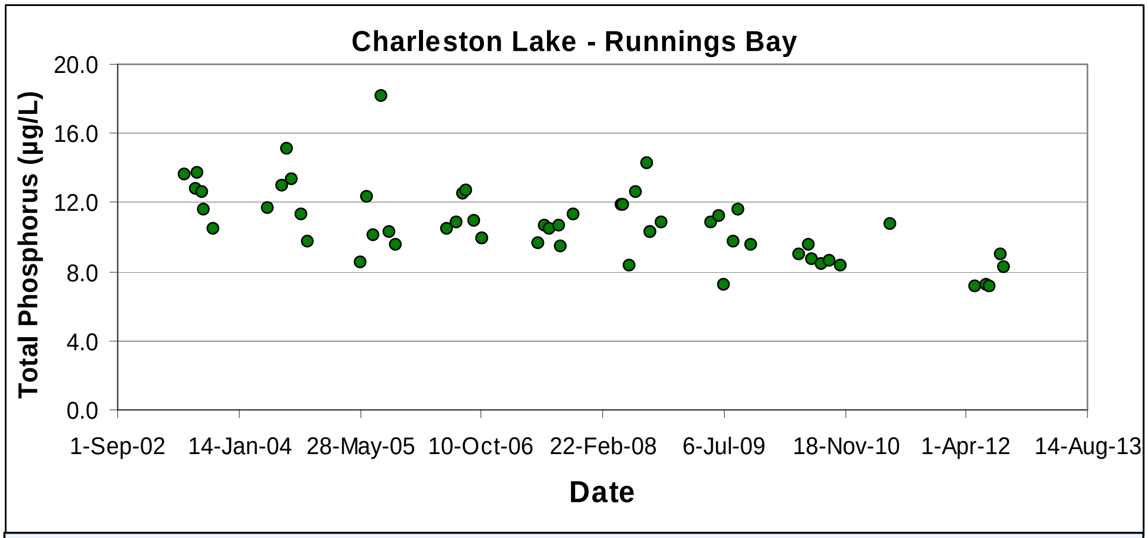

Figure 3. Long-term trend in monthly total phosphorus concentrations for 2003-2012 for Charleston Lake (Runnings Bay), sampled as part of the Lake Partner Program.

Seasonal differences in total phosphorus concentrations

Lakes that are off the Canadian Shield are sampled monthly because they are more likely to show seasonal differences in TP concentrations. In cases where concentrations increase towards the late summer, it is important to ascertain whether or not these concentrations could contribute to late summer algal blooms. In many cases, especially in the Kawartha Lakes, there are considerable increases in TP concentrations as the ice-free season progresses. In many cases, the concentrations span two or even all three of the classic trophic status categories (e.g., Figure 4). Many of the complex seasonal processes in these lakes would be difficult to assess without the data that volunteers collect on a monthly basis.

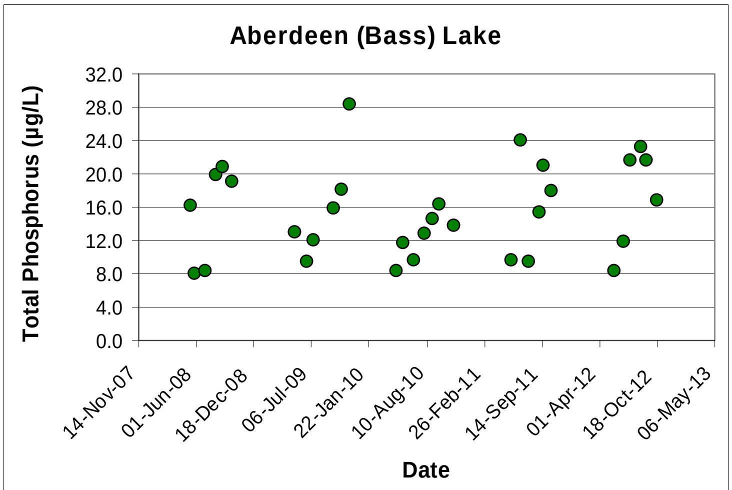

Figure 4. An example of a lake that shows seasonal differences in total phosphorus concentrations that span three of the classic trophic status categories (oligotrophic, mesotrophic and eutrophic).

Anomalous data points

When there are several years of precise TP data, it is **less** likely that anomalous data points will interfere with the interpretation of the data. These “outliers” can be the result of sample contamination in the field, such as a single zooplankton that was left in the tube after rinsing with unfiltered surface water. Anomalous data points represent a small percentage of the total number of samples and are easy to identify, especially after several years of data have been collected. In some lakes, there may be a consistent source of contamination (high zooplankton densities) that affect some samples, but they should not have an effect on the overall data set. This situation can be seen in the Cache Lake dataset, which shows slight between-year trends in TP in the lake and one outlier in 2011 (Figure 5). This is an excellent data set that cannot likely be improved through any change in methods. We know that the percentage of outliers is approximately the same (2-5%) whether professionals or volunteers collect these data.

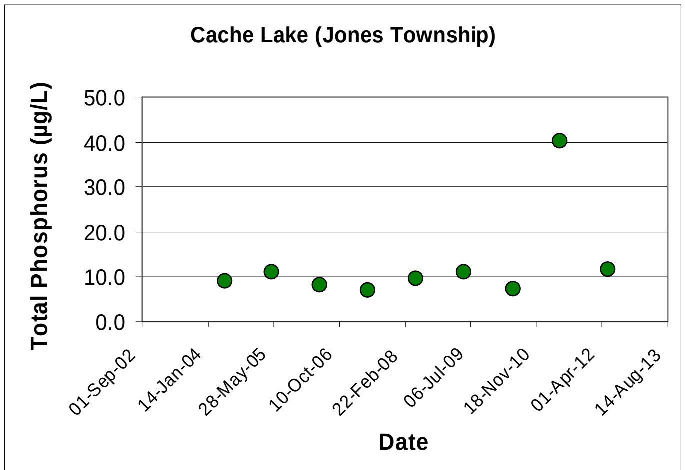

Figure 5. A lake that shows slight between-year trends in TP in the lake and one anomalous data point in 2011.

Common questions people ask about total phosphorus analysis:

What are TP1 & TP2? TP1 and TP2 are duplicate TP concentrations (sample pairs). These two “duplicate” samples help us to verify our confidence in the results. It is normal for there to be differences between TP1 and TP2. When there are major differences between TP1 and TP2, it is probably that one of the two samples was contaminated (usually the higher value). Contamination can occur when the sample water contains zooplankton or other debris. We submit two water samples for TP analysis. We know that about 5% of all TP samples submitted through the LPP are “bad splits,” where there are major* differences between TP1 and TP2. Analyzing two samples is also a contingency against one sample being lost due to breakage during shipment or laboratory accidents.

Why are we filtering water samples? Large zooplankton will add disproportionate amounts of TP to a sample. For example, if your lake is 10 µg/L, a single zooplankton can increase the reading to 35 µg/L. Filtering the samples removes this source of variation. Normally there are very few large zooplankton in a water sample; however, the incidence of unusually high TP readings has dropped significantly since we began filtering samples in 2003.

Why do we take our water samples from the deep spot location on my lake or bay? There are many different ways to design a lake monitoring program. The Lake Partner Program is designed to answer two simple but important questions: “What is my lake’s trophic status?” and “How are the TP concentrations changing between years and over time?” We know from other studies that a mid-lake, surface water sample is considered to be a good representative of the TP concentrations for the whole lake. Therefore, sampling at many different locations around the lake does not improve our understanding of the lake’s nutrient concentrations with respect to TP.

* Major differences between duplicate samples are considered to be samples that differ by more than 30% from the lower of the two values, AND the absolute difference between duplicates is greater than 5 µg/L (MOE, unpublished data). Duplicate samples that were in poor agreement according to these criteria are highlighted in yellow in the published LPP dataset