Headwaters of the Inland Waterway

Tip of the Mitt Watershed Council

2010 Lake Profile

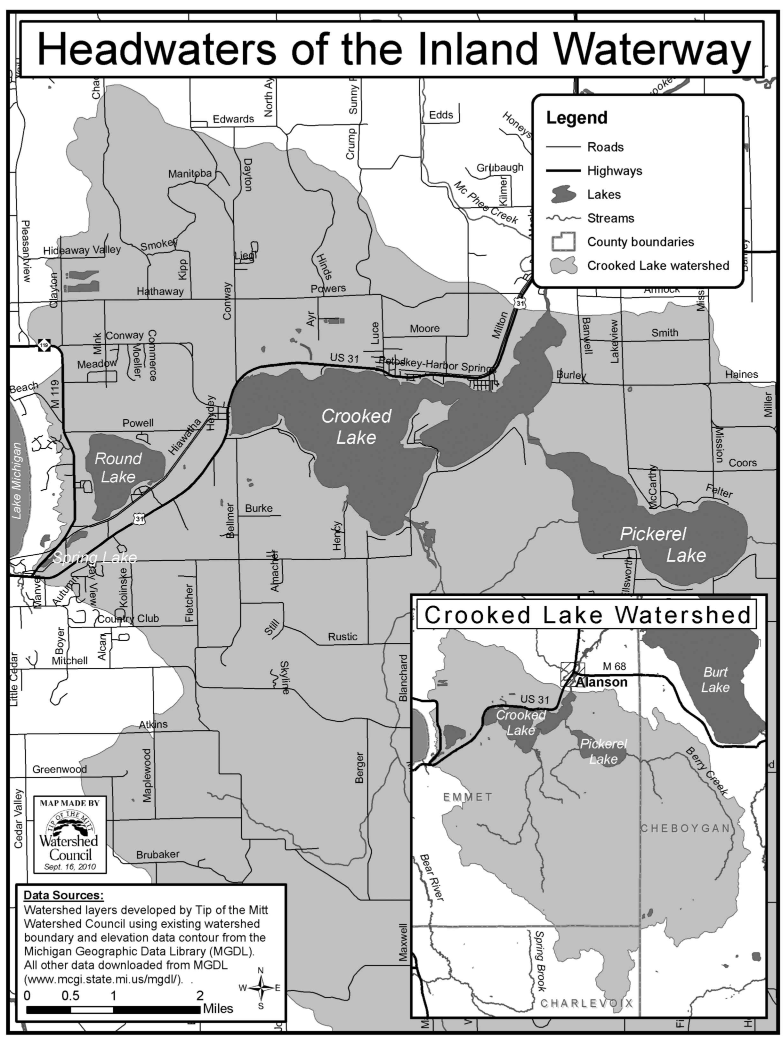
What attracts people to Northern Michigan? In general, people come north to enjoy the natural beauty of the area's pristine ecosystems, but if asked for one specific landscape feature, most would undoubtedly say our "lakes". Lakes define the landscape of Northern Michigan and sustain local economies, providing stunning views, abundant fisheries, and tremendous recreational opportunities. In the Tip of the Mitt Watershed Council service area there are nearly 60 lakes greater than 100 acres in size, and 14 of these are among the State's largest with over 1,000 acres of lake-surface area. The region also boasts some of the State's deepest lakes with five lakes having maximum depths of 100 feet or more. Several of these "giants" are found in the Inland Waterway, including Crooked and Pickerel Lakes with 2,350 and 1,080 acres respectively. However, all the lakes in the Inland Waterway have qualities that allure and captivate residents and visitors fortunate enough to experience the enchanting natural beauty of these aquatic treasures first hand.

Crooked, Pickerel, Round, and Spring Lakes are located in the headwaters of the Inland Waterway, providing abundant water that sustains a transportation, recreation and wildlife corridor that extends across the northern Lower Peninsula. It all starts at Spring Lake, a pleasant 6-acre pond off of M119 just outside Petoskey, which flows through another small lake before emptying into the larger 350-acre Round Lake. An outlet on the east side of Round Lake carries water to Crooked Lake, which is also supplied by water from Pickerel Lake to the east. Then, the water from these lakes empties into the Crooked River and continues its 40-mile journey across the tip of the mitt before emptying into Lake Huron at Cheboygan.

Over the last few decades, the Watershed Council has put forth great effort to preserve the Headwater Lakes of the Inland Waterway and ensure they remain a high quality resource for the enjoyment of future generations. Water quality of the region's lakes, both large and small, has been monitored by staff and volunteers alike, providing valuable data on the overall health of our waters. Our cornerstone water quality monitoring programs include our Comprehensive Water Quality Monitoring and Volunteer Lake Monitoring programs.

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 over 20 years. The Volunteer Lake Monitoring program was started in 1984 and has relied on hundreds of dedicated volunteers who monitor water clarity, algae abundance, phosphorus levels and more. In addition to monitoring, the Watershed Council has worked with lake shoreline owners and lake organizations on a variety of projects to protect the lakes scattered throughout Northern Michigan. Projects carried out on these lakes have ranged from comprehensive aquatic plant surveys to shoreline restoration projects. Details about recent water resource management initiatives in the Headwaters of the Inland Waterway are included in this report.

We hope you find this report both informative and helpful. If you have any questions, comments, or concerns, please contact 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
in the Headwaters of the Inland Waterway

Tip of the Mitt Watershed Council has been consistently monitoring water quality throughout the Headwaters of the Inland Waterway for decades. Starting on just 10 lakes in 1987, the Watershed Council's Comprehensive Water Quality Monitoring Program has expanded to include over 50 lakes and rivers throughout Northern Michigan. An incredible amount of data has been generated from this program and utilized by the Watershed Council, lake and stream associations, local governments and regulatory agencies in an effort to protect and improve the water resources that are so important to the region.

Every three years, Watershed Council staff head into the field as soon as ice is out to monitor lakes and rivers spread across the tip of the mitt. Over 60% of the region's lakes greater than 100 acres in size, and all major rivers are included in the program. In each of these water bodies, the Watershed Council collects a variety of data, including parameters such as dissolved oxygen, pH, chloride, phosphorus and nitrogen.

Information gathered in the Comprehensive Water Quality Monitoring Program has proven to be very useful. The data are used by the Watershed Council and others to characterize water bodies, identify specific problems and examine trends over time. One obvious trend found by analyzing data from this program is that chloride (a component of salt) levels have increased significantly in many water bodies during the last 22 years. Why? We need not look any farther than ourselves to find the answer as we use salt in everything from de-icing to cooking.

The following pages contain descriptions of the types of data collected in the program as well as select data from the Headwaters of the Inland Waterway. We have also included charts to provide a graphic display of trends occurring in the lake. For additional information about the Comprehensive Water Quality Monitoring Program please visit our web site at www.watershedcouncil.org/protect.

Parameters and Results

pH

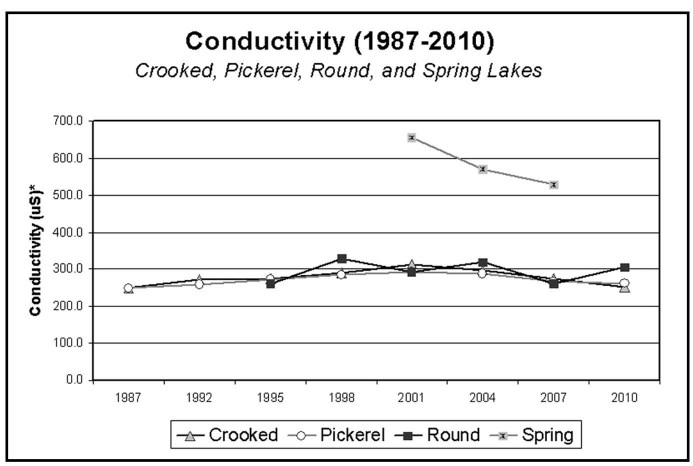
pH values provide a measurement of the acidity or alkalinity of water. Measurements above 7 are alkaline, 7 is considered neutral, and levels below 7 are acidic. When pH is outside the range of 5.5 to 8.5, most aquatic organisms become stressed and populations of some species can become depressed or 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 from the Headwaters of the Inland Waterway show that pH levels consistently fall within this range, with a minimum of 7.10 (Pickerel, 1992) and a maximum of 8.55 (Round, 2010).

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 at mid-depth and at the surface in the Headwaters of the Inland Waterway have consistently exceeded State minimums, ranging from 8.7 PPM (Pickerel, 1998) to 12.6 PPM (Spring, 2004). On two occasions, dissolved oxygen levels near the bottom of the lakes were below 7 PPM (Pickerel, 1992 & Crooked, 1998). Oxygen depletion at the bottom is typical for many lakes, though it can be an indicator of water quality impairment.

Conductivity

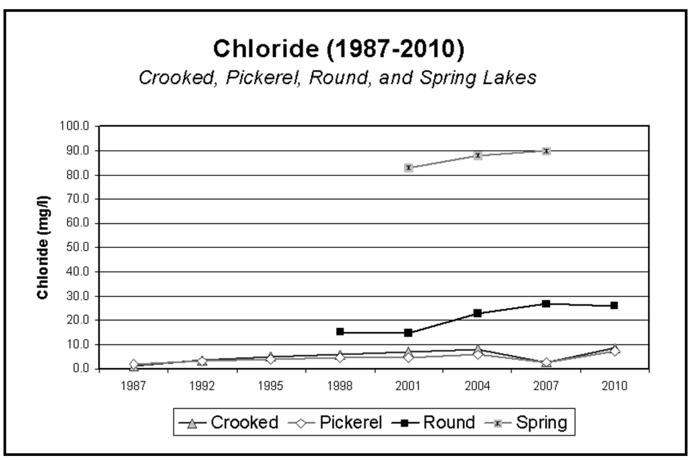
Conductivity is a measure of the ability of water to conduct an electric current, which is dependent upon the concentration of charged particles (ions) dissolved in the water. Research shows that conductivity is a good indicator of human impacts on aquatic ecosystems because levels usually increase as population and human activity in the watershed increase. Readings on lakes monitored by the Watershed Council have ranged from 175 to 656 microSiemens (µS), and in the Headwaters of the Inland Waterway, ranging from a low of 230 µS (Pickerel, 1987) to a high of 656 µS (Spring, 2004). Conductivity levels in Spring Lake have been above 500 µS since monitoring began in 2004, which is probably due to the lake's proximity to the commercial district along US31.



Our H2Observer has been spotted severaltimes on Pickerel and Crooked Lakes conductingwater quality monitoring research, aquatic plant surveys and more.

Chloride

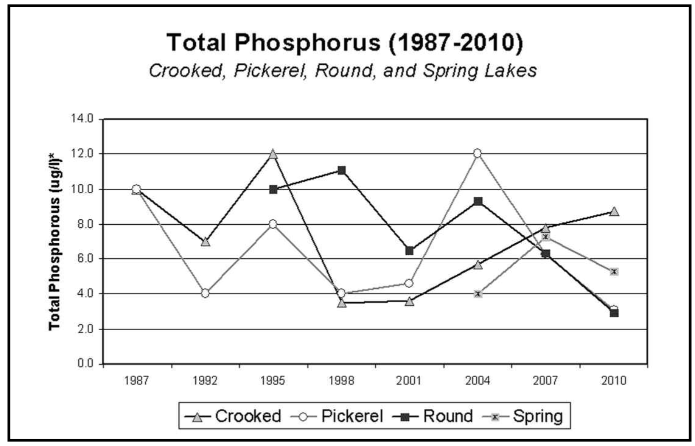
Chloride, a component of salt, is present naturally at low levels in Northern Michigan surface waters due to the marine origin of bedrock (typically < 5 PPM). Chloride is a "mobile ion," meaning it is not removed by chemical or biological processes in soil or water. Many products associated with human activities contain chloride (e.g., de-icing salts, water softener salts, and bleach). Although most aquatic organisms 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 concentrations have gradually increased in all four lakes of the Headwaters of the Inland Waterway and are highest in the lakes closest to Petoskey (Round and Spring).



Total Phosphorus

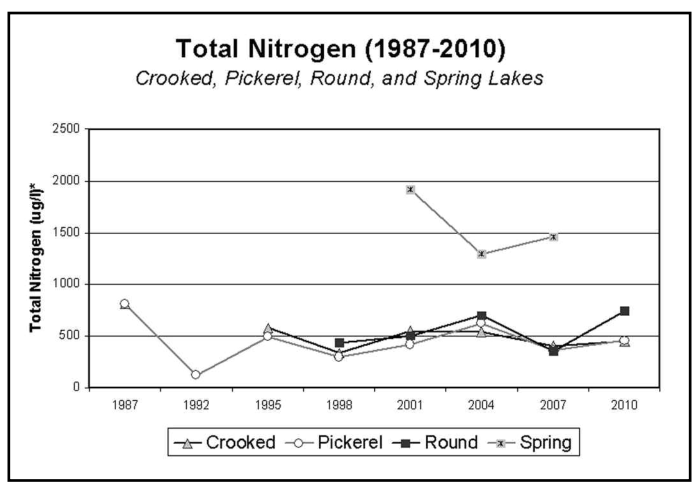
Phosphorus is the most important nutrient for plant productivity in surface waters because it is usually in shortest supply relative to nitrogen and carbon. A water body is considered phosphorus limited if the ratio of nitrogen to phosphorus is greater than 15:1. In fact, most lakes monitored by the Watershed Council are 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 of less than 10 PPB in high quality surface waters.

In the Headwaters of the Inland Waterway, total phosphorus concentrations have gone up and down with no clear trends in the data. Phosphorus levels have generally been less than 10 PPB, which indicates that water quality remains high in the Headwater lakes.



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 (e.g. fertilizers, faulty septic systems, and storm water 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. Total nitrogen levels in the Headwaters of the Inland Waterway have ranged from 125 PPB (Pickerel, 1992) to 2818 PPB (Spring, 2010). Total nitrogen levels are exceptionally high in Spring Lake, which is another indication of contaminants polluting the lake from the nearby urban area.



*Unit descriptions: mg/l = parts per million, µg/l = parts per billion, µS = microSiemens per centimeter

Comprehensive Water Quality Monitoring Program 2007 Data*

Water Body	Date	Dissolved Oxygen (mg/l)	pH (units)	Specific Conductivity (µS)	Chloride (mg/l)	Nitrate-Nitrogen (µg/l)	Total Nitrogen (µg/l)	Total Phosphorus (µg/l)
Bass Lake	4/19/2007	12.33	8.41	309.6	38.1	17.0	504.0	7.9
Bear River	5/24/2007	8.78	8.26	338.0	12.3	103.5	305.0	8.6
Bellaire Lake	4/19/2007	12.43	8.36	294.9	8.5	428.1	469.0	4.6
Benway Lake	4/16/2007	11.37	8.08	311.7	8.5	419.4	556.0	1.6
Birch Lake	4/19/2007	12.48	8.30	257.0	15.6	42.5	279.0	3.7
Black Lake	5/4/2007	11.74	8.16	262.5	6.0	54.5	269.0	3.5
Black River	4/9/2007	13.14	8.17	260.7	2.9	62.4	250.0	3.1
Boyne River	4/2/2007	10.29	8.32	366.4	6.1	368.2	475.0	3.2
Burt Lake	5/8/2007	11.19	8.29	273.6	10.4	120.3	254.0	3.0
Charlevoix, Main Basin	5/2/2007	13.00	8.19	271.9	10.2	300.0	498.0	2.2
Charlevoix, South Arm	5/2/2007	12.28	8.30	285.3	9.1	570.6	508.0	2.4
Cheboygan River	4/9/2007	14.18	8.34	282.9	6.1	68.4	338.0	4.8
Clam Lake	4/17/2007	12.10	8.24	300.5	8.8	421.4	471.0	2.6
Crooked Lake	4/25/2007	11.62	8.31	275.1	7.8	267.9	404.0	2.8
Crooked River	3/28/2007	11.97	8.36	290.3	8.9	224.8	373.0	4.9
Deer Lake	4/24/2007	11.41	8.32	239.9	6.7	49.1	308.0	2.6
Douglas Lake	4/20/2007	12.24	8.22	194.9	6.8	46.9	455.0	9.4
Elk Lake	4/17/2007	13.24	8.31	249.4	9.3	262.3	338.0	2.9
Elk River	4/2/2007	11.64	8.47	267.1	8.0	245.0	305.0	1.0
Ellsworth Lake	4/16/2007	11.90	8.12	310.3	9.6	349.3	409.0	3.5
Hanley Lake	4/19/2007	11.79	8.26	316.5	9.4	443.7	547.0	3.3
Huffman Lake	4/30/2007	10.43	8.41	277.2	4.7	38.0	179.0	6.9
Huron, Duncan Bay	5/8/2007	12.11	8.27	215.5	8.2	170.5	311.0	3.9
Indian River	5/22/2007	10.13	8.25	284.7	10.4	105.2	316.5	3.9
Intermediate Lake	4/19/2007	12.11	8.33	315.9	11.3	442.6	608.0	3.4
Jordan River	4/2/2007	10.04	8.30	322.0	6.0	981.5	1021.0	5.6
Lancaster Lake	4/20/2007	10.08	8.25	201.1	7.9	53.8	444.0	13.5
Larks Lake	5/3/2007	10.88	8.50	189.6	4.2	66.0	453.0	7.6
Little Sturgeon River	5/21/2007	9.82	8.30	293.3	13.2	57.5	202.0	8.1
Long Lake	5/4/2007	11.40	8.21	191.3	8.9	45.3	346.0	4.4
Maple River	4/9/2007	14.41	8.17	222.3	3.3	270.3	472.0	3.0
Michigan, Bay Harbor	5/30/2007	10.87	8.13	262.2	13.4	279.0	391.0	2.5
Michigan, Grand Traverse Bay	4/17/2007	13.34	8.29	232.6	6.3	257.3	331.0	2.0
Michigan, Little Traverse Bay	5/17/2007	13.40	8.29	228.0	11.6	259.0	397.0	2.5
Mullett Lake	5/8/2007	11.54	8.28	276.2	12.9	73.0	211.0	3.1
Munro Lake	5/8/2007	11.88	8.35	187.8	4.0	79.6	948.0	9.5
Nowland Lake	5/10/2007	10.40	8.49	184.2	6.5	10.2	567.0	8.1
Paradise Lake	4/20/2007	12.58	8.29	180.7	10.9	35.5	569.0	8.3
Pickerel Lake	4/25/2007	11.07	8.31	267.5	6.3	209.1	361.0	2.7
Pigeon River	5/21/2007	9.75	8.37	316.0	6.8	28.0	247.0	7.8
Pine River	4/2/2007	13.54	8.47	277.7	7.7	322.2	418.0	4.6
Rainy River	4/9/2007	13.14	8.09	248.8	4.5	32.7	411.0	8.3
Round Lake (Emmet Cty)	5/1/2007	10.44	8.54	262.9	26.9	16.7	350.0	6.3
Silver Lake (Wolverine)	4/30/2007	11.15	8.30	190.0	4.2	35.2	1203.0	2.8
Six-mile Lake	4/24/2007	11.38	8.21	260.6	6.9	224.9	433.0	4.2
Skegemog Lake	4/17/2007	12.75	8.36	257.7	8.3	300.0	311.0	1.8
Spring Lake	5/1/2007	11.07	8.25	571.5	88.2	857.7	1292.0	7.3
St. Clair Lake	4/16/2007	11.97	8.13	293.6	6.1	283.8	385.0	3.2
Sturgeon River	4/9/2007	14.41	8.26	340.5	12.2	280.5	280.0	2.3
Susan Lake	4/24/2007	10.83	8.28	251.4	9.5	29.1	333.0	3.6
Tannery Creek	3/28/2007	12.22	8.22	428.1	37.1	705.2	902.0	5.7
Thumb Lake	4/30/2007	11.66	8.33	177.8	4.4	37.0	293.0	2.8
Torch Lake	4/17/2007	13.07	8.34	245.9	6.2	364.6	377.0	2.2
Twin Lakes	5/1/2007	11.27	8.40	239.5	2.3	10.3	275.0	7.7
Walloon, Foot	5/7/2007	11.77	8.18	243.6	12.4	91.2	279.0	1.9
Walloon, Mud Basin	5/9/2007	10.92	8.32	277.7	15.2	9.6	424.0	10.2
Walloon, North Arm	5/7/2007	10.91	8.24	267.1	14.2	268.5	458.0	4.1
Walloon, West Arm	5/9/2007	12.27	8.27	238.4	9.3	157.7	385.0	3.0
Walloon, Wildwood Basin	5/7/2007	11.79	8.24	238.8	12.5	82.9	255.0	2.7
Wildwood Lake	4/30/2007	10.13	8.42	247.0	13.2	>1	379.0	6.2
Wilson Lake	4/16/2007	11.75	8.11	317.6	9.7	405.2	595.0	1.9

*2010 data will be available in early 2011.

*Unit descriptions: mg/l = parts per million, µg/l = parts per billion, µS = microSiemens per centimeter

WORKING TOGETHER

To control aqautic invasive plants on Pickerel and Crooked Lakes

Tip of the Mitt Watershed Council

Throughout the summer months, it is not uncommon to see Crooked Lake dotted with fishing boats as you drive past its shoreline on US31. Crooked remains a popular destination for anglers, many of whom would agree that the fishing is still good. The lake's robust fishery is at least partially due to the Pickerel-Crooked Lake Association's (PCLA) admirable aquatic plant management efforts, which have been ongoing for the last decade and with expert help from the Watershed Council. From comprehensive surveys to active invasive species control, PCLA members have worked tirelessly to maintain a healthy, diverse, and native aquatic plant population that has undoubtedly benefited the lakes' fisheries.

Aquatic plants are a vital component of the lake ecosystem, but they can become a recreational nuisance when growth is excessive, and in extreme cases could even affect water quality. Heavy aquatic plant growth sometimes occurs naturally given the correct combination of environmental variables (e.g., light and nutrient availability), but is accelerated due to factors such as nutrient pollution (fertilizers, human/animal wastes, stormwater, etc.) or the introduction of non-native species. Concerns regarding non-native (invasive) species and fisheries habitat prompted PCLA to inventory aquatic plants throughout Crooked and Pickerel Lakes, implement invasive species control measures, and educate residents regarding the importance of aquatic plants and the dangers of invasive species.

PCLA'a aquatic plant management began with purple loosestrife, an attractive, but invasive wetland and lakeshore plant that crowds out native species. With Watershed Council guidance, PCLA volunteers carried out surveys to inventory all purple loosestrife infestations in Crooked and Pickerel Lakes. Initially, control consisted of cutting the invasive plants and herbicide application, but then it shifted to biological control using the *Galerucella* beetle. PCLA volunteers have now gathered beetles at Watershed Council Galerucella collection events for several years and released them in purple loosestrife patches on their lakes. Due to these efforts, purple loosestrife is largely under control and has not taken over the lakes' shorelines.

After a few years of fund-raising efforts, PCLA was able to take another big step forward in aquatic plant management by sponsoring a comprehensive survey aimed at collecting baseline data on the lakes' vegetation. In the summer of 2008, Watershed Council staff carried out the survey, collecting and documenting plant specimens at 479 sites throughout Crooked and Pickerel Lakes. During this survey, a total of 31 different aquatic plants were found, the most common being bulrush, eel-grass, muskgrass, naiad, and variable-leaf water-milfoil. Only one invasive species, curly-leaf pondweed, was found and was, fortunately, limited to one small area.

Following the survey, PCLA went right to work and organized a work-day to manually remove the curly-leaf pondweed. This year, PCLA and Watershed Council staff returned to the site to assess progress, remap the infestation, and strategize future control efforts. Manual removal will be attempted again next season, but if deemed unsuccessful PCLA may opt for other control measures.

Volunteers collect *Galerucella* beetles to distribute in areas around the lakes that have purple loosestrife. The beetles have been a highly effective biological control on Pickerel and Crooked Lakes.

During the last few years, Pickerel and Crooked Lakes have also been surveyed for invasive Phragmites, which is another non-native wetland plant that is similar to purple loosestrife in that it crowds out the native plants. However, invasive Phragmites is considered to be worse than purple loosestrife because it grows so tall (up to 15') and so completely dominates the wet areas it inhabits. Through a collaborative effort between the Watershed Council and the University of Michigan Biostation, both lakes were surveyed. Results from the surveys were reassuring. Many stands of Phragmites were discovered, but ALL were found to be of the native variety. Thus, for the time being Pickerel and Crooked Lakes are safe from this invader. However, PCLA and the Watershed Council must and shall remain vigilant regarding this and other aquatic invasive species.

PCLA and the Watershed Council have put a lot of effort into managing the aquatic plant communities of Pickerel and Crooked Lakes. It has paid off. The lakes are healthy in terms of water quality, the fisheries are strong, invasive plant species largely under control, and the lakes remain very pleasant and enjoyable water bodies for recreation. Working together has been both fruitful and rewarding, and we fully intend to collaborate on future projects for the benefit of Pickerel and Crooked Lakes.

Volunteer Lake Monitoring

Local Volunteers Monitor & Protect Our Lakes

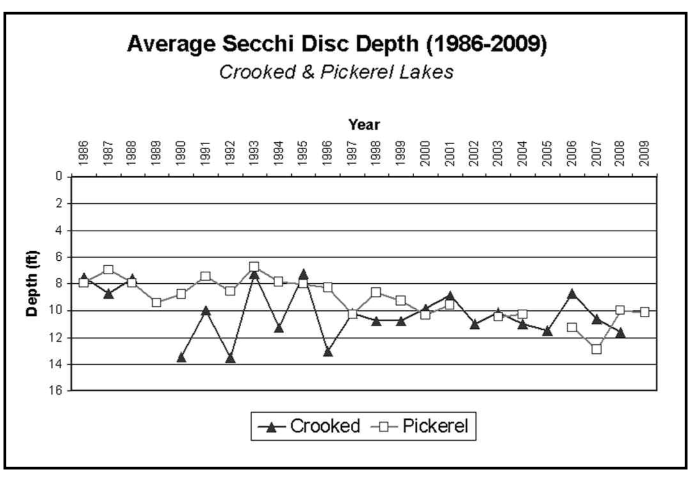
Since 1984, Tip of the Mitt Watershed Council has coordinated the Volunteer Lake Monitoring program (VLM), relying upon hundreds of volunteers to monitor the water quality of dozens of lakes in the northern Lower Peninsula of Michigan. During the most recent summer for which data are available (2009), 38 volunteers monitored water quality at 31 stations on 23 lakes.

A tremendous amount of data has been generated by the VLM program and is available to the public via our web site (www.watershedcouncil.org/protect). 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 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. Volunteers have monitored water quality in several of the Headwaters of the Inland Waterway over the past few decades. The following section summarizes the parameters monitored and results.

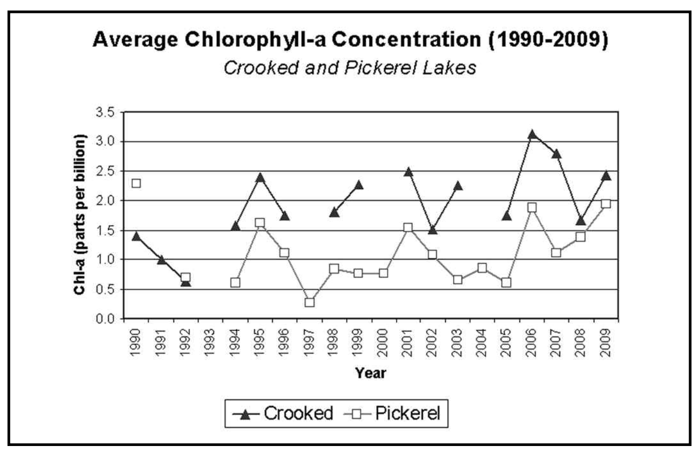
Secchi Disc

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

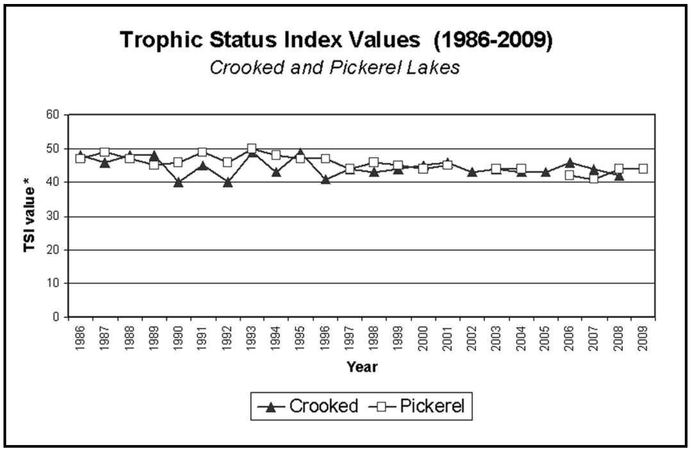
Chlorophyll-a is a pigment found in all green plants, including algae. Water samples collected by volunteers are analyzed for chlorophyll-a to determine the amount of phytoplankton (minute free-floating algae) in the water column. There is a strong relationship between chlorophyll-a concentrations and 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 calcite.



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

*Unit descriptions: mg/l = parts per million, µg/l = parts per billion, µS = microSiemens per centimeter

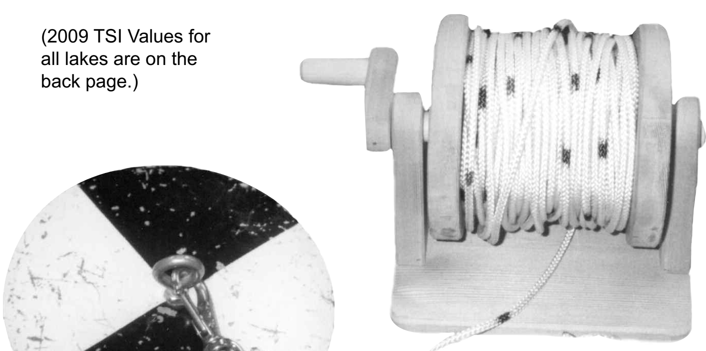


from 0 to 100. Lower values (0-38) indicate an oligotrophic or low productive system, medium values (39-49) indicate a mesotrophic or moderately productive system, and higher values (50+) indicate a eutrophic or highly productive system. Lakes with greater water clarity and smaller phytoplankton populations 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 are an indication of a lake's biological productivity. 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. A highly productive eutrophic lake could have problems with oxygen depletion whereas the low-productivity oligotrophic lake may have a lackluster fishery. Mesotrophic lakes are a happy medium, lying somewhere in between and moderately productive.

Depending upon variables such as age, depth, and soils, lakes are sometimes naturally eutrophic. However, nutrient and sediment pollution caused by humans can lead to the premature eutrophication of a lake, referred to as "cultural eutrophication". A lake that undergoes cultural eutrophication can affect the fisheries, cause excess plant growth, and result in algal blooms that can be both a nuisance and a public health concern.

(2009 TSI Values for all lakes are on the back page.)



Tools of the Trade...
Volunteer Lake Monitors use a Secchi disc to measure water clarity.

Results from the Headwaters of the Inland Waterway

Volunteer monitors have collected water quality in the Headwaters of the Inland Waterway for well over 20 years! Crooked and Pickerel Lakes have been monitored as part of the Watershed Council's program since 1986 and records indicate that there are data stretching back to 1974 from other programs. Round Lake has been monitored sporadically and inconsistently… in other words, we are looking for a consistent volunteer monitor – could it be you?

The long-term Secchi disc and chlorophyll-a data from these lakes allow Watershed Council staff to assess water quality and examine changes over time. Average Secchi disc depths in Crooked and Pickerel Lakes have gone up and down, though there has been a gradual increase in clarity in Crooked Lake since the mid 1990s. Average chlorophyll-a concentrations have also gone up and down on Crooked and Pickerel Lakes, showing no definitive pattern, but increasing slightly during recent years.

Zebra mussels have been present in Crooked and Pickerel Lakes for a number of years. Zebra mussels are voracious filter-feeders that feed upon algae and essentially clear the water column. Unfortunately, zebra mussels are not cleaning the water, but rather removing the algae that are the base of the food chain and ultimately, causing ecosystem disruptions. Their feeding habits are probably responsible for the increased water clarity in many lakes where present. consistently monitored. Interestingly, chlorophyll-a concentrations have not decreased in Pickerel and Crooked Lakes. It would appear that either zebra mussels in Crooked and Pickerel Lakes do not occur in sufficient densities to impact algal populations or that nutrient inputs into the lake are high enough to sustain phytoplanktonic algae despite impacts from filter-feeding zebras.

The trophic status index scores for Crooked and Pickerel Lakes consistently fall in the mesotrophy category (moderately productive), though both lakes have wavered on the edge of oligotrophy (low productivity). Both lakes are large, deep, nutrient-poor, and oxygen-rich, which is more typical of oligotrophic lakes in Northern Michigan. Recent data from the Comprehensive Water Quality Monitoring program show lower total phosphorous concentrations, suggesting that there could be a gradual shift to oligotrophy.

Overall, data show that Crooked and Pickerel Lakes have exceptionally high quality waters. Without dedicated volunteers, we would have less data, so we would like to send out a big "thank you" to all those that have helped with the program. We would also like to encourage others to become involved with our volunteer program to help us monitor and protect the aquatic treasures of Northern Michigan. If you would like to get involved, please contact the program coordinator, Kevin Cronk, at (231) 347-1181 ext. 109 or by e-mailing kevin@watershedcouncil.org.

* 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.

Trophic Status Index* (TSI) Values for Lakes Monitored in 2009

Lake	TSI	Lake	TSI	Lake	TSI
Bass Lake	43	Huffman Lake	50	Pickerel Lake	44
Black Lake	39	Lake Marion	41	Six Mile Lake	45
Burt Lake, Central Basin	36	Lake Michigan, Bay Harbor	25	Thayer Lake	42
Burt Lake, North	39	Lake Michigan, Little Traverse Bay	28	Thumb Lake	32
Crooked Lake	42	Long Lake, Cheboygan County	35	Twin Lake	39
Douglas Lake - Cheboygan	39	Mullett Lake, Center	38	Walloon Lake, Foot Basin	34
Douglas Lake - Otsego	42	Mullett Lake, Pigeon Bay	36	Walloon Lake, North	39
Elk Lake	36	Munro Lake	43	Walloon Lake, West Arm	35
Lake Charlevoix, Main	32	Paradise Lake	45	Walloon Lake, Wildwood	32
Lake Charlevoix, South Arm	35				

*TSI values range are based on secchi disc data and 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.

Special Thanks to Our Volunteer Lake Monitors
Michael Pierce & John Fowler

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