Northern MIchigan's

Gem Lakes

2010 Report

Tip of the Mitt Watershed Council

Bass Lake • Birch Lake • Deer Lake • Huffman Lake • Larks Lake • Long Lake • Marion Lake Nowland Lake • Silver Lake • Susan Lake • Thumb Lake • Twin Lake • Wildwood Lake

What would Michigan be without water? One might as well ask what the Sahara would be without sand or the Himalayas without mountains. Michigan is defined by water and, in fact, the definition of Michigan in some Native American languages literally means water, "big lake" to be precise.

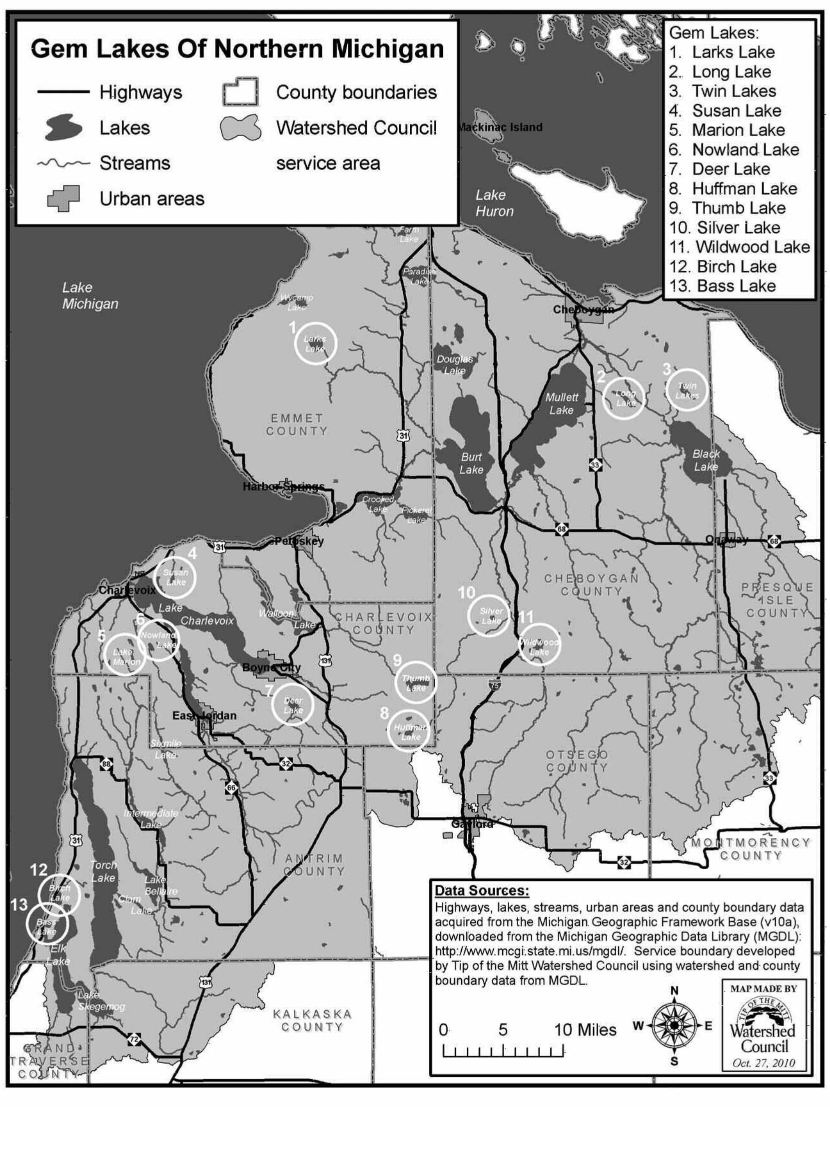
Water formed Michigan, frozen water that is, thousands of feet thick. A series of glaciers advanced and retreated across Michigan over the course of millions of years, creating the present-day landscape of rolling hills and broad plains; dotted with lakes, crisscrossed with rivers, and surrounded by freshwater seas. Glacial scouring and huge ice chunks that were left behind formed thousands of lakes across the landscape, lakes of all shapes and sizes, each unique: each beautiful and special in its own way.

Many people live in or travel through Northern Michigan because of these lakes and the character they lend to the region. Most are familiar with the large, picturesque, and stunning lakes, such as Torch or Burt, but few experience the hidden treasures, the small, charming lakes that abound. The Watershed Council has long recognized the value of these hidden gems and worked diligently for decades to protect them. The Gem Lakes included in this report are: Bass, Birch, Deer, Huffman, Larks, Long, Marion, Nowland, Silver, Susan, Thumb, Twin, and Wildwood Lakes.

Lakes throughout Northern Michigan, whether large or small, are monitored by staff and volunteers alike who gather valuable data to keep tabs on the health of our waters. Over 50 lakes and streams in the region are monitored in early spring by Watershed Council staff on an every three year basis through our Comprehensive Water Quality Monitoring Program. Volunteers supplement the comprehensive program and fill in data gaps by collecting weekly water quality data throughout summer months as part of our Volunteer Lake Monitoring Program.

In addition to monitoring, the Watershed Council works with property owners, associations, local governments, and others on a variety of projects to protect lakes throughout Northern Michigan. Projects carried out on these lakes have ranged from lake-wide aquatic plant surveys to individual shoreline property restoration projects. Details about recent projects involving the Gem Lakes are included in this report.

We hope you find the information presented in this report both interesting and insightful. 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 Gem Lakes of Northern Michigan

Tip of the Mitt Watershed Council has consistently monitored the water quality of Northern Michigan lakes for decades as part of the Comprehensive Water Quality Monitoring Program. When the program was launched in 1987, Watershed Council staff monitored a total of 10 lakes. Since then, the program has continually expanded and now, remarkably, includes more than 50 lakes and rivers throughout the tip of the mitt. Over the course of 20+ years of monitoring, we have managed to build an impressively large water quality dataset. This unique, historical dataset is, simply put: invaluable. Data from the program are regularly used by Watershed Council, lake and stream associations, local governments, regulatory agencies, and others in efforts to protect and improve the water resources that are so important to the region.

Every three years, Watershed Council staff head into the field in the early spring, as soon as ice is out to monitor lakes and rivers spread across the tip of the mitt. All lakes over 1000 acres and the majority of lakes greater than 100 acres in size, as well as all major rivers, are included in the program. In each of these water bodies, the Watershed Council collects a variety of physical and chemical data, including parameters such as dissolved oxygen, pH, chloride, phosphorus and nitrogen.

Water quality data collected in the field are compiled and used by Watershed Council staff 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 Gem Lakes. We have also included charts to provide a graphic display of trends occurring in the lakes. For additional information about the Comprehensive Water Quality Monitoring Program please visit our web site at www.watershedcouncil.org/protect

Parameters and Results

pH

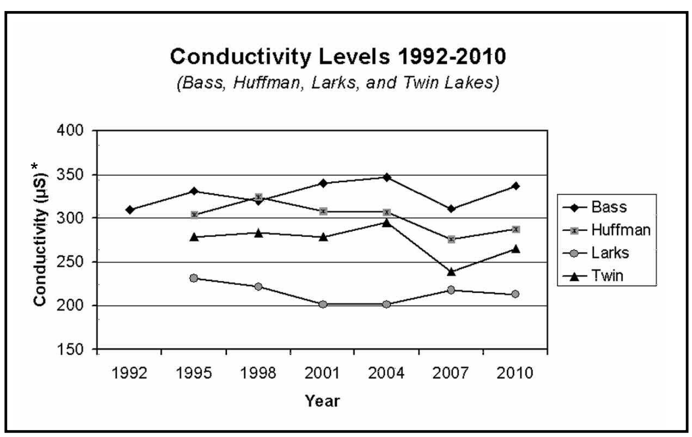
pH values provide a measurement of the acidity or alkalinity of water. Measurements above 7 are alkaline, 7 is considered neutral, and levels below 7 are acidic. When pH is outside the range of 5.5 to 8.5, most aquatic organisms become stressed and populations of some species can become depressed or 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 Gem Lakes show that pH levels consistently fall within this range, with a minimum of 7.19 (Silver, 1995) and a maximum of 8.68 (Nowland, 2001).

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 Gem Lakes have consistently exceeded State minimums, ranging from 7.9 PPM (Silver, 1998) to 13.1 PPM (Long, 1995). Throughout the history of the program dissolved oxygen levels were less than 5 PPM only four times and near the bottom of the lake in each instance (Bass, Long, Silver, and Thumb). Oxygen depletion at the bottom of small lakes is not uncommon and generally not a big concern for lakes in our area, but it can be an indicator of water quality impairment.

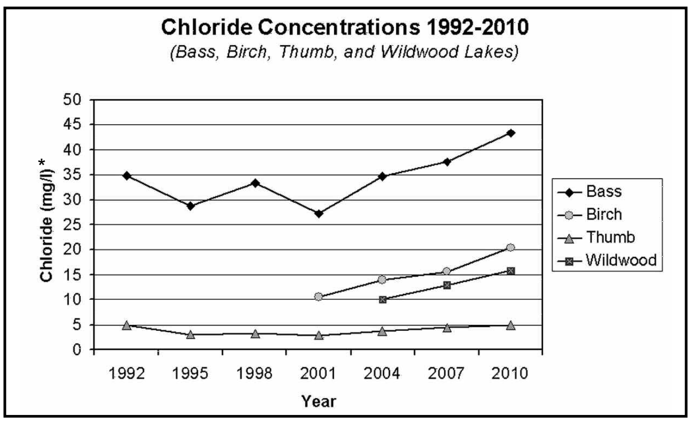
Conductivity

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 Gem Lakes, ranging from a low of 175 µS (Thumb, 2007) to a high of 353 µS (Bass, 2004). Conductivity data from the Gem Lakes do not show increases that are typical of lakes impacted by urban areas. However, Bass Lake does have higher conductivity levels than the other Gem Lakes and is located adjacent to the Village of Elk Rapids.



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 in the Gem Lakes have ranged from 1 PPM (Thumb, 1987) to 43.8 (Bass, 2010). Chloride levels in most of the Gem Lakes have changed little over time, which provides testimony to their pristine status. However, chloride levels are considerably higher in Bass Lake than the other Gem Lakes, and appear to be increasing in Birch and Wildwood Lakes.

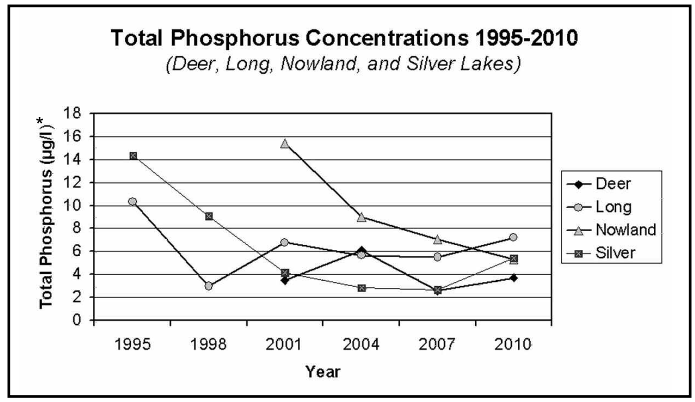


Nutrients

Phosphorus and nitrogen are essential nutrients for plant growth. Nutrients occur naturally and can be found in soils, water, air, plants, and animals. However, excess nutrients from sources such as fertilizers, faulty septic systems, and storm water runoff lead to nutrient pollution, which can have negative impacts on our surface waters. In general, nutrient concentrations are highest in small, shallow lakes and lowest in large, deep lakes.

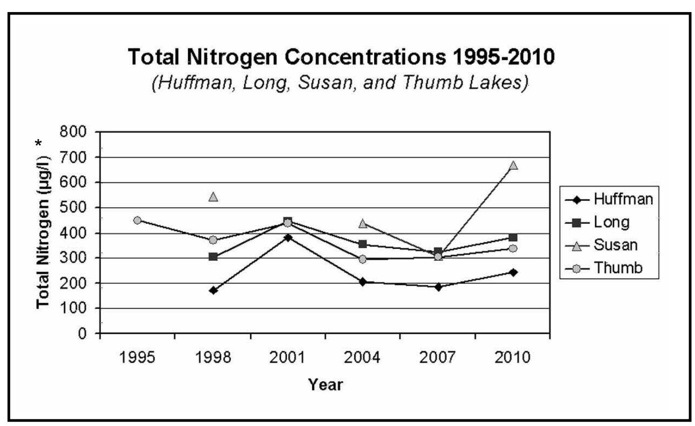
Total Phosphorus

Phosphorus is the most important nutrient for plant productivity in our lakes 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. Because of the impact that phosphorus can have on surface waters, legislation has been passed in Michigan to ban phosphorus in soaps and detergents and currently there is an effort underway to regulate phosphorus in fertilizers. Water quality standards for nutrients in surface waters have not been established, but total phosphorus concentrations are usually less than 10 PPB in the high quality lakes of Northern Michigan. Total phosphorus concentrations have decreased in a few of the Gem Lakes and gone up and down in others. Most phosphorus readings have been less than 10 PPB; further evidence that water quality in the Gem Lakes remains high.



Total Nitrogen

Nitrogen is a very abundant element throughout the earth's surface and is a major component of all plant and animal matter. Nitrogen is also generally abundant in our lakes and streams and needed for plant and algae growth. Interestingly, algae have adapted to a wide variety of nitrogen situations in the aquatic environment, some fixating nitrogen directly from the atmosphere to compete in low-nitrogen environments (blue-green algae), while others tend to thrive in nitrogen-rich environments (diatoms). Total nitrogen levels in the Gem Lakes have ranged from 165 PPB (Huffman, 1998) to 1203 PPB (Silver, 2007). Nitrogen levels are higher in some of the Gem Lakes than others, but there do not appear to be any clear trends in the data.



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

Comprehensive Water Quality Monitoring Program

Water quality data from the surface of all waters bodies monitored in 2010.

Indicates a lake included in this profile report. Water Body	Date	Dissolved Oxygen (mg/l)*	Specific Conductivity (µS)*	pH (units)*	Nitrate-Nitrogen (µg/l)*	Total Nitrogen (µg/l)*	Total Phosphorus (µg/l)*	Chloride (mg/l)*
Bass Lake	4/14/2010	11.21	335.3	8.53	11	584	8.8	42.9
Bear River	3/24/2010	13.05	283.1	8.30	192	433	16.2	14.3
Bellaire Lake	4/23/2010	11.19	315.9	8.29	347	452	3.7	10.7
Ben-way Lake	4/6/2010	11.06	358.0	11.32	406	567	6.4	10.8
Birch Lake	4/14/2010	11.36	271.6	8.43	3	273	5.7	20.5
Black Lake	4/28/2010	10.87	289.3	8.34	27	265	6.8	6.0
Black River	4/15/2010	10.54	254.1	8.16	20	308	4.0	4.3
Boyne River	3/26/2010	12.71	359.0	8.45	390	626	7.0	11.4
Burt Lake	4/28/2010	10.68	297.2	8.32	94	240	3.7	11.5
Charlevoix, Main Basin	4/19/2010	12.52	272.7	8.38	343	474	1.4	11.1
Charlevoix, South Arm	4/19/2010	11.80	280.8	8.34	427	547	1.3	9.9
Cheboygan River	4/15/2010	9.41	285.0	8.35	34	269	2.9	8.5
Clam Lake	4/23/2010	10.76	317.6	8.25	322	423	2.7	10.0
Crooked Lake	3/24/2010	11.72	252.8	8.51	269	443	8.7	8.7
Crooked River	4/21/2010	10.76	293.9	8.50	137	296	4.5	9.4
Deer Lake	3/26/2010	11.63	265.4	8.45	53	411	4.6	15.2
Douglas Lake	3/30/2010	11.27	214.8	8.25	55	544	7.8	7.3
Elk Lake	4/19/2010	12.80	246.7	8.35	193	411	9.6	9.8
Elk River	4/14/2010	12.49	261.3	8.51	205	313	2.0	10.0
Ellsworth Lake	3/29/2010	10.39	374.8	8.09	404	696	7.0	11.6
Hanley Lake	4/5/2010	10.53	367.3	8.27	451	725	3.0	10.9
Huffman Lake	3/26/2010	10.66	287.2	8.36	84	248	2.3	4.5
Huron, Duncan Bay	4/22/2010	10.85	278.6	8.36	77	322	3.6	9.7
Indian River	4/21/2010	11.32	301.4	8.48	75	226	1.6	12.4
Intermediate Lake	4/23/2010	10.63	344.8	8.25	363	458	3.2	11.8
Jordan River	3/29/2010	10.22	340.5	8.22	1122	1567	8.3	7.1
Lancaster Lake	4/1/2010	8.49	276.0	7.72	75	596	6.9	9.1
Larks Lake	3/30/2010	11.62	213.0	8.51	76	706	4.8	4.3
Little Sturgeon River	4/21/2010	11.36	320.1	8.35	54	228	2.9	14.5
Long Lake	4/15/2010	11.17	206.2	8.19	57	355	6.3	9.0
Maple River	4/22/2010	10.30	275.9	8.16	308	544	4.5	6.4
Marion Lake	5/10/2010	no data	no data	no data	<1	482	9.0	22.2
Michigan, Bay Harbor	5/3/2010	11.31	277.0	8.16	284	493	2.2	14.8
Michigan, Grand Traverse Bay	4/28/2010	12.40	241.1	8.26	251	360	1.4	11.8
Michigan, Little Traverse Bay	5/10/2010	12.03	244.5	8.29	268	373	2.2	12.8
Mullett Lake	4/22/2010	11.63	298.0	8.37	56	287	2.7	11.7
Munro Lake	4/1/2010	11.55	215.4	8.41	36	1022	13.3	4.9
Nowland Lake	4/14/2010	11.09	190.1	8.47	7	583	5.4	6.2
Paradise Lake	4/22/2010	10.52	207.2	8.30	8	325	5.0	11.2
Pickerel Lake	3/24/2010	11.26	261.6	8.26	183	453	3.1	7.3
Pigeon River	4/21/2010	10.09	341.5	8.37	35	233	3.8	6.5
Pine River, Charlevoix	4/14/2010	12.42	268.2	8.36	273	349	0.5	11.2
Round Lake (Emmet Cty)	3/30/2010	11.95	306.3	8.52	49	739	2.9	25.9
Silver Lake (Wolverine)	4/20/2010	10.65	194.4	8.35	26	247	3.3	4.9
Six-mile Lake	3/29/2010	10.52	333.5	8.14	279	541	4.4	7.2
Skegemog Lake	4/19/2010	10.87	255.8	8.45	186	292	1.4	9.6
Spring Lake	3/24/2010	12.46	529.9	8.21	1397	1457	5.3	90.0
St. Clair Lake	3/29/2010	10.49	351.0	8.14	260	560	5.4	8.8
Sturgeon River	4/22/2010	11.03	374.0	8.33	194	273	1.0	13.9
Susan Lake	3/26/2010	12.04	282.7	8.36	111	685	8.0	10.5
Thumb Lake	4/1/2010	10.99	200.7	8.22	38	301	10.0	5.1
Torch Lake	4/23/2010	12.39	260.3	8.31	270	371	0.7	8.0
Twin Lakes	4/23/2010	11.49	259.6	8.32	27	393	9.7	2.2
Walloon, Foot	4/28/2010	10.31	265.5	8.29	75	316	3.2	12.8
Walloon, Mud Basin	4/28/2010	9.14	296.8	8.30	25	371	9.3	16.4
Walloon, North Arm	4/28/2010	9.53	298.0	8.32	194	539	5.3	14.5
Walloon, West Arm	4/28/2010	10.66	259.8	8.29	134	377	3.0	11.1
Walloon, Wildwood Basin	4/28/2010	10.29	260.6	8.32	68	274	3.4	12.3
Wildwood Lake	4/20/2010	10.35	295.0	8.38	<1	332	11.9	16.0
Wilson Lake	4/7/2010	10.50	358.7	8.28	433	800	5.3	10.7

*Unit descriptions: mg/l = milligrams/liter (parts per million), µg/l = micrograms/liter (parts per billion), µS = microSiemens per centimeter

LOCAL ORDINANCE GAPS ANALYSIS

Local government is the first line of defense for our environment. However, most local governments also recognize the challenges of doing so. Even though they often appreciate the important economic, ecological and aesthetic benefits of wise resource management, it is not always easy to accomplish.

Many issues arise at the local level to threaten the health of our precious water resources. At Tip of the Mitt Watershed Council, we see time and again how the lack of local ordinances, or weak ordinances, leaves citizens without the necessary tools to protect their lake, river, or ground water source. We often hear from local residents when these threats arise, and the common question is, “Why can’t we do anything about this?”

Interestingly, the question is often asked by folks who believe local zoning should be kept to a minimum. But when they see the consequences of no zoning, many of them become leading advocates for ordinances that protect water resources.

Ideological stances that insist upon “no zoning” are often coupled with challenges that arise when attempting to protect a water body surrounded by multiple jurisdictions. These are key reasons for us to address this issue, and we have determined that:

1. No one in this region has documented the “big picture” of what currently exists in local water protection zoning and how that overlaps or competes with adjacent jurisdictions; and

2. There is a lack of direction and no plan for improving weak ordinances and enacting missing ordinances.

The need is serious because the water resources of the region are a crucial economic driver. High water quality in our lakes and rivers translates into solid property values and a high quality of life. But every year, numerous pressures bring more stress to these same water resources and we need to have a balanced approach for managing them. If the situation is left untreated, our communities will move forward with less direction, wasting money, time and effort while our water remains vulnerable to various threats.

These situations inspired the Watershed Council to get creative and search for ways to help local officials and ultimately, local citizens. We have solutions, and one of them is our *Local Ordinance Gaps Analysis* project.

The goal of this project is to evaluate all existing water-related ordinances in our 4-county service area of Cheboygan, Emmet, Charlevoix, and Antrim. The analysis is being done at the county, city, and township levels to determine if existing water-related zoning is strong, adequate, weak or missing. There are two powerful outcomes for this project:

- ✔ Convenient collection of relevant ordinances for easy reference.

- ✔ A formal report detailing results of the evaluation. This will include recommendations for improving weak ordinances, as well as suggestions for how to enact new ordinances to fill in the gaps that exist in current protections.

This project benefits many local communities in our region, providing well-documented, thoughtful approaches for them to consider that will have a long-term, lasting impact. It gives local decision makers a valuable tool they can use to make a positive difference and ensure protection of Northern Michigan’s environment and economy.

Upon completion, we will do extensive follow-up with the local governments, including distribution of the report, presentations to review how to use the report, and work sessions to support them as they implement the report recommendations. An evaluation form will be developed for local government officials to complete after they read the report.

In the process of gathering the necessary information to do this work, it has become obvious that this Gaps Analysis is something that will be extremely beneficial to local governments and citizens. It is a huge undertaking that requires a lot of research and work, but the final product will be useful to numerous local government entities for literally years to come.

Volunteer Lake Monitoring

Local Volunteers Monitor & Protect Our Lakes

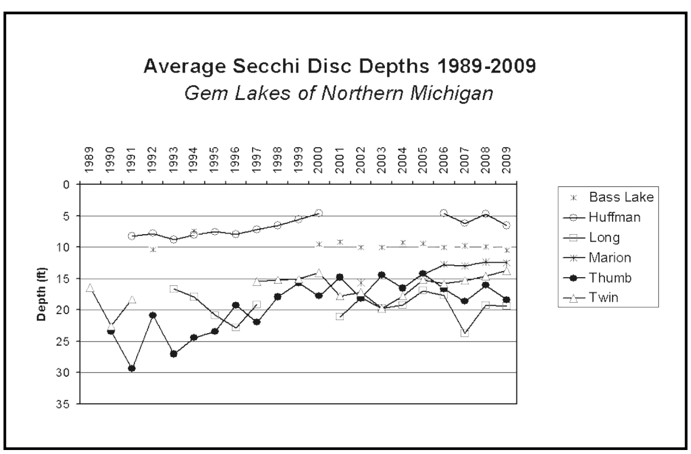
Since 1984, Tip of the Mitt Watershed Council has coordinated the Volunteer Lake Monitoring program (VLM), relying upon hundreds of volunteers to monitor the water quality of dozens of lakes in the northern Lower Peninsula of Michigan. During the most recent summer for which data are available (2009),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

A remarkable 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 many of the Gem Lakes over the past few decades. The following section summarizes the parameters monitored and results.

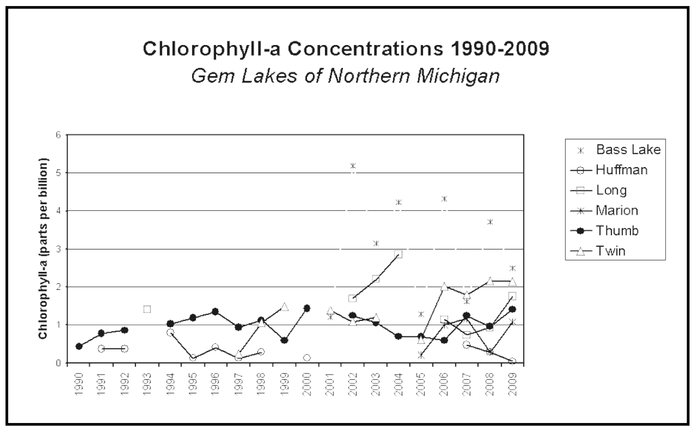
Secchi Disc

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 over 80 feet in large inland lakes and Great Lakes' bays!



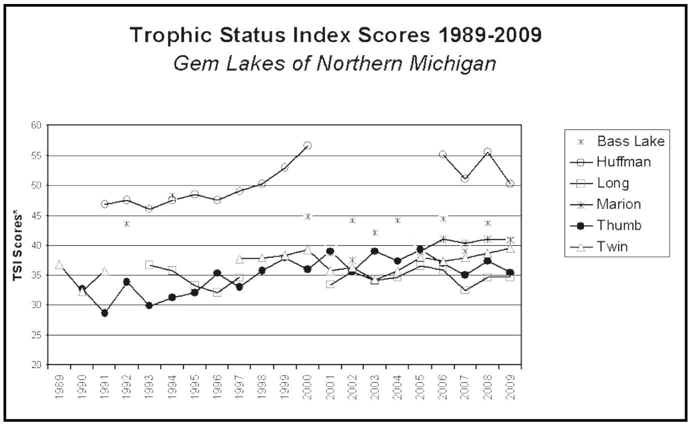
Chlorophyll-a

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 usually 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 data 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 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 generally shallow and nutrient rich. A highly productive eutrophic lake could have problems with oxygen depletion whereas the low-productivity oligotrophic lake may have a lackluster fishery. Mesotrophic lakes lie somewhere in between and are 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". Cultural eutrophication can affect the fisheries, lead to excessive plant growth, and result in algal blooms that can be both a nuisance and a public health concern.

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

Results from the Gem Lakes

The Gems currently monitored as part of the Volunteer Lake Monitoring Program include Bass, Deer, Huffman, Larks, Long, Marion, Thumb, and Twin Lakes. All the volunteers on the Gem Lakes are incredibly devoted to their respective lakes. Volunteer data stretches back to the late 1980s and early 1990s on four of these lakes !

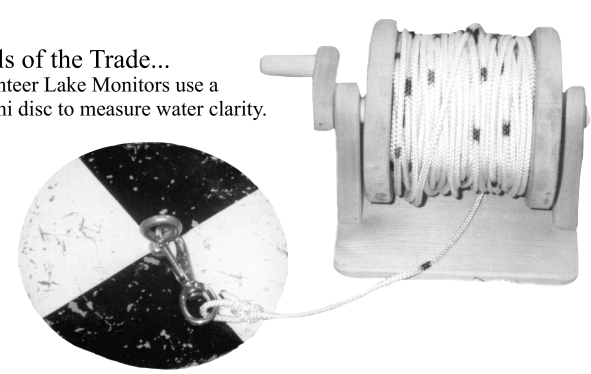
Watershed Council staff assess water quality and examine changes over time using the long-term Secchi disc and chlorophyll-a data from these lakes. Average Secchi disc depths have gone up and down in most of the Gem Lakes with no clear trends. Surprisingly, water clarity has decreased on both Huffman and Thumb Lakes. There have been algae blooms reported from Huffman Lake as well as signs of nutrient pollution documented during a shoreline survey, which may be responsible for the decrease in water clarity. A similar survey on Thumb Lake showed little evidence of nutrient pollution, but chlorophyll data collected by volunteers indicate that increases in phytoplanktonic algae correspond to the decrease in water clarity. The Thumb Lake scenario is a great example of how data from different parameters monitored by volunteers can be combined to assess changes in a lake, though it remains a mystery as to what has caused the increase in phytoplanktonic algae.

Biological productivity in the Gem Lakes ranges from oligotrophic (low productivity) to eutrophic (high productivity). Trophic status index scores indicate that Long and Thumb Lakes are consistently oligotrophic, Twin Lake wavers on the edge of oligotrophy and mesotrophy (moderately productive), Bass and Marion Lakes are usually categorized as mesotrophic, and Huffman Lake has moved from mesotrophic to eutrophic. Long, Thumb, and Twin Lakes are larger and deeper than the other lakes and therefore, not surprising that data classify them as oligotrophic. Bass, Huffman, and Marion Lakes are smaller and much shallower, such that one would expect them to be more biologically productive.

Volunteers are doing an excellent job of monitoring Northern Michigan's Gem Lakes. Without their dedication and enthusiasm, we would have much less data to assess lake health and fewer eyes on our precious waters. Thus, we can not thank our volunteers enough for the critical role they play in protecting the lakes of Northern Michigan. We and the waters of Northern Michigan are eternally grateful! Of course, there are many more Gems in Northern Michigan that need to be monitored, so please consider joining the program to protect these aquatic treasures.

If you would like to get involved or would like additional information, please contact the program coordinator, Kevin Cronk, at (231) 347-1181 ext. 109 or by e-mailing kevin@watershedcouncil.org.

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



*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.

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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.

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