Paradise Lake
2006 Report

Tip of the Mitt Watershed Council

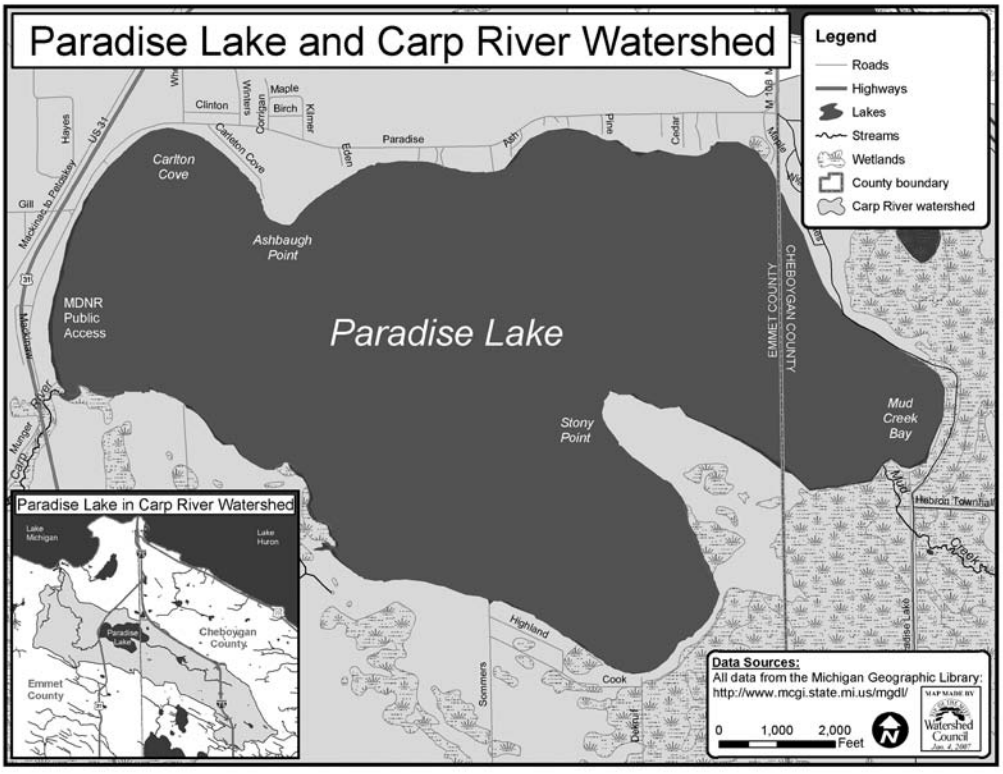
From eagles and loons nesting above its waters to aquatic weevils munching on milfoil below, Paradise Lake brims with life. Its enchanting waters spread 1,900 acres across the northern tip of the Lower Peninsula, through both Emmet and Cheboygan Counties. From the inlet stream Mud Creek in the southeast corner clean waters circulate past the protected preserve on Stony Point, skirt the shoreline community of Carp Lake in the northeast and flow out the southwest corner to form the Carp River.

Tip of the Mitt Watershed Council has worked for decades to ensure that it remains a magnificent resource. The information and data contained in this report illustrate the hard work of our staff and volunteers to ensure the high water quality of Paradise Lake now and in the future.

You will find in this report data specific for Paradise Lake from two of our cornerstone water quality monitoring programs – Comprehensive Water Quality Monitoring and Volunteer Lake Monitoring. The Comprehensive Water Quality Monitoring program is run by Watershed Council staff who have monitored water quality of Northern Michigan's lakes and streams for the last 17 years. The Volunteer Lake Monitoring program was started in 1984 and relies on dozens of helpful volunteers who collect weekly data on water clarity and algae abundance. These two programs have provided valuable data on the overall health of our waters. Inside are details from recent surveys of Paradise Lake.

In addition to monitoring programs, Tip of the Mitt Watershed Council has a long history of partnering with Paradise Lake Association and others to protect the high quality waters of Paradise Lake. Inside we have highlighted some of these partnership efforts including shoreline surveys and aquatic plant management.

We hope you find this report both informative and helpful. If you have any questions, comments, or concerns, please contact the Tip of the Mitt Watershed Council at (231) 347-1181 or visit our website at www.watershedcouncil.org.



Comprehensive Water Quality Monitoring

Water Quality Trends: 17 years of data

The Comprehensive Water Quality Monitoring (CWQM) program began in 1987 on 10 lakes in the northern Lower Peninsula and has steadily expanded to the present 54 monitoring sites on 47 lakes and rivers. We now have over 1,300 records in our CWQM database, which are used by Watershed Council staff to characterize lakes and streams, identify specific water quality problems, and view trends or changes in water quality over time. Perhaps the greatest value of the CWQM program is that of an educational and informational tool to generate public interest and promote stewardship of aquatic resources.

By graphing the data collected over the last 17 years, Watershed Council staff have been able to discern a few trends. Total phosphorus concentrations appear to be decreasing on a number of the lakes. Are residents taking more care to prevent phosphorus inputs by reducing or eliminating fertilizers and properly maintaining septic systems? Or could this somehow be linked with the introduction of the invasive zebra mussel to lakes and rivers in our region? Zebra mussels began to appear in the Great Lakes region around 1988, which coincides with the beginning of our monitoring program. While phosphorus levels seem to be decreasing, chloride levels are definitely increasing. Almost all of the lakes monitored for 10+ years show increased chloride concentrations, with a particularly large increase between 2001 and 2004.

Parameters and Results

Every three years, the CWQM program waters are sampled and tested in the spring, as soon after "ice-out" as possible. Testing of physical parameters, including temperature, dissolved oxygen, pH, and conductivity, is done on-site with an electronic instrument called a Hydrolab™. Water samples are collected at the surface, mid-depth, and bottom of the water column with a specialized sample collection device called a Kemmerer bottle. The samples are then sent to a consulting laboratory for analysis of nitrates, total nitrogen, total phosphorus, and chlorides. The following section provides brief descriptions and general findings for parameters that we measure.

pH

pH values provide a measurement of the acidity or alkalinity of water. Measurements above 7 are alkaline, 7 is considered neutral, and levels below 7 are acidic. When pH is outside the range of 5.5 to 8.5, most aquatic organisms become stressed and populations of some species can become depressed or disappear entirely. State law requires that pH be maintained within a range of 6.5 to 9.0 in all waters of the state. Data collected on Paradise Lake has shown that pH levels consistently fall within this range, with a minimum of 7.4 and maximum of 8.4.

Kevin Cronk, our Monitoring and Research Coordinator, uses the Hydrolab to measure water quality.

Dissolved Oxygen

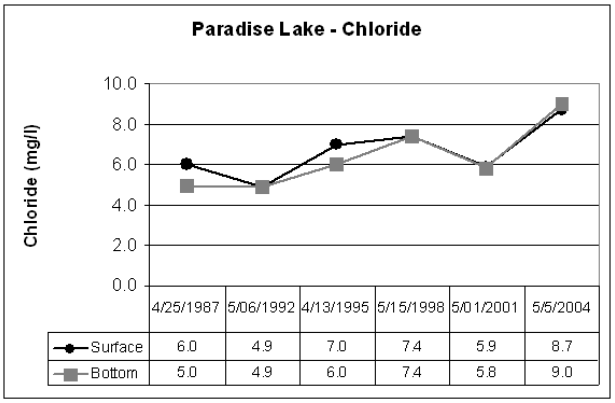
Oxygen is required by almost all organisms, including those that live in the water. Oxygen dissolves into the water from the atmosphere (especially when there is turbulence) and through photosynthesis of aquatic plants and algae. State law requires that a minimum of 5 to 7 parts per million (PPM) be maintained depending on the lake type. Dissolved oxygen levels recorded in Paradise Lake have ranged from 8.31 to 12.91 PPM.

Conductivity

Conductivity is a measure of the ability of water to conduct an electric current, which is dependent upon the concentration of charged particles (ions) dissolved in the water. Readings on lakes monitored by the Watershed Council have ranged from 176 to 656 microSiemens (mS), with an average of 284mS. Conductivity levels in Paradise Lake have increased steadily with the lowest reading of 176mS in 1992 to the highest of 225mS in 2001. A steady increase in conductivity levels generally occurs due to greater human activity in the watershed and may indicate that water pollution is occurring.

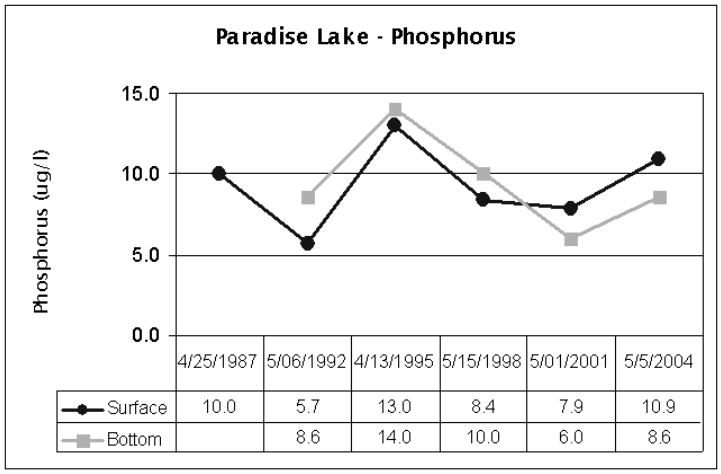
Chloride

Chloride, a component of salt, is present naturally at low levels in Michigan surface waters due to the marine origin of bedrock in Northern Michigan (typically < 5 PPM). Chloride is a "mobile ion," meaning it is not removed by chemical or biological processes in soil or water. Many products associated with human activities contain chloride (e.g., de-icing salts, water softener salts, and bleach). Although most fish are not affected until chloride concentrations exceed 1,000 PPM, increasing chloride concentrations are indicative of other pollutants associated with human activity (such as automotive fluids from roads or nutrients/bacteria from septic systems) reaching our waterways. Chloride levels have steadily increased in most lakes monitored by the Watershed Council, including Paradise Lake, where levels have increased from ~5 PPM (1987) to ~9 PPM (2004).



Total Phosphorus

Phosphorus is the most important nutrient for plant productivity in surface waters because it is usually in shortest supply relative to nitrogen and carbon. A water body is considered phosphorus limited if the ratio of nitrogen to phosphorus is greater than 15:1 and, in fact, all



lakes monitored by the Watershed Council were found to be phosphorus limited. Although water quality standards have not been set for lakes, the U.S. EPA recommends that total phosphorus concentrations in streams discharging into lakes not exceed 50 parts per billion (PPB). Phosphorus is normally found at concentrations less than 10 PPB in high quality surface waters. In Paradise Lake, phosphorus levels have ranged from 5.7 PPB (1992) to 14 PPB (1995).

Total Nitrogen

Nitrogen is another essential nutrient for plant growth. It is a very abundant element throughout the earth's surface and is a major component of all plant and animal matter. Although nutrients occur naturally, nutrient pollution is usually the result of human activities (from things such as fertilizer, faulty septic systems, and stormwater runoff). In general, the lowest nutrient levels were found in Lake Michigan and large deep inland lakes, while the highest nutrient levels were found in small shallow lakes. Nitrogen levels in Paradise Lake have ranged from 373 PPB (2004) to 1,010 PPB (1987).

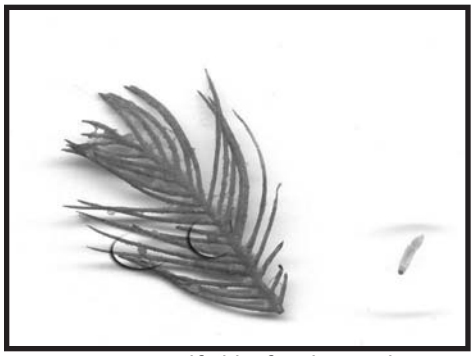
Comprehensive Water Quality Monitoring 2004 Data Summary

	Depth in Water Column	Dissolved Oxygen (mg/l=PPM)	Specific Conductivity (microSiemens/cm)	pH	Total Nitrogen (micro m/l=PPB)	Total Phosphorus (micro/l=PPB)	Chloride (mg/l=PPM)
Paradise Lake	Surface	11.03	206.0	8.14	484	10.9	8.7
	Middle	11.13	206.2	8.11	373	8.9	9.3
	Bottom	11:15	206.1	8.13	389	8.6	9.0

Partnering to Protect Paradise Lake

Weevils in Paradise

We all yearn for paradise, even tiny weevils. Several years ago, a throng of aquatic weevils were introduced to Paradise (Lake) and it appears they're content to stay. Eurasian watermilfoil (EWM), an invasive aquatic plant, was growing out of control, so a project was undertaken to stock weevils.



Eurasian watermilfoil leaf with weevil eggs and larva.

The weevil (Euhrychiopsis lecontei) is a small aquatic beetle that is native to many Michigan lakes and has been found to be an excellent bio-control agent. Although naturally feeding on native watermilfoils, the weevil has shown to have exotic tastes, preferring a Eurasian flavor. The weevil's dietary preference has been a boon for Paradise Lake residents, as the stocking quickly brought nuisance aquatic plant growth under control. Fortunately, the weevils seem to have taken to Paradise, as the lake ecosystem has been in balance ever since.

A decade has passed since the Watershed Council first encountered dense growths of EWM during an aquatic plant survey on Paradise Lake. During the summer of 1996, the Paradise Lake Association contracted the Watershed Council to comprehensively survey the aquatic plant communities of the lake. Aquatic plants were sampled at 134 sites throughout the lake and revealed that EWM was crowding out native species.

The Association was keenly aware of the negative impacts of EWM on recreation and the lake ecosystem, but also cognizant of the drawbacks of commonly-used methods (e.g., herbicides, harvesting) for controlling EWM.

After carefully considering available options, the Paradise Lake Association went out on a limb and decided to pursue biological control of the nuisance EWM growth. At that time, Ohio-based EnviroScience, Inc. had developed the MiddFoil® process to control EWM growth by stocking weevils, but it had not yet been tested in Michigan. Although out on a limb, the Association took the bull by the horns and contracted EnviroScience to stock weevils.

Thankfully, the weevil stocking project has met with great and enduring success. Approximately 14,000 weevils were stocked from 1998 to 2000 and all but decimated the dense EWM beds. Since that time, a balance has been maintained. An EWM resurgence reported one year usually disappears the next.

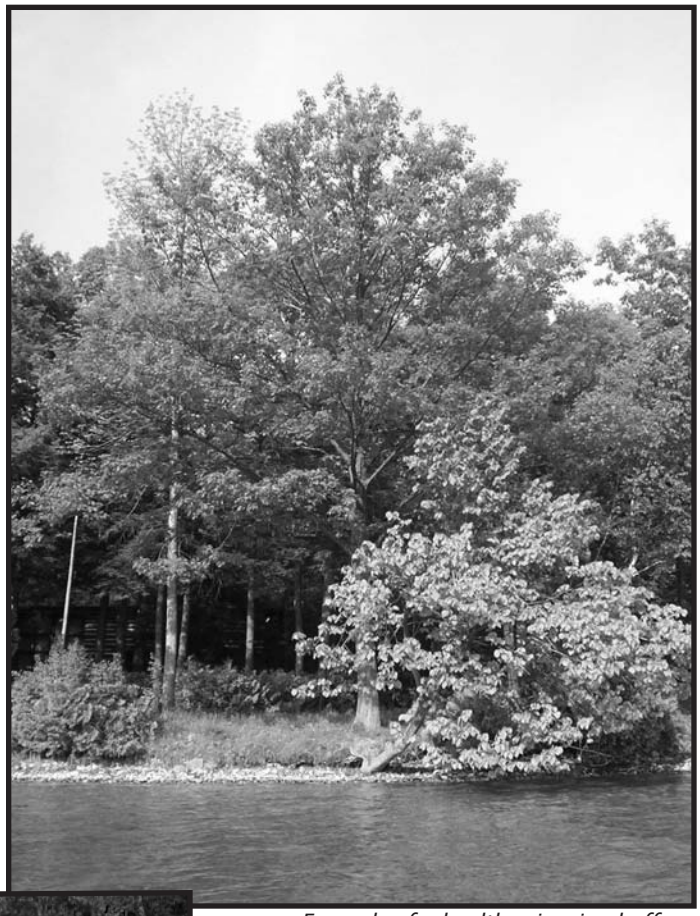
The weevils appear to be happy in Paradise and Paradise residents happy with the weevils.

Invasive Eurasian watermilfoil (Myriophyllum spicatum to the left) and native watermilfoils (M. sibiricum in center and M. heterophyllum to the right).

With Great Land Comes Great Responsibility

Paradise Lake shoreline property owners are fortunate to have a little piece of Paradise, but this great piece of land comes with great responsibility. Shoreline properties are critical to the lake ecosystem as they are the interface between land and water.

It is within this interface, which is also referred to as the riparian zone, that human activity has the greatest potential for impacting water quality. A naturally vegetated riparian zone provides tremendous benefits to the lake ecosystem. The vegetation holds soils in place, filters contaminants from surface runoff, provides habitat for aquatic and terrestrial organisms, and shades near-shore areas. Removing too much vegetation from the shoreline and replacing it with seawalls, fertilized turf grasses, and impervious surfaces (e.g., roads, roofs) can cumulatively have negative impacts. Thus, shoreline property owners must manage their land responsibly to safeguard the lake's water quality.



Example of a healthy riparian buffer.

Paradise Lake Association members demonstrated their commitment to wise shoreline management by sponsoring a comprehensive shoreline survey. The shoreline survey, performed by Watershed Council staff in 2002, documented shoreline conditions, such as erosion and greenbelts, but with a particular focus on indicators of nutrient pollution.

Nutrient pollution comes from sources such as excess fertilizers, malfunctioning septic systems and stormwater runoff. Nutrients stimulate plant growth, which could have serious consequences for Paradise Lake because the lake is shallow and already contains abundant plant growth.

Watershed Council staff conducting a shoreline survey.

Survey results showed that approximately 20% of developed properties on the lake exhibited signs of nutrient pollution. No severe water pollution problems were found, but multiple minor nutrient pollution occurrences will add up.

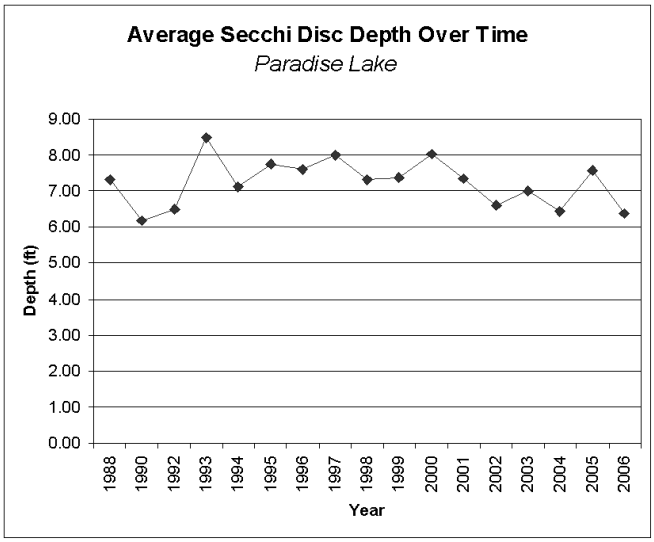
Upon completing the shoreline survey the Association made further investments in Paradise Lake's water quality by collaborating with the Watershed Council in follow-up activities. Shore surveys provide valuable information, but the value is not maximized until action is taken. Questionnaires were sent to shoreline residences in 2003 in an effort to work with property owners to identify and eliminate nutrient pollution sources. Many shoreline residents responded and worked with the Watershed Council and Lake Association to reduce nutrient pollution to the lake. These committed residents set an example for the rest; taking responsibility for their great piece of land to protect Paradise Lake's great water quality for generations to come.

Volunteer Lake Monitoring

Since 1984 the Tip of the Mitt Watershed Council has coordinated the Volunteer Lake Monitoring program (VLM), relying upon dozens of volunteers to monitor the water quality of 35 lakes in the northern Lower Peninsula of Michigan. During the summer of 2006, 40 volunteers monitored water quality at 32 stations on 24 lakes.

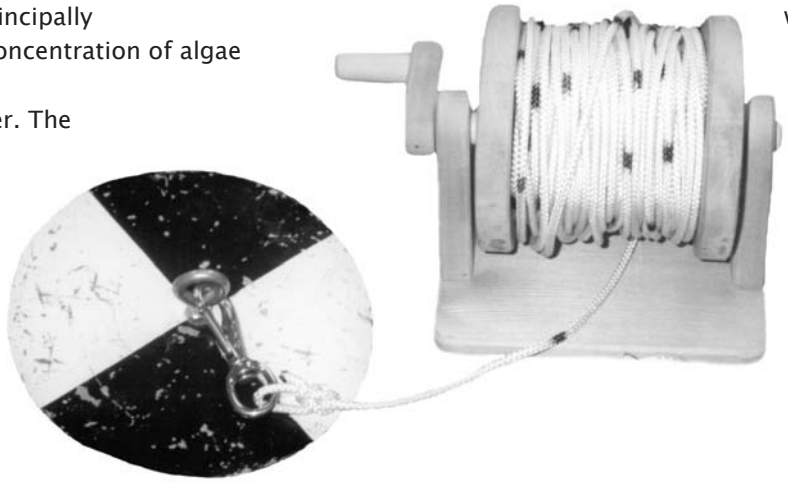
A tremendous amount of data has been generated by the VLM program and is now available to the public via our web site (www.watershedcouncil.org/volunteerlake.html). This data is essential for discerning short-term changes and long-term trends in the lakes of Northern Michigan. Ultimately, the dedicated effort of volunteers and staff will help improve lake management and protect and enhance the quality of Northern Michigan's waters.

Volunteers have monitored water quality on Paradise Lake since 1988. Volunteers measure water clarity on a weekly basis using a Secchi disc. Every other week volunteers collect water samples to be analyzed for chlorophyll-a. Staff at the Watershed Council process the data and determine Trophic Status Index (TSI) scores to classify the lakes and make comparisons. The following section contains detailed explanations and charts showing data from Paradise Lake as well as others.



Secchi Disc

The Secchi disc is a weighted disc (eight inches in diameter, painted black and white in alternating quarters) that is used to measure water clarity. The disc is dropped down through the water column and the depth at which it disappears is noted. Using Secchi disc measurements, we are able to determine the relative clarity of water, which is principally determined by the concentration of algae and/or sediment in the water. The clarity of water is a simple and valuable way to assess water quality. Lakes and rivers that are very clear usually contain lower levels of nutrients and sediments and, in most cases, boast high quality waters. Throughout the summer, different algae bloom at different times, causing clarity to vary greatly. Secchi disc depths have ranged from just a few feet in small inland lakes to 40-50 feet in large inland lakes and Great Lakes' bays.



Chlorophyll-a

Chlorophyll-a is a pigment found in all green plants, including algae. Water samples collected by volunteers are analyzed for chlorophyll-a to determine the amount of phytoplankton (minute free-floating algae) in the water column. There is a strong relationship between chlorophyll-a concentrations and Secchi disc depth. Greater amounts of chlorophyll-a indicate greater phytoplankton densities, which reduce water clarity and, thus, the Secchi disc depth as well. So why collect chlorophyll-a data? The chlorophyll-a data provides support for Secchi disc depth data used to determine the productivity of the lake, but it can also help differentiate between turbidity caused by algal blooms versus turbidity caused by other factors such as sedimentation or marl.

Trophic Status Index

Trophic Status Index (TSI) is a tool developed by Bob Carlson, Ph.D. from Kent State University to determine the biological productivity of a lake. Formulas developed to calculate the TSI value utilize Secchi disc depth and chlorophyll-a measurements collected by our volunteers. TSI values range from 0 to 100. Lower values (0-38) indicate an oligotrophic or low productive system, medium values (39-49) indicate a mesotrophic or moderately productive system, and higher values (50+) indicate a eutrophic or highly productive system. Lakes with greater water clarity and smaller phytoplankton populations would score on the low end of the scale, while lakes with greater turbidity and more phytoplankton would be on the high end. TSI values do not measure water quality, but simply place the lake on a scale of biological productivity. Lakes may be placed in the eutrophic category as a result of algal blooms, which are often a public concern and can be indicative of water pollution problems. On the other hand, low productivity of oligotrophic lakes may result in a lackluster fishery when compared to highly productive eutrophic lakes.

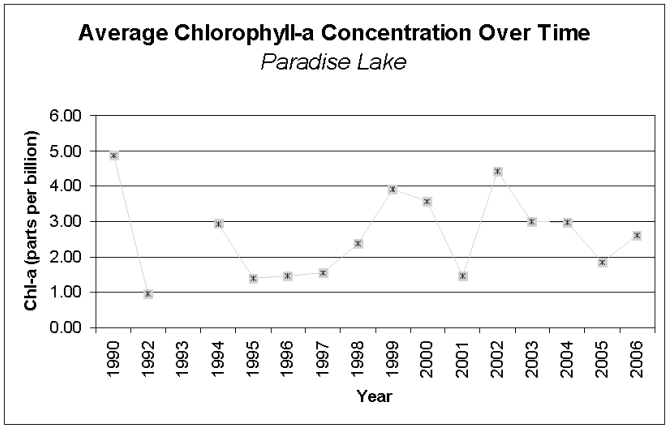
A 2006 TSI value of 45 places Paradise Lake in the mesotrophic category (see table on following page). Oligotrophic lakes are characteristically deep, clear, nutrient poor, and with abundant oxygen. On the other end of the spectrum, Eutrophic lakes are shallow, nutrient rich and full of productivity, which when excessive can lead to oxygen depletion. Mesotropic lakes lie somewhere in between and are moderately productive.

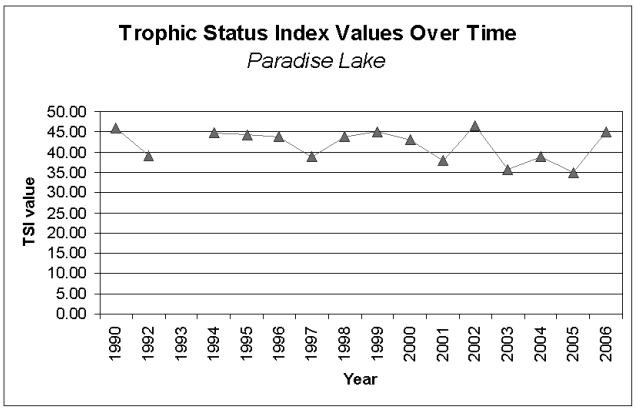
Special Thanks to
our 2006 Paradise Lake
Volunteer Monitor

Richard Dragoo

Tools of the Trade

Volunteer Lake Monitors use a Secchi disc (page 6, bottom) to measure water clarity and an integrated sampling device (above) to collect water to measure chlorophyll-a.





TSI Values continued

Trophic Status Index (TSI) Values for Lakes Monitored in 2006*					
Lake	TSI	Lake	TSI	Lake	TSI
Bass Lake	44	Lake Charlevoix, South Arm	28	Pickerel Lake	38
Black Lake	27	Lake Marion	31	Silver Lake	30
Burt Lake, Central Basin	33	Lake Michigan, Bay Harbor	11	Six Mile Lake	46
Burt Lake, North	35	Lake Michigan, Little Traverse Bay	24	Thumb Lake	31
Burt Lake, South	33	Lake Skegemog	37	Twin Lakes	37
Crooked Lake	44	Long Lake, Cheboygan County	30	Walloon Lake, Foot Basin	35
Douglas Lake-Cheboygan	38	Mullett Lake, Center	23	Walloon Lake, North	40
Douglas Lake-Otsego	39	Mullett Lake, Pigeon Bay	31	Walloon Lake, West Arm	35
Elk Lake	26	Munro Lake	45	Walloon Lake, Wildwood	36
Lake Charlevoix, Main	25	Paradise Lake	45		

* TSI value not available for all lakes monitored due to lack of data needed to calculate the TSI value.

This report would not be possible without the dedicated help of the volunteer lake monitors, so we would like to sincerely thank all who have participated in this program.

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