LAKE PARTNER PROGRAM

WESTERN PART OF LAKE PANACHE

Prepared for:

West Bay Campers' (Espanola) Association Inc.

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Background

In 2012, the West Bay Campers' (Espanola) Association Inc. applied to the then Ministry of the Environment (MoE), now the Ministry of the Environment, Conservation and Parks (MECP) to participate in its Lake Partner Program. The initiative involves many hundreds of volunteers from over 600 lakes in Ontario, collecting valuable long term data on spring time phosphorus concentrations and measurements of Secchi disc depth during the ice-free season.

During the first year (i.e., 2012), a total of six stations were sampled in the western end of Lake Panache (**Figure 1**); the program has continued through 2020. Herein, information is presented for the years 2012 through 2019; the results from 2020 have not yet been provided by the MECP. The samples for total phosphorus are collected once per year in the spring and forwarded for analyses to the MECP's Dorset Environmental Science Centre (DESC). Total phosphorus data based on DESC analytical methods are approximately ten times more precise than data collected before 2002.

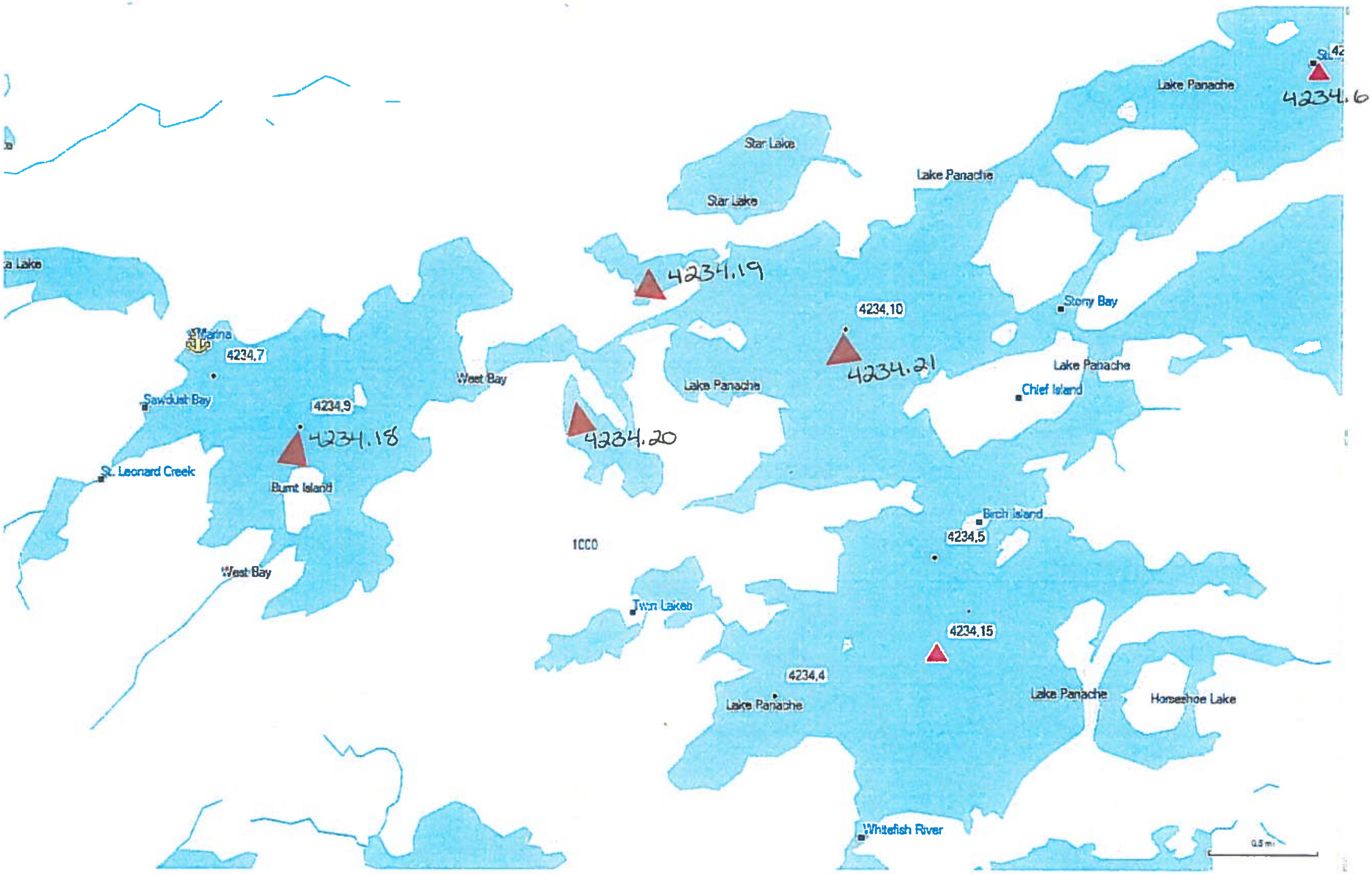
Why measure phosphorus?

Every lake has a natural concentration of phosphorus, which is a plant nutrient that is in limited supply in virtually all of Ontario's lakes, rivers and streams. The smaller the concentration of phosphorus, the less algae there will be, and generally fewer weeds. Low total phosphorus also means clear water. There are many ways for phosphorus to enter a lake. Some comes from natural sources including upstream wetlands, streams, for example, from Lake Augusta, surface runoff from undeveloped lands, groundwater, and wind-borne dust, rain and snow. Human activities in a lake's watershed can increase the amount of phosphorus over and above that supplied by natural sources. In Ontario's recreational lakes, effluent from private sewage treatment systems can contain large amounts of phosphorus that can eventually migrate into surface waters. As well, untreated runoff from those parts of shoreline lots that have been altered from their natural forested conditions can also contribute substantial amounts of phosphorus; this source is called stormwater runoff.

By measuring total phosphorus over a long term, say five to ten years, limnologists (i.e., scientists who study freshwater lakes, rivers and streams) can confirm not only the enrichment status of a lake, but whether or not trends are occurring. Concentrations of phosphorus that are typically less than 10 micrograms per litre (μg/L) or parts per billion are unenriched lakes and have a high quality; they are dilute and unproductive and rarely experience nuisance algal blooms. Lakes that have phosphorus concentrations that exceed 20 μg/L are enriched and typically have frequent blooms of blue green algae. Concentrations between 10 μg/L and 20 μg/L reflect a moderately enriched lake; such lakes exhibit a broad range of

Figure 1.

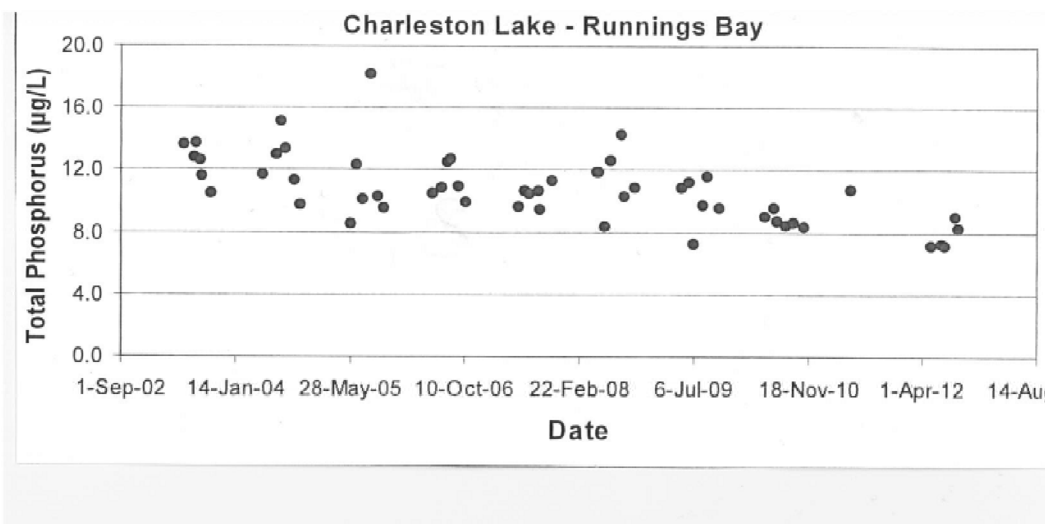
Six sampling locations in western end of Lake Panache, Lake Stewardship Phosphorus/Secchi disc program.



characteristics and can be clear and unproductive at one end of the scale, or susceptible to moderate algal blooms at concentrations near 20 µg/L. Based on a review of data from over 1,400 Ontario's inland lakes, more than 50% have average concentrations of total phosphorus between 4.0 µg/L and 10 µg/L.

Between-year Differences in Concentrations of Total Phosphorus

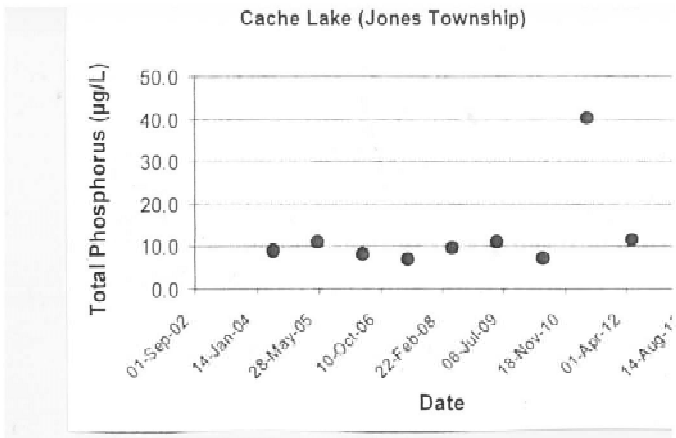
Once there are several years of data, it is possible to examine the results of trends through time. Three years of data are needed to establish a reliable average to measure the current trophic state status of a lake. However, three years are not enough to examine trends. Most lakes do not usually show large, between-year differences; this is the reason why annual data are collected, that is, to determine normal between-year variability. Although three years of data may show some increases or decreases, the differences are probably due to normal between-year natural influences. Once there are several years of high quality data, it is possible to confirm that a trend is occurring, such as the slight downward trend noted below for Running's Bay of Charleston Lake.



Long-term trends in monthly total phosphorus concentrations for 2003 – 2012 for Charleston Lake (Running Bay), sampled as part of the MECP's Lake Partner Program.

Anomalous Data Points

When there are several years of precise total phosphorus data, it is less likely that anomalous results or readings will interfere with the interpretation of the data. However, outliers can occur from time to time. According to the MECP, "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 . . . This situation can be seen in the Cache Lake dataset, which shows slight between-year trends in total phosphorus and one outlier in 2011. This is an excellent data set that cannot likely be improved through any change in methods." The MECP has determined that the percentage of outliers is approximately the same (i.e., 2% - 5%) whether professionals or volunteers collect the data.

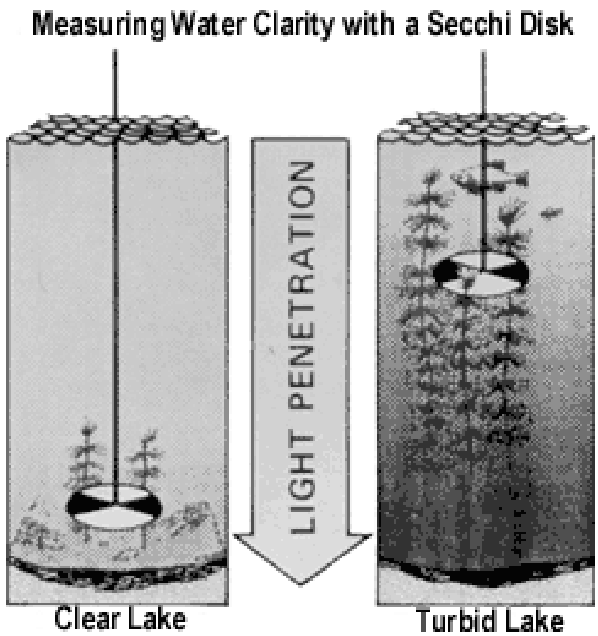


A lake that shows a slight between year trend and an anomalous data pint in 2011.

Why water clarity?

Typically, increases in total phosphorus concentrations may decrease water clarity in a lake by stimulating algal growth. Water clarity is measured by a Secchi disc, which is weighted circular plate, painted with opposite black and white quadrants, attached to a measured rope (see below). The disc is named after Father Pietro Angelo Secchi, astronomer and scientific advisor to the Pope, who tested the instrument in the Mediterranean Sea on April 20, 1865.

The Secchi disc visibility or degree of water clarity is determined by slowly lowering the disc into the water until it is on the verge of disappearing; this depth is recorded. The disc is lowered a little further until it completely disappears; it is then slowly raised until it reappears, and the depth is also recorded. The average of the two readings is the Secchi disc depth. Obviously, readings may vary to some extent depending on daylight conditions, wave action, and the eyesight of the observer. Values that exceed about 4.0 metres reflect a very clear lake and high quality system; measurements which are less than about 2.0 metres indicate aquatic enrichment, while lakes having values between 2.0 metres and 4.0 metres are moderately enriched.

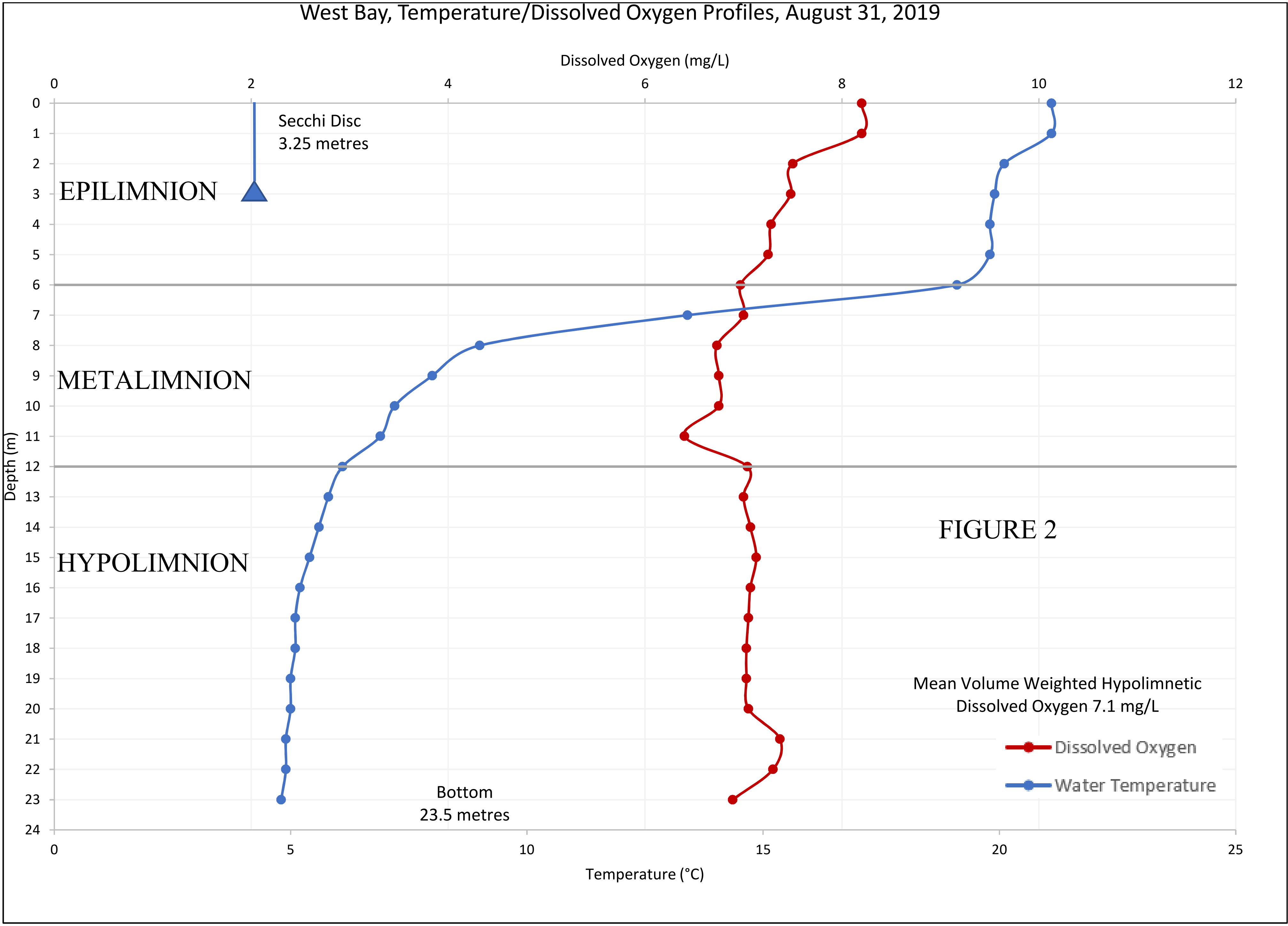


However, some caution must be used when interpreting Secchi disc data, which have been collected from the six stations, five to eight times through the ice-free season. In this regard, water clarity or Secchi disc depth by itself cannot generally be used to infer trophic status. This is because light penetration in a lake can also be controlled by dissolved organic carbon (DOC), or by non-biological turbidity. As well, water clarity can be altered by invading species such as zebra mussels. It is always best therefore, to use total phosphorus to evaluate the nutrient status of a lake. Water clarity readings are nonetheless valuable to track changes that might be occurring that would not be detected by monitoring concentrations of total phosphorus alone (e.g., zebra mussel invasions or watershed disturbances).

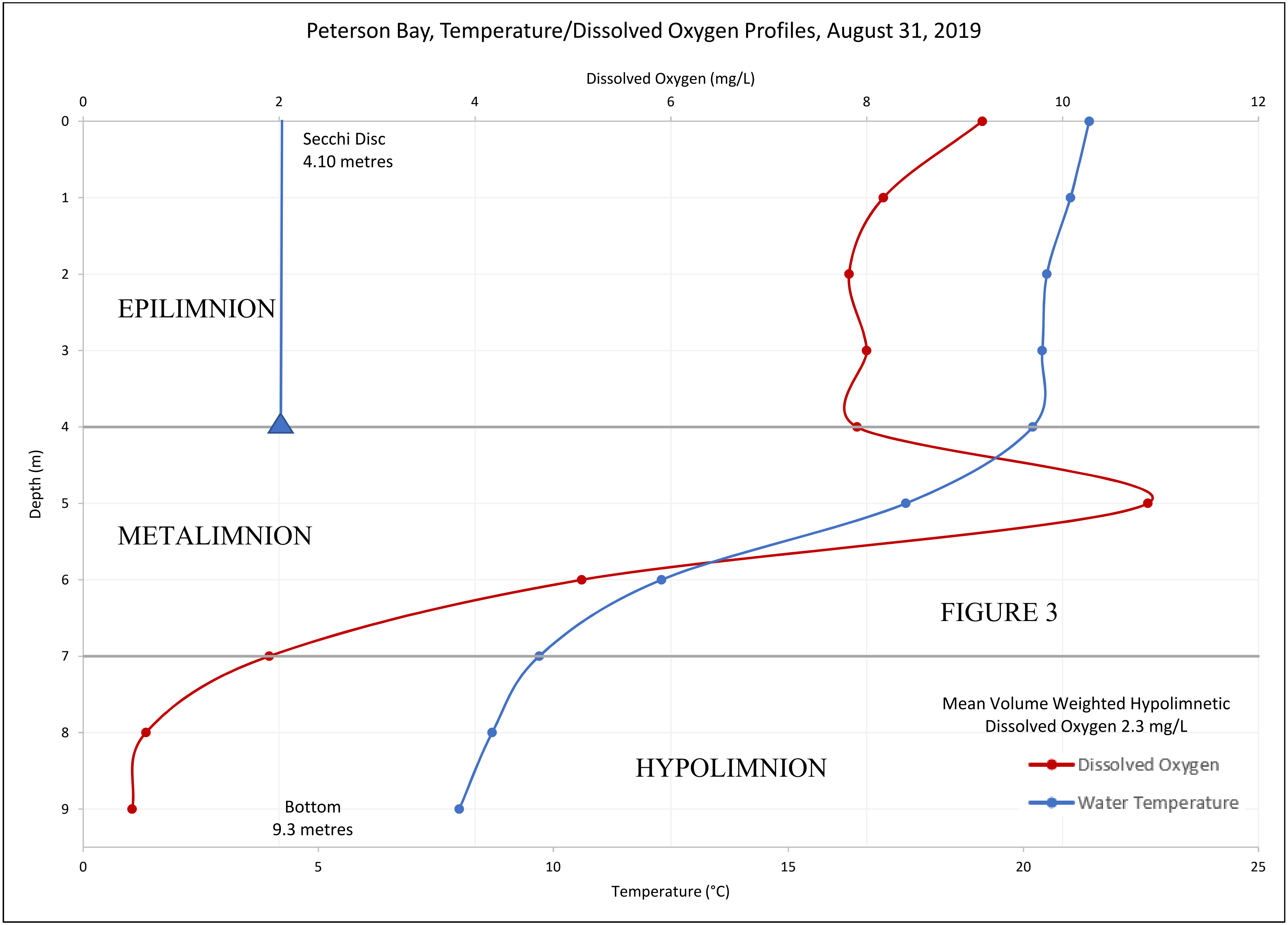
Water Temperature and Dissolved Oxygen

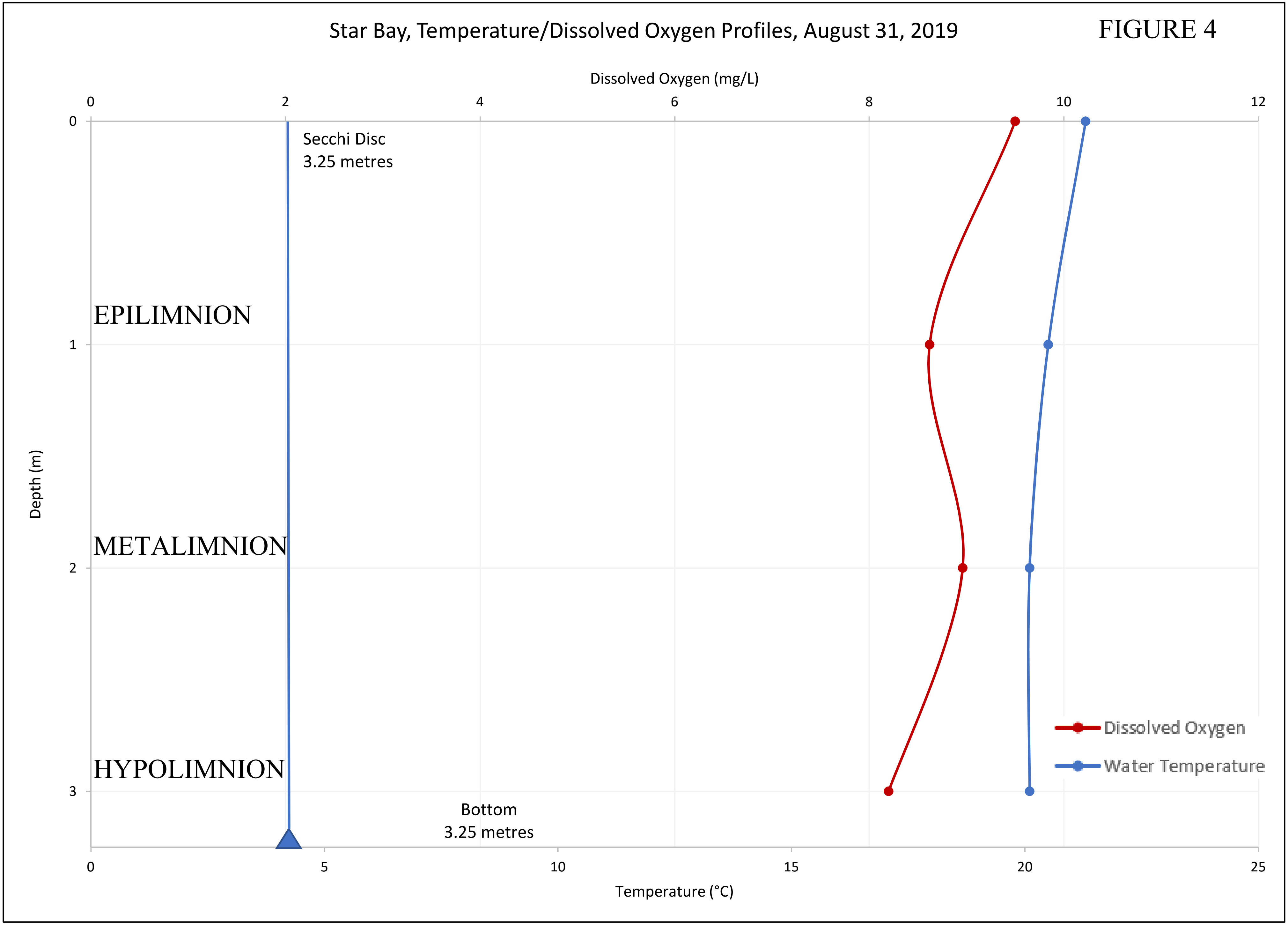
To further explore quality conditions in the western end of Lake Panache, water temperature and concentrations of dissolved oxygen were obtained at the six sampling occasions shown in **Figure 1** on August 31, 2019. This is the best time for confirming a lake's health from the perspective of optimal lake trout habitat. Accordingly, temperature and dissolved oxygen readings were recorded every metre of depth, surface to bottom, plotted (**Figures 2** through **7**) and interpreted in the context of a healthy ecosystem for lake trout.

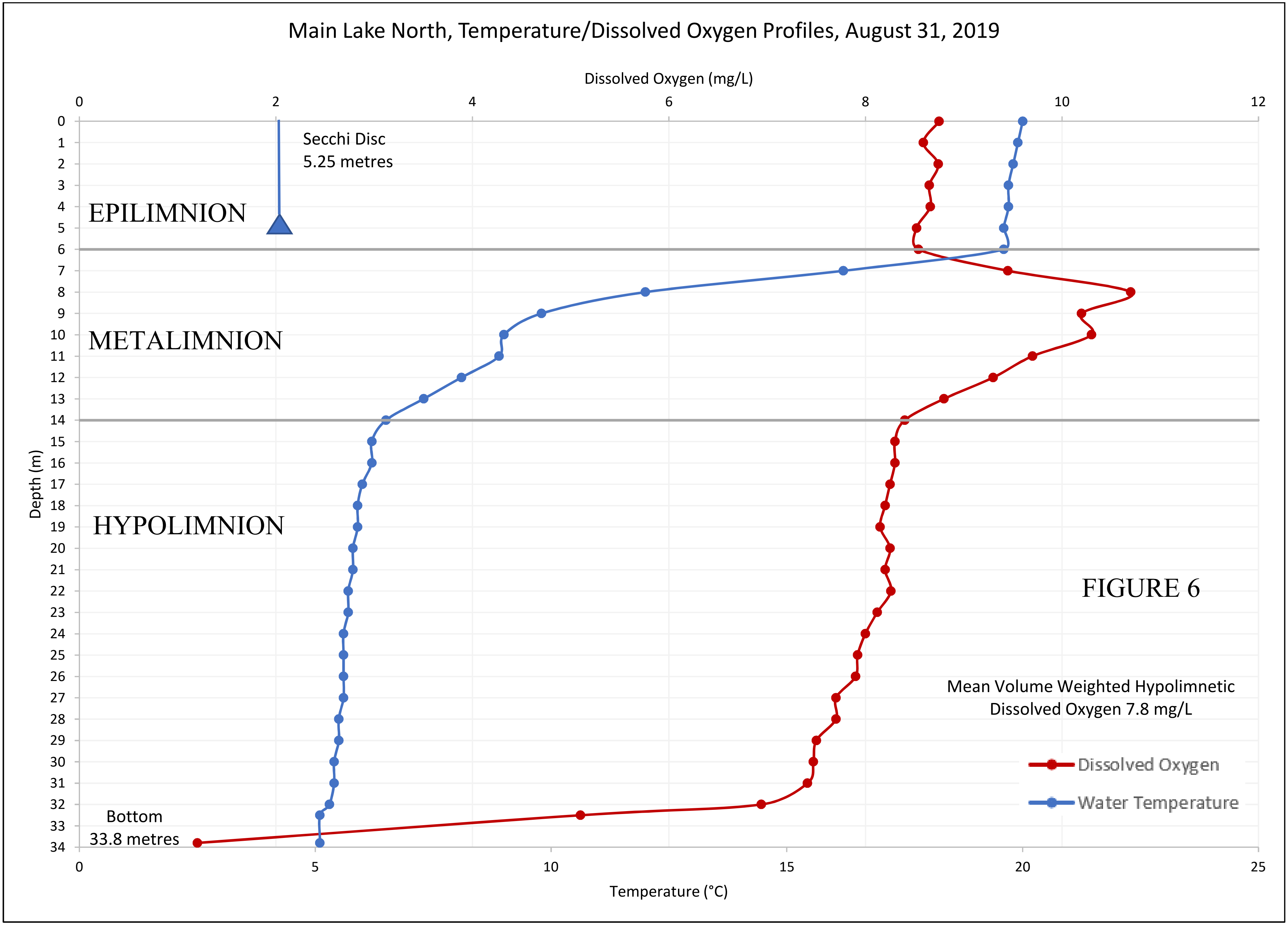
Figures 2 through **6** show the approximate position of the three summertime temperature layers. The upper stratum in which temperature is more or less uniform with depth, is called the epilimnion. The metalimnion is the intermediate zone in which the temperature declines rapidly with depth. The deep coldwater zone is called the hypolimnion; this is where water temperatures are fairly uniform with depth. This type of thermal

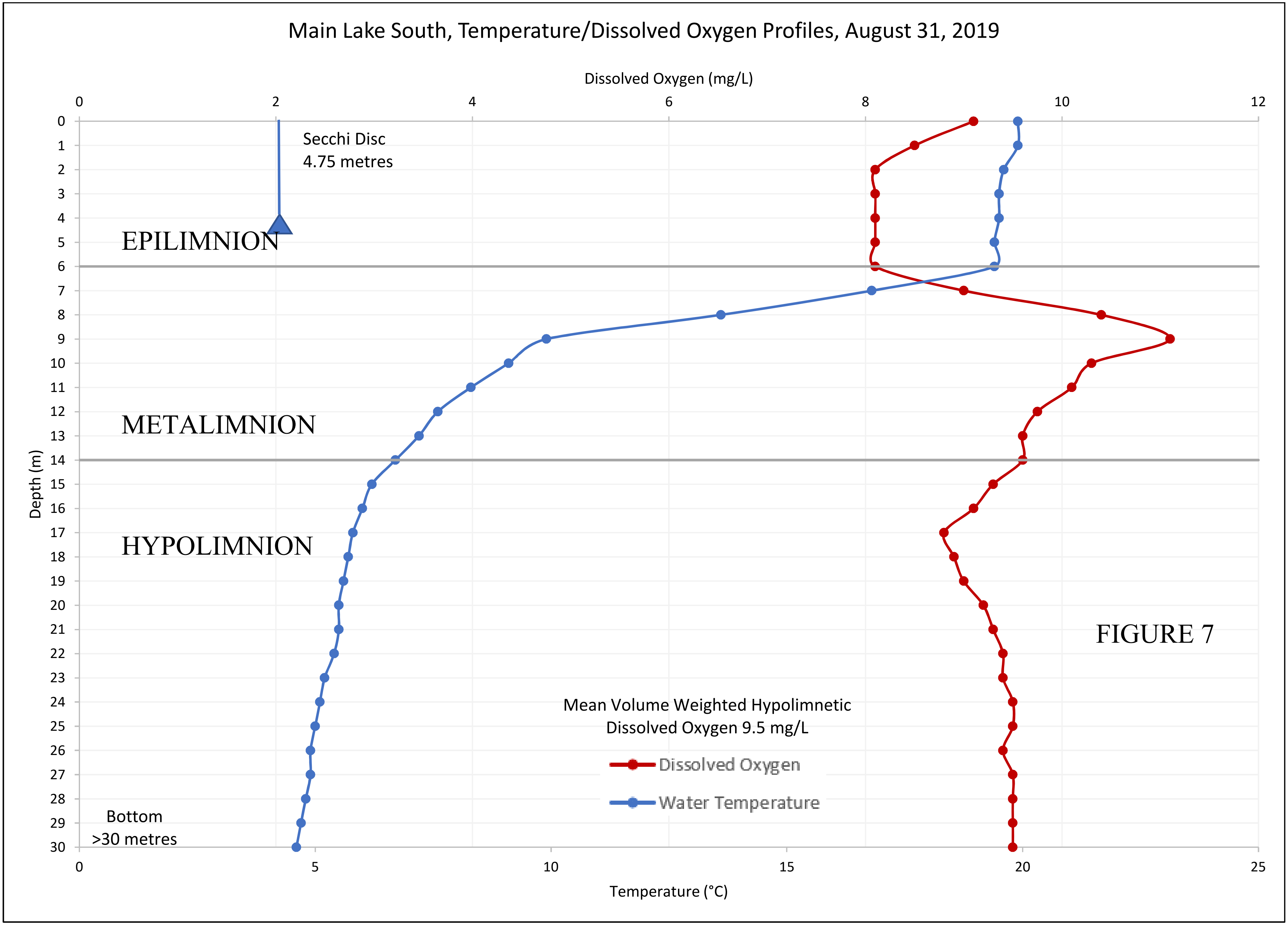


West Bay, Temperature/Dissolved Oxygen Profiles, August 31, 2019
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
Secchi Disc
3.25 metres
EPILIMNION
METALIMNION
HYPOLIMNION
FIGURE 2
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Mean Volume Weighted Hypolimnetic
Dissolved Oxygen 7.1 mg/L
Dissolved Oxygen
Water Temperature
Bottom
23.5 metres
0
5
10
15
20
25
Temperature (°C)


Peterson Bay, Temperature/Dissolved Oxygen Profiles, August 31, 2019
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
Secchi Disc
4.10 metres
EPILIMNION
METALIMNION
FIGURE 3
HYPOLIMNION
Mean Volume Weighted Hypolimnetic
Dissolved Oxygen 2.3 mg/L
Dissolved Oxygen
Water Temperature
Bottom
9.3 metres
Depth (m)
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
Temperature (°C)


Star Bay, Temperature/Dissolved Oxygen Profiles, August 31, 2019
FIGURE 4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
Secchi Disc
3.25 metres
EPILIMNION
METALIMNION
HYPOLIMNION
Bottom
3.25 metres
Depth (m)
0
1
2
3
Dissolved Oxygen
Water Temperature
0
5
10
15
20
25
Temperature (°C)


Main Lake North, Temperature/Dissolved Oxygen Profiles, August 31, 2019
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
Secchi Disc
5.25 metres
EPILIMNION
METALIMNION
HYPOLIMNION
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
FIGURE 6
Mean Volume Weighted Hypolimnetic
Dissolved Oxygen 7.8 mg/L
Dissolved Oxygen
Water Temperature
Bottom
33.8 metres
0
5
10
15
20
25
Temperature (°C)


Main Lake South, Temperature/Dissolved Oxygen Profiles, August 31, 2019
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
Secchi Disc
4.75 metres
EPILIMNION
METALIMNION
HYPOLIMNION
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
FIGURE 7
Mean Volume Weighted Hypolimnetic
Dissolved Oxygen 9.5 mg/L
Dissolved Oxygen
Water Temperature
Bottom
>30 metres
0
5
10
15
20
25
Temperature (°C)

stratification is typical in Ontario's Precambrian Shield lake trout lakes. As shown in **Figures 2** through **6**, strong thermal stratification prevails at all sampling locations, except for Star Bay which is too shallow to stratify (**Figure 7**). Locations of the metalimnion are also shown, commencing at about 6.0 metres of depth. For Peterson Bay, a metalimnion high in the water column reflects the effects of steep and high shorelines, meaning that surface waters are not as influenced by late summer winds, as are the other "open" water sites.

Changes in dissolved oxygen concentrations with depth and season depend, for the most part, on the depth of a lake. The warm surface, epilimnetic waters float on the cooler, more dense metalimnetic waters during the summer months. The difference in density (i.e., the surface waters are less dense than the underlying metalimnetic waters) creates a resistance to water column mixing by wind and wave action; in fact, many deep lakes do not become uniformly mixed again until the surface waters cool in the fall, when the lakes undergo their "fall turnover". During the summer stratification period, the surface waters are constantly being mixed by wind action and are well-supplied with oxygen through photosynthesis by algae. As a result, the epilimnetic layer has high concentrations of dissolved oxygen. In contrast, the hypolimnetic bottom waters are limited in their ability to replenish their oxygen supply, and must rely on oxygen derived form the "spring turnover" (i.e., the second period of a year when a lake's oxygen supply is naturally replenished) to off-set respiration and decomposition of sedimented and sedimenting organic material, including algae produced in the lake's epilimnion.

Some lake trout lakes are oversupplied with artificial or human-made loadings of phosphorus, which indirectly can influence their late summer deep water oxygen content (i.e., lake trout habitat). This results when an increased load of phosphorus from shoreline development causes more algae to develop; when the algal cells settle and decompose in a lake's hypolimnion, they diminish the supply of dissolved oxygen through decomposition processes, thereby negatively impacting lake trout habitat. For example, the Municipality of Dysart *et al* which centers on the Village of Haliburton has a total of 42 lake trout lakes; of these, 19 are considered to be at their development capacity. The Ministry of Natural Resources and Forestry (MNRF) has determined that a lake trout lake is at capacity when its Mean Volume Weighted Hypolimnetic Dissolved Oxygen (MVWHDO) is less than 7.0 milligrams per litre (mg/L). Simply put, the MVWHDO is the average concentration of dissolved oxygen in the cooler, deeper waters in late summer. The value of 7.0 mg/L or greater is considered acceptable habitat for lake trout. When a lake's MVWHDO falls below 7.0 mg/L, the Province considers the lake to be at-capacity. In the context of the **2020 Provincial Policy Statement**, being designated as an at-capacity lake trout lake means no further lot creation or re-development, unless an applicant or landowner can demonstrate how new phosphorus loads can be controlled to their virtual point of elimination. In terms of causal effects relating to the at-capacity designation, there are two primary sources of phosphorus that are associated with shoreline development, one being sewage and the other being stormwater. The main problem is that at present, there are no household sewage treatment systems that are recognized in the **Ontario Building Code** as capable of reducing sewage-related phosphorus.

It is important to note that factors other than depth and human-made loadings of phosphorus can have an influence on concentrations of dissolved oxygen in the bottom waters. More specifically, the natural shape of a lake's basin or its morphometry can strongly influence its deep water oxygen regime. For example, undeveloped lake trout lakes having "deep holes" are typically characterized by poor oxygen conditions in their deeper waters. An analysis of morphometric data from 22 Precambrian Shield lakes in the County of Haliburton and the District Municipality of Muskoka revealed that the shape of a lake's basin can exact a very large influence on dissolved oxygen profiles in late summer, **which is very much a natural condition**. Fourcorners Lake is an example of an at-capacity lake trout lake in the Municipality of Dysart *et al*; the reason that it is at-capacity is because its MVWHDO is less than 7.0 mg/L. This diminished dissolved oxygen regime relates entirely to natural causes, as there are no developed shoreline residential lots on it, only a small hunt camp. In terms of evaluating the effects of new shoreline development on late summer, deep water lake trout habitat, the natural causes are rarely if ever considered as contributing factors, perhaps because they are non-controllable.

What Can Be Said About the Data Collected from the Western End of Lake Panache?

Table 1 summarizes the information collected yearly from six sampling sites in the western end of Lake Panache for the eight year period 2012 – 2019. Individual readings and related averages are presented in **Appendix A**.

- In total, 95 total phosphorus samples have been collected by the West Bay Campers' (Espanola) Association Inc., and analyzed by staff of the MECP at the Dorset Environmental Science Centre (a single sample was broken or otherwise lost). At each sampling site, duplicate samples were collected. Two hundred and fifty-three Secchi disc readings were taken over the eight year period. This information was reviewed to confirm the trophic status of the six areas and to assist in determining long-term trends and variability amongst sampling locations.

- The total phosphorus data confirm the unenriched or oligotrophic character (i.e., low phosphorus content) in surface waters at the western end of Lake Panache. According to the MECP, the values presented in **Table 1** and **Appendix A** represent a high quality lake as per the Ministry's Interim Provincial Water Quality Objective for this parameter. Specifically, the Ministry's policy states that, "A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 µg/L or less. This should apply to all lakes naturally below this value." As indicated in **Table 1** and **Appendix A**, all values from stations in the western end of Lake Panache are below 10 µg/L.

- There are no short-term increasing or decreasing trends apparent from the total phosphorus data base.

- Secchi disc values for all locations except Star Lake show high water clarity. There are no Provincial Water Quality Objectives for lake clarity, as determined from Secchi disc readings. For clear water lakes such as Lake Panache, readings greater than 4.0 metres represent oligotrophic or nutrient-poor conditions. With the exception of one average value, all Secchi disc annual averages exceeded the 4.0 metre criterion. In West Bay in 2013 and 2017, the annual average values were 3.9 metre and 3.5 metre, respectively, just below the 4.0 metre limit. Classification of Star Bay based on Secchi disc readings is not appropriate, owing to the shallowness of the Bay and Secchi disc being visible on bottom sediments.

- Peterson Bay is too shallow (i.e., 6.1 metres) to sustain lake trout.

- The vertical distribution of dissolved oxygen in West Bay and the two Main Lake stations are orthograde, or non-diminishing with depth, which is characteristic of Precambrian Shield lake trout lakes. For Peterson Bay and Stoney Bay, dissolved oxygen diminishes with depth, with anaerobic or oxygen-poor conditions occurring at or near bottom. This type of oxygen distribution is referred to as clinograde; its presence is often associated with eutrophic or enriched lakes. While true, many of Ontario's small and undeveloped lake trout lakes exhibit this condition; however, they are nutrient poor, and by consequence, should not be characterized as eutrophic systems. Also apparent in Peterson Bay, Stoney Bay and the two Main Lake stations are increases in dissolved oxygen in the metalimnion. This is termed a positive hetrograde oxygen distribution, with maximum concentrations typically exceeding 10 µg/L. Such increases almost certainly resulted from optimal photosynthesis of phytoplankton, which are microscopic algae suspended in the water column and that prefer a coolwater environment. Some limnologists (i.e., scientists who study fresh water lakes, rivers and streams) are of the opinion that such dissolved oxygen distribution curves typically occur in mesotrophic or moderately enriched lakes. However, one must be cautious when relating this type of distribution to a trophic condition, particularly in many small, undeveloped Precambrian Shield lakes. In such lakes, this vertical distribution is typically associated with a well-developed metalimnion, Secchi disc readings that exceed 5.0 metre, and a nutrient regime characteristic of unpolluted, unenriched lakes.

- Estimated MVWHDO values for five stations in the western part of Lake Panache are shown below.

Location	Estimated Mean Volume Weighted Hypolimnetic Dissolved Oxygen (mg/L)
West Bay	7.1
Stoney Bay	3.9
Star Bay	Not Applicable
Main Lake North	7.8
Main Lake South	9.5

Values for West Bay and the two Main Lake stations exceed 7.0 mg/L, meaning excellent deep water habitat for lake trout. In contrast, the concentration in Stoney Bay is considerably less than the 7.0 mg/L criterion (i.e., 3.9 mg/L). Assuming Stoney Bay has lake trout, the Province would not support approval of any new severances, or subdivision plans, or re-development unless it can be demonstrated that the proposal will have no negative impacts on lake trout habitat. Provincial water quality evaluators associate the 7.0 mg/L criterion to Policy 2.1.8 of the **2020 Provincial Policy Statement**. It states that development and site alteration shall not be permitted on adjacent lands to fish habitat unless no negative impacts can be demonstrated. As mentioned earlier, there are no sewage treatment systems in the **Ontario Building Code** that are capable of removing phosphorus. Given that the MVWHDO for Stoney Bay is less than 7.0 mg/L, new lot creation or any type of new development that would increase the annual load of phosphorus would indeed be a challenge. Water temperatures in Peterson Bay are too high to support lake trout during the warm weather months of the year.

Future Action

1. The phosphorus/Secchi disc sampling program be continued in 2021.
2. Temperature, dissolved oxygen profiles be repeated in the late summer of 2021, with an additional deep-water station in Stoney Bay.

3. A Stewardship Manual be prepared and distributed to members of the West Bay Campers' (Espanola) Association Inc. and other interested parties.

Respectfully submitted by:

Michael Michalski

APPENDIX A – PHOSPHORUS VALUES AND SECCHI DISC MEASUREMENTS AT SIX LOCATIONS IN THE WESTERN END OF LAKE PANACHE, 2012 - 2019

Appendix A. **Phosphorus values on five occasions in the western end of Lake Panache at six locations and average Secchi disc visibilities.**

Location	Date	Total Phosphorus #1 (µg/L)	Total Phosphorus #2 (µg/L)	Secchi Disc Average (m)	Secchi Disc Number of Readings
West Bay	27/5/12	4.6	4.2	5.2	8
	20/5/13	6.2	7.0	3.9	5
	14/7/14	5.0	8.8	4.8	6
	18/5/15	7.2	6.8	4.3	5
	23/5/16	4.0	4.4	4.1	6
	9/7/17	6.8	6.4	3.5	6
	21/5/18	8.6	8.8	4.2	5
	9/6/19	8.4	8.2	4.1	6
		6.4	6.8	4.3	47
Star Bay	27/5/12	7.0	7.4	3.2*	8
	20/5/13	6.2	6.6	2.9*	5
	14/7/14	6.4	7.0	2.8*	6
	18/5/15	7.2	6.6	2.9*	5
	23/5/16	5.0	4.4	3.0*	6
	9/7/17	9.0	9.4	2.7	6
	21/5/18	5.6	4.8	2.4	5
	9/6/19	7.2	7.2	2.3	6
		6.6	6.7	2.8*	47
Peterson Bay	27/5/12	6.8	7.0	5.8	8
	20/5/13	6.4	--	5.1	5
	14/7/14	7.2	5.8	4.5	6
	18/5/15	7.8	6.8	4.8	5
	23/5/16	7.0	7.2	5.0	6
	9/7/17	8.2	8.8	3.8	6
	21/5/18	7.4	7.0	4.1	5
	9/6/19	6.2	6.8	3.9	6
		7.1	6.4	4.6	47

Location	Date	Total Phosphorus #1 (µg/L)	Total Phosphorus #2 (µg/L)	Secchi Disc Average (m)	Secchi Disc Number of Readings
Stoney Bay	27/5/12	3.2	3.4	6.3	8
	20/5/13	5.4	6.0	5.2	5
	14/7/14	4.2	4.0	4.9	6
	18/5/15	6.4	6.6	5.4	5
	23/5/16	4.4	4.2	5.7	6
	9/7/17	5.2	5.2	6.1	6
	21/5/18	6.4	5.8	5.8	5
	9/6/19	6.65	5.6	5.9	6
		5.2	5.3	5.6	47
Main Lake North	27/5/12	3.2	4.2	7.1	8
	20/5/13	4.2	4.2	5.8	5
	14/7/14	3.6	3.6	5.1	6
	18/5/15	4.2	4.4	5.4	5
	23/5/16	4.8	4.6	6.1	6
	9/7/17	4.8	4.6	4.8	6
	21/5/18	4.6	4.6	5.1	5
	9/6/19	4.8	5.0	5.9	6
		4.3	4.4	5.7	47
Main Lake South	27/5/12	5.0	3.4	7.0	8
	20/5/13	5.4	5.2	5.9	5
	14/7/14	4.0	4.0	6.1	6
	18/5/15	5.2	5.2	6.3	5
	23/5/16	4.0	6.4	6.1	6
	9/7/17	5.8	5.2	5.6	6
	21/5/18	5.2	5.0	8.2	5
	9/6/19	5.4	5.2	7.0	6
		5.0	4.9	6.5	47

APPENDIX B – COMMON QUESTIONS ASKED ABOUT THE LAKE PARTNER PROGRAM

Appendix B. Common Questions Asked About the Lake Partner Program

What are TP 1 and TP 2? TP 1 and TP 2 are duplicate samples collected for total phosphorus concentrations (i.e., sample pairs). These assist in verifying confidence in the results. It is normal for there to be differences between TP 1 and TP 2. When there are major differences, it is probable that one of the two samples was contaminated (i.e., usually the higher value). Contamination can occur when the sample water contains zooplankton or other debris. This is why two samples are submitted for analysis. About 5% of all total phosphorus samples submitted from lakes throughout the Province are "bad splits", where there are major differences between the TP 1 and TP 2 values. According to MECP, 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 5.0 micrograms per litre (µg/L). Analyzing two samples is also a contingency against one sample being lost due to breakage or laboratory accidents. No "bad splits" have been reported to date for the samples collected from the six stations at the western end of Lake Panache.

Why are the samples collected for total phosphorus filtered? Large zooplankton will add a disproportionate amount of total phosphorus to a sample. For example, if a lake's total phosphorus concentration is normally 10 µg/L, a single zooplankton can increase the reading to 35 µg/L. Filtering the sample removes this source of variation. Typically, there are very few zooplankton in a water sample; however the incidence of unusually high total phosphorus readings has dropped significantly since the MECP began filtering samples in 2003.

Why are water samples and Secchi disc readings taken from deep spot locations in a lake or bay? There are many different ways to design a lake monitoring program. The Lake Partner Program was designed to answer two simple but important questions. What is my lake's trophic status? and, How are the total phosphorus concentrations changing between years and over time? What is known from other studies is that a mid-lake, surface water sample is considered to be a good representative of total phosphorus concentration for the whole lake. Accordingly, sampling at many different locations around the lake does not improve our understanding of the lake's nutrient concentration with respect to total phosphorus.

What does it mean if the results have been fairly stable for several years? Should the sampling be stopped? No! The Lake Partner Program is based on long-term data; the complex and dynamic nature of inland lakes requires continued monitoring and research. For example, long term sampling will be helpful in detecting impacts due to climate change, nutrient loading and/or other environmental stressors.

What does it mean if our results are suddenly quite different this year? It could be an anomaly or a sampling error (for example, contamination by zooplankton left in the sample tube after rinsing), or, it may indicate the start of a change that will become clearer over time. Some lakes exhibit differences in total phosphorus as a result of large changes in rainfall year-over-year. Variation from year-to-year in total phosphorus concentrations is not unusual; however, what is important is that the cause of the variation should be investigated.

What are the potential effects of climate change on central Ontario lakes? The District Municipality of Muskoka has explored likely impacts of climate change on the biology of lakes, with the following conclusions.

- The warming climate will cause noticeable changes in the thermal regimes of some lakes, including parts of Lake Panache, making their surface waters warmer in summer than at present. The extent of this warming may prove lethal to some planktonic species such as *Daphnia.* It is logical to assume therefore that there will be some re-ordering of zooplankton communities in such lakes and embayments that are sensitive to climate warming. This change could also lead to a restructuring of the phytoplankton community to lowered productivity, and ultimately to a change in the capacity of lakes to support fish.

- The warming climate may increase the stress on coldwater fish species such as lake trout, and may also result in some lakes and bays that now support lake trout unable to do so (for example, Stoney Lake). Affected lakes will be those that currently have relatively small deep water habitats (i.e., low MVWHDO). The deep water habitat will become even further reduced and anoxic (i.e., oxygen poor). Large deep lakes including the main basins of Lake Panache will not be so affected.

- The warming climate will increase the length of the open-water season, which in turn will shift some seasonal cycles in various algal or animal species earlier in the year. This longer growing season, coupled with warmer surface waters will definitely alter the cycling of algal populations, and increase the frequency with which nuisance algal blooms occur. Lakes and embayments with oxygen poor conditions in their deeper waters (i.e., Peterson Bay and Stoney Lake), typically have phosphorus loadings from their sediments in a process called "internal loading", which can further stimulate algal blooms.