October 2024

TOWNLINE LAKE

WATER QUALITY SUMMARY

PREPARED FOR:
TOWNLINE LAKE IMPROVEMENT BOARD
MONTCALM COUNTY, MI

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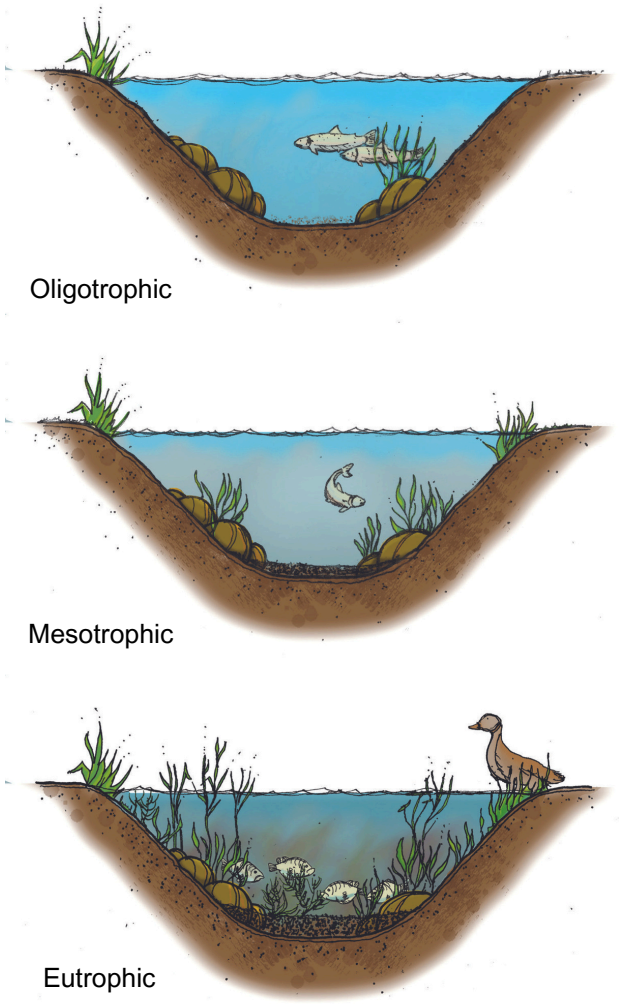
LAKE WATER QUALITY

Lake water quality is determined by a unique combination of processes that occur both within and outside of the lake. In order to make sound management decisions, it is necessary to have an understanding of the current physical, chemical, and biological condition of the lake, and the potential impact of drainage from the surrounding watershed.

Lakes are commonly classified as oligotrophic, mesotrophic, or eutrophic. Oligotrophic lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in the cool, deep bottom waters during late summer to support cold-water fish such as trout and whitefish. By contrast, eutrophic lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warmwater fish such as bass and pike. Lakes that fall between these two extremes are called mesotrophic lakes.

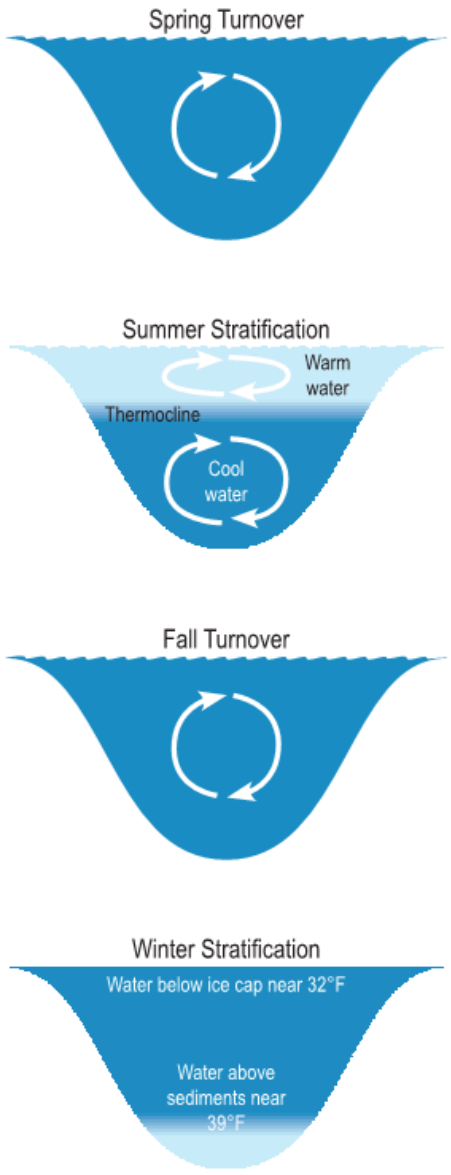
Under natural conditions, most lakes will ultimately evolve to a eutrophic state as they gradually fill with sediment and organic matter transported to the lake from the surrounding watershed. As the lake becomes shallower, the process accelerates. When aquatic plants become abundant, the lake slowly begins to fill in as sediment and decaying plant matter accumulate on the lake bottom. Eventually, terrestrial plants become established and the lake is transformed to a marshland. The aging process in lakes is called "eutrophication" and may take anywhere from a few hundred to several thousand years, generally depending on the size of the lake and its watershed. The natural lake aging process can be greatly accelerated if excessive amounts of sediment and nutrients (which stimulate aquatic plant growth) enter the lake from the surrounding watershed. Because these added inputs are usually associated with human activity, this accelerated lake aging process is often referred to as "cultural eutrophication." The problem of cultural eutrophication can be managed by identifying sources of sediment and nutrient loading (i.e., inputs) to the lake and developing strategies to halt or slow the inputs.



Lake classification.

TEMPERATURE

Temperature is important in determining the type of organisms which may live in a lake. For example, trout prefer temperatures below 68°F. Temperature also determines how water mixes in a lake. As the ice cover breaks up on a lake in the spring, the water temperature becomes uniform from the surface to the bottom. This period is referred to as "spring turnover" because water mixes throughout the entire water column. As the surface waters warm, they are underlain by a colder, more dense strata of water. This process is called thermal stratification. Once thermal stratification occurs, there is little mixing of the warm surface waters with the cooler bottom waters. The transition layer that separates these layers is referred to as the "thermocline." The thermocline is characterized as the zone where temperature drops rapidly with depth. As fall approaches, the warm surface waters begin to cool and become more dense. Eventually, the surface temperature drops to a point that allows the lake to undergo complete mixing. This period is referred to as "fall turnover." As the season progresses and ice begins to form on the lake, the lake may stratify again. However, during winter stratification, the surface waters (at or near 32°F) are underlain by slightly warmer water (about 39°F). This is sometimes referred to as "inverse stratification" and occurs because water is most dense at a temperature of about 39°F. As the lake ice melts in the spring, these stratification cycles are repeated.



Seasonal thermal stratification cycles.

DISSOLVED OXYGEN

An important factor influencing lake water quality is the quantity of dissolved oxygen in the water column. The major inputs of dissolved oxygen to lakes are the atmosphere and photosynthetic activity by aquatic plants. An oxygen level of about 5 mg/L (milligrams per liter, or parts per million) is required to support warmwater fish. In lakes deep enough to exhibit thermal stratification, oxygen levels are often reduced or depleted below the thermocline once the lake has stratified. This is because the oxygen has been consumed, in large part, by bacteria that use oxygen as they decompose organic matter (plant and animal remains) at the bottom of the lake. Bottom-water oxygen depletion is a common occurrence in eutrophic and some mesotrophic lakes. Thus, eutrophic and most mesotrophic lakes cannot support coldwater fish because the cool, deep water (that the fish require to live) does not contain sufficient oxygen.

TROPHIC STATE INDICATORS

Key parameters used to evaluate a lake's productivity or trophic state include total phosphorus, chlorophyll-*a*, and Secchi transparency.

Phosphorus is the nutrient that most often stimulates excessive growth of aquatic plants and causes premature lake aging. By measuring phosphorus levels, it is possible to gauge the overall health of a lake.

Chlorophyll-*a* is a pigment that imparts the green color to plants and algae. A rough estimate of the quantity of algae present in the water column can be made by measuring the amount of chlorophyll-*a* in the water column.

A Secchi disk is a round, black and white, 8-inch disk that is used to estimate water clarity. Generally, it has been found that plants can grow to a depth of about twice the Secchi disk transparency.

Generally, as phosphorus inputs to a lake increase, algae growth and chlorophyll-*a* increase and Secchi transparency decreases.

Secchi disk.

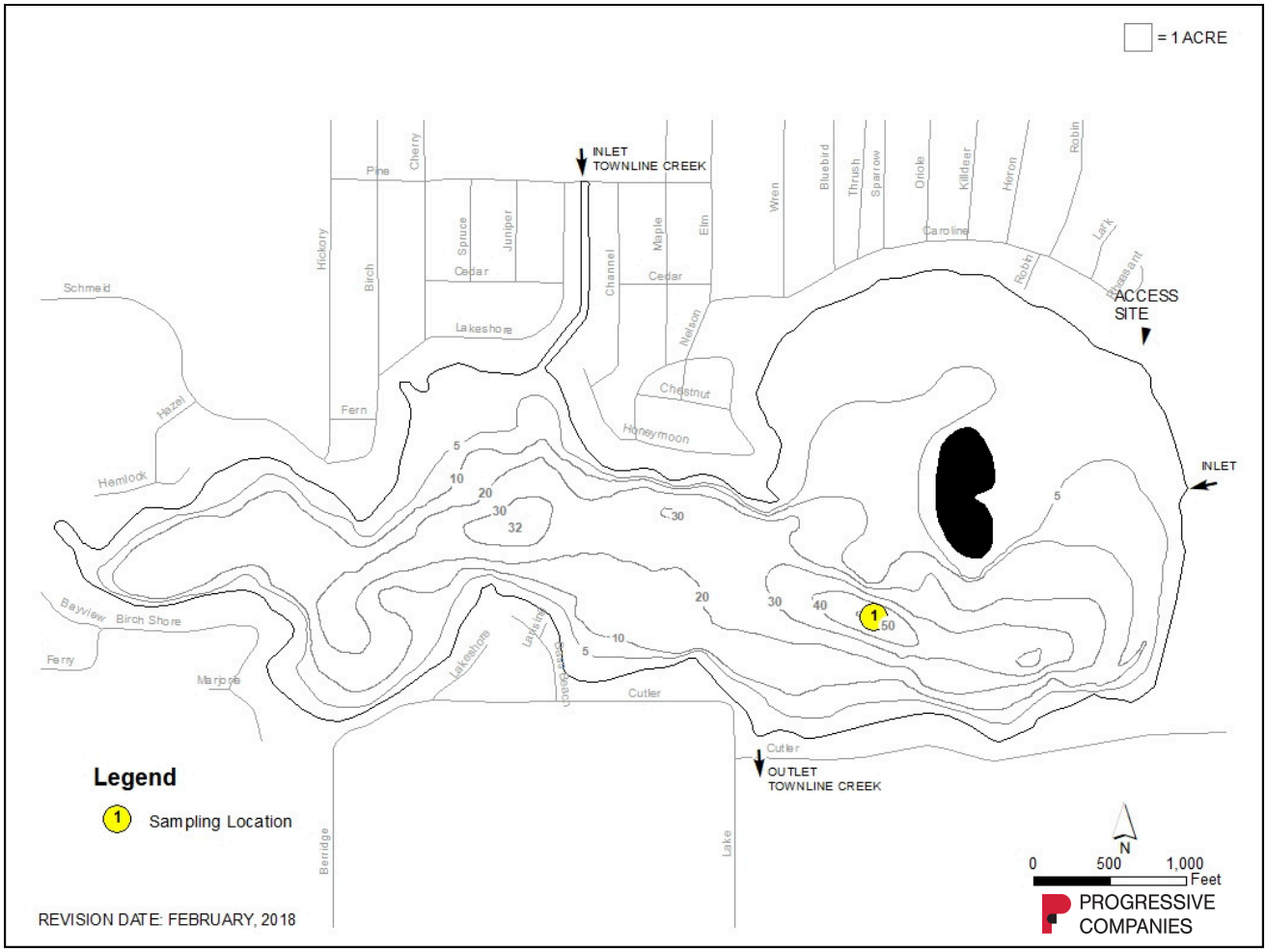
TABLE 1 - LAKE CLASSIFICATION CRITERIA

Lake Classification	Total Phosphorus (ug/L)*	Chlorophyll-*a* (ug/L)*	Secchi Transparency (feet)
Oligotrophic Mesotrophic Eutrophic	Less than 10 10 to 20 Greater than 20	Less than 2.2 2.2 to 6.0 Greater than 6.0	Greater than 15.0 7.5 to 15.0 Less than 7.5

* ug/L = micrograms per liter

SAMPLING RESULTS AND DISCUSSION

Sampling results are provided in Tables 2 and 3. In March of 2024, sampling was conducted during spring turnover when water temperatures were cool and dissolved oxygen concentrations were high. During the August sampling period, Townline Lake was thermally stratified; the lake was warm and well-oxygenated at the surface, and was cool with low oxygen near the bottom. In 2024, total phosphorus concentrations were below the detectable limit in the spring time. Summer phosphorus levels were high near the lake bottom. The elevated bottom-water phosphorus is due to internal release of phosphorus from the lake sediments amid anoxic conditions.



Townline Lake Sampling Location Map.

TABLE 2 - TOWNLINE LAKE 2024 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (F)	Dissolved Oxygen (mg/L)*	Total Phosphorus (ug/L)*
25-Mar-24	1	1	40.1	11.8	<10
25-Mar-24	1	10	40.1	11.8	<10
25-Mar-24	1	20	40.1	11.8	<10
25-Mar-24	1	30	40.1	11.8	<10
25-Mar-24	1	40	40.1	11.7	<10
25-Mar-24	1	50	40.1	11.7	<10
14-Aug-24	1	1	77.5	8.6	14
14-Aug-24	1	10	74.2	7.1	17
14-Aug-24	1	20	70.7	0.2	20
14-Aug-24	1	30	57.1	0.0	119
14-Aug-24	1	40	54.8	0.0	257
14-Aug-24	1	46	54.0	0.0	278

TABLE 3 - TOWNLINE LAKE 2024 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll-*a* (ug/L)*
25-Mar-24	1	15	ND*
14-Aug-24	1	7	5

* mg/L = milligrams per liter = parts per million
* ug/L = micrograms per liter = parts per billion
* ND = none detected

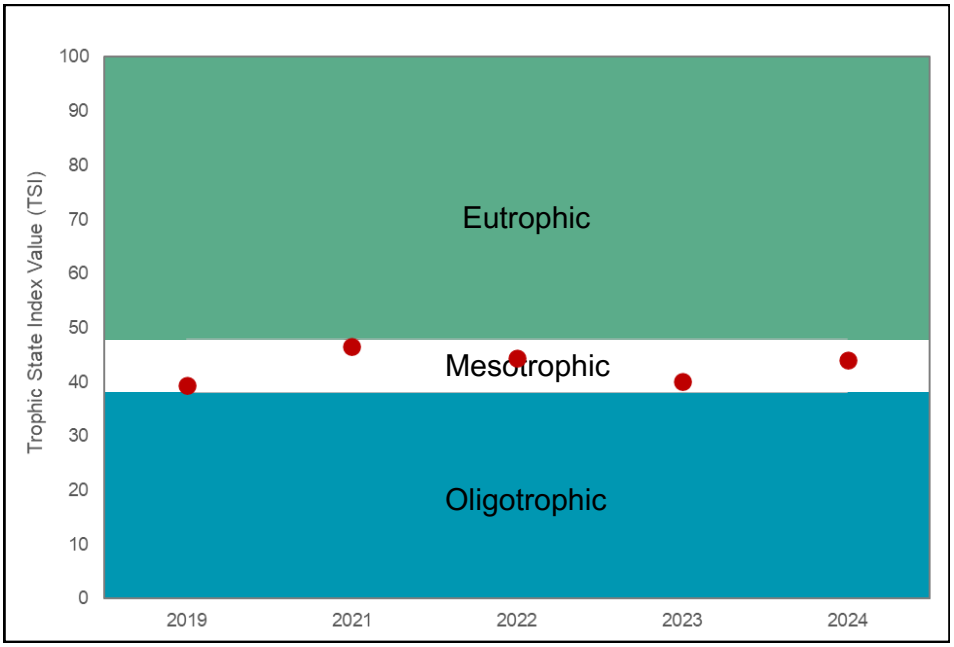
TOWNLINE LAKE TROPHIC STATE

Carlson's Trophic State Index (TSI) was developed from mathematical relationships that allowed phosphorus, chlorophyll-*a*, and Secchi transparency readings to be converted to a numerical scale from 0 to 100, with increasing numbers indicating more productive lakes. Table 4 shows how the TSI can be used to rate the trophic state of Michigan lakes.

TABLE 4 - TSI INDEX FOR MICHIGAN

Trophic State	TSI Value
Oligotrophic	Less than 38
Mesotrophic	38 to 48
Eutrophic	Greater than 48

The average TSI values for Townline Lake based on spring phosphorus and summer chlorophyll-*a* and Secchi transparency data collected between 2019 and 2024 are shown in the graph below.



Based on water quality data collected from 2019 to 2024, Townline Lake is mesotrophic. Average spring phosphorus concentrations in Townline Lake are usually within the mesotrophic range, but met the criteria for an oligotrophic system in 2024. Summer chlorophyll-*a* values, while typically low, were approaching the eutrophic threshold in August. Water clarity was moderate at the time of sampling and consistent with previous summer values.

Spring sampling was not conducted in 2020 due to pandemic restrictions, therefore, TSI could not be calculated.