

An Explanation of Some Terms and Concepts Used in the RMBEL Lake Monitoring Reports

by Doug Pribyl, August 2018

Lake water samples we routinely send to RMB Environmental Labs (RMBEL) in Detroit Lakes are analyzed for three attributes or parameters: total phosphorus, chlorophyll-a, and Secchi depth.

Total phosphorus is a measure of the concentration of phosphorus in all forms. Some phosphorus is in an inorganic form called orthophosphate or soluble reactive phosphorus. This is the form that can be used directly by plants. Other phosphorus is incorporated in organic materials such as algae that is not available to other plants unless it is released through decomposition by bacteria or other grazing organisms. In the lab, organic phosphorus is digested or chemically decomposed and converted to inorganic phosphorus. Total phosphorus then is the total of inorganic and organic phosphorus. The concentration of total phosphorus is given in micrograms per liter, abbreviated $\mu\text{g/L}$, and sometimes reported as parts per billion (ppb). A microgram is a millionth of a gram.

Chlorophyll-a is the light-sensitive pigment used by plants, algae, and some bacteria to produce their own food using photosynthesis. Chlorophyll-a is a particular type of chlorophyll that is present in all photosynthesizing organisms; other types of chlorophyll are not. Since chlorophyll-a is present in all green plants and algae, it provides a reasonably good measure of the amount of living and growing organic material (biomass) present in the lake. As with total phosphorus, the concentration of chlorophyll-a is given in micrograms per liter.

Secchi depth is a simple measure of the transparency or clarity of the water. A round white disc 8-inches in diameter is lowered into the water and the depth at which the disc is no longer visible is recorded as the Secchi depth. It is often reported in meters but RMBEL conveniently reports it in feet.

Trophic state is an indication of how productive a lake is in terms of the amount of living plant material (biomass) it contains. Lakes can be categorized into one of four trophic states: oligotrophic, mesotrophic, eutrophic, or hypereutrophic, based on increasing productivity. Measurements of total phosphorus, chlorophyll (actually chlorophyll-a), and Secchi depth are used to assess the nutrient status or trophic state of a lake.

The **Trophic State Index (TSI)** is used to quantitatively establish the trophic state of a lake. The TSI is found by measuring total phosphorus, chlorophyll-a, and Secchi depth, and then mathematically converting each of the measurements to a unitless number, the TSI. A TSI of less than 30 designates clear lakes having little productivity and very low nutrients (oligotrophic). A TSI of 70 and greater designates green lakes with very high productivity and very high nutrient content (hypereutrophic). A TSI of 50 is a useful dividing line between a lake with moderate productivity (mesotrophic) and a lake with high productivity (eutrophic). The table below provides information that allows comparisons of Swan Lake with state-wide water quality standards and with other lakes in the Northern Lakes and Forest Ecoregion.

Measurement	Lake Standard	Ecoregion TSI range
Total phosphorus ($\mu\text{g/L}$)	<30	49–61
Chlorophyll ($\mu\text{g/L}$)	<9	46–61
Secchi depth (ft)	>6.5	—
TSI <30 is oligotrophic; TSI between 30 and 50 is mesotrophic; TSI >50 is eutrophic.		

Note that Secchi depth measurements are transformed in such a way that a greater Secchi depth corresponds to a lower Secchi TSI.

Despite averaging of the three TSIs by both the Minnesota Pollution Control Agency and RMBEL, averaging is not recommended. Chlorophyll, a relatively good estimator of biological productivity, should be the primary index used for trophic state classification.