Water Quality Assessment of Long Lake

Waushara County, Wisconsin

By Richard Stephens, WEAL, 6-22-06

This assessment of Long Lake water quality is based on spring and fall overturn data collected from a 1993 to 1994 study and from the Water and Environmental Analysis Laboratory (WEAL) spring and fall lake overturn program from fall 2003 to spring 2006. Lake overturn data was selected for the following reason. As lakes warm in summer and cool in late fall, temperature based water density gradients occur that cause lakes to stratify. This stratification process can reach a point where the lower portion of stratified water, referred to as the hypolimnion, is cut off from the upper layer of water, the epilimnion. Since the hypolimnion cannot be aerated from surface contact, chemical and biological processes that occur mainly in the sediment, deplete dissolved oxygen and release nitrogen, phosphorus and other chemicals to the water. As lake water warms in spring and cools in fall, stratification breaks down allowing the entire volume of lake water to mix. Since the water is well mixed, a representative sample can be obtained from the surface that includes nutrients from sediment release. This lake overturn water tends to have the highest concentration of dissolved and suspended nutrients and consequently is the best indication of potential algae growth and lake water quality. It should also be noted that this process of anaerobic sediment release, referred to as 'internal loading' continuously recycles phosphorus and nitrogen that has settled to the bottom back into the lake water. Thus, any nutrient addition to the lake, especially phosphorus, can have a very long term or permanent negative effect on water quality and the lake aging process, referred to as eutrophication.

Long Lake is a natural seepage lake characterized by two deep basins connected by a narrow but deep channel. In most areas of the lake the steep basin slope creates a relatively narrow littoral zone (shallow water area where light can penetrate to the bottom and support rooted aquatic plants) limiting the area of rooted plant beds and minimizing the area of wave action and potential resuspension of sediment. Dissolved oxygen and temperature profiles form 1993 and 1994 show a large well defined hypolimnion during summer stratification indicating a strong potential for internal loading. The lake has a small surface watershed consisting of steep slopes and highly permeable soils. Land around the lake is highly developed with many dwellings in close proximity to shore areas. The potential for nutrient enrichment from both surface runoff and shallow groundwater is high.

Comparison of recent data to the 1993-94 study shows that water chemistry has changed little in the last 13 years. Long lake has very slight turbidity and color, exhibiting clear water and good light penetration. The water is hard with high buffering capacity and is not sensitive to the effects of acid rain. The saturation index of water sampled during overturn shows that on average the lake is near neutral, not having a tendency toward either marl deposition of dissolution. During the summer growing season an increase in pH brought about by photosynthetic activity may tip the saturation index toward marl deposition. Marl formation would be beneficial, it tends to trap and bind phosphorus thus removing some of this nutrient from the water as the marl particle settles to the lake

bottom. Dissolved levels of sodium, potassium, chloride, and sulfate are at normal background levels for this area and do not indicate that the lake is being impacted in a major way by human activity.

Nitrogen and phosphorus are the two major nutrients that accelerate the eutrophication process and cause esthetic problems from algae blooms and increased aquatic plant growth. Concentrations of inorganic nitrogen, consisting of dissolved ammonium, nitrite and nitrate, at or above 0.30 mg/L (parts per million) can support algae blooms at nuisance levels. The average concentration of inorganic nitrogen in the two basins is 0.13 mg/L N and ranges from 0.05 to 0.29 mg/L N. There is not enough inorganic nitrogen in the lake water at this time to support an algae bloom. Organic nitrogen concentrations average about 0.40 mg/L N and probably represent contributions from floating plant debris, bacteria, algae and zooplankton. This is in a range representative of good water quality and seems to have no adverse effects on water clarity. Concentrations of soluble reactive phosphorus (SRP) above 0.010 mg/L P can support excessive algae growth in lakes. The average concentration of SRP in the two basins is 0.006 mg/L P and ranges from 0.002 to 0.012 mg/L P indicating that phosphorus is probably not a problem at present. Total phosphorus (TP) concentrations of 0.020 mg/L or more is also indicative of excessive phosphorus. TP levels in the lake average 0.013 mg/L P and range from 0.003 to 0.018 mg/L P. Once again these phosphorus levels indicate that not enough is present in the lake to be a problem at the present time. The Water Quality Index, based on TP, puts the lake at good to very good water quality. The graph of TP over time shows that phosphorus levels are in the Oligotrophic to Mesotrophic Trophic state also indicating good to very good water quality. Although both nitrogen and phosphorus may be limiting algae growth, the Nitrogen/Phosphorus (N/P) ratio is well over 15 indicating that phosphorus is the nutrient most limiting to algae.

The water quality in Long Lake has changed little since the 1993-94 study; there are no obvious trends in water quality indicating improvement or degradation. The Water Quality Index and Trophic State Index both show the lake to be in the good to very good water quality range. The lake has steep basin profiles limiting the habitat for rooted aquatic plants to the shallow bays on the east and west ends and a narrow littoral zone along north and south shores. These factors contribute to the better than average water quality and esthetics the lake exhibits compared to other central Wisconsin lakes. This lake environment is however, very fragile and subject to irreversible damage. The relatively high density of development around the lake combined with steep slopes make the lake susceptible to erosion and nutrient contamination from surface runoff. Highly permeable soils allow for nutrient and other contaminant movement through shallow groundwater inflow. Runoff from snow melt or intense rain storms can move soil, plant material, and dissolve nutrients down the steep slopes into lake. It is imperative that the slopes to the lake be maintained with good vegetative cover and a buffer strip (of preferably native vegetation) be left near the shore. Pet waste should be cleaned up before it can be washed into the lake. Feeding of ducks and geese should be minimized to limit nutrient input. No lawn fertilizer should be used in areas that drain toward the lake or may contribute to the lake through groundwater flow. People should also realize that even well designed and properly functioning septic systems discharge leachate to the

soil under the drain fields. This leachate contains nitrate, chlorides and other wastes that move rapidly with groundwater. If the groundwater flow is toward the lake, this leachate will eventually reach the lake and contribute to eutrophication. In addition, nutrients such as phosphorus and ammonium adsorb to soil particles and at first do not move with the groundwater. However, as the soil becomes saturated with phosphorus and ammonium, they will begin to move with groundwater by saturated flow (as the soil particle absorption sites become full the nutrients move down stream to the next soil particle). If the direction of groundwater flow is toward the lake, this phosphorus and ammonium nitrogen can eventually enter the lake through the groundwater route.

I recommend that the Long Lake Association continue with spring overturn monitoring at least every other year or so using the lake package B that tracks only nutrient concentrations. This should be adequate to detect long term trends in water quality.