Milton

Volunteer Lake Monitoring Program

Introduction

The City of Milton's volunteer lake monitoring program began in 2011 with the goals of collecting data to establish long-term trends in lake water quality, encourage lake stewardship through participation in the monitoring program, and provide information on Surprise Lake that will be helpful in making appropriate management decisions. While conditions may vary from year to year, long-term data collection is the key to tracking trends in water quality over time. Surprise Lake, a 32-acre lake with a maximum depth of 40 feet, is in the Puyallup River watershed within the city limits of Milton. This report contains a summary of the data collected during the 2018 lake monitoring season (May – October).

Monitoring Program

Water chemistry and physical characteristics of lakes vary both seasonally and with depth. Lake volunteers collected physical data (water transparency, water color, weather conditions, other observations), made measurements of temperature and dissolved oxygen, and collected water samples for chemical analysis (total phosphorus, chlorophyll *a*) on a monthly basis beginning in early May and ending in late October.

While lake levels on Surprise Lake are not regularly tracked, the volunteers do measure depth at the monitoring site each time they monitor the lake and have noted that the depth of the site has decreased over the last several years at the monitoring site.

Measurements of temperature and dissolved oxygen were made throughout the water column at the deepest point in the lake. The "shallow" samples for total phosphorus analysis were collected one meter below the surface of the lake; the "deep" samples were collected one meter above the lake bottom. Samples for chlorophyll *a* were collected only from the upper, lighted part of the lake, where algae are most typically found. Field data and samples were collected in 2018 by the Dan Hull and Linda Pomeroy-Hull and the data and lab results can be found in Table 1.

Dissolved Oxygen and Water Temperature Profiles

With the onset of warmer weather in spring and early summer, deep lakes will begin to separate into a warmer, low-density layer at the surface, known as the epilimnion, and a cooler, high-density layer at the bottom, known as the hypolimnion. Between the epilimnion and the hypolimnion is a layer of rapidly changing temperature called the metalimnion, or thermocline. Thus, begins the process of thermal stratification. Once this condition is fully developed, in summer, there is no vertical mixing of the upper and lower layers because of their density differences.

The vertical profiles of temperature and dissolved oxygen are similar during stratification (see figure 1); warmer water with abundant oxygen near the surface, and cooler water with declining or no oxygen at depth. A well oxygenated epilimnion is usually the result of the diffusion of oxygen from the atmosphere and the presence of algae that generate oxygen as a byproduct of photosynthesis. A hypolimnion with reduced or no oxygen is the result of the decomposition of organic matter that settles into that layer. These conditions occur despite the general rule that, all other factors being equal, cold water can hold more dissolved oxygen than warm water.

With the onset of cooler weather in the fall, the thermal stratification begins to break down and the shallow and deep layers of water begin to mix vertically once again. This phenomenon is usually called turnover.

This year the temperature and dissolved oxygen profiles show that stratification of the lake was already underway in early May (blue line), as in previous years. Turnover was complete by late October (purple line) with the temperature profile uniform from top to bottom.

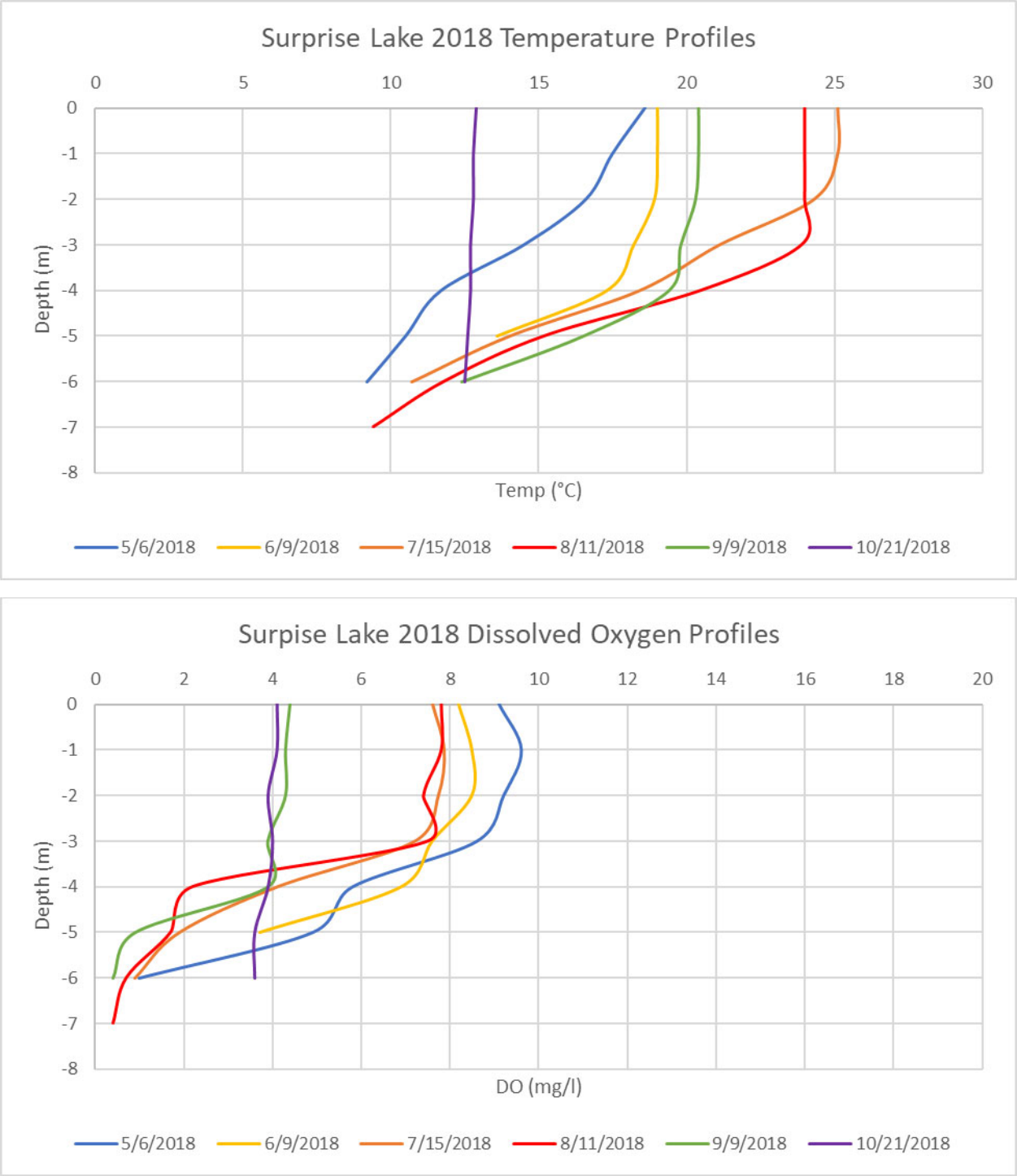


Figure 1.

Transparency

Water transparency is measured using an 8-inch diameter, black-and-white secchi disk and is traditionally reported as secchi depth. It is influenced by several factors such as dissolved substances, algae, and sediment particles. Transparency readings can also be affected by waves, wind, and glare. Higher secchi depth readings indicate clearer water (more transparent) while lower secchi depth readings indicate more turbid water. Clear water allows more light to penetrate deeper in the lake, allowing photosynthesis in aquatic plants and algae to occur; this leads to higher levels of dissolved oxygen. Conversely, a decrease in transparency is often seen with an increase in algae, or an influx of sediment and detritus due to a major storm event or because of human activities in the watershed. Nevertheless, secchi depth is commonly used as an approximation of algal abundance.

Secchi depth measurements observed in the 2018 monitoring season ranged from 2.1 to 5.5 meters, with an average depth of 3.4 meters. Graphs showing the results for secchi depth for all years of data collection are shown below in Figure 2. Like previous years, water transparency in 2018 was highest early in the monitoring season.

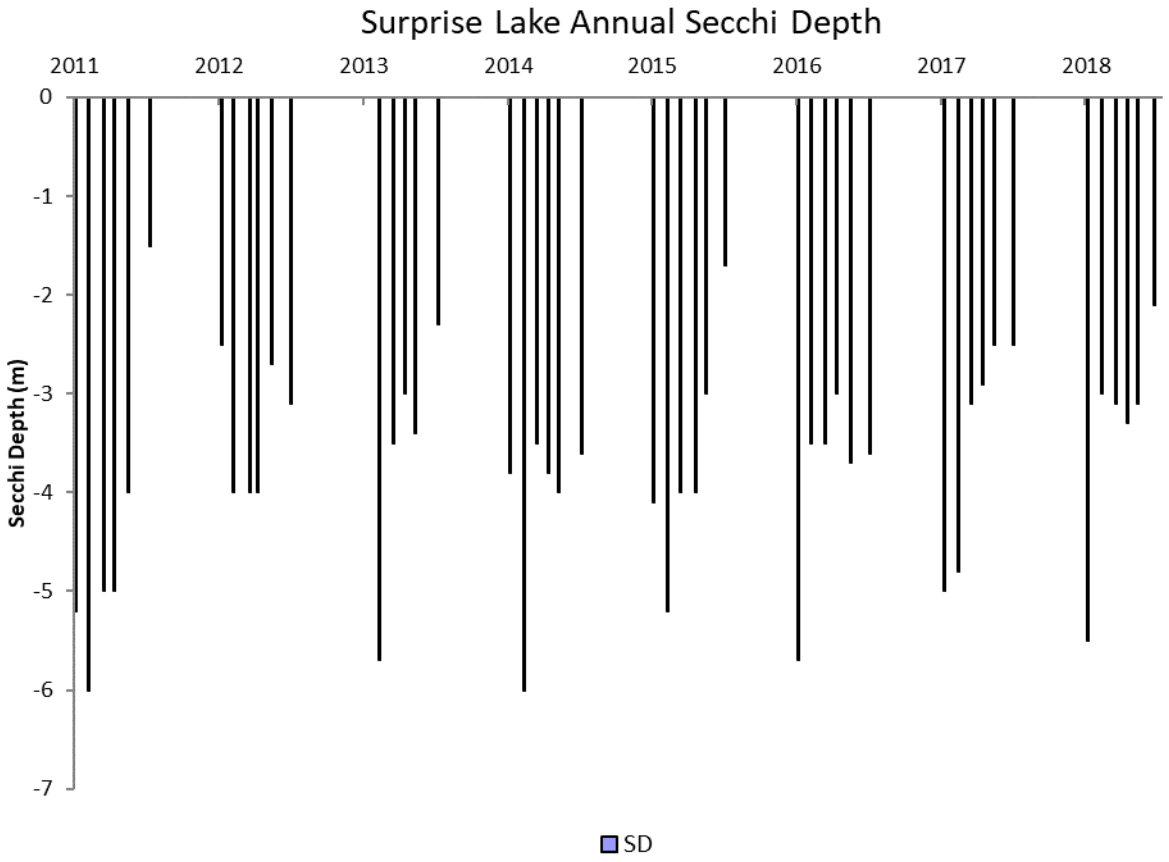


Figure 2.

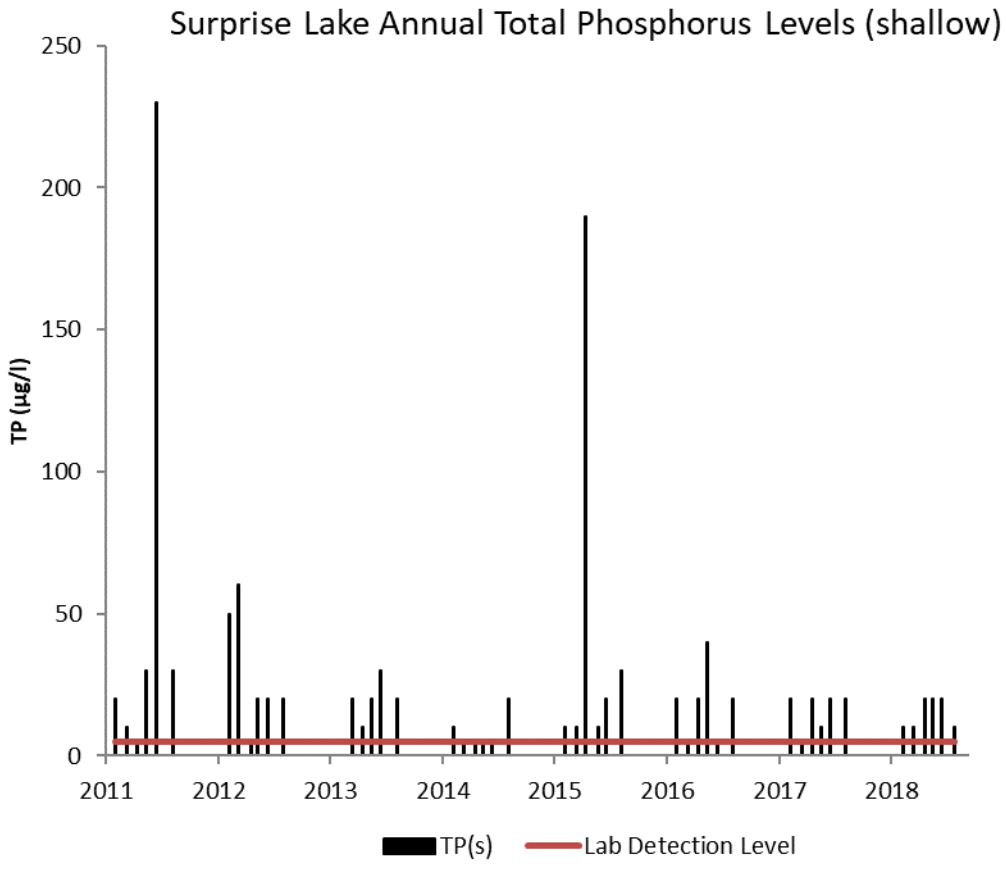
Nutrients

Nutrients are chemicals necessary for growth of fish, algae and aquatic plants. Phosphorus and nitrogen are the main nutrients of concern in a lake system. In many lakes, phosphorus is the limiting nutrient in the system, which means it is only available to plants and algae in very limited quantities. Once the limited supply of phosphorus is exhausted, the algal population cannot expand further.

In lakes that are deep enough to stratify, typically in summer, total phosphorus concentrations in the hypolimnion increase and remain higher than in the epilimnion until the time of turnover, normally in the fall. This increase in phosphorus in the hypolimnion is caused in large part by the decomposition of phosphorus-rich organic matter at depth, a process that also consumes any oxygen present, and once oxygen is depleted or very low, phosphorus is released from the bottom sediments. When vertical mixing eventually occurs in the lake, usually in the fall, the high phosphorus load in the hypolimnion is brought to the epilimnion. With this influx of phosphorus, algal populations in that layer can increase to the point of producing an algal bloom.

Total phosphorus concentrations for Surprise Lake in 2018 ranged from 10 µg/l to 20 µg/l in the shallow samples, and from below detection levels to 70 µg/l in the deep samples. In general, nutrient conditions for shallow samples were like those observed in previous years. The deep samples had lower levels of total phosphorus early in the season and levels increased over the summer months.

The graphs in Figure 3 show both shallow and deep total phosphorus levels for all years sampled.



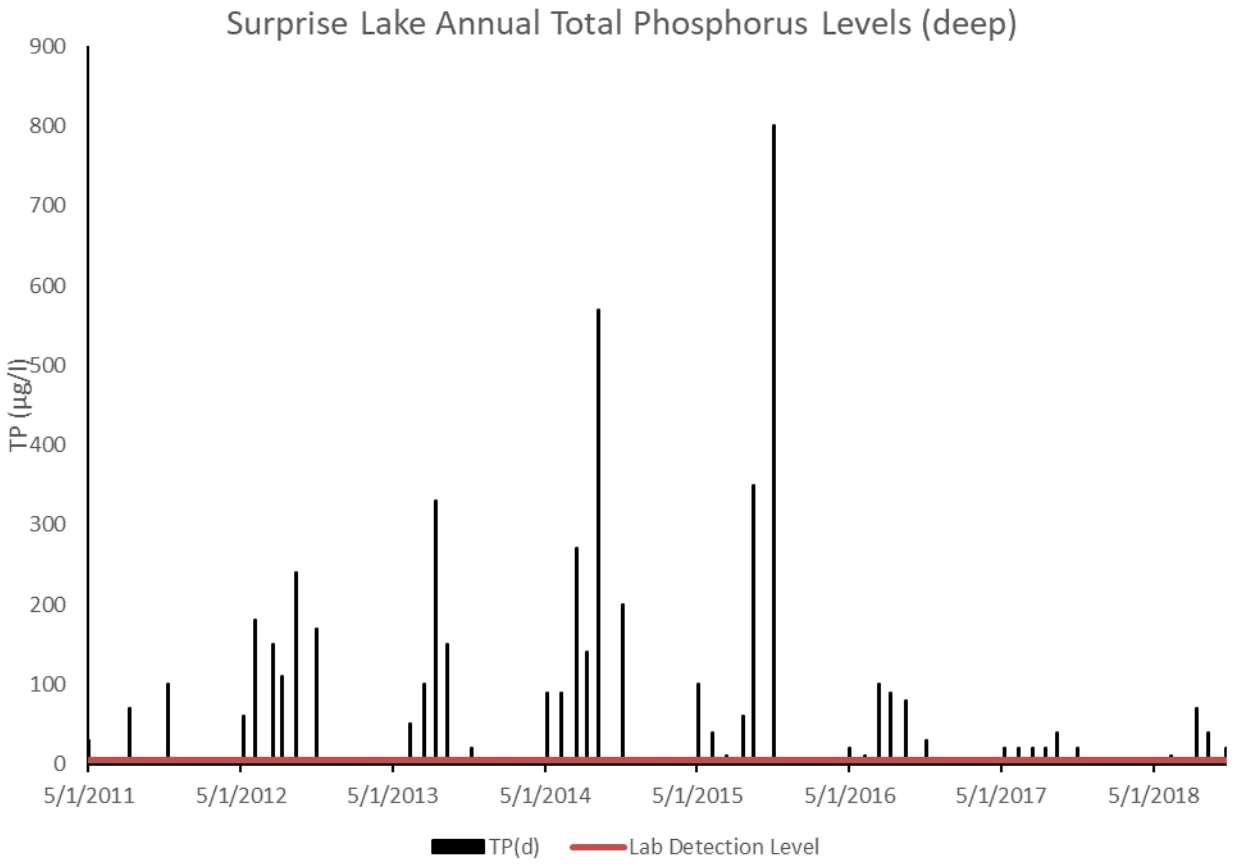


Figure 3.

Chlorophyll *a*

Chlorophyll *a* is one of the green pigments found in nearly all algae. The concentration of chlorophyll *a* is commonly used to estimate the amount of algae and to assess the productivity (trophic state) of the lake. Test results must be interpreted carefully, however, because chlorophyll *a* levels can be variable in time and space. In addition, various species of algae contain differing amounts of chlorophyll per cell. The amount of chlorophyll can also vary with the health and age of the algal population, as well as with weather conditions. Additionally, algae typically concentrate at different levels in the water column in response to preferred light and temperature conditions, thereby escaping collection.

Chlorophyll *a* levels at the one-meter depth in 2018 ranged from below detection level to 74 mg/m^3 with the highest levels occurring in June. Levels for all years are shown below in Figure 4.

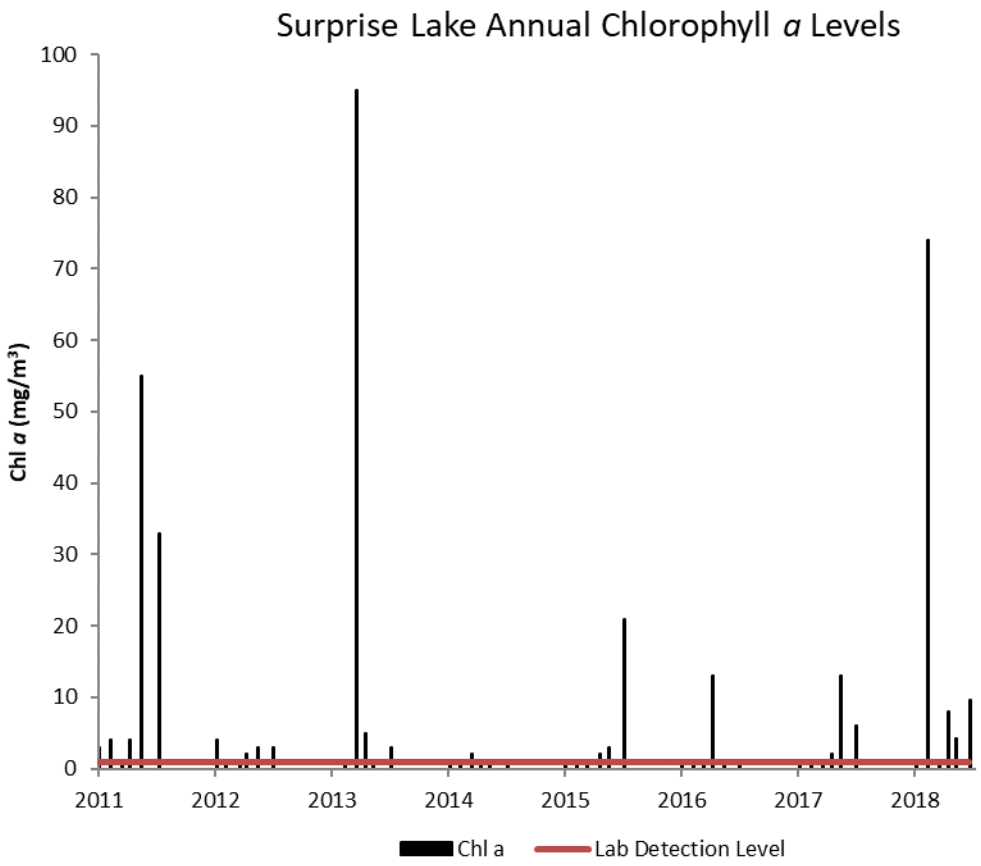


Figure 4.

Trophic State Index

The Trophic State Index (TSI) is a rating system that describes biological productivity - the capacity of a lake to produce and support aquatic life including algae, plants, and animals. The index is a scale that ranges from 1 to 100 with low TSI values indicating low biological productivity and high TSI values indicating high biological productivity. Lakes have traditionally been classified into four different groups, based on their level of productivity. The groups from the lowest to highest productivity level are oligotrophic, mesotrophic, eutrophic, and hypereutrophic. Generally, lakes with TSI values between 0 and 40 are oligotrophic, those between 40 and 60 are mesotrophic, and those between 60 and 100 are eutrophic. Hypereutrophic lakes are those whose TSI values are greater than 70. In addition, Table 3 presents comparisons of TSI values to corresponding water quality parameters.

Once the TSI value has been calculated for a lake, the result can be compared to other lakes or the value can be recalculated each year to determine whether there is an upward or downward trend for the lake.

For purposes of this report, TSI values were calculated using average summer values (mid-June through mid- September) of chlorophyll *a*, shallow total phosphorus, and secchi depth. It is important to remember that one dramatically different result in a small number of samples can significantly impact the TSI value. The TSI average values for the all years are shown below in Figure 5 and Table 2. This year's results indicate that Surprise Lake is a mesotrophic lake. A mesotrophic lake produces and supports moderate populations of living organisms (plants & animals). Mesotrophic lakes generally have moderate nutrient concentrations, moderate algae and aquatic plant growth, and water clear enough for swimming.

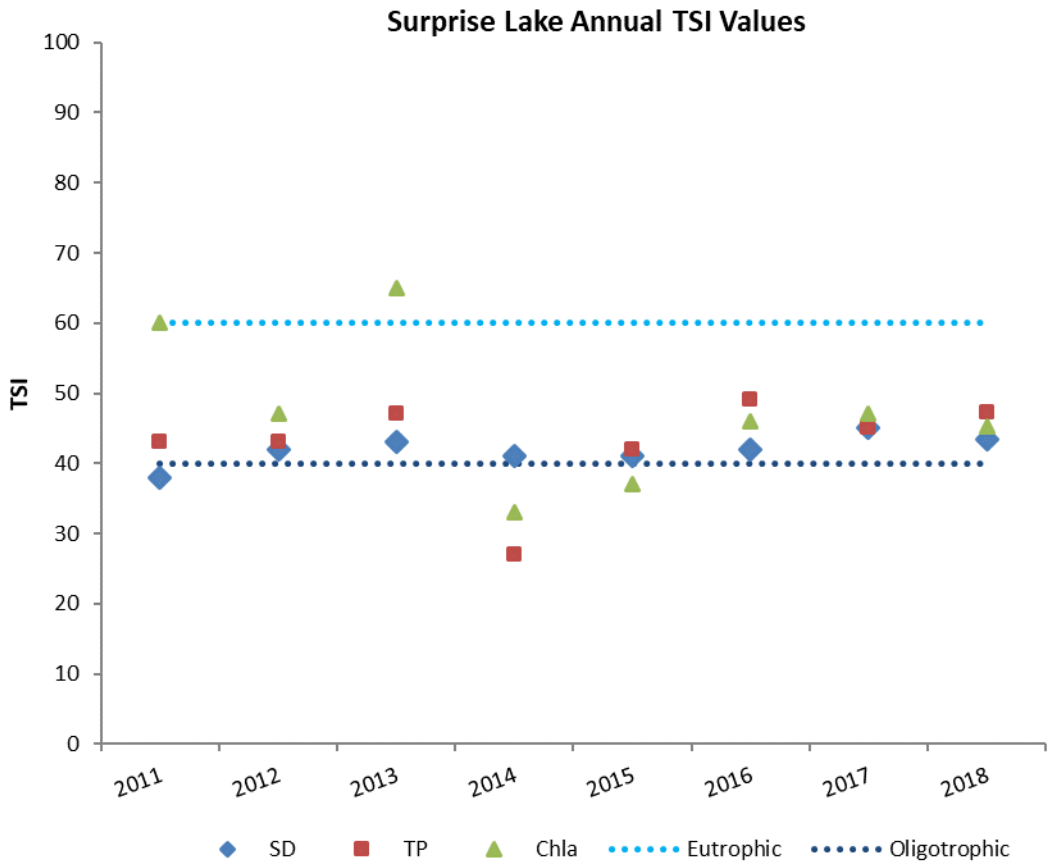


Figure 5.

Table 2. Surprise Lake			
	TSI (SD)	TSI (TP)	TSI (Chl-a)
2011	38	43	60
2012	42	43	47
2013	43	47	65
2014	41	27	33
2015	41	42	37
2016	42	49	46
2017	45	45	47
2018	43	47	45

Table 3. Comparison of Trophic State Index to Water Quality Parameters and Lake Productivity				
Trophic State	TSI	Secchi Disk (m)	Total Phosphorus (µg/l)	Chlorophyll *a* (µg/l)
Oligotrophic	0	64	0.75	0.04
	10	32	1.5	0.12
	20	16	3	0.34
	30	8	6	0.94
Mesotrophic	40	4	12	2.60
	50	2	24	6.40
Eutrophic	60	1	48	20
	70	0.5	96	56
	80	0.25	192	154
	90	0.12	38	427
	100	0.062	768	1,183
(NOTE: The original source of this table and the equations is Carlson, R.E., 1977. A Trophic State Index for Lakes. Limnology and Oceanography, 22:361-369.)				

Summary

Data collected on Surprise Lake in 2018 by volunteers are summarized as follows:

- Thermal stratification in Surprise Lake was well underway at the first sampling date in early May, and turnover was complete by the last sampling date in late October.
- Transparency, as measured by secchi disc, averaged 3.4 meters.
- Concentrations of total phosphorus in shallow samples were like those observed in previous years; concentrations of chlorophyll *a* were high in June, but were otherwise like previous years, but concentrations of total phosphorus in deep samples were low early in the season and increased until the time of turnover.
- TSI calculations for 2018 classify Surprise Lake as a mesotrophic lake.

Recommendations

Lakes are a reflection of their watershed. They receive water, dissolved substances carried in water, and sediment from its watershed. Lakes also receive particulates and gases from the atmosphere; and energy from the sun and wind. The condition of a lake at any one time is determined by what is already in the lake, and by what is coming into the lake – attesting to the fact that lakes are complex ecosystems.

Lake management is a complicated job that takes the combined efforts of local government, community groups, individuals, and landowners. To be effective lake management is a long-term commitment and investment.

Many lakes suffer from too many nutrients (phosphorus and nitrogen), entering a lake with stormwater or soil erosion from the surrounding watershed. When it rains nutrients wash into ditches and down storm drains eventually ending up in the lake. This can lead to problems such as excessive aquatic plant growth, nuisance and/or toxic algae blooms, lower water clarity, stressed fish and wildlife, and lower property values.

Here are some voluntary actions that can be taken to protect the health of the lake:

- Avoid fertilizer. If you do fertilize choose phosphorus-free products.

- Scoop pet waste, bag it and toss it in the trash.
- Divert runoff from roofs and driveways into stable vegetated areas.
- If you have a septic system, schedule routine inspections.
- Cover bare soil area with mulch or plants.
- Fix eroding areas in the yard, driveway, and parking areas.
- Don’t dump aquarium contents into the lake.
- Maintain existing natural shorelines – these areas provide additional wildlife benefits for birds, turtles, frogs and other aquatic life.
- Re-establish shoreline vegetation by replacing some lawn with other plants such as shrubs, trees, and perennials. The deeper roots of native trees and shrubs can trap and filter more phosphorus.
- Check boats and trailers for weeds and other invasive species.
- Be active in your lake homeowners’ association.

Table 1. Surprise Lake Summer 2018 Data

Date	Site Depth (m)	Secchi Depth (m)	Air Temp (°C)	Water Temp (°C) Top	Dissolved Oxygen (mg/l) Top	Water Temp (°C) Bottom	Dissolved Oxygen (mg/l) Bottom	Water Color	Suspended Algae	Chlorophyll *a* (mg/m^3)	Total Phosphorus (µg/l) shallow	Total Phosphorus (µg/l) deep	Comments
5/6/2018	6.5	5.5	27	18.6	9.1	9.2	1	6	light	<2*	10	<10*	Wind - NW, calm to breezy; partly cloudy; ripples, hazy sunlight. No odor; 2 fishing, 2 swimmers/waders
6/10/2018	6.2	3	22	19	8.2	13.6	3.7	6	none	74	10	10	Wind cond: breezy, SW; Water surface: small waves: partly cloudy, bright cloud conditions. No odor, 50 geese & ducks; 3 boats, 4 fishing, 8 swimmers/waders
7/15/2018	7	3.1	33	25.1	7.6	10.7	0.9	6	none	<2*	20		Wind cond: light, NW. Partly cloudy. Water surface cond: ripples. Strong sunlight. No water odor. 100 geese/ducks. 1 boat, 3 people fishing, 30 swimmers/waders. No deep TP sample; deep Chlorophyll a sample = 3 mg/m^3
8/12/2018	7.9	3.3	23	24	7.8	9.4	0.4	6	none	8	20	70	Wind cond: light, SW; partly cloudy; ripples to small waves; hazy sunlight; no water odor. 50-60 geese & ducks. 1 boat, 2 people fishing, 20 swimmers/waders.
9/9/2018	7	3.1	25	20.4	4.4	12.4	0.4	6	none	4.3	20	40	Breezy, SW winds. Partly cloudy, small waves, hazy sunlight. No odor, 50 geese/ducks, 2 boats, 2 people fishing, 3 swimmers/waders. No replicates collected.
10/21/2018	7.7	2.1	12.5	12.9	4.1	12.5	3.6	6.5	light	9.6	10	20	Calm; overcast (fog), calm water surface. Fishy odor; 250+ geese, 50 ducks. No boats, fishing, or swimmers. Replicates collected: B samples - TP=20µg/l; Chla = 17.6 mg/m^3