Lakes at the Top of the Lower Peninsula

Douglas, Lancaster, Munro & Paradise Lakes

2012 Profile

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.

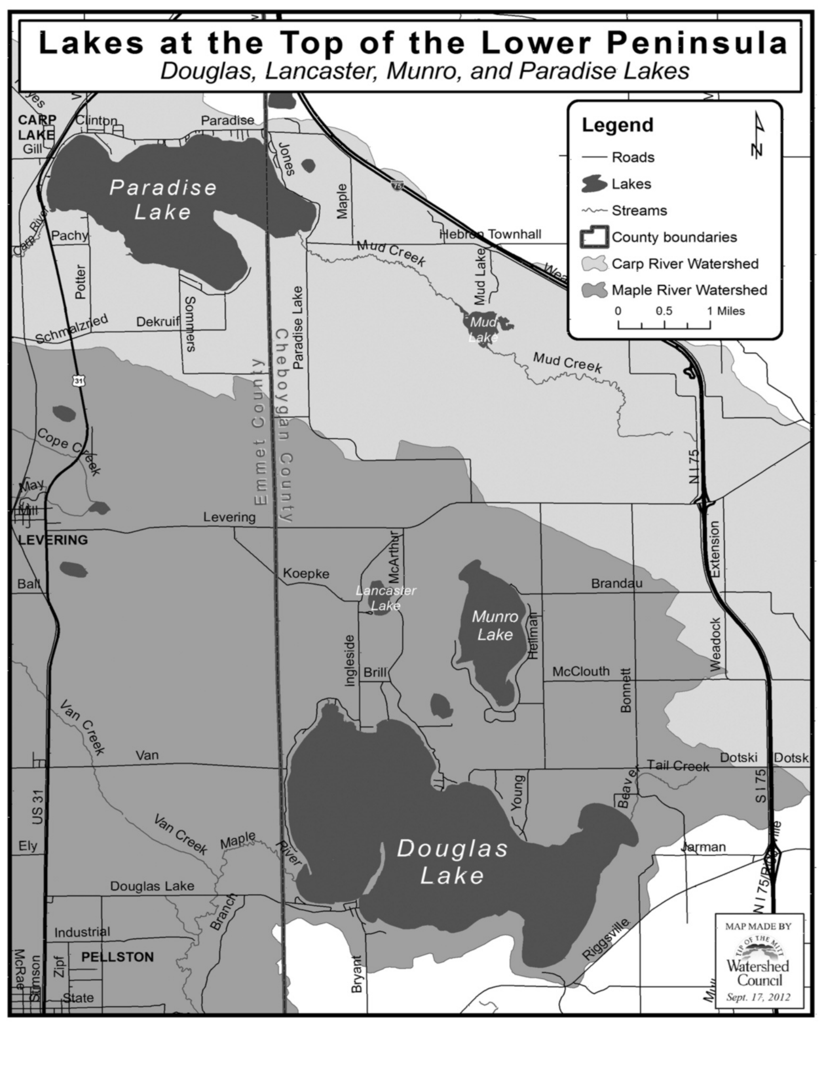
Water formed Michigan, frozen water that is, thousands of feet thick. A series of glaciers advanced and retreated across Michigan over the course of millions of years, creating the present-day landscape of rolling hills and broad plains dotted with lakes, crisscrossed with rivers, and surrounded by freshwater 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. At the top of the tip of the Lower Peninsula, Douglas, Lancaster, Munro, and Paradise Lakes stand out as truly magnificent water bodies. These lakes do indeed rise to the top, as thousands of people could tell you – those who have had the pleasure of experiencing and enjoying these lakes over the years. The Watershed Council has long recognized the value of these tip-top lakes and worked diligently for decades to protect their water quality and ecosystem integrity.

Lakes throughout Northern Michigan, whether large or small, are monitored by Watershed Council staff and volunteers alike who gather valuable data to keep tabs on the health of our waters. Currently 59 lakes and streams in the region are monitored in early spring 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 have ranged from lake-wide aquatic plant surveys to individual shoreline property restoration projects.

Details about recent projects involving the lakes at the top of the Lower Peninsula are included in this report. We hope you find the information presented 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

Tip of the Mitt Watershed Council has been consistently monitoring 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 burgeoned 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 the 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 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 23 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 Douglas, Lancaster, Munro, and Paradise Lakes. We have also included charts to provide a graphic display of trends occurring in these 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

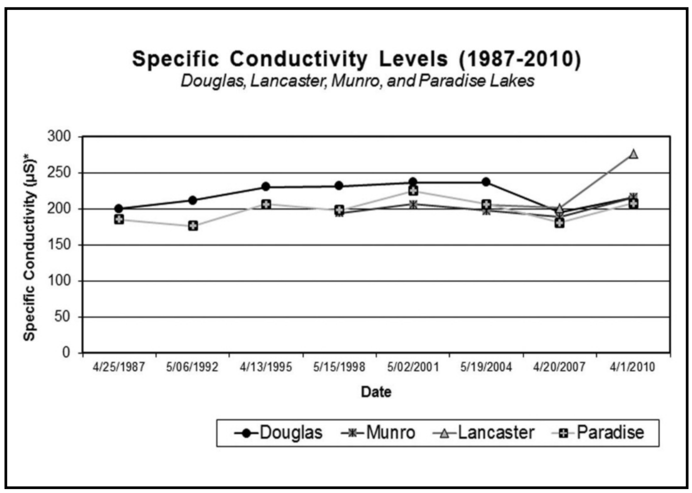
pH values provide a measurement of the acidity or alkalinity of water. Measurements above 7 are alkaline, 7 is considered neutral, and levels below 7 are acidic. State law requires that pH be maintained within a range of 6.5 to 9.0 in all waters of the state. When pH is outside this range, many aquatic organisms become stressed and populations of some species can become depressed or disappear entirely. Data collected from Douglas, Lancaster, Munro and Paradise Lakes show that pH levels consistently meet state standards, with a low of 7.08 (Douglas, 1992) and a high of 8.67 (Munro, 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. Springtime dissolved oxygen levels recorded at mid-depth and at the surface in these lakes have consistently exceeded State minimums, ranging from 5.4 PPM (Lancaster, 2004) to 13.1 PPM (Douglas, 1998). On several occasions, dissolved oxygen levels near the bottom of Lancaster Lake have been below 5 PPM. Oxygen depletion at the bottom is typical for many lakes, particularly small lakes like Lancaster with a deep hole (52 acres and 57' deep), though it can be an indicator of water quality impairment.

Conductivity

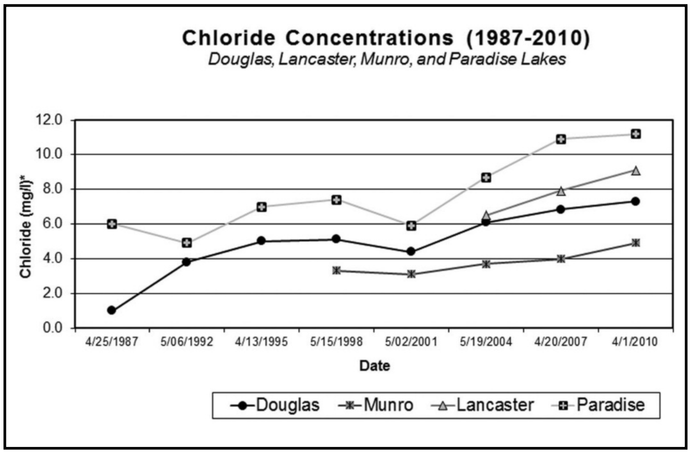
Conductivity is a measure of the ability of water to conduct an electric current, which is dependent upon the concentration of charged particles (ions) dissolved in the water. Research shows that conductivity is a good indicator of human impacts on aquatic ecosystems because levels usually increase as population and human activity in the watershed increase. Readings from lakes monitored by the Watershed Council have ranged from 175 to 656 microSiemens (µS). Measurements from the lakes at the top of the Lower Peninsua have ranged from a low of 176 µS (Paradise, 1992) to a high of 408 µS (Lancaster, 2012). Douglas and Paradise Lakes, with the longest-term datasets, experienced a gradual increase in conductivity levels from 1987 to 2004, followed by a large decrease in 2007. Although uncertain as to why levels decreased, data from 2010 indicate that conductivity levels may again be on an upward trend.



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

Chloride

Chloride, a component of salt, is present naturally at low levels in Northern Michigan surface waters due to the marine origin of the underlying bedrock (typically < 5 PPM). Human activity in a watershed and associated water quality impacts can be assessed by monitoring chloride because 1) many products associated with people contain chloride (e.g., de-icing salts, water softener salts, fertilizers, and bleach), and 2) chloride is a "mobile ion," meaning it is not removed by chemical or biological processes in soil or water. Chloride concentrations have increased over time in all four of the lakes in the top of the Lower Peninsula; from as low as 1 ppm in Douglas Lake in 1987 to 12.2 PPM in Paradise Lake in 2007. Michigan has not set limits for chloride in surface waters, though the United States Environmental Protection Agency (USEPA) recommends that 230 parts per million (ppm) be established for chronic toxicity and 860 ppm for acute toxicity. Current chloride concentrations in Northern Michigan lakes and streams are far below the USEPA recommended limits, but regardless, increases are indicative of anthropogenic impacts from other associated pollutants that reach our waterways (such as automotive fluids from roads or nutrients/bacteria from septic systems).



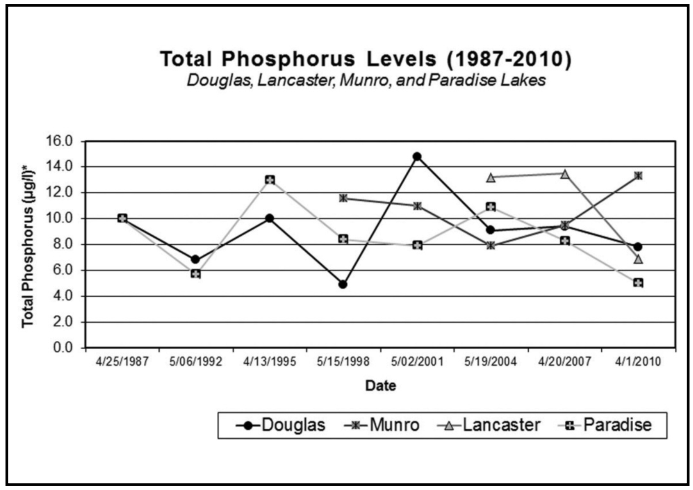
Nutrients

Nutrients are needed by organisms to live, grow, and reproduce; occurring naturally in soils, water, air, plants, and animals. Phosphorus and nitrogen are essential nutrients for plant growth and important for maintaining healthy, vibrant aquatic ecosystems. However, excess nutrients from sources such as fertilizers, faulty septic systems, and stormwater 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

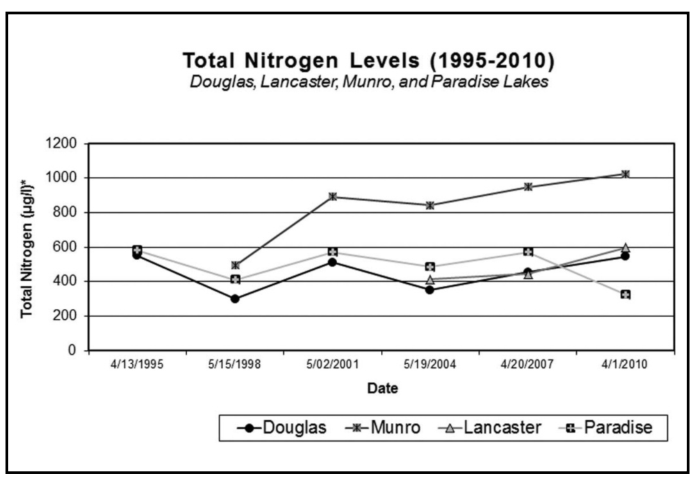
Phosphorus is the most important nutrient for plant productivity in our lakes because it is usually in shortest supply relative to nitrogen and carbon. A water body is considered phosphorus limited if the ratio of nitrogen to phosphorus is greater than 15:1. Most lakes monitored by the Watershed Council are found to be phosphorus limited.

Because of the negative impacts that phosphorus can have on surface waters, legislation has been passed in Michigan to ban phosphorus in soaps, detergents, and fertilizers. Water quality standards for nutrients in surface waters have not been established, but total phosphorus concentrations are usually less than 10 parts per billion (PPB) in the high quality lakes of Northern Michigan. Total phosphorus concentrations at the surface in Douglas, Lancaster, Munro, and Paradise Lakes have ranged from 4.9 PPB (Douglas, 1998) to 14.8PPB (Douglas, 2001). There are no clearly defined trends in the phosphorus data from these lakes.



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 fixing nitrogen directly from the atmosphere to compete in low-nitrogen environments (blue-green algae), while others thrive in nitrogen-rich environments (some diatom species). Total nitrogen levels in Douglas, Lancaster, Munro, and Paradise Lakes have ranged from 298 PPB (Douglas, 1998) to 1022 PPB (Munro, 2010). Nitrogen concentrations have increased over time in Munro and Lancaster Lakes, which could be the result of runoff from adjacent agricultural areas.



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

Comprehensive Water Quality Monitoring Program

How do Douglas, Lancaster, Munro and Paradise Lakes compare?

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

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	4/14/10	11.21	335.3	8.53	11	584	8.8	42.9
Bear River	3/24/10	13.05	283.1	8.30	192	433	16.2	14.3
Bellaire Lake	4/23/10	11.19	315.9	8.29	347	452	3.7	10.7
Ben-way Lake	4/6/10	11.06	358.0	11.32	406	567	6.4	10.8
Birch Lake	4/14/10	11.36	271.6	8.43	3	273	5.7	20.5
Black Lake	4/28/10	10.87	289.3	8.34	27	265	6.8	6.0
Black River	4/15/10	10.54	254.1	8.16	20	308	4.0	4.3
Boyne River	3/26/10	12.71	359.0	8.45	390	626	7.0	11.4
Burt Lake	4/28/10	10.68	297.2	8.32	94	240	3.7	11.5
Charlevoix, Main Basin	4/19/10	12.52	272.7	8.38	343	474	1.4	11.1
Charlevoix, South Arm	4/19/10	11.80	280.8	8.34	427	547	1.3	9.9
Cheboygan River	4/15/10	9.41	285.0	8.35	34	269	2.9	8.5
Clam Lake	4/23/10	10.76	317.6	8.25	322	423	2.7	10.0
Crooked Lake	3/24/10	11.72	252.8	8.51	269	443	8.7	8.7
Crooked River	4/21/10	10.76	293.9	8.50	137	296	4.5	9.4
Deer Lake	3/26/10	11.63	265.4	8.45	53	411	4.6	15.2
Douglas Lake	**3/30/10**	**11.27**	**214.8**	**8.25**	**55**	**544**	**7.8**	**7.3**
Elk Lake	4/19/10	12.80	246.7	8.35	193	411	9.6	9.8
Elk River	4/14/10	12.49	261.3	8.51	205	313	2.0	10.0
Ellsworth Lake	3/29/10	10.39	374.8	8.09	404	696	7.0	11.6
Hanley Lake	4/5/10	10.53	367.3	8.27	451	725	3.0	10.9
Huffman Lake	3/26/10	10.66	287.2	8.36	84	248	2.3	4.5
Huron, Duncan Bay	4/22/10	10.85	278.6	8.36	77	322	3.6	9.7
Indian River	4/21/10	11.32	301.4	8.48	75	226	1.6	12.4
Intermediate Lake	4/23/10	10.63	344.8	8.25	363	458	3.2	11.8
Jordan River	3/29/10	10.22	340.5	8.22	1122	1567	8.3	7.1
Lancaster Lake	**4/1/10**	**8.49**	**276.0**	**7.72**	**75**	**596**	**6.9**	**9.1**
Larks Lake	3/30/10	11.62	213.0	8.51	76	706	4.8	4.3
Little Sturgeon River	4/21/10	11.36	320.1	8.35	54	228	2.9	14.5
Long Lake	4/15/10	11.17	206.2	8.19	57	355	6.3	9.0
Maple River	4/22/10	10.30	275.9	8.16	308	544	4.5	6.4
Marion Lake	5/10/10	no data	no data	no data	<1	482	9.0	22.2
Michigan, Bay Harbor	5/3/10	11.31	277.0	8.16	284	493	2.2	14.8
Michigan, Grand Traverse Bay	4/28/10	12.40	241.1	8.26	251	360	1.4	11.8
Michigan, Little Traverse Bay	5/10/10	12.03	244.5	8.29	268	373	2.2	12.8
Mullett Lake	4/22/10	11.63	298.0	8.37	56	287	2.7	11.7
Munro Lake	**4/1/10**	**11.55**	**215.4**	**8.41**	**36**	**1022**	**13.3**	**4.9**
Nowland Lake	4/14/10	11.09	190.1	8.47	7	583	5.4	6.2
Paradise Lake	**4/22/10**	**10.59**	**207.2**	**8.30**	**8**	**325**	**5.0**	**11.2**
Pickerel Lake	3/24/10	11.26	261.6	8.26	183	453	3.1	7.3
Pigeon River	4/21/10	10.09	341.5	8.37	35	233	3.8	6.5
Pine River, Charlevoix	4/14/10	12.42	268.2	8.36	273	349	0.5	11.2
Round Lake (Emmet Cty)	3/30/10	11.95	306.3	8.52	49	739	2.9	25.9
Silver Lake (Wolverine)	4/20/10	10.65	194.4	8.35	26	247	3.3	4.9
Six-mile Lake	3/29/10	10.52	333.5	8.14	279	541	4.4	7.2
Skegemog Lake	4/19/10	10.87	255.8	8.45	186	292	1.4	9.6
Spring Lake	3/24/10	12.46	529.9	8.21	1397	1457	5.3	90.0
St. Clair Lake	3/29/10	10.49	351.0	8.14	260	560	5.4	8.8
Sturgeon River	4/22/10	11.03	374.0	8.33	194	273	1.0	13.9
Susan Lake	3/26/10	12.04	282.7	8.36	111	685	8.0	10.5
Thumb Lake	4/1/10	10.99	200.7	8.22	38	301	10.0	5.1
Torch Lake	4/23/10	12.39	260.3	8.31	270	371	0.7	8.0
Twin Lakes	4/23/10	11.49	259.6	8.32	27	393	9.7	2.2
Walloon, Foot	4/28/10	10.31	265.5	8.29	75	316	3.2	12.8
Walloon, Mud Basin	4/28/10	9.14	296.8	8.30	25	371	9.3	16.4
Walloon, North Arm	4/28/10	9.53	298.0	8.32	194	539	5.3	14.5
Walloon, West Arm	4/28/10	10.66	259.8	8.29	134	377	3.0	11.1
Walloon, Wildwood Basin	4/28/10	10.29	260.6	8.32	68	274	3.4	12.3
Wildwood Lake	4/20/10	10.35	295.0	8.38	<1	332	11.9	16.0
Wilson Lake	4/7/10	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

Deep Roots on Douglas Lake

Douglas Lake, a 3,700 acre lake in Northern Cheboygan County, is the cherished home of both the Douglas Lake Improvement Association (DLIA) and the University of Michigan Biological Station (UMBS). It is also the birth place of the Tip of the Mitt Watershed Council; our organization and name conceived during a meeting in a small rustic cabin on the shores of Douglas at UMBS. Our roots grow deep on Douglas and are ever intertwined with UMBS and DLIA as we work collaboratively with both on many fronts.

Over the years, the Watershed Council has worked closely with UMBS staff, teaching faculty, and researchers to share information and coordinate monitoring, surveys, and assessments of local water bodies. We meet with faculty and researchers at least once a year and provide a list of research ideas for class projects that further our efforts to protect Northern Michigan water resources. In turn, UMBS provides invaluable services to the Watershed Council, sharing research findings and providing discounted chemical analyses of water samples. Recently, we worked with UMBS staff to install a native plant-based rain garden in front of their lecture hall where we held our 2012 annual meeting. UMBS Director, Knute Nadelhoffer, was our keynote speaker.

In terms of assessments, the Watershed Council performed shoreline surveys on Douglas Lake in 1988 and 2002 that were at least partly sponsored by DLIA. This year, we worked with DLIA and UMBS to carry out a comprehensive aquatic plant survey on the Lake. After an invasive species presentation given by Watershed Council staff at a DLIA annual meeting a few years ago, association members grew increasingly concerned about the proliferation of invasive species and the potential for some of these, particularly Eurasian watermilfoil, to invade Douglas Lake. Following conversations between DLIA, UMBS, and the Watershed Council, it was decided that the summer UMBS limnology class would take on the aquatic plant survey and the Watershed Council would pick up where the class left off and complete the survey.

Watershed Council staff provided training for the students to teach them methodologies and plant identification and then, impressively, the students collected data at 135 sites on the lake during their field semester! The Watershed Council followed through and finished the survey during the fall. The aquatic plant survey report will be completed in the winter of 2013; a final product that showcases the intimate and productive relationship between DLIA, UMBS, and the Watershed Council.

View of Douglas Lake from the observation deck at the University of Michigan Biological Station

Volunteer Lake Monitoring

Local Volunteers Monitor & Protect Our Lakes

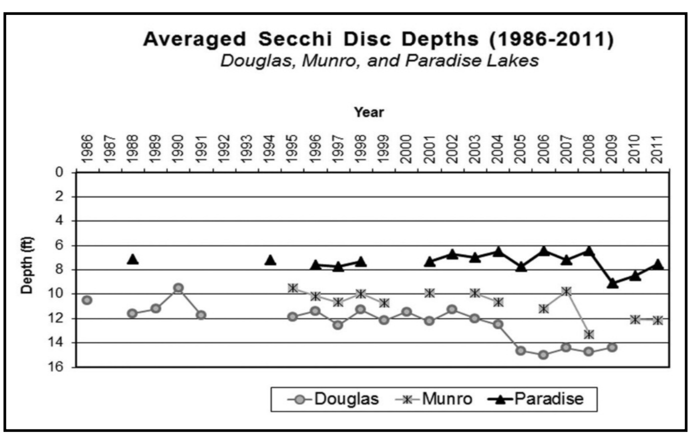
Since 1984, Tip of the Mitt Watershed Council has coordinated the Volunteer Lake Monitoring program (VLM), relying upon hundreds of volunteers to monitor the water quality of dozens of lakes in the northern Lower Peninsula of Michigan. During the most recent summer for which data are available (2011), 61 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). These data are 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 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 Douglas, Munro and Paradise Lakes over the past few decades. The following section summarizes the parameters monitored and results.

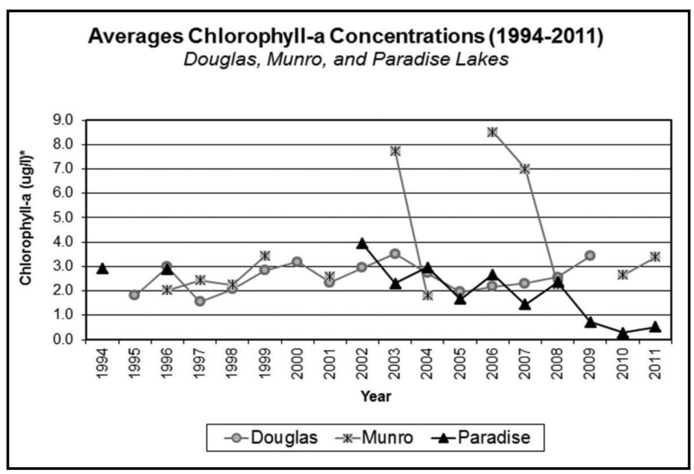
Secchi Disc

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. The clarity of water, which is principally determined by the concentration of algae and/or sediment in the 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 types 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 estimate 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

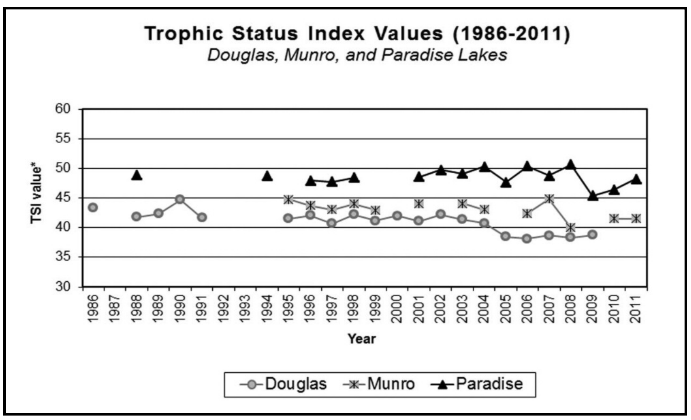
Trophic Status Index (TSI) is a tool developed by Bob Carlson, Ph.D. from Kent State University, to determine the biological productivity of a lake. Formulas developed to calculate the TSI value utilize data collected by our volunteers. TSI values range from 0 to 100. Lower values (0-38) indicate an 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

*Unit description: μg/l = parts per billion 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.

(2011 TSI Values for all lakes on back page.)



Results from Douglas, Munro and Paradise Lakes

Volunteers on Douglas, Munro, and Paradise Lakes monitor water quality at the deepest locations of each of these lakes. Douglas Lake has been monitored since 1986, Paradise since 1988, and Munro since 1995. There are gaps in the data for all three lakes during seasons when volunteers were not available to monitor or when they were unable to collect a sufficient amount of data during the summer to make results comparable. Regardless, efforts by dedicated volunteers have provided a robust dataset for assessing water quality and examining changes over time.

Since 2002, water transparency has increased in Douglas Lake from approximately 12 feet of depth to nearly 15 feet. Munro and Paradise Lakes also show signs of increasing water transparency in recent years, though trends are not as well pronounced. The introduction of zebra mussels into Douglas and Paradise Lakes, which is thought to have occurred in the last ten years on both lakes, provides a plausible explanation for these trends. Zebra mussels are filter-feeders that prey upon algae and essentially clear the water column, which would explain the increase in water transparency. Unfortunately, zebra mussels are not cleaning the water, but rather removing the algae that are the base of the food chain. This loss of primary productivity (i.e., algae) alters the entire food web, ultimately leading to a reduction in top predator fish populations, such as trout or walleye.

Chlorophyll-a data collected by volunteers should reflect the loss of primary productivity, since it essentially provides a measure of planktonic algae in the water column. In the case of Paradise Lake, the chlorophyll-a data support the hypothesized impact of zebra mussels because concentrations began to decrease in 2008, which is when water clarity sharply increased. Chlorophyll-a levels in Douglas Lake also decreased in tandem with increasing water transparency, but within a few years, chlorophyll-a concentrations began increasing again and by 2009, were back to former levels.

The trophic status index scores show that Douglas and Paradise Lakes have become less biologically productive, which is expected due to zebra mussels. Douglas Lake historically fell into the mesotrophic or moderately productive category, but zebra mussel impacts have pushed scores down to where it now borders on oligotrophy (low biological productivity). Zebra mussels have also altered the biological productivity of Paradise Lake, which once wavered on the edge of eutrophy (highly productive), but now consistently scores in the mesotrophic category. Munro Lake has been consistently mesotrophic, though closer to oligotrophic during recent years. It will be interesting to see how conditions change in these lakes; whether zebra mussels continue to alter the ecosystems of Douglas and Paradise Lakes and if recent trends in Munro continue.

Volunteers continue to provide an invaluable service by monitoring Douglas, Munro, and Paradise Lakes. Without their dedication and enthusiasm, we would have much less data to assess lake health and fewer eyes on our precious waters. We cannot thank our volunteers enough for the critical roles they play in helping protect the lakes of Northern Michigan. We and the waters of Northern Michigan are eternally grateful! Of course, new monitors are always needed, so please consider joining the program to help protect and preserve the lakes at the top of the Lower Peninsula.

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.

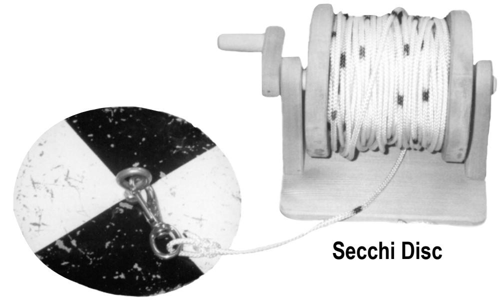
Thank you

Volunteer Lake Monitors

Richard Segrist
(Douglas Lake)

Beverly Zelt
(Munro Lake)

Richard Elliot
(Paradise Lake)



Secchi Disc

* 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 2011

Lake	TSI*	Lake	TSI*	Lake	TSI*
Bass Lake	45	Lake Marion	43	Six Mile Lake	46
Black Lake	39	Lake Michigan, Bay Harbor	27	Thayer Lake	43
Burt Lake, Central Basin	36	Lake Michigan, Little Traverse Bay	29	Thumb Lake	35
Burt Lake, North	37	Lake Skegemog	39	Twin Lake	42
Burt Lake, South	35	Long Lake, Cheboygan County	38	Walloon Lake, Foot Basin	38
Crooked Lake	46	Mullett Lake, Center	37	Walloon Lake, North	42
Douglas Lake - Cheboygan	41	Mullet Lake, Pigeon Bay	37	Walloon Lake, West Arm	39
Douglas Lake - Otsego	41	Munro Lake	42	Walloon Lake, Wildwood	37
Elk Lake	36	Paradise Lake	48		
Lake Charlevoix, South Arm	36	Pickerel Lake	44		

* 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.

THANK YOU

We would like to thank the UMBS Limnology class for assisting us with an aquatic plant survey on Douglas Lake this past summer.

Top: UMBS boats heading out past Pells Island to sample.

Top Left: Mandy Bromilow, Miranda Steffler and Tessa Diem, sampling plants in Marl Bay on douglas Lake.

Bottom Left: The photo keeps record of the plants found at site 517 on Douglas Lake.

Right: The sampling equipment includes a grappling hook, GPS, depth finder, compass, notebook, whirlpacks, sunscreen, lunches, clipboards and sorting pan.