MI/DEQ/WRD-13/007

Cooperative Lakes Monitoring Program

Michigan's Citizen Volunteer
Partnership for Lakes

"MI Lakes - Ours to Protect"

ANNUAL SUMMARY REPORT

2012

Michigan's Citizen Volunteers
Michigan Lake & Stream Associations, Inc.
Michigan Department of Environmental Quality
Michigan State University Department of Fisheries and Wildlife
Great Lakes Commission
Huron River Watershed Council

Michigan Clean Water Corps
www.micorps.net

Michigan's Lakes and the Tragedy of the Commons

In 1968, Garrett Hardin published his classic environmental essay *The Tragedy of the Commons* in the journal *Science*. In it he succinctly depicted the degradation and exploitation of the environment to be expected whenever many individuals share a common resource, such as federal rangeland, state and national parks, the atmosphere, streams and lakes. Using a community pasture as an example, he explained how each herder added more and more animals to his herd until the pasture was destroyed by overgrazing. Each herder benefited monetarily by adding animals to his herd, but bore no responsibility for the pasture and its sustainability.

While Hardin popularized the tragedy of the commons, others before him identified the characteristic fate of common property. In fact, two thousand years ago, Aristotle in his book *Politics* stated, "what is common to the greatest number has the least care bestowed upon it. Everyone thinks chiefly of his own, hardly at all of the common interest". Lakes and streams are clearly a common property, shared by the riparian property owners and the community of citizens who use and enjoy the water, fish, wildlife and aesthetic appeal.

True to the tragedy of the commons, most lakes provide countless hours of recreational enjoyment for numerous users. Some receive waste discharges from municipal and industrial sources. Nearly all are impacted by urban and agricultural development and stormwater runoff, septic systems and lawn fertilizers, increasing weed growth, algae blooms and muck accumulation. Very few are managed to sustain their quality for future generations. With over 11,000 lakes in Michigan, limited state agency staff can provide only partial oversight and must concentrate on the most serious problems. Local governments, although possessing management tools like Lake Improvement Boards and Watershed Councils, address police and fire protection, schools, infrastructure development, and waste management as higher priorities. Riparian property owners who should be the leading advocates for lake protection and promoting collaborative management partnerships are more often interested in recreational activities such as swimming, fishing and boating.

Unfortunately, most lakes are fulfilling Hardin's principle of the tragedy of the commons. Only a few exceptional communities are proof that the principle is not an irrefutable law of human society. When communities accept ownership in their natural resources, lakes and streams can be high quality, sustainable commons. The more each lake owner and user invests in this responsibility, the more certain our children will be that they will “inherit our water resources in the same quality that we the present generation borrowed it from them”. Working together we can protect Michigan’s lakes!

Cooperative Lakes Monitoring Program

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DATA CORRECTIONS FROM PREVIOUS REPORTS

There are no known errors to report.

If you believe that the tabulated data for your lake in this Report are in error please contact Bill Dimond, CLMP program coordinator by telephone at 517-241-9565 or email at dimondw@michigan.gov. It is important for the credibility of the CLMP that all data be accurately reported. When tabulation and reporting errors are found they need to be identified and a correction statement issued. We appreciate your support in the review of CLMP data and maintaining a high level of quality for the program.

INTRODUCTION

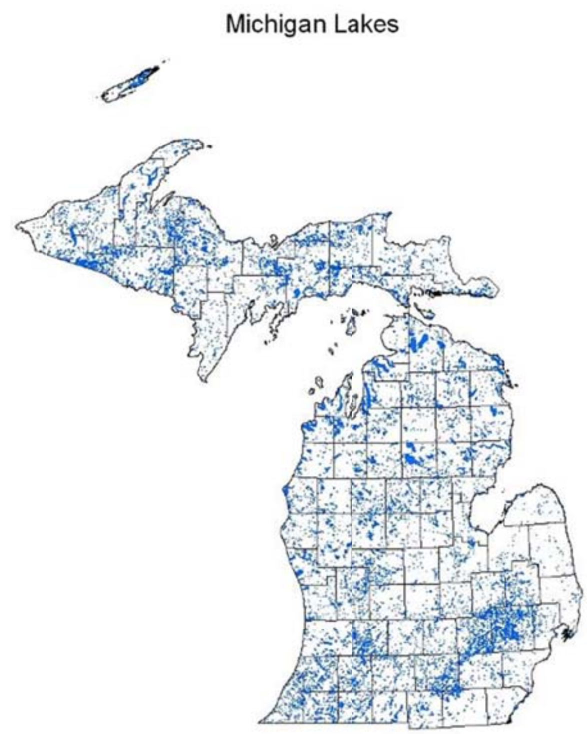
Michigan's unique geographical location provides its citizens with a wealth of freshwater resources including over 11,000 inland lakes. In addition to being valuable ecological resources, lakes provide aesthetic and recreational value for the people of Michigan and neighboring states. An ideal Michigan summer pastime is going to a cottage on an inland lake to fish, water-ski, swim, and relax.

As more and more people use the lakes and surrounding watersheds, the potential for pollution problems and use impairment increases dramatically. Although many of Michigan's inland lakes have a capacity to accommodate the burden of human activities in the short term, continuing stress on the lakes and lake watersheds over time will ultimately lead to adverse water quality and recreational impacts.

Reliable information including water quality data, levels of use, and use impairment are essential for determining the health of a lake and for developing a management plan to protect the lake. As the users and primary beneficiaries of Michigan's lake resources, citizens must take an active role in obtaining this information and managing their lakes.

To meet this need, the Department of Environmental Quality (DEQ), Michigan Lake & Stream Associations (MLSA), the Great Lakes Commission, the Huron River Watershed Council, and Michigan State University have partnered to implement the Cooperative Lakes Monitoring Program (CLMP). The purpose of this effort is to help citizen volunteers monitor indicators of water quality in their lake and document changes in lake quality. The CLMP

Michigan's abundant water resources...



Source: Michigan Department of Natural Resources

...include over 11,000 inland lakes.

provides sampling methods, training, workshops, technical support, quality control, and laboratory assistance to the volunteer monitors. Michigan State University's Department of Fisheries and Wildlife supports the partnership with technical assistance.

THE SELF-HELP LEGACY

Originally known as the Self-Help Program, the CLMP continues a long tradition of citizen volunteer monitoring. Michigan has maintained a volunteer lake monitoring program since 1974, making it the second oldest volunteer lake monitoring program in the nation. The original program monitored water quality by measuring water clarity with a Secchi disk.

In 1992, the former Department of Natural Resources and MLSA entered into a cooperative agreement to expand the program. An advanced Self-Help program was initiated that included a monitoring component for the plant nutrient phosphorus. In 1994, a side-by-side sampling component was added to the program to assure the quality of the data being collected.

The CLMP continues the "self-help" legacy by providing citizens an opportunity to learn and participate in lake management. Currently, the CLMP supports monitoring components for Secchi disk transparency, total phosphorus, chlorophyll *a*, dissolved oxygen/temperature and aquatic plants.

The CLMP is a cost-effective process for the DEQ to increase the baseline data available for Michigan's lakes as well as establish a continuous data record for determining water quality trends. Therefore the DEQ/citizen volunteer partnership is critical to lake management in Michigan.

CLMP Contacts

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http://www.micorps.net

CLMP and MiCorps

The CLMP is also a principal program within the Michigan Clean Water Corps (MiCorps), a network of volunteer monitoring programs in Michigan. MiCorps was created through an executive order by former Governor Jennifer Granholm to assist the DEQ in collecting and sharing water quality data for use in management programs and to foster water resource stewardship. MiCorps provides volunteer monitoring programs with many services including:

Training programs,
A web site-*www.micorps.net*,
A data exchange network,
An email list serve,
An annual conference, and
A monitor's newsletter.

The mission of MiCorps is to network, support, and expand volunteer water quality monitoring organizations across the state. To learn more about MiCorps visit www.micorps.net.

Michigan Clean Water Corps

LAKE QUALITY

A lake's condition is influenced by many factors, such as the amount of recreational use it receives, shoreline development, and water quality. Lake *water quality* is a general term covering many aspects of chemistry and biology. The health of a lake is determined by its water quality.

CLMP Goals

- Provide baseline information and document trends in water quality for individual lakes.
- Educate lake residents, users, and interested citizens in the collection of water quality data, lake ecology, and lake management practices.
- Build a constituency of citizens to practice sound lake management at the local level and to build public support for lake quality protection.
- Provide a cost-effective process for the DEQ to increase baseline data for lakes state-wide.

CLMP Measurements

- Secchi disk transparency
- Spring total phosphorus
- Exotic aquatic plant watch
- Summer total phosphorus
- Chlorophyll *a*
- Dissolved oxygen and temperature
- Aquatic plant identification and mapping

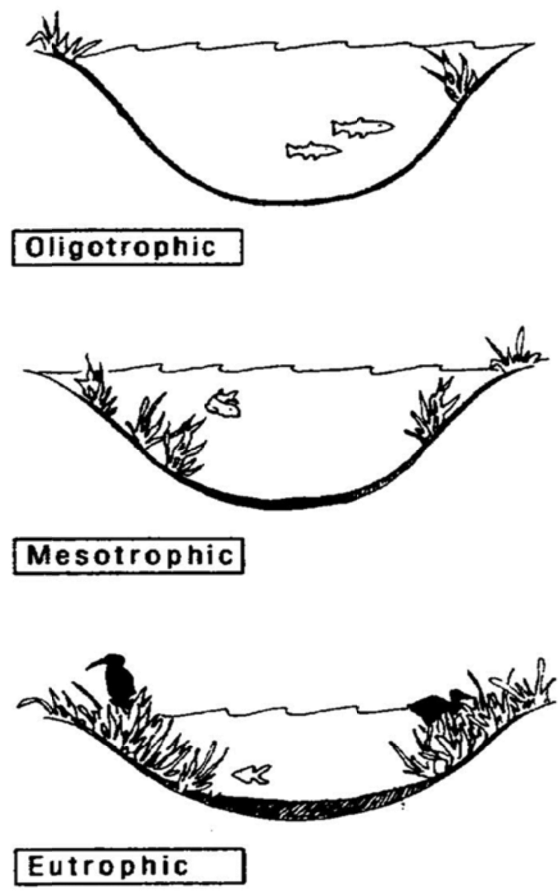
Increasing lake productivity can impact water quality and result in problems such as excessive weed growth, algal blooms, and mucky bottom sediments. *Productivity* refers to the amount of plant and animal life that can be produced within the lake.

Plant *nutrients* are a major factor that cause increased productivity in lakes. In Michigan, *phosphorus* is the nutrient most responsible for increasing lake productivity.

The CLMP is designed to specifically monitor changes in lake productivity. The current program enlists citizen volunteers to monitor water clarity, the algal plant pigment chlorophyll *a* and dissolved oxygen throughout the summer months and total phosphorus during the spring and late summer. These parameters are indicators of primary (algal) productivity and, if measured over many years, may document changes in the lake.

CLASSIFYING LAKES

A lake's ability to support plant and animal life defines its level of productivity, or *trophic state.* Lakes are commonly classified based on their productivity. Low productive *oligotrophic* lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient *dissolved oxygen* in the cool, deep-bottom waters during late summer to support cold water fish, such as trout and whitefish. By contrast, high productive *eutrophic* lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warm water fish, such as bass and pike. Lakes that fall between these two classifications are called *mesotrophic* lakes. Lakes that exhibit extremely high productivity, such as nuisance algae and weed growth are called *hypereutrophic* lakes.



Possible trophic states of inland lakes.
(Source: Hamlin Lake Improvement Board)

EUTROPHICATION

The gradual increase of lake productivity from oligotrophy to eutrophy is called lake aging or *eutrophication.* Lake eutrophication is a natural process resulting from the gradual accumulation of nutrients, increased productivity, and a slow filling in of the lake basin with accumulated sediments, silt, and muck. Human activities can greatly speed up this process by dramatically increasing nutrient, soil, or organic matter input to the lake. This human influenced, accelerated lake aging process is known as *cultural eutrophication.* A primary objective of most lake management plans is to slow down cultural eutrophication by reducing the input of nutrients and sediments to the lake from the surrounding land.

MEASURING EUTROPHICATION

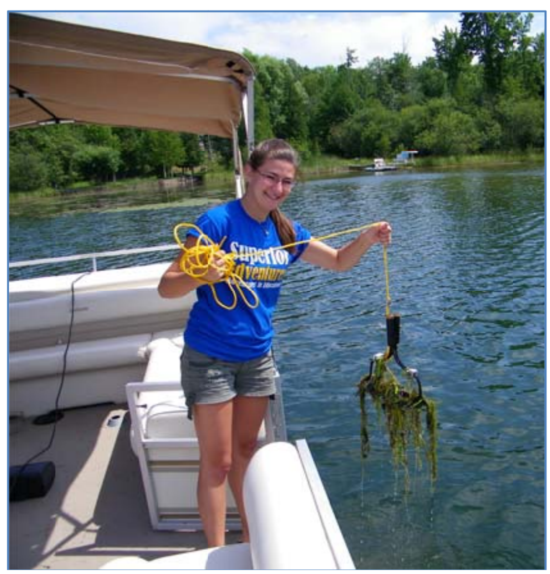
Measuring a lake's water quality and eutrophication is not an easy task. Lakes are a complex ecosystem made up of physical, chemical, and biological components in a constant state of action and interaction.

As on land, plant growth in lakes is not constant throughout the summer. Some species mature early in the season, die back, and are replaced by other species in a regular succession.

While overall population levels often reach a maximum in mid-summer, this pattern is influenced or altered by numerous factors, such as temperature, rainfall, and aquatic animals. For the same reasons lakes are different from week to week, lake water quality can fluctuate from year to year.

Given these factors, observers of lake water quality must train themselves to recognize the difference between short-term, normal fluctuations and long-term changes in lake productivity (e.g., eutrophication). Many years of reliable data collected on a consistent and regular basis are required to separate true long-term changes in lake productivity from seasonal and annual fluctuations.

(Above) Young CLMP volunteers examine a piece of bladderwort, a native aquatic plant they have collected from Lake Margrethe in Crawford County. These boys helped a group of adult volunteers survey the aquatic vegetation in the lake as part of the CLMP Aquatic Plant Identification and Mapping program. Excessive or rapid aquatic plant growth can be a sign of lake eutrophication. (Below) CLMP assistant Paige Filice demonstrates plant collection techniques on Spider Lake in Grand Traverse County (MiCorps photos by Paige Filice and Jo Latimore).



Important Measures of Eutrophication

Nutrients are the leading cause of eutrophication. Nitrogen and *phosphorus* both stimulate plant growth. Both are measured from samples of water and reported in units of µg/l (micrograms per liter), or ppb (parts per billion). *Phosphorus* is the most important nutrient affecting lake productivity, and is often used directly as a measure of eutrophication.

Plants are the primary users of nutrients. *Chlorophyll a* is a component of the cells of most plants, and can be used to measure the concentration of small plants in the water, such as algae. *Chlorophyll a* is measured from samples of water and reported in units of µg/l. Macrophytes are aquatic plants with stems and leaves. The location of different species of plants can be mapped, and the density can be measured in pounds of plants per acre of lake.

***Transparency*,** or the clarity of water, is measured using a device known as a *Secchi disk*. This is an eight inch diameter target painted black and white in alternate quadrants. The disk is attached to a marked line, or measuring tape, and lowered from a boat into the lake. The distance into the water column the disk can be seen is the transparency, measured in feet or meters. A short distance of visibility means that there are suspended particles or algae cells in the water, an indication of nutrient enrichment.

Dissolved Oxygen *(DO)* which is oxygen dissolved in the water, is necessary to sustain fish populations. Fish, such as trout, require more DO than warm water species. Eutrophic lakes occasionally have levels of DO below the minimum for fish to survive, and fish kills can result.

Sediments can be measured to determine how fast material is depositing on the bottom. This may indicate watershed erosion, or a large die-off of aquatic plants.

Fish can be sampled using nets. In an oligotrophic lake there are likely to be cold water species, such as trout. Warm water fish, such as sunfish, bass, bullheads, and carp are more typical of a eutrophic lake.

Temperature affects the growth of plants, the release of nutrients, and the mixing of layers of water in the lake. Temperature measurements can determine if mixing occurs, moving nutrients from the lake bottom up into the surface waters promoting algae blooms.

LAKE PRODUCTIVITY INDEX (TSI)

The general lake classification scheme described on page four puts lakes into four categories depending on biological productivity level, or trophic state: oligotrophic, mesotrophic, eutrophic, hypereutrophic. While these categories are convenient, they are somewhat misleading because in reality, lake water quality is a continuum progressing from very good to very poor conditions. A more precise method of describing the productivity of a lake is to use a numerical index calculated directly from water quality data. The CLMP uses Carlson's (1977) *Trophic State Index* (TSI), to describe the productivity of the lakes enrolled in the program.

Carlson developed mathematical relationships for calculating the TSI from summer measurements of Secchi depth transparency, chlorophyll *a*, and total phosphorus in lakes. These parameters are good indirect measures of a lake's productivity, with chlorophyll *a* the most direct trophic state indicator . The TSI expresses lake productivity on a continuous numerical scale from 0 to 100, with increasing numbers indicating more eutrophic conditions. The zero point on the TSI scale was set to correlate with a Secchi transparency of 64 meters (210 feet).

The computed TSI values for an individual lake can be used for comparison with other lakes, to evaluate changes within the lake over time, and to estimate other water quality parameters within the lake. You can use the chart on the next page to convert measured parameter values to TSI values to determine the trophic status category. Michigan generally classifies a TSI <38 as oligotrophic, 38-48 as mesotrophic, 48-61 as eutrophic, and >61 as hypereutrophic. Please note that the dividing lines between the trophic status categories are somewhat arbitrary since lake water quality is a continuum and there is no broad agreement among lake scientists as to the precise point of change between each of these classifications.

Carlson's TSI Equations

$$TSI_{SD} = 60 - 33.2 \log_{10} SD$$

$$TSI_{TP} = 4.2 + 33.2 \log_{10} TP$$

$$TSI_{CHL} = 30.6 + 22.6 \log_{10} CHL$$

where,
SD = Secchi depth transparency (m)
TP = total phosphorus concentration (µg/l)
CHL = chlorophyll *a* concentration (µg/l)

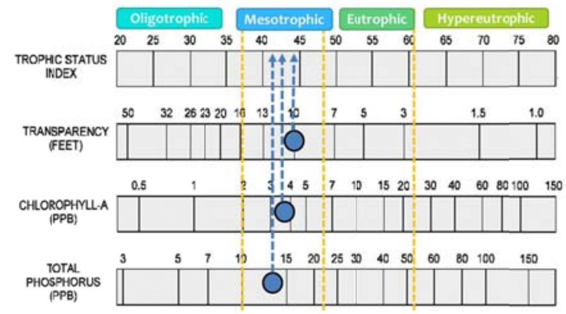
Bill Dimond (lower right) of the Michigan Department of Environmental Quality (DEQ) joins CLMP volunteers Duane Drake and Dan Anderson on Clam Lake in Antrim County for side-by-side lake sampling, part of the quality assurance program for CLMP data (Photo: Dean Branson, Three Lakes Association).

Example of how to use the chart below:

A volunteer from Horsehead Lake, Mecosta County, measured Secchi disk transparency, chlorophyll *a*, and summer total phosphorus. After receiving the results, the volunteer plots each of the parameters on the graph below. The volunteer uses the mean value of the Secchi disk data, the median value of the chlorophyll *a* data, and the summer phosphorus value, all available in the CLMP Annual Report.

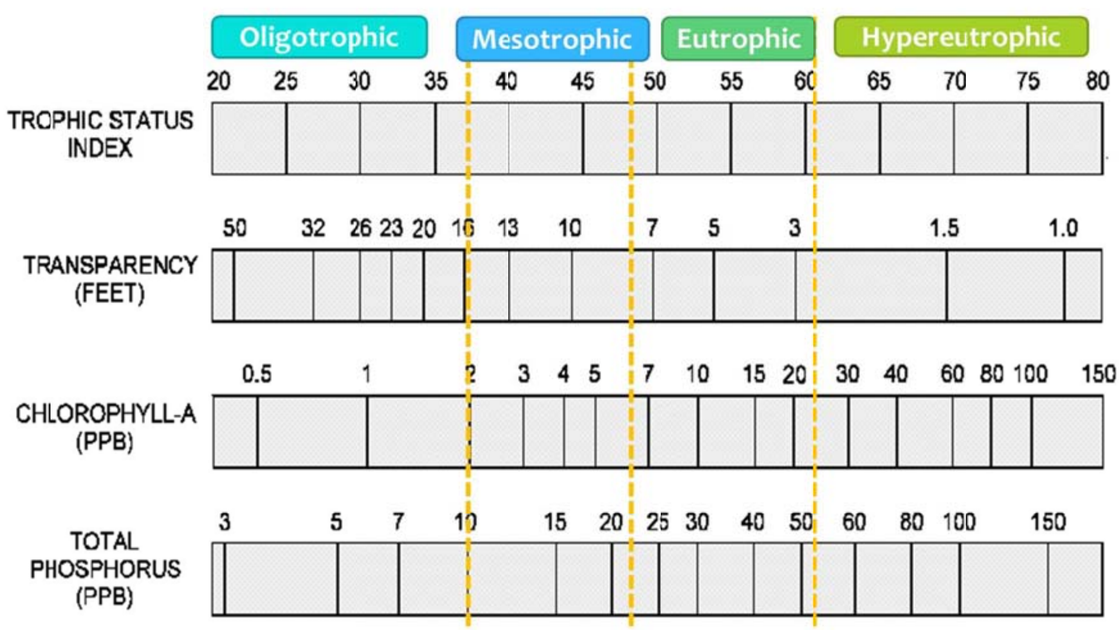
By drawing a straight line up from each of the points, the volunteer learns that the different TSI parameters for Horsehead Lake fall between 40 and 45, which places Horsehead Lake in the middle of the mesotrophic range. The lines from the different parameters do not exactly match up because of natural variability in the data.

Example: CARLSON'S TROPHIC STATE INDEX



> You may use the larger TSI chart below to record your lake's data and determine its Trophic Status Index category.

CARLSON'S TROPHIC STATE INDEX



The dashed vertical lines indicate Michigan's Inland Lakes Trophic Status Classification Criteria (Figure: Michigan State University Extension; modified from Minnesota Pollution Control Agency).

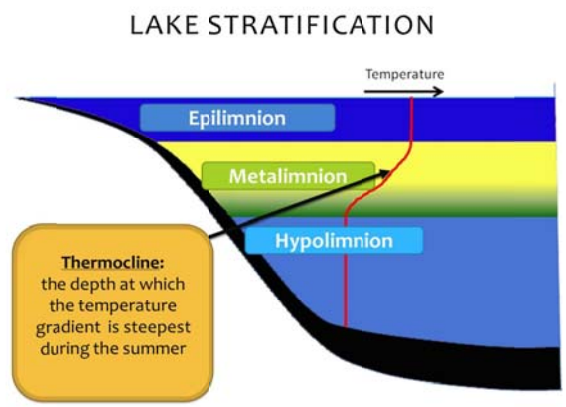
OTHER MEASURES OF LAKE PRODUCTIVITY

Dissolved Oxygen (DO) and Temperature

Dissolved oxygen and temperature are two fundamental measurements of lake productivity. The amount of dissolved oxygen in the water is an important indicator of overall lake health.

For approximately two weeks in the spring and fall, the typical lake is entirely mixed from top to bottom during a process called "overturn", when all water in the lake is 4 degrees Celsius. In the winter there is only a small difference between the temperature of the water under the ice (0°C) and the water on the bottom (4°C). However, in the summer most lakes with sufficient depth (greater than 30 feet) are stratified into three distinct layers of different temperatures. These layers are referred to as the epilimnion (warm surface waters) and hypolimnion (cold bottom waters) which are separated by the metalimnion, or thermocline layer, a stratum of rapidly changing temperature. The physical and chemical changes within these layers influence the cycling of nutrients and other elements within the lake.

During summer stratification the thermocline prevents dissolved oxygen produced by plant photosynthesis in the warm waters of the well-lit epilimnion from reaching the cold dark hypolimnion waters. The hypolimnion only has the dissolved oxygen it acquired during the short two-week spring overturn. This finite oxygen supply is gradually used by the bacteria in the water to decompose the dead plant and animal organic matter that rains down into the hypolimnion from the epilimnion, where it is produced. With no opportunity for re-supply the dissolved oxygen in the hypolimnion waters is gradually exhausted. The greater the supply of organic matter from the epilimnion and the smaller the volume of water in the hypolimnion the more rapid the oxygen depletion in the hypolimnion. Highly productive eutrophic lakes with small hypolimnetic volumes can lose their dissolved oxygen in a matter of a few weeks after spring overturn ends and summer stratification begins. Conversely, low productive oligotrophic lakes with large hypolimnetic volumes can retain high oxygen levels all summer.



Lakes over 25 feet in depth typically stratify into three layers during the summer. Water temperature will be warmest in the upper layer (epilimnion), decline through the metalimnion, and be coldest in the hypolimnion (Figure: Michigan State University Extension).

When a lake's hypolimnion dissolved oxygen supply is depleted, significant changes occur in the lake. Fish species like trout and whitefish that require cold water and high dissolved oxygen levels are not able to survive. With no dissolved oxygen in the water the chemistry of the bottom sediments are changed resulting in the release of the plant nutrient phosphorus into the water from the sediments. As a result the phosphorus concentrations in the hypolimnion of productive eutrophic and hypereutrophic lakes can reach extremely high levels. During major summer storms or at fall overturn, this phosphorus can be mixed into the surface waters to produce nuisance algae blooms.

Some eutrophic lakes of moderate depth (25 to 35 feet maximum deep) can stratify, lose their hypolimnion dissolved oxygen and then destratify with each summer storm. So much phosphorus can be brought to the surface water from these temporary stratifications and destratifications that the primary source of phosphorus for the lake is not the watershed but the lake itself in the form of internal loading or recycling.

Besides the typical lake stratification pattern just described, it is now known that some Michigan lakes may not follow this pattern. Small lakes with significant depth, and situated in hilly terrain or protected from strong wind forces, may not completely circulate during spring overturn every year. Additionally, some lakes deep enough to stratify will not, if they have a long fetch oriented to the prevailing wind or are influenced by major incoming river currents. Finally, lakes with significant groundwater inflow may have low dissolved oxygen concentrations due to the influence of the groundwater instead of the lake's productivity and biological decomposition.

The dissolved oxygen and temperature regime of a lake is important to know in order to develop appropriate management plans. A lake's oxygen and temperature patterns not only influence the physical and chemical qualities of a lake but the sources and quantities of phosphorus, as well as the types of fish and animal populations.

Aquatic Plant Mapping

A major component of the plant kingdom in lakes is the large, leafy, rooted plants. Compared to the microscopic algae the rooted plants are large. Sometimes they are collectively called the "macrophytes" ("macro" meaning large and "phyte" meaning plant). These macrophytes are the plants that people sometimes complain about and refer to as lake weeds.

Far from being weeds, macrophytes or rooted aquatic plants are a natural and essential part of the lake, just as grasses, shrubs and trees are a natural part of the land. Their roots are a fabric for holding sediments in place, reducing erosion and maintaining bottom stability. They provide habitat for fish, including structure for food organisms, nursery areas, foraging and predator avoidance. Waterfowl, shore birds and aquatic mammals use plants to forage on and within, and as nesting materials and cover.

Though plants are important to the lake, overabundant plants can negatively affect fish populations, fishing and the recreational activities of property owners. Rooted plant populations increase in abundance as nutrient concentrations increase in the lake. As lakes become more eutrophic rooted plant populations increase. They are rarely a problem in oligotrophic lakes, only occasionally a problem in mesotrophic lakes, sometimes a problem in eutrophic lakes and often a problem in hypereutrophic lakes.

In certain eutrophic and hypereutrophic lakes with abundant rooted plants it may be advantageous to manage the lake and its aquatic plants for the maximum benefit of all users. Plant management may also be necessary if invasive, non-native plants are introduced to the lake and threaten the native plant ecosystem. To be able to do this effectively it is necessary to know the plant species present in the lake and their relative abundance and location. A map of the lake showing the plant population locations and densities greatly aids management projects.

CLMP PROJECT RESULTS

—IMPORTANT—

CLMP monitoring results for participating lakes are now available on the web in addition to being presented in summary form here in the annual report. To view current year and past results, please visit MiCorps' Data Exchange Network at www.micorps.net (select "Data Exchange") and follow the instructions to find data on your lake of interest. On the site, you may search the database for lakes by lake name, county or watershed. You can also limit the data delivered to you by date or monitoring parameter(s). Monitoring data will appear on the Data Exchange well in advance of publication of the annual report. CLMP volunteers may also find instructions on the website about how to enter their own data into the Data Exchange.

Secchi Disk Transparency

Citizen volunteers measure Secchi disk transparency from late spring to the end of the summer. Ideally, 18 weekly measurements are made from mid-May through mid-September. As a minimum, eight equally spaced measurements from the end of May to the beginning of September are accepted to provide a good summer transparency mean (average) for the lake. Frequent transparency measurements are necessary throughout the growing season since algal species composition in lakes can change significantly during the spring and summer months, which can dramatically affect overall water clarity.

A summary of the transparency data collected by the lake volunteers during 2012 is included in Appendix 1. The number of measurements, or readings, made between mid-May and mid-September and the minimum and maximum Secchi disk transparency values are included for each lake that participated in the program. For those lakes with eight or more evenly spaced readings over this time period, the mean, median, standard deviation, and Carlson TSI_{SD} values were calculated and listed.

The mean, or average, is simply the sum of the measurements divided by the number of measurements. The median is the middle value when the set of measurements is ordered from lowest to highest value. The standard deviation is a common statistical determination of the dispersion, or variability, in a set of data.

The data range and standard deviation gives an indication of seasonal variability in transparency in the lake. Lakes with highly variable Secchi disk readings need to be sampled frequently to provide a representative mean summer transparency value. Few measurements and inconsistent sampling periods for these lakes will result in unreliable data for annual comparisons.

The TSI_{SD} values were calculated using Carlson's equations (see page 7) and the mean summer transparency values. (Note: the mean transparency value is converted from feet to meters for the TSI_{SD} calculation) The graphical relationship (see page 8) can be used to relate the TSI_{SD} value to the general trophic status classification for the lake (i.e., oligotrophic, mesotrophic, eutrophic) as well as to provide a rough estimate of summer chlorophyll *a* and total phosphorus levels in the lake. If the transparency measurements are made properly and consistently year after year, the Secchi disk transparency annual means or TSI_{SD} values can be compared to evaluate changes, or trends, in trophic status of the lake over time, see the figure below.

During 2012, Secchi disk transparency data were reported for 197 lakes (217 basins). Approximately 2986 transparency measurements were reported, ranging from 2.0 to 46.0 feet. For the lakes with eight or more equally spaced readings between mid-May and mid-September, the overall mean, or average, Secchi disk transparency was 13.1 feet. The Carlson TSI_{SD} values ranged from 27 to 59 for these lakes with a mean value of 41. A Carlson TSI value of 41 is generally indicative of a mesotrophic lake (see page 7).

Secchi disk transparency measurements were reported for 197 of the 220 enrolled lakes for a participation rate of 90%.

Total Phosphorus

Phosphorus is one of several essential nutrients that algae need to grow and reproduce. For most lakes in Michigan, phosphorus is the most important nutrient, the limiting factor, for algae growth. The total amount of phosphorus in the water is typically used to predict the level of productivity in a lake. An increase in phosphorus over time is a measure of nutrient enrichment in a lake.

The CLMP volunteers monitor for total phosphorus during spring overturn, when the lake is generally well mixed from top to bottom, and during late summer, when the lake is at maximum temperature stratification from the surface to the bottom. Spring overturn is an opportune time of the year to sample just the surface of a lake to obtain a representative sample for estimating the total amount of phosphorus in the lake. A surface sample collected during late summer represents only the upper water layer of the lake, the epilimnion, where most algal productivity occurs. The late summer total phosphorus results, along with the Secchi disk transparency and chlorophyll measurements, are used to determine the trophic status of the lake. The spring overturn total phosphorus data, collected year after year, are useful for evaluating nutrient enrichment in the lake.

Total phosphorus results for the 2012 CLMP are included in Appendix 2. The spring total phosphorus data are listed first, followed by the late summer data. The TSI_{TP} values were calculated using Carlson's equations (see page 7) and the late summer total phosphorus data. Results from replicate and side-by-side sampling are also provided. Approximately 13% of the replicate samples collected by the volunteers were analyzed as part of the data quality control process for the CLMP. Also, the DEQ participated in side-by-side sampling on approximately 3% of the lakes.

During 2012, samples for total phosphorus measurements were collected on 197 lakes/basins. The spring overturn total phosphorus results ranged from <5 to 46 µg/l with a mean (average) of 11.0 µg/l and a median value of 9 µg/l. The late summer total phosphorus results ranged from <5 to 99 µg/l with 13.9 µg/l as the mean and 11 µg/l as the median. The Carlson TSI_{TP} values ranged from <27 to 70 for these lakes with a mean value of 39. A Carlson TSI value of 39 is generally indicative of a very good quality mesotrophic lake (see page 7).

For the spring overturn sampling, 150 total phosphorus samples were turned in from 179 enrolled lakes, for an 84% participation rate. For late summer sampling, 191 samples were received from 202 enrolled lakes/basins for a 95% participation rate.

Chlorophyll *a*

Chlorophyll is the green photosynthetic pigment in the cells of plants. The amount of algae in a lake can be estimated by measuring the chlorophyll *a* concentration in the water. As an algal productivity indicator, chlorophyll *a* is often used to determine the trophic status of a lake.

Chlorophyll monitoring was added to the CLMP in 1998. Volunteers were asked to collect and process five sets of chlorophyll *a* samples, one set per month from May through September. For purposes of calculating TSI values only those lakes that had data for at least four of the five sampling events were used. During 2012 volunteers collected a minimum of four samples on 120 lakes (128 basins).

Results from the 2012 chlorophyll monitoring are included in Appendix 3. Results for each monthly sampling event are listed as well as the mean, median, and standard deviation of the monthly data for each lake. The TSI_{CHL} values were calculated using Carlson's equations (page 7) and the median summer chlorophyll values. Volunteer-collected replicate samples were analyzed for quality assurance on about 11% of the lakes, and side-by-side sampling with MiCorps staff was conducted on 3% of the lakes. These data are included.

A total of 511 chlorophyll samples were collected and processed in 2012. The chlorophyll *a* levels ranged from <1 to 43 µg/l over the five-month sampling period. The overall mean (average) was 3.8 µg/l. The Carlson TSI_{CHL} values ranged from <31 to 60 with a mean value of 40. A Carlson TSI value of 40 is generally indicative of a very good quality mesotrophic lake (see page 7).

During 2012, a total of 132 lake sites were registered for chlorophyll sampling. A total of 130 sites were represented at least minimally through the submission of at least one sample, for a minimum participation rate of 98%. At least four samples were turned in for 125 lake sites, for a complete participation rate of 95%. Two samples were turned in, but not processed due to quality control issues for a rejection rate of less than 0.5%.

TSI Comparisons

The TSI_{CHL}, TSI_{SD}, and TSI_{TP} values for the individual lakes can be compared to provide useful information about the factors controlling the overall trophic status in these lakes (Carlson and Simpson, 1996). For lakes where phosphorus is the limiting factor for algae growth, all three TSI values should be nearly equal. However, this may not always be the case. For example, the TSI_{SD} may be significantly larger than the TSI_{TP} and TSI_{CHL} values for lakes that precipitate calcium carbonate, or marl, during the summer. The marl particles in the water column would scatter light and reduce transparency in these lakes, which would increase the TSI_{SD}. Also, phosphorus may adsorb to the marl and become unavailable for algae growth, which would reduce the TSI_{CHL}. For lakes where zooplankton grazing or some factor other than phosphorus limits algal biomass, the

TSI_{TP} may be significantly larger than the TSI_{SD} and TSI_{CHL}.

Dissolved Oxygen and Temperature

Temperature and dissolved oxygen are typically measured as surface-to-bottom profiles over the deep part of the lake. Temperature is usually measured with a thermometer or an electronic meter called a themistor. Dissolved oxygen is either measured with an electronic meter or by a chemical test. The CLMP uses an electronic meter (YSI Models 95D, 550A, or Pro20) designed to measure both temperature, with a themistor, and dissolved oxygen. The meter is calibrated by the volunteer monitor before each sampling event.

Dissolved oxygen and temperature are measured from the surface to within 3 feet of the bottom, as a profile, in the deepest basin of the lake. Measurements are taken at 5-foot intervals in the upper part of the water column. Through the mid-depth region or thermocline (15 to 45 feet), measurements are taken at 2½ foot intervals. Below the thermocline, measurements are usually made every 5 feet. Measurements are made every two weeks from mid-May to mid-September in the same deep basin location.

During 2012, CLMP participants in the dissolved oxygen/temperature project sampled 59 lake sites. A total of 315 dissolved oxygen/temperature profiles (over 4700 measurements) were recorded. The lakes involved in the project are identified in Appendix 4. The results of the sampling are highly varied depending upon the size, depth, volume and productivity of the lake sampled. Because of these highly varied results and the amount of individual data collected, each lake's results are not included in this report. Each participating lake community will receive individual data graphs for their lake. Instead of individual results, representative oxygen and temperature patterns are illustrated in Appendix 4. For the most part, data collected on lakes participating in the 2012 project are used to present these representative patterns. Volunteer monitors may compare the results from their lake with the patterns illustrated in Appendix 4.

While it is not possible to illustrate every conceivable temperature and dissolved oxygen scheme that may develop in a lake, five common summer patterns are presented in Appendix 4. These five patterns include: (1) a very high quality oligotrophic lake with a very large hypolimnion volume, (2) a good quality mesotrophic lake with a moderate hypolimnion volume, (3) a mesotrophic/eutrophic lake with a small hypolimnion, (4) a mesotrophic lake which is too shallow to maintain stratification (such lakes usually have the same temperature and dissolved oxygen concentrations from surface to bottom as the result of frequent mixing), and (5) a mesotrophic lake with dissolved oxygen spikes in the thermocline (caused by algae producing oxygen via photosynthesis in this zone of high biological productivity).

Aquatic Plant Mapping

The Aquatic Plant Identification and Mapping parameter is the most labor-intensive volunteer activity within the CLMP. Typically, a team of volunteers from each enrolled lake is involved, with assistance from a MiCorps biologist.
Preparation begins with volunteers attending a half-day intensive training on

aquatic plant identification and mapping techniques. Prior to heading to the lake, the volunteers develop a sampling strategy for their lake, based on size and known areas of plant growth. Sampling transects (straight lines parallel to shore) are identified, along which plant samples are collected, generally at the one, four and eight foot depths with a constructed sampling rake. The rake is tossed out into the lake and retrieved from the four compass directions. The density of each plant species is determined by its presence on one, two, three or all four of the rake tosses. The sampling effort often requires several days. The data from all the transects then are used to create a plant distribution map and report. A complete description of procedures is provided in Wandell and Wolfson (2007).

AQUATIC PLANT SAMPLING RAKE
Cut handles off two garden rakes and bolt rakes back to back with two "C" bolts. Use a small hose clamp between rake tines to prevent side to side slipping. Drill a hole in remaining wooden handle core and twist a moderately large eye bolt into hole. The rope should be about 20 feet long. File off any sharp edges. Wear gloves when using rake to protect hands from cuts.

2012 was a very active year for the CLMP Aquatic Plant Identification and Mapping program! Six lakes conducted surveys:

- Lake Angelus (Oakland Co.)
- Ann Lake (Benzie Co.)
- Deer Lake (Oakland Co.)
- Earl Lake (Livingston Co.)
- Lake Margrethe (Crawford Co.)
- Spider Lake (Grand Traverse Co.)

In addition, three lakes that had mapped their vegetation in recent years continued or repeated their surveys:

- Perch Lake (Iron Co.)
- Sweezey Lake (Jackson Co.)
- Viking Lake (Otsego Co.)

Results of these surveys, including maps and full reports, can be found on the MiCorps Data Exchange online at www.micorps.net.

Exotic Aquatic Plant Watch

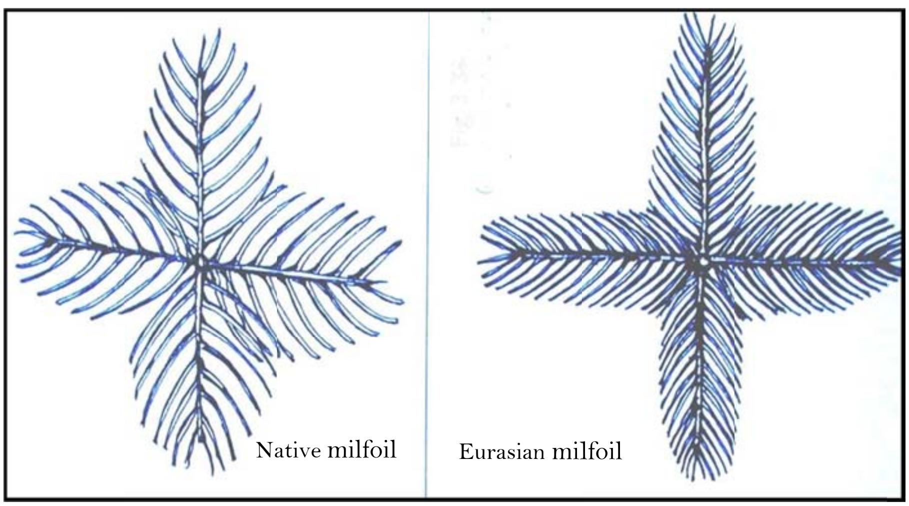
Beginning in 2007, the CLMP sponsored a pilot monitoring project to identify and map invasive aquatic plants in Michigan lakes, with the intent to add the Exotic Aquatic Plant Watch as a permanent component of the CLMP. This project is less time- and labor-intensive than Aquatic Plant Identification and Mapping, because only select invasive plants are surveyed.

The Exotic Aquatic Plant Watch project became a permanent component of the CLMP in 2011, due to steadily increasing interest and the high-quality data being generated by volunteers.

If exotic plant populations are found early before they become widespread around the lake, rapid response to the infestations will improve the options for management. The cost for treating small infestations will be considerably less than waiting until the exotic, invasive plants are covering large areas of the lake.

Volunteer participants are trained to identify select exotic aquatic plants of concern for Michigan lakes: currently, curly-leaf pondweed, Eurasian milfoil, starry stonewort and Hydrilla. Using a GPS unit, volunteers survey their lakes and map the location of any exotic plant beds with the GPS unit, or by hand.

In 2012, 25 lakes enrolled in the Exotic Aquatic Plant Watch, and 14 submitted reports, for a participation rate of 56%. A summary of the results is presented in Appendix 5.



Stem cross sections at a leaf node of a typical native milfoil (left) and Eurasian milfoil, an invasive, non-native plant (right). Note that Eurasian milfoil has more leaflets on each leaf than native milfoils. Eurasian milfoil generally has more than 12 leaflets on one side of the leaf's central axis, while native milfoils have fewer than 12.

DATA USE

A voluntary survey on the MiCorps Data Exchange web page helps track interest in the data collected in the CLMP and the MiCorps stream monitoring program. One hundred sixty-one data users responded to the survey in 2012. A summary of the results is below.

27% - Academia (students & professors from a variety of institutions, including 6 Michigan universities, and institutions in Indiana, Wisconsin, Oregon, Minnesota, and Washington)
26% - Interested individuals
25% - Lake associations, volunteers
7% - State government (Michigan DNR, DEQ)
6% - Business (environmental consulting firms, regional development groups)
5% - Non-governmental organizations (e.g., Mid-Michigan Environmental Action Council, watershed councils)
3% - Other governmental agencies (e.g., federal, townships, conservation districts)
1% - Media

CONCLUSION

Data from the CLMP provide citizens with basic information on their lakes that can be used as indicators of the lake's productivity. If measured over many years, these data may be useful in documenting changes and trends in water quality. More importantly these data will assist the local community with the management of their lake. Michigan's lakes are high quality resources that should be protected from nutrient and sediment inputs to keep them as the special places we use and enjoy. To do this, each lake should have its own management plan.

Although CLMP data provide very useful water quality information, for certain management programs it may be necessary to assemble more specific data or information on a lake's condition. The DEQ and MLSA may be able to help you obtain additional information on your lake.

REFERENCES

Carlson, R.E. 1977. A trophic state index for lakes. *Limnol. Oceanogr. 22(2):* 361-369

Carlson, R. and Simpson, J. 1996. A Coordinator's Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. February 1996.

Hamlin Lake Improvement Board. 1994. Protecting Hamlin Lake - a homeowners guide. Prepared by: Progressive Architecture Engineering Planning, Grand Rapids, MI. July 1994.

Michigan DNR. 1990. Protecting Inland Lakes - a watershed management guidebook. Prepared by: Planning and Zoning Center, Inc., Lansing, MI. February 1990.

Minnesota PCA. 1991. Citizen Lake-Monitoring Program - 1990 report on the transparency of Minnesota lakes. Minnesota Pollution Control Agency, Division of Water Quality. St. Paul, MN. June 1991.

Wandell, H. and Wolfson, L. 2007. A Citizen's Guide for the Identification, Mapping and Management of the Common Rooted Aquatic Plants of Michigan Lakes. (2nd Edition) MSU Extension Water Quality Series WQ-55.

FROM MONITORING TO STEWARDSHIP: A Profile of How Volunteers on Indian Lake, Kalamazoo County, are Using CLMP Monitoring to Protect Their Lake

Submitted by Nancy Wilks, Newsletter Editor, Indian Lake Association

Indian Lake is a rather common name among Michigan's inland lakes. During the 1970s the TV musical group, The Partridge Family, recorded a popular song about vacationing at Indian Lake, although lyrics do not indicate that lake's location. Our Indian Lake is located in southeast Kalamazoo county, and was part of a Potawatomi Indian reservation during the early 19th century. Those inhabitants were relocated by order of the US government in 1840, and opportunity for nearby residents to acquire shoreline for development of lakefront resorts and homes became available. Indian Lake is a 758 acre lake with two main, connected basins of water. The larger main basin, 'Big Indian' has a depth of up to 75 feet, and contains the majority of the 333 properties. This larger basin has 2 small bays and 2 artificial channels. The smaller basin, 'Little Indian', has few households plus a church camp. Much of the Little Indian shoreline is wetland. Portage River has an inlet and an outlet in Little Indian, and Dorrance Creek has an inlet. Water from these streams passes to the lake through local farmland. There is no public access site.

Parts of Big Indian lake bottom had been mined for marl in the past, resulting in unnatural lake bottoms and excessive aquatic weed growth, both native and, lately, invasive species. A special assessment district for aquatic plant control was initiated in 2003.

A local resident, Jeffrey Schimp, volunteered to perform Secchi disk water clarity measurements starting in 1981, and continues performing that measurement to this day. The Indian Lake Association (ILA) was formed in 1987 by lake residents to provide lake quality assessment, riparian education and recreation. ILA members started attending MLSA meetings, where CLMP has familiarized us with invasive species identification, water quality determinations, shoreline buffer benefits and watershed evaluation. In 2003 Greg Nichols encouraged the ILA to measure dissolved oxygen, water temperature, chlorophyll-α, and phosphorus levels in the deepest part of the lake. All CLMP parameters measured by ILA were within limits for oligotrophic or mesotrophic status, despite aggressive aquatic vegetation growth, so in 2009 we expanded our monitoring beyond CLMP and began measuring phosphorus and nitrate levels at several additional locations, including stream inlets and stormwater runoff sites. Now we can see where some nutrient level readings indicate that different areas around the lake might have different management needs. ILA also independently monitors lake water levels and *E. coli*.

Challenges to Indian Lake residents persist despite dutiful monitoring. At the north end of Big Indian, which is adjacent to Little Indian, very aggressive aquatic weed growth prohibits passage of boat traffic by mid-July; we refer to that area as the 'salad bowl.' Over half of our shoreline is armored, and the ILA is educating residents about the benefits of buffer zones, using publications and meetings, with limited success. A few residents have installed buffers at their shorelines, and this is attracting the attention of other residents, who slow down to examine them as they drive their boats past these properties.

ILA has actively advocated a new Portage River watershed plan. A grant from the State of Michigan for $223,718 was approved in April, 2012, to help fund this watershed plan development. ILA will continue participation on a steering committee. The objectives of this watershed plan include reduction of lake nutrient loading, and the establishment of the total daily maximum loads (TDML) for *E. coli* in the watershed. This is an example of how ILA leveraged our water quality data collected by volunteers to initiate change in the watershed by partnering with government agencies.

For more information on Indian Lake stewardship efforts, contact John Wilks at IndianLakePres@aol.com.

Do you have a success story of how your community has used CLMP data to implement a protection program for your lake? We would like to hear from you. Contact Bill Dimond at 517-241-9565 or dimondw@michigan.gov.

ACKNOWLEDGMENTS

Jo Latimore from the Michigan State University Department of Fisheries and Wildlife, Paul Steen of the Huron River Watershed Council, and Bill Dimond of the Michigan Department of Environmental Quality prepared this report. Additionally, those involved in coordinating the CLMP include Scott Brown and Jean Roth of Michigan Lake and Stream Associations, Inc. Support was provided by Anne Sturm of the Great Lakes Commission who maintained the MiCorps Data Exchange.

We sincerely thank the dedicated volunteers who have made the CLMP one of the nation's most successful citizen volunteer lake monitoring programs. We are also indebted to Ralph Vogel for constructing the Secchi disks for the CLMP, and to those volunteers who entered their data into the MiCorps Data Exchange.

2012 CLMP Volunteer Lake Monitors

In 2012, at least 408 Volunteer Lake Monitors participated in Michigan's Cooperative Lakes Monitoring Program. The CLMP staff welcomes all the new volunteers, and commends every volunteer's dedication and enthusiasm! Asterisks (*) indicate Certified Volunteer Mentors – experienced volunteers who have been specially trained to assist new volunteers in learning CLMP monitoring techniques.

Dave Adams
David Allen
Robert Alvey
Kimberly Andrews
Russ Anton
Barbara Armstrong
Richard Bachelor
Dan Bailey
Rick Bakka
David Ball
Susan Barnes
Neil Barr
Sara Basso
Nancy Beckwith*
Nancy Belton
Julie Bennett
Lawrence Bittner
Bonnie Blackledge
Diane Blanchard
Emery Blanksma
Dick Blumenstein
Larry Bogart
Marl Boley
Arthur Bombrys
David Boprie
Michael Boss
Susan Boss
Bob Boyd
Mark Bradburn
Dennis Bradley
Hope Bradley
Jim Bradley
Leonard Brockhahn
Kyle Brown
Richard Brown
Wm. Scott Brown
Gordon Buchanan
Carim Calkins
Keith Carman
Paul Carmichael
Sally Casey
Ursula Charaf
Karen Christensen
Julie Christiansen
Kim Clapham
Steve Clouse
Gregory Cole
Jim Collins
Michael Cook
Chris Cortez
Craig Cotterman
Gerald Cox
Keith Crompton
David Crowe
Paul Curell
Dennis Curtice
Anne Cusmano
Paul Dalpra
Courtney Damkroger
Linda Daniels
Stacy Daniels
Fred Daris
Emma Darling
Fredrick Darling
Ed Dauw
Jacqueline Dauw
Linda Davis
Harry Dawson
Paul Demerritt
Mike Devarenne
John DiGiovanni
Wayne Disegna
Dave Dohring
Arnold Domanus Jr.
Kevin Doyle
Duane Drake
Terry Dugan*
Andra DuPont
Janet Durbin
Wes Durbin
Allen Dyer
Cherly Dyer
Kimberly Ellis
Woody Ely
Daniel Evert
Paul Fallon
Rose Fedewa
Donald Ferguson
Christine Fiedler
William Finzel
Lorie Fitzgerald
Chris Floyd
Bob Forche
David Foster
Starr Foster
Dale French
Ursula Froehlich
William Fronk
Roger Gaede
Mike Gallagher
Greg Garrett
Ted Gatto
Laurence Gavin
Susanne Gay
William Gay
Douglas Gembis
Gerald Gerou
Charles Gill
Ken Gill
James Gilliom
Joe Goossens
Andrea Grix
Connie Hales
Dave Hales
Tina Hall
Cary Hamann
Terrie Hampel
George Hanley
Doug Hansen
Chuck Hartman
Stevie Hartman
John Hartsig
John Hause
Glen Hayden
Daniel Hayes
Rita Heady
Ronald Heady
Wayne Held
Ron Henning
William Henning
Jim Hibbard
Nanette Hibler
Ed Highfield
Virginia Himich
Art Hoadley
Arthur Hoadley
Lynn Hoepfinger*
John Hoffman
Emmett Holmes
Karen Holmes
Roger Hopkins
Susan Houseman
John Howko
Ruth Hubbard
Sheryl Hugger
Jerry Hughes
Ron Hughes
Sharon Hurlbert
Bob Hutchings
Harris John Iler
Joanne Iler
Bill Ingle
Bonnie Isaacs
Laura Jacobson-Pentces
Connie Jayne
Marlo Jayne
Thomas Jenkins
Fred Jensen
Frederick Jensen
Dan Johnson
Gary Johnson
Joel Johnson
Mike Jones
Bonnie Kanitz
William Kantor
James Kasey
Ben Kent
Martha Kern-Boprie
Emil Kezerle
Wayne Kiefer
Netty Kiekover
Calvin Killen
Bruce King
Marvin Kingsley
Phil Kinney
Ray Klomes
Robert Kluczynski
John Kolleth
Gerry Kraft
John Kreag
Ronald Kreiger
Sheri Kurtyak
Carolyn LaGrasso
Rosalie Lake
Tom Lange
Mitchell Le Claire
Lori Leugers
Mark Leugers
Bruce Lichliter
John Lindahl
Ernest (Mike) Litch*
Lynda Little
Mark Little
Jeremy Lockrey
Michele Lockrey
Gary Logston
David Long
Matthew Long
Doris Loomans
Lonnie Loveland
Steve Lucas
Robert Mackenzie
Joe Maguire
Anne Mammel

Becca Mammel
Tim Mammel
Tom Mammel
Mike Marcinek
John Mater
David Maxson
Eldonna May
Rosemary McCormick
Bob McDonald
Char McDonnell
Jim McDowell
Alan McGowen
Jim McGurrin
Alan McNamara
Rick Meeks*
Rich Meeuwenberg
Sandra Michalik
William Mick
David Miller
Tom Millington
Bill Miner
Terry Mohler
Terry Monson
Thomas Moore
Darlene Morey
Dick Morey*
Mike Moschetta
Pam Moseley
Sidney Moseley
Thomas Murphy
Tim Murphy
Michael Mutschler
Rob Namowicz
Reno Nave
Kenneth Nelson
Patricia Nelson
Wayne Nesbitt
Krystyna Neuman
Don Nichols
Greg Nichols
Wilma Nichols
Cecil Niswonger
Lon Nordeen
Becky Norris
Richard Claude Notestine
Ed Novak
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Steve Ockaskis
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Kathleen Peterson
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Mike Pinson
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John Price
Joe Primozich
Chuck Pugh
Judith Pugh
George Purlee
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Bob Randall
Bill Rehling
Eric Reid
Raymond Reinertson
Jack Reinhardt
Roy Retting
Kurt Richardson
George Richey
Janet Rimar
Scott Rissi
Robert Robertson
Harold Rosengren
Jim Ross
Jean Roth
Jim Roth
Steve Roth
Nick Roupas
Rick Rumstead
Tom Rush
Bob Sacksteder
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Ronald Scheff
Jeff Schimp
Robert Schirado
Jeff Schlueter
Katie Schlueter
Jack Schoeppach
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Mary Shaw
Gerald Shepard
John Sheppard
John Sick
Richard Sierakowksi
Mike Single
Marie Smith
Mark Smith
Michael Smith
Paul Sniadecki*
Darrol Spurgeon
David Stafford
Linda Stafford*
Tim Stegeman
Ron Steiner
Gary Stelow
Kathleen Stelow
John Stivers
Julie Stivers
Daniel Stock
Beth Storm
Henry Storm
Roger Storm
Chris Streeter
Sue Streeter
Jan Stuhlmann
Wayne Swallow
Kent Taylor
Gertrude Temple
Robert Temple
Kay Terry
Greg Thebo
Thomas Thering
Richard Tice
Bill Tidey
Thomas Tisue
William Tomlin
Rusty Trapp
Robert Turnquist
Joan Uhley
James Van Herweg
Robert VanDenBrouck
Barbara VanDenEeden
John VanderMeer
Lesa VanderMeer
Stuart Vedder
Robert Vermette
Al Vichunas
Ralph Vogel
Ed Waits
Bill Waldeck
Jack Walls
Michael Walma
Jim Walters
Howard Wandell*
John (Red) Warner
Darrin Wassom
Rhonda Wassom
Jana Waters
Susan Wedzel
Milt Weeks
Milton Weeks
Judd Wellard
Mary Ann Wellard
Ken Wendt
Karyn West
Susan White
Ellen Whitehead
Emily Whittaker
Jon Wilford
John Wilks
Gus Winston
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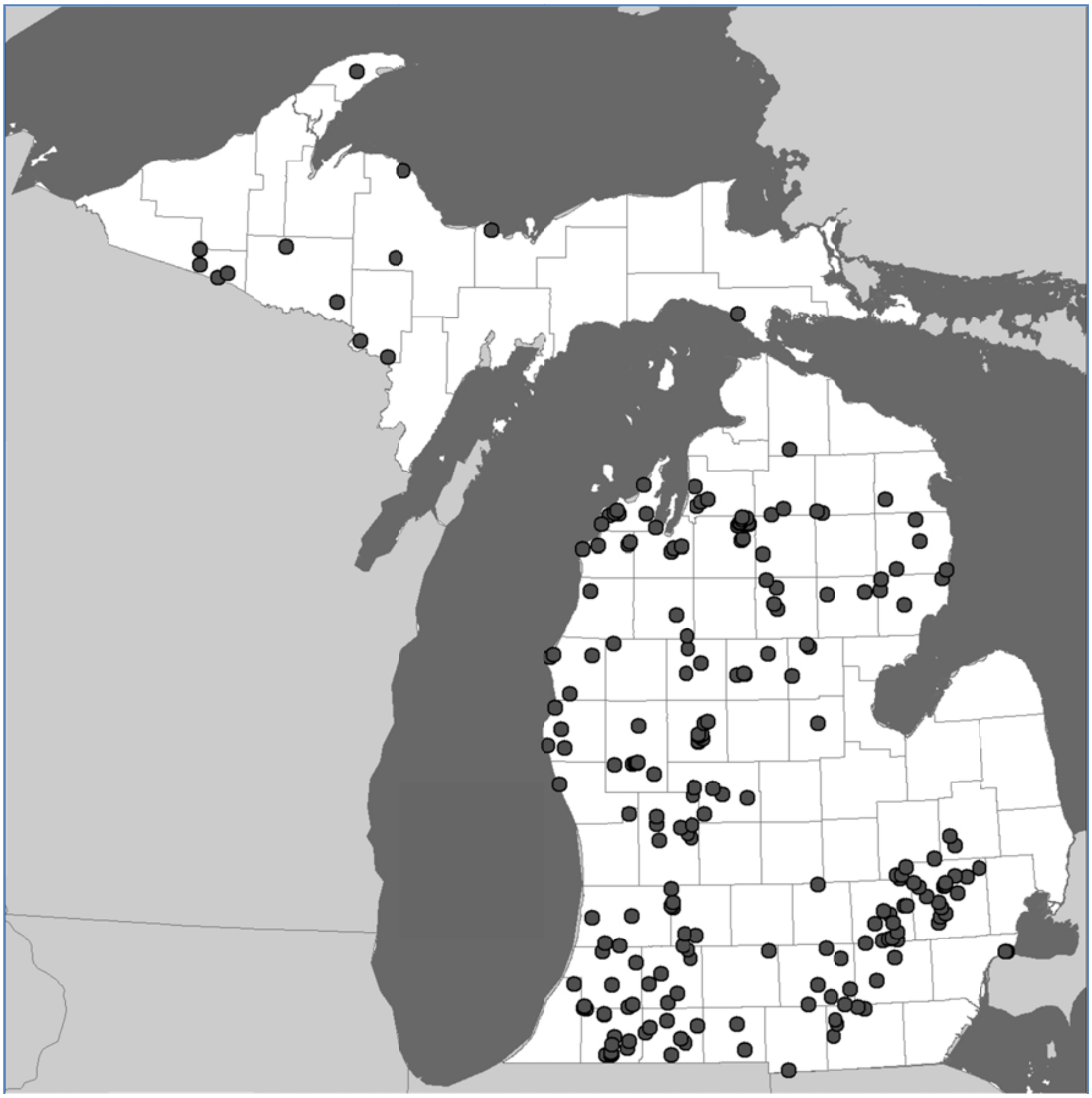
Don Wolstenholme
Gary Wolter*
Pat Wolters
Chuck Wolverton
John Yukon
Carolyn Zader
Sue Zanotti
Jack Zeiler
Lisa Zigmont
Dennis Zimmerman
John Zimney
Cheryl Zuelke
John Zuelke

Statewide Distribution of CLMP Lakes Sampled During 2012



APPENDICES

Appendix 1

2012 Secchi Disk Transparency Results

Appendix 2

2012 Total Phosphorus Results

Appendix 3

2012 Chlorophyll Results

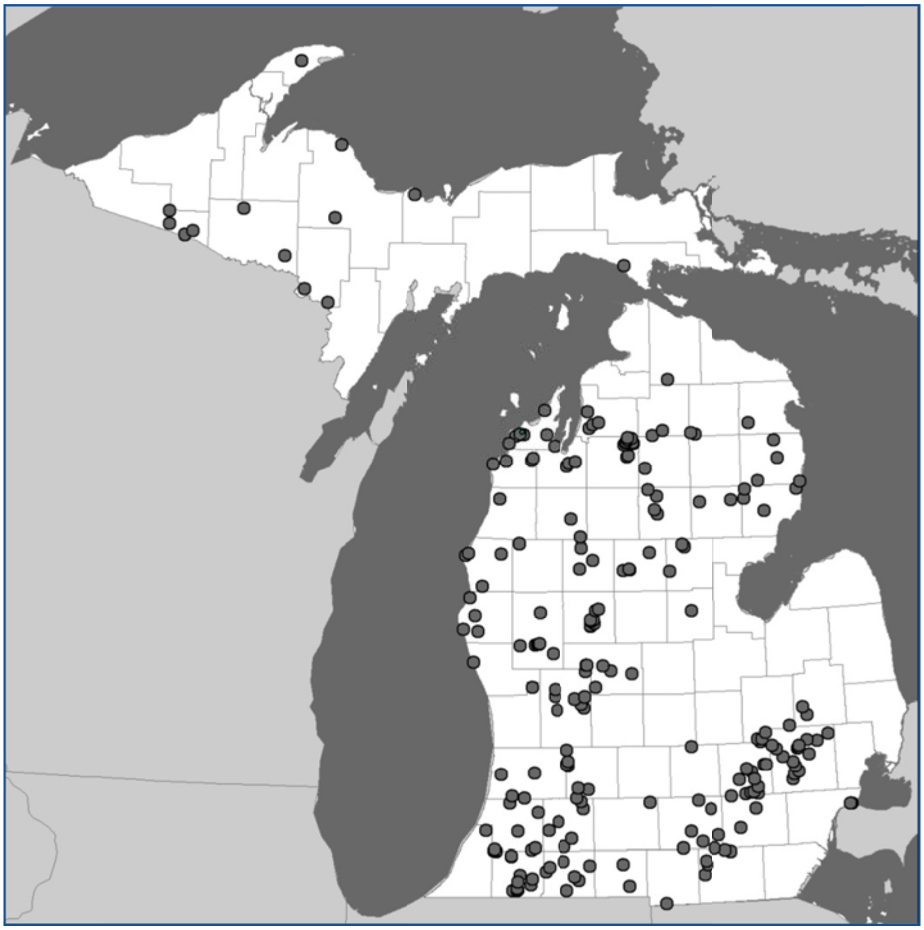
Appendix 4

2012 Dissolved Oxygen and Temperature:
Participating Lakes and Example Results

Appendix 5

2012 Exotic Aquatic Plant Watch Results

Appendix 1
2012 Cooperative Lakes Monitoring Program
Secchi Disk Transparency



Map above shows the distribution of the 221 lakes enrolled in Secchi Disk Transparency in the 2012 CLMP Program.

Recorded Secchi Disk Transparency Values:

Mean (average):	13.1 feet
Minimum:	2.0 feet
Maximum:	46.0 feet (Higgins Lake, Roscommon County)

Michigan Clean Water Corps
www.micorps.net

APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	County	Site ID Number	Secchi Disk Transparency (feet) Number of Readings	Range Min	Max	Mean	Median	Standard Deviation	Carlson TSI_{SD} (transparency)
Allen	Gogebic	270207	8	7.5	12.5	8.8	8.5	1.7	46
Angelus	Oakland	631227	18	18.5	>30.0	>22.4	>22.3	3.2	<32
Ann	Benzie	100082	18	11.0	25.5	17.5	14.5	5.2	36
Antoine	Dickinson	220028	8	13.0	>20	>15.8	>15.5	2.1	<37
Arbutus (1)	Grand Traverse	280396	17	11.0	>13.5	>12.1	>12.0	1.0	<41
Arbutus (2)	Grand Traverse	280109	17	10.0	28.0	17.4	15.0	5.7	36
Arbutus (3)	Grand Traverse	280108	17	10.0	25.0	16.6	15.0	4.9	37
Arbutus (4)	Grand Traverse	280397	17	10.0	23.0	15.8	13.0	4.7	37
Arbutus (5)	Grand Traverse	280398	17	11.0	20.0	14.8	13.0	3.6	38
Arnold	Clare	180107	18	13.0	27.5	18.4	18.0	4.1	35
Bar (South)	Leelanau	450237	18	7.0	9.0	7.9	8.0	0.6	47
Barlow	Barry	080176	14	6.0	17.5	11.3	11.3	3.3	42
Barton	Kalamazoo	390215	16	4.0	11.0	7.0	6.8	2.1	49
Bass	Kalkaska	400129	*						
Bear	Kalkaska	400026	11	23.0	36.0	29.5	28.0	4.0	28
Bear	Manistee	510257	19	9.0	15.0	10.7	10.0	2.0	43
Beatons	Gogebic	270105	11	12.0	21.0	15.9	15.0	2.9	37
Beaver	Alpena	040097	5	7.0	15.0				
Bellaire	Antrim	050052	17	8.0	27.0	14.4	13.0	6.2	39
Big	Osceola	670056	14	10.0	19.0	15.4	16.0	2.8	38
Bills (Reinhardt)	Newaygo	620062	17	7.0	24.0	11.1	10.0	4.7	42
Bills (Waits)	Newaygo	620311	16	5.5	21.5	10.5	8.0	5.2	43
Birch (Fallon)	Cass	140061	18	12.0	20.0	15.3	15.0	2.6	38
Birch (Temple)	Cass	140187	18	7.0	22.0	13.4	13.0	3.9	40
Blue	Kalkaska	400017	17	18.0	31.0	24.9	23.0	5.0	31

APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	County	Site ID Number	Secchi Disk Transparency (feet)						Carlson
			Number of	Range				Standard	TSI_{SD}
			Readings	Min	Max	Mean	Median	Deviation	(transparency)
Blue	Mecosta	540092	16	7.0	23.0	11.8	10.5	4.6	42
Blue (North)	Kalkaska	400131	11	18.0	28.0	20.4	20.0	2.9	34
Blue Heron	Wayne	821552	*						
Bostwick	Kent	410322	9	5.0	>17.5	>8.3	>7.0	3.8	<47
Bradford (Big)	Otsego	690036	11	18.0	31.0	21.1	21.0	3.5	33
Bradford (Little)	Otsego	690151	8	12.0	14.0	13.1	13.0	0.6	40
Brevoort	Mackinac	490036	9	8.5	14.5	10.9	11.0	1.8	43
Brooks	Leelanau	450222	16	9.0	13.0	10.6	10.0	1.0	43
Brown	Jackson	380477	17	5.0	15.0	8.7	8.0	2.8	46
Bruin	Washtenaw	810575	*						
Buckhorn (North)	Oakland	631113	*						
Byram	Genesee	250364	18	9.0	20.0	17.3	17.5	2.7	36
Canadian (Main)	Mecosta	540172	15	5.5	12.0	8.4	8.0	2.0	46
Canadian (West)	Mecosta	540171	15	5.0	12.0	8.3	7.5	2.5	47
Cascade Impoundment	Kent	410686	15	2.0	5.5	3.6	3.5	1.0	59
Cedar	Alcona	010017	18	6.5	10.0	8.3	8.3	1.3	47
Cedar	Iosco	350231	18	9.0	12.5	11.1	11.3	1.1	42
Cedar	Leelanau	450234	15	9.5	20.5	13.9	12.5	3.3	39
Cedar	Van Buren	800241	10	7.5	15.0	11.6	12.0	2.5	42
Center	Osceola	670238	17	13.5	25.5	19.6	19.0	4.1	34
Chabenau	Marquette	520508	14	8.5	19.5	13.1	12.3	4.0	40
Chain	Iosco	350146	13	9.5	13.0	11.7	12.0	1.0	42
Chancellor (Blue)	Mason	530287	11	20.0	33.5	27.5	26.5	5.1	29
Chemung	Livingston	470597	18	8.0	17.0	13.5	14.0	2.5	40

APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	County	Site ID Number	Secchi Disk Transparency (feet)						Carlson TSI_{SD} (transparency)
			Number of Readings	Range Min	Range Max	Mean	Median	Standard Deviation	
Christiana	Cass	140055	14	>5.0	>15.0	>8.9	>8.0	2.8	<46
Clam	Antrim	050101	18	10.0	20.0	14.3	14.5	3.4	39
Clark	Jackson	380173	8	8.5	29.5	15.3	10.8	7.7	38
Clear	Jackson	380453	18	10.0	16.0	11.4	11.0	1.6	42
Clear	Ogemaw	650042	13	11.5	18.0	14.7	14.5	2.1	38
Clifford	Montcalm	590142	19	7.5	16.5	11.5	11.0	2.9	42
Cobb	Barry	080259	18	7.5	33.5	17.0	13.3	8.6	36
Coldwater	Branch	120077	13	8.0	27.0	14.1	10.0	6.4	39
Cora	Van Buren	800260	18	12.0	23.5	16.7	16.0	2.7	37
Corey	St. Joseph	750142	16	9.0	17.5	11.1	10.5	2.1	42
Cranberry	Oakland	631228	15	7.0	>13.0	>8.9	>7.5	2.1	<46
Crockery	Ottawa	700422	17	2.0	7.0	4.6	4.0	2.0	55
Crooked	Kalamazoo	390599	13	9.5	18.0	12.2	11.5	2.4	41
Crooked	Kalkaska	400133	*						
Crooked (Big)	Kent	410714	9	8.5	12.5	10.1	9.5	1.3	44
Crooked (Upper)	Barry	080071	9	9.5	14.0	11.1	10.5	1.6	42
Crystal	Benzie	100066	8	20.0	40.0	26.6	23.5	7.4	30
Crystal	Montcalm	590105	14	6.5	21.5	11.4	9.3	5.2	42
Crystal	Oceana	640062	16	3.5	19.0	12.8	13.5	4.9	40
Cub	Kalkaska	400031	14	12.0	15.0	13.9	14.0	0.9	39
Deer	Alger	020127	10	8.0	16.0	11.4	11.0	2.2	42
Deer	Oakland	631128	18	7.0	15.5	10.6	11.0	2.3	43
Derby	Montcalm	590144	9	6.5	38.0	17.6	15.5	8.9	36
Devils	Lenawee	460179	4	9.0	25.0				

APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	County	Site ID Number	Number of Readings	Secchi Disk Transparency (feet) Range Min	Max	Mean	Median	Standard Deviation	Carlson TSI_{SD} (transparency)
Diamond	Cass	140039	*						
Dinner	Gogebic	270126	17	8.0	18.0	10.8	10.0	3.1	43
Duck	Calhoun	130172	14	7.0	20.0	11.5	11.0	3.7	42
Duck	Gogebic	270127	12	8.0	12.5	9.8	9.5	1.4	44
Duck	Muskegon	610778	10	9.0	14.5	11.9	12.0	1.8	41
Duncan	Barry	080096	16	3.0	11.5	4.2	3.5	2.0	56
Eagle	Allegan	030259	20	13.0	20.5	15.7	14.8	2.2	37
Eagle	Cass	140057	17	4.0	16.0	7.9	6.0	4.1	47
Eagle	Kalkaska	400130	9	9.5	15.0	11.9	12.0	2.0	41
Earl	Livingston	470554	18	5.5	8.5	6.5	6.0	1.1	50
Emerald	Kent	410709	18	7.5	14.5	11.6	11.8	1.6	42
Emerald	Newaygo	620167	14	10.0	17.0	14.1	14.0	2.4	39
Evans	Lenawee	460309	16	11.5	18.0	14.5	15.0	2.1	39
Fair	Barry	080260	8	10.5	14.0	11.9	11.5	1.1	41
Farwell	Jackson	380454	17	9.0	>32	>16.7	>13	7.8	<36
Fenton	Genesee	250241	9	15.0	23.0	18.6	18.0	2.9	35
Fish	Van Buren	800461	17	5.5	15.0	10.1	10.5	2.5	44
Fishers	St. Joseph	750139	18	5.5	31.0	14.1	9.0	9.3	39
Fremont	Newaygo	620029	13	6.0	23.5	11.3	10.0	4.8	42
Freska	Kent	410702	12	6.0	12.0	9.2	9.5	1.9	45
Gallagher	Livingston	470210	9	9.5	15.0	12.9	13.5	2.2	40
George	Clare	180056	*						
Glen (Big)	Leelanau	450049	17	15.0	>29	>20.5	>19.5	3.8	<34
Glen (Little)	Leelanau	450050	12	8.5	12.0	10.3	10.0	1.4	44

APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	County	Site ID Number	Secchi Disk Transparency (feet) Number of Readings	Range Min	Range Max	Mean	Median	Standard Deviation	Carlson TSI_{SD} (transparency)
Gratiot	Keweenaw	420030	12	11.0	20.0	14.7	13.8	2.8	38
Gravel	Van Buren	800271	10	9.0	18.0	12.2	11.0	3.3	41
Green Oak (Silver)	Livingston	470589	12	10.0	24.5	14.9	13.0	4.3	38
Gull	Kalamazoo	390210	18	9.0	27.0	14.1	10.8	6.1	39
Hamburg	Livingston	470568	18	15.0	27.0	18.8	17.5	3.7	35
Hamlin (Lower)	Mason	530073	18	5.0	14.0	8.4	7.0	3.2	46
Hamlin (Upper)	Mason	530074	18	2.0	8.5	5.0	4.5	1.9	54
Hannah Webb	Iron	360165	*						
Harper	Lake	430030	15	12.5	22.0	17.5	17.0	2.9	36
Hawk	Oakland	631115	18	6.0	>14.0	>10.1	>10.5	2.4	<44
Herring (Upper)	Benzie	100247	14	6.0	14.5	9.8	8.5	3.3	44
Hicks	Osceola	670062	12	3.0	6.5	5.1	5.5	1.1	54
Higgins (N. Basin)	Roscommon	720026	8	30.0	44.0	37.8	38.8	5.5	25
Higgins (S. Basin)	Roscommon	720028	8	29.0	46.0	39.1	40.0	5.2	24
High	Kent	410703	*						
Horsehead	Mecosta	540085	17	7.5	19.0	11.1	10.0	3.0	42
Houghton (Cut River)	Roscommon	720163	5	5.5	6.5				
Houghton (Denton)	Roscommon	720164	5	6.0	7.0				
Hubbard (1)	Alcona	010101	8	12.0	15.0	13.8	14.0	1.0	39
Hubbard (2)	Alcona	010102	8	10.0	16.0	13.4	13.5	2.0	40
Hubbard (3)	Alcona	010103	13	11.5	25.0	15.8	15.0	3.5	37
Hubbard (4)	Alcona	010104	13	12.0	24.0	15.5	15.0	3.2	38
Hubbard (5)	Alcona	010105	13	11.5	22.0	15.6	15.0	3.1	38
Hubbard (6)	Alcona	010106	16	11.0	28.5	14.8	13.0	4.1	38

APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	**County**	**Site ID Number**	Number of Readings	Secchi Disk Transparency (feet) Range Min	Max	Mean	Median	Standard Deviation	**Carlson** $\mathbf{TSI_{SD}}$ (transparency)
Hubbard (7)	Alcona	010107	7	10.0	18.0				
Hunter	Gladwin	260119	12	8.0	17.0	11.3	11.0	2.9	42
Hutchins	Allegan	030203	15	7.5	18.0	11.0	8.5	4.1	43
Independence	Marquette	520149	15	8.0	15.0	10.5	10.5	1.9	43
Indian	Kalamazoo	390305	13	7.0	30.0	14.8	12.0	7.5	38
Indian	Kalkaska	400015	11	9.5	17.0	13.1	13.0	3.1	40
Indian	Osceola	670227	18	11.0	24.0	16.4	16.0	2.6	37
Island	Grand Traverse	280164	13	14.0	38.0	18.7	15.0	7.4	35
Island (Little)	Iosco	350245	16	4.5	>10.5	>6.9	>6.8	1.6	<49
James	Roscommon	720171	13	5.0	11.5	7.7	7.0	1.9	47
Juno	Cass	140058	14	>5.5	>10.5	>7.1	>7.0	1.5	<49
Kelsey (Big)	Cass	140195	8	7.0	10.5	8.7	9.0	1.4	46
Kelsey (Little)	Cass	140196	7	7.0	15.5				
Kimball	Newaygo	620107	13	2.5	9.0	6.0	6.0	1.6	51
Klinger	St. Joseph	750136	18	4.5	28.0	12.7	10.5	6.2	40
Lakeville	Oakland	630670	16	6.0	23.0	13.6	14.0	6.2	40
Lancelot (1)	Gladwin	260104	12	7.0	11.0	8.2	8.0	1.1	47
Lancelot (2)	Gladwin	260112	8	3.0	12.5	7.4	8.5	3.3	48
Lancelot (3)	Gladwin	260113	9	3.5	12.0	7.6	8.5	2.7	48
Lancer	Gladwin	260116	14	7.5	13.5	11.3	12.0	1.9	42
Leelanau (North)	Leelanau	450236	18	11.5	24.5	18.3	18.8	5.2	35
Leelanau (South)	Leelanau	450235	14	9.5	17.5	13.8	14.5	2.2	39
Long	Gogebic	270189	10	10.0	17.0	12.6	12.0	2.1	41
Long	Gogebic	270179	10	10.0	18.0	13.3	13.0	2.6	40

APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	County	Site ID Number	Secchi Disk Transparency (feet)						Carlson
			Number of	Range				Standard	TSI_{SD}
			Readings	Min	Max	Mean	Median	Deviation	(transparency)
Long	Iosco	350076	18	14.0	17.0	14.8	15.0	0.9	38
Long	Oakland	631118	18	12.0	17.0	13.8	13.5	1.2	39
Long (Little)	Barry	080279	9	>10.5	>22.0	>16.9	>18	4.0	<36
Long (Upper)	Oakland	631117	*						
Maceday/Lotus	Oakland	630415	*						
Magician	Cass	140065	18	>5.0	>21.0	>10.8	>9.8	4.5	<43
Margrethe	Crawford	200157	13	14.0	34.0	19.5	15.5	7.1	34
Marl	Genesee	250480	14	5.5	16.0	9.4	9.5	2.6	45
Mary	Dickinson	220039	18	15.0	19.0	16.9	17.3	1.2	36
Mary	Iron	360071	18	14.0	22.5	20.1	20.0	1.9	34
Maston	Kent	410764	34	6.5	22.0	12.1	10.0	5.0	41
Maynard	Alcona	010126	*						
Mecosta	Mecosta	540057	16	7.0	20.0	9.9	8.5	3.8	44
Middle Straits	Oakland	630732	12	8.0	25.0	13.2	11.5	5.5	40
Moon	Gogebic	270120	16	13.0	28.0	19.2	20.3	4.1	35
Murray	Kent	410268	13	7.5	17.0	10.7	10.5	2.8	43
Muskellunge	Kent	410765	17	7.5	21.0	14.4	15.0	3.8	39
Muskellunge	Montcalm	590154	16	5.0	13.0	7.8	7.5	2.3	47
Muskoday	Wayne	821553	*						
Nepessing	Lapeer	440220	9	6.0	19.0	11.1	11.0	4.4	42
Ore	Livingston	470100	14	7.0	21.0	11.1	9.0	4.5	42
Orion	Oakland	630554	17	9.0	15.0	12.1	11.5	1.9	41
Osterhout	Allegan	030263	18	7.0	11.0	9.3	10.0	1.6	45
Oxbow	Oakland	630666	4	11.5	16.0				

APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	**County**	**Site ID Number**	**Secchi Disk Transparency (feet)** Number of Readings	Range Min	Max	Mean	Median	Standard Deviation	**Carlson TSI_{SD}** (transparency)
Painter	Cass	140108	14	>4.5	>8.0	>6.0	>6.0	1.1	<51
Papoose	Kalkaska	400134	*						
Park	Clinton	190099	14	6.5	>15	>9.8	>9	2.6	<44
Parke	Oakland	631119	13	9.0	19.0	14.6	15.0	2.8	38
Paw Paw (Little)	Berrien	110765	18	4.5	7.0	5.3	5.3	0.8	53
Payne	Barry	080103	9	8.0	13.0	10.2	10.0	1.7	44
Pentwater	Oceana	640089	8	3.0	7.0	4.4	4.0	1.3	56
Perch	Iron	360046	13	3.5	10.0	5.9	5.0	2.1	52
Perrin	St. Joseph	750314	17	8.5	15.0	11.5	11.0	2.1	42
Pickerel	Kalkaska	400035	18	18.0	28.0	23.9	23.5	2.4	31
Pickerel	Newaygo	620066	13	12.5	21.0	16.1	15.0	2.6	37
Pine Island (Big)	Kent	410437	18	6.0	15.0	9.4	8.5	2.8	45
Platte	Benzie	100086	18	9.5	20.5	14.4	14.5	3.1	39
Pleasant	St. Joseph	750144	13	6.5	11.5	9.0	9.0	1.4	45
Pleasant	Wexford	830183	18	7.0	10.5	8.4	8.3	1.0	47
Portage	Washtenaw	810248	16	6.5	18.5	14.2	15.5	3.8	39
Posey	Lenawee	460423	9	6.5	8.0	7.2	7.0	0.4	49
Pretty	Mecosta	540079	*						
Puterbaugh	Cass	140170	14	7.0	19.0	10.7	9.0	3.8	43
Randall	Branch	120078	18	4.5	17.5	8.3	6.8	3.7	47
Rifle	Ogemaw	650022	10	11.5	23.0	17.4	16.0	3.7	36
Robinson	Cass	140194	14	4.5	7.5	6.5	6.5	0.8	50.0
Round	Lenawee	460304	7	9.0	21.0				
Round	Livingston	470546	11	8.0	14.0	9.7	8.0	2.2	44

APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	County	Site ID Number	Secchi Disk Transparency (feet)						Carlson
			Number of	Range				Standard	TSI_{SD}
			Readings	Min	Max	Mean	Median	Deviation	(transparency)
Round	Mecosta	540073	16	5.5	11.0	7.4	7.0	1.4	48
Round	Jackson/Lenawee	460249	11	13.0	>16	>14.0	>13.0	1.3	<39
Sand	Lenawee	460264	8	12.5	17.0	14.0	14.0	1.4	40
Sanford	Benzie	100208	18	14.0	34.0	20.6	18.0	5.9	34
Sanford	Midland	560169	14	4.0	9.0	6.2	6.0	1.8	51
School Section (1)	Mecosta	540080	14	9.5	13.5	11.4	11.5	1.4	42
School Section (2)	Mecosta	540190	14	8.5	13.0	11.0	11.5	1.4	43
Sherman	Kalamazoo	390382	6	12.5	19.5				
Shinanguag	Genesee	250519	16	6.5	13.0	9.2	8.8	1.7	45
Shingle	Clare	180108	*						
Silver	Genesee	250481	18	9.0	22.0	14.1	13.0	4.4	39
Silver	Oceana	640341	8	3.5	>7	>5.1	>5	1.2	<54
Silver	Van Buren	800534	18	8.0	12.0	9.6	9.3	1.3	45
Spider	Grand Traverse	280395	18	12.5	25.0	17.5	15.5	4.5	36
Squaw	Kalkaska	400135	8	11.0	15.5	12.8	12.0	2.0	40
Starvation	Kalkaska	400030	17	19.0	29.0	23.5	23.0	3.5	32
Stoneledge	Wexford	830186	*						
Stony	Oceana	640049	18	4.0	7.5	5.5	5.5	0.9	53
Strawberry	Livingston	470213	*						
Sturgeon	St. Joseph	750333	3	2.5	3.5				
Sweezey	Jackson	380470	11	9.0	13.5	11.0	10.0	1.9	43
Sylvan	Newaygo	620168	15	12.0	31.0	19.7	16.0	6.6	34
Tahoe	Oceana	640332	12	4.5	11.5	8.3	8.3	2.6	47
Taylor	Oakland	631114	17	16.5	23.0	18.0	17.5	1.5	35

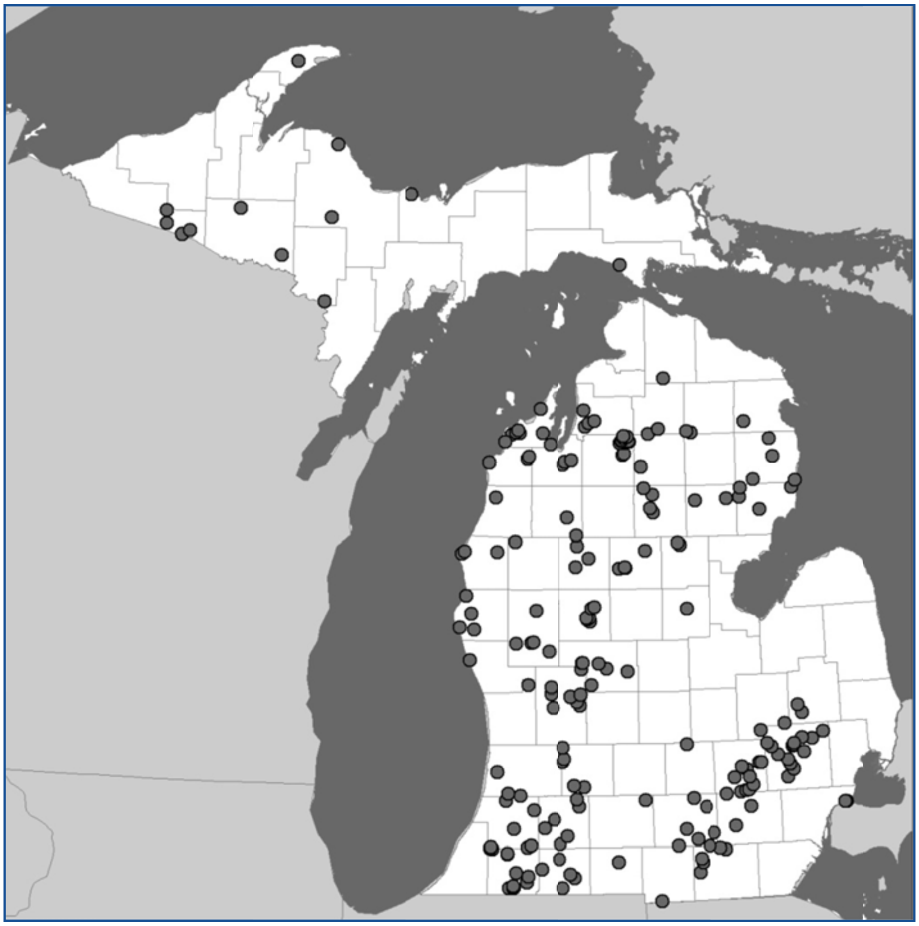
APPENDIX 1
2012 COOPERATIVE LAKES MONITORING PROGRAM
SECCHI DISK TRANSPARENCY RESULTS

Lake	County	Site ID Number	Secchi Disk Transparency (feet) Number of Readings	Range Min	Range Max	Mean	Median	Standard Deviation	Carlson TSI_{SD} (transparency)
Templene	St. Joseph	750322	*						
Torch (North)	Antrim	050055	18	18.0	41.0	30.1	31.5	8.0	28
Torch (South)	Antrim	050240	16	17.0	36.0	27.5	30.5	5.8	29
Triangle	Livingston	470591	10	7.0	>15.0	>9.9	>9.3	2.2	<44
Twin (Big)	Cass	140165	*						
Twin (Big)	Kalkaska	400025	15	15.0	29.0	20.5	21.0	4.4	34
Twin (East)	Montmorency	600013	3	9.0	>20				
Twin (Little)	Kalkaska	400013	17	13.5	23.5	18.0	18.0	2.6	35
Twin (Little-South)	Cass	140166	18	6.5	21.0	10.8	9.8	3.7	43
Twin (West)	Montmorency	600014	13	9.0	17.0	11.8	12.0	2.1	41
Van Etten	Iosco	350201	17	2.0	10.0	6.2	7.0	2.6	51
Vaughn	Alcona	010049	3	8.0	14.5				
Viking	Otsego	690136	16	2.0	7.0	4.3	4.0	1.3	56
Vineyard	Jackson	380263	12	8.0	15.0	10.1	9.3	2.3	44
Webinguaw	Newaygo	620283	10	3.0	5.0	4.1	4.0	0.7	57
White	Oakland	630684	6	14.0	20.0				
Wildwood	Cheboygan	160230	13	8.0	12.0	9.2	8.5	1.2	45
Windover	Clare	180069	10	11.0	20.0	15.3	14.0	3.2	38
Woods	Kalamazoo	390542	18	7.0	14.0	10.5	10.3	2.2	43
Zukey	Livingston	470212	9	7.5	13.5	10.6	10.0	2.2	43

* No measurements reported

> and < : At least one measurement was made on lake bottom, so TSI calculation is artifically inflated.

Appendix 2
2012 Cooperative Lakes Monitoring Program
Total Phosphorus Results



Map above shows the distribution of the 191 lakes/basins enrolled in late summer Total Phosphorus monitoring in the 2012 CLMP Program.

Recorded Total Phosphorus Values:

Spring Mean:	11.0 µg/l	Summer Mean:	13.9 µg/l
Minimum:	<5 µg/l	Minimum:	<5 µg/l
Maximum:	46 µg/l	Maximum:	99 µg/l
(Kimball Lake, Newaygo Co.)		(Sturgeon Lake, St. Joseph Co.)	

Michigan Clean Water Corps
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APPENDIX 2
2012 COOPERATIVE LAKES MONITORING PROGRAM
SPRING AND SUMMER TOTAL PHOSPHORUS RESULTS

Lake	County	Site ID Number	Total Phosphorus (µg/l) Spring Overturn				Late Summer				Carlson TSI
			Vol	Rep.	DEQ	Rep.	Vol	Rep	DEQ	Rep	TSITP (summer TP)
Allen	Gogebic	270207					9				36
Angelus	Oakland	631227	9				8	8			34
Ann	Benzie	100082	8				15				43
Arbutus	Grand Traverse	280109	3 W				7				32
Arnold	Clare	180107	2 W	2 W			4				<27
Bar (South)	Leelanau	450237	*				13				41
Barlow	Barry	080176					7	5			32
Barton	Kalamazoo	390215					9				36
Bass	Kalkaska	400129	6	6			*				
Bear	Kalkaska	400026	2 W				7				32
Bear	Manistee	510122	6				10				37
Beatons	Gogebic	270105	10				6				30
Beaver	Alpena	040097	*				3 W				<27
Bellaire	Antrim	050052	4 T	4 T			4 T				<27
Big	Osceola	670056	*				16				44
Bills (Waits)	Newaygo	620311					10				37
Birch (Fallon)	Cass	140187					3 W				<27
Birch (Temple)	Cass	140061	7	9			3 W				<27
Blue	Kalkaska	400017	*				6				30
Blue	Mecosta	540092	4 T				6				30
Blue (North)	Kalkaska	400131	7				7				32
Blue Heron	Wayne	821553					*				
Bostwick	Kent	410322	16				34	33			55
Bradford (Big)	Otsego/Crawford	690036	*				3 W		7	9	<27

APPENDIX 2
2012 COOPERATIVE LAKES MONITORING PROGRAM
SPRING AND SUMMER TOTAL PHOSPHORUS RESULTS

		Site ID	Total Phosphorus (µg/l)								Carlson
Lake	**County**	**Number**	**Spring Overturn**				**Late Summer**				**TSI**$_{TP}$
			Vol	Rep.	DEQ	Rep.	Vol	Rep	DEQ	Rep	(summer TP)
Brevoort	Mackinac	490036	11				*				
Brooks	Leelanau	450222	7				11				39
Brown	Jackson	380477	18				7				32
Bruin	Washtenaw	810575	5				13				41
Buckhorn (North)	Oakland	631113	*				*				
Cascade Impoundment	Kent	410686	43				42				58
Cedar	Alcona/Iosco	010017	3 W	4 T			11				39
Cedar	Leelanau	450234					4 T				<27
Cedar	Van Buren	800241	*				8				34
Center	Osceola	670238	4 T	4 T			4 T				24
Chabenau	Marquette	520508	5				11				39
Chain	Iosco	350146	7				9				36
Chancellor (Blue)	Mason	530287	14				12	12			40
Chemung	Livingston	470597	34				10	11			37
Christiana	Cass	140055	12				17	20			45
Clam	Antrim	050101	*				3 W				<27
Clark	Jackson	380173	5				11				39
Clear	Jackson	380453					12		9		40
Clear	Ogemaw	650042					7				32
Clifford	Montcalm	590142	14				13				41
Cobb	Barry	080259	6				6				30
Cora	Van Buren	800260	6				8				34
Corey	St. Joseph	750142	7				8				34
Cranberry	Oakland	631228	28				29				53

APPENDIX 2
2012 COOPERATIVE LAKES MONITORING PROGRAM
SPRING AND SUMMER TOTAL PHOSPHORUS RESULTS

Lake	County	Site ID Number	Total Phosphorus (µg/l) Spring Overturn Vol	Rep.	DEQ	Rep.	Late Summer Vol	Rep	DEQ	Rep	Carlson TSITP (summer TP)
Crockery	Ottawa	700422					17				45
Crooke (Upper)	Barry	080071	*				13	13			41
Crooked	Kalamazoo	390599	*				9	7			36
Crooked (Big)	Kent	410714	7				21	21			48
Crooked (North)	Kalkaska	400133	22				18				46
Crystal	Benzie	100066					6				30
Crystal	Montcalm	590105	1 W				10				37
Crystal	Oceana	640062	9	9			12				40
Cub	Kalkaska	400031	8				8				34
Deer	Alger	020127	6				3 W				<27
Deer	Oakland	631128	7				10				37
Derby	Montcalm	590144	4 T	2 W			10	10	4		37
Devils	Lenawee	460179	8				12				40
Diamond	Cass	140039	6				6				30
Dinner	Gogebic	270126	11				11				39
Duck	Calhoun	130172	7				15				43
Duck	Gogebic	270127	7				19	20			47
Duck	Muskegon	610778	11	9			13				41
Duncan	Barry	080096	38				25				51
Eagle	Allegan	030259	11				11				39
Eagle	Cass	140057	9				12				40
Eagle	Kalkaska	400130	18				11				39
Earl	Livingston	470554	33				30				53
Emerald	Kent	410709	5				11				39

APPENDIX 2
2012 COOPERATIVE LAKES MONITORING PROGRAM
SPRING AND SUMMER TOTAL PHOSPHORUS RESULTS

Lake	County	Site ID Number	Total Phosphorus (µg/l) Spring Overturn Vol	Rep.	DEQ	Rep.	Late Summer Vol	Rep	DEQ	Rep	Carlson TSI TP (summer TP)
Evans	Lenawee	460309	*				7				32
Fair	Barry	080260	27				12				40
Farwell	Jackson	380454	6				7				32
Fenton	Genesee	250241	12				12				40
Fish	Van Buren	800461	10				16	16			44
Fisher (Big)	Leelanau	450224	6				5				27
Fishers	St.Joseph	750139	8				*				
Freska	Kent	410702	13				9				36
Gallagher	Livingston	470210					17 c				45
George	Clare	180056	11				14				42
Glen (Big)	Leelanau	450049	6				7				32
Glen (Little)	Leelanau	450050	6				9				36
Gravel	Van Buren	800271	7				9				36
Green Oak (Silver)	Livingston	470589	9				11				39
Gull	Kalamazoo	390210	6				3 W				<27
Hamlin (Lower)	Mason	530073	18 c				34				55
Hamlin (Upper)	Mason	530074	16 c				61				63
Hannah Webb	Iron	360165	*				7				32
Harper	Lake	430030	*				9				36
Hawk	Oakland	631115	25				17				45
Herring (Upper)	Benzie	100247	11				13				41
Hicks	Osceola	670062	42				28	29			52
Higgins (N. Basin)	Roscommon	720026	3 W				9				36
Higgins (S. Basin)	Roscommon	720028	2 W				7				32

APPENDIX 2
2012 COOPERATIVE LAKES MONITORING PROGRAM
SPRING AND SUMMER TOTAL PHOSPHORUS RESULTS

Lake	County	Site ID Number	Total Phosphorus (µg/l) Spring Overturn				Late Summer				Carlson TSI_{TP}
			Vol	Rep.	DEQ	Rep.	Vol	Rep	DEQ	Rep	(summer TP)
High	Kent	410703	*				11				39
Horsehead	Mecosta	540085	6				11				39
Houghton (Cut River)	Roscommon	720163	10				14				42
Houghton (Denton)	Roscommon	720164	9				18				46
Hubbard	Alcona	010106	1 W				7				32
Hutchins	Allegan	030203	7	7			13				41
Independence	Marquette	520149	9	8			12				40
Indian	Kalamazoo	390305	5				5 c				27
Indian	Kalkaska	400015	4 T				10				37
Indian	Osceola	670227	7				*				
Island	Grand Traverse	280164	2 W				7				32
James	Roscommon	720171	18	17			19				47
Juno	Cass	140058	22				23				49
Kelsey (Big)	Cass	140195					18				46
Kelsey (Little)	Cass	140196	12				16				44
Kimball	Newaygo	620107	46				20				47
Klinger	St. Joseph	750136	*				3 vv e				<27
Lakeville	Oakland	630670	15				15				43
Lancelot	Gladwin	260104	8	9			23				49
Lancer	Gladwin	260116	10				19				47
Leelanau (North)	Leelanau	450236	3 W				13	10			41
Leelanau (South)	Leelanau	450235	2 W				12				40
Little Island	Iosco	350245	9				20				47
Long	Gogebic	270179	2 W				11				39

2012 COOPERATIVE LAKES MONITORING PROGRAM
SPRING AND SUMMER TOTAL PHOSPHORUS RESULTS

Lake	County	Site ID Number	Total Phosphorus (µg/l) Spring Overturn Vol				Late Summer Vol	Rep	DEQ	Rep	Carlson TSI$_{TP}$ (summer TP)
				Rep.	DEQ	Rep.					
Long	Iosco	350076	7				7				32
Long	Oakland	631117					41				58
Long	Oakland	631118	11				11				39
Long (Little)	Barry	080279					6				30
Maceday/Lotus	Oakland	630415					*				
Magician	Cass	140065	*				6	7			30
Margrethe	Crawford	200157	4 H,T				10	8			37
Mary	Dickinson	220039	12				8				34
Mary	Iron	360071	9				6				30
Maston	Kent	410764	9				11				39
Maynard	Alcona	010126	11				*				
Mecosta	Mecosta	540057	2 W	3 W			7				32
Middle Straits	Oakland	630732	15				16				44
Moon	Gogebic	270120	6				7				32
Murray	Kent	410268	19 g				10				37
Muskellunge	Kent	410765	11				11				39
Muskellunge	Montcalm	590154	8				16	15			44
Muskoday	Wayne	821553					*				
Nepessing	Lapeer	440220	9				29				53
Ore	Livingston	470100	10				18	15			46
Orion	Oakland	630554	19				15				43
Osterhout	Allegan	030263	*				13				41
Oxbow	Oakland	630666	10				13				41
Painter	Cass	140108	20				34				55

APPENDIX 2
2012 COOPERATIVE LAKES MONITORING PROGRAM
SPRING AND SUMMER TOTAL PHOSPHORUS RESULTS

Lake	County	Site ID Number	Total Phosphorus (µg/l) Spring Overturn Vol	Rep.	DEQ	Rep.	Late Summer Vol	Rep	DEQ	Rep	Carlson TSI$_{TP}$ (summer TP)
Papoose	Kalkaska	400134	*				18				46
Park	Clinton	190099	33				22				49
Parke	Oakland	631119	11				11				39
Payne	Barry	080103	12				8				34
Pentwater	Oceana	640089					26				51
Perch	Iron	360046	9				18				46
Perrin	St. Joseph	750314	10 e				14				42
Pickerel	Kalkaska	400035	6				4 T				<27
Pickerel	Newaygo	620066	16				10				37
Pine Island (Big)	Kent	410437	8				23				49
Pleasant	Washtenaw	810264					18				46
Pleasant	Wexford	830183	13				15				43
Portage	Washtenaw/Livingston	810248	11				6				30
Posey	Lenawee	460423	29				20	19			47
Pretty	Mecosta	540079	8				8				34
Rifle	Ogemaw	650022	4 T				14				42
Round	Jackson/Lenawee	460249	16	16			14				42
Round	Lenawee	460304					11 g	13			39
Round	Livingston	470546	11				11				39
Round	Mecosta	540073	10				11				39
Sand	Lenawee	460264					11				39
Sanford	Benzie	100208	5 f				16				44
Sanford	Midland	560169	22				73				66
School Section	Mecosta	540080	4 T				6	7			30

APPENDIX 2
2012 COOPERATIVE LAKES MONITORING PROGRAM
SPRING AND SUMMER TOTAL PHOSPHORUS RESULTS

Lake	County	Site ID Number	Total Phosphorus (µg/l) Spring Overturn Vol	Rep.	DEQ	Rep.	Late Summer Vol	Rep	DEQ	Rep	Carlson TSITP (summer TP)
Sherman	Kalamazoo	390382	12				14				42
Shinanguag	Genesee	250519	18	17			17	17			45
Shingle	Clare	180108	15				17				45
Silver	Oceana	640341	24				34				55
Silver	Van Buren	800534	19 e				6				30
Spider	Grand Traverse	280395	7				6				30
Squaw	Kalkaska	400135	*				19	17			47
Starvation	Kalkaska	400030	3 W				8				34
Stony	Oceana	640049	9				19				47
Strawberry	Livingston	470213	12				19				47
Sturgeon	St. Joseph	750333					99				70
Sweezey	Jackson	380470	7				10				37
Tahoe	Oceana	640332	11				13				41
Taylor	Oakland	631114	19 b				16				44
Templene	St. Joseph	750322	*				*				
Torch (North)	Antrim	050055	*				6 c				30
Torch (South)	Antrim	050240	*				3 W				<27
Triangle	Livingston	470591	15				14	12			42
Twin (Big)	Kalkaska	400025	9				6	7			30
Twin (Big-North)	Cass	140165	16	19			6				30
Twin (East)	Montmorency	600013	8		6		12				40
Twin (Little)	Kalkaska	400013	2 W	2 W			10				37
Twin (Little-South)	Cass	140166	10				14				42
Twin (West)	Montmorency	600014	5		2		4 T				24

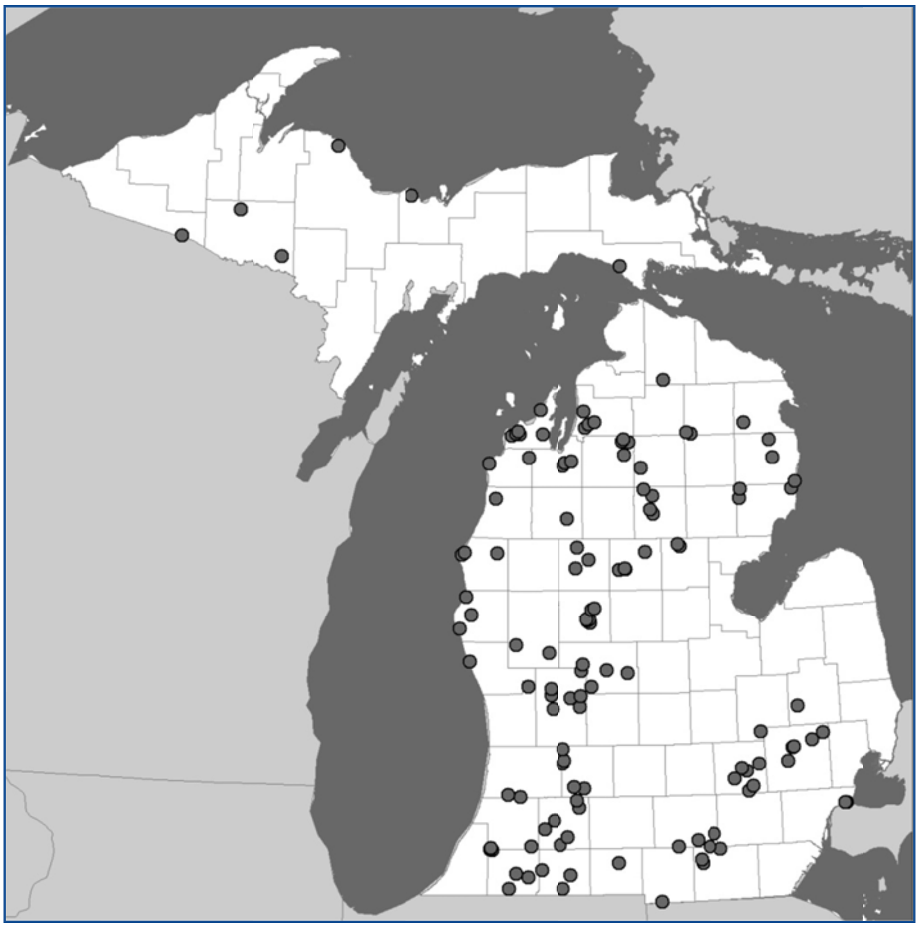
APPENDIX 2
2012 COOPERATIVE LAKES MONITORING PROGRAM
SPRING AND SUMMER TOTAL PHOSPHORUS RESULTS

Lake	County	Site ID Number	Total Phosphorus (µg/l) Spring Overturn Vol	Rep.	DEQ	Rep.	Late Summer Vol	Rep	DEQ	Rep	Carlson TSITP (summer TP)
Van Etten	Iosco	350201	15				68				65
Vaughn	Alcona	010049	22	17			*				
Viking	Otsego	690136	19				17				<27
Vineyard	Jackson	380263	6				11				39
Webinguaw	Newaygo	620283	14				21				48
White	Oakland	630687					20				47
Wildwood	Cheboygan	160230	8				17				45
Windover	Clare	180069	12				11				39
Woods	Kalamazoo	390542	17				19				47
Zukey	Livingston	470212	7	5			7				32

Results Codes:

* No sample received or received too late to process.
T Value reported is less than the reporting limit (5 µg/l). Result is estimated.
W Value is less than the method detection limit (3 µg/l)
b Used ink that ran on label
c Sample not collected at proper time - may not be comparable to other data
e Dates on sample bottle and data form did not match.
f Sample thawed slightly prior to processing due to improper turn-in.
g Data form not completed.

Appendix 3
2012 Cooperative Lakes Monitoring Program
Chlorophyll Results



Map above shows the distribution of the 107 lakes enrolled in Chlorophyll monitoring in the 2012 CLMP Program.

Recorded Chlorophyll Values:

Mean:	3.8 µg/l
Minimum:	<1 µg/l
Maximum:	43 µg/l (Cascade Impoundment, Kent County)

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APPENDIX 3
2012 COOPERATIVE LAKES MONITORING PROGRAM
CHLOROPHYLL RESULTS

		Site ID		Chlorophyll *a* (μg/L)						Std.	Carlson
Lake	**County**	**Number**	**May**	**June**	**July**	**Aug**	**Sept**	**Mean**	**Median**	**Dev.**	**TSI_{CHL}**
Angelus	Oakland	631227	<1.0	<1.0	1.2	1.4	<1.0b	0.8	0.5	0.4	<31
Ann	Benzie	100082	1.6	<1.0	1.7	1.3	1.5	1.3	1.5	0.5	35
Arbutus	Grand Traverse	280109	<1.0	1.3	1.2	2.5	1.9	1.5	1.3	0.8	33
Arnold	Clare	180107	<1.0	<1.0	2.2	1.2	2.1	1.3	1.2	0.8	32
Barlow	Barry	080176	1.0	1.7	1.7	1.4	1.5b	1.5	1.5	0.3	35
Barton	Kalamazoo	390215	3.3	<1.0	6.4	5.1	1.4	3.3	3.3	2.5	42
Vol/Rep						4.4					
Bear	Kalkaska	400026	*	1.5	1.2	1.1	1.2	1.3	1.2	0.2	32
Bear	Manistee	510122	1.2	5.4	3.2	3.5	2.4	3.1	3.2	1.5	42
Beaver	Alpena	040097	2.0	1.1	1.5	1.3	<1.0	1.3	1.3	0.5	33
Bellaire	Antrim	050052	<1.0	1.4	1.7	2.0	1.8	1.5	1.7	0.6	36
Big	Osceola	670056	1.7	1.0	1.8	4.4	2.8	2.3	1.8	1.3	36
Bills (Waits)	Newaygo	620311	1.0	*	2.3	3.1	2.9	2.3	2.6	0.9	40
Birch (Fallon)	Cass	140187	1.4a	1.9a	2.1a	1.9	1.5	1.8	1.9	0.3	37
Birch (Temple)	Cass	140061	1.1	2.2	1.9	1.7	1.9	1.8	1.9	0.4	37
Blue	Kalkaska	400017	1.8	1.1	1.3	1.9	1.3	1.5	1.3	0.3	33
Blue	Mecosta	540092	1.4	1.2	2.4	3.2	2.9	2.2	2.4	0.9	39
Blue (North)	Kalkaska	400131	1.0	<1.0	<1.0	<1.0	<1.0	0.6	0.5	0.2	<31
Bostwick	Kent	410322	1.5	3.9	5.5	13.0	8.7	6.5	5.5	4.5	47
Brevoort	Mackinac	490036	<1.0	1.1	2.2	*	*				
Brooks	Leelanau	450222	*	26.0	8.5	5.1	8.9	12.1	8.7	9.4	52
Vol/Rep					9.1						
Bruin	Washtenaw	810575	<1.0	1.2	1.9	1.2	1.9	1.3	1.2	0.6	32
Cascade Impoundment	Kent	410686	21.0	4.0	43.0	12.0	9.3	17.9	12.0	15.3	55

APPENDIX 3
2012 COOPERATIVE LAKES MONITORING PROGRAM
CHLOROPHYLL RESULTS

		Site ID	Chlorophyll *a* (µg/L)							Std.	Carlson
Lake	**County**	**Number**	**May**	**June**	**July**	**Aug**	**Sept**	**Mean**	**Median**	**Dev.**	**TSI_{CHL}**
Cedar	Alcona	010017	<1.0	1.7	4.0	2.7	2.5	2.3	2.5	1.3	40
Cedar	Van Buren	800241	2.0	3.8	2.5	2.4	2.4	2.6	2.4	0.7	39
Center	Osceola	670238	1.2	1.8	2.1	1.6	2.4	1.8	1.8	0.5	36
Chabenau	Marquette	520508	1.2	2.6	2.2	6.7	6.8	3.9	2.6	2.7	40
Vol/Rep							4.1				
Chain	Iosco	350146	2.8	4.7	5.0	2.3	4.0	3.8	4.0	1.2	44
Chemung	Livingston	470597	2.4	3.1	2.7	5.9	3.0	3.4	3.0	1.4	41
Christiana	Cass	140055	2.1	4.1	3.2	4.2	3.5	3.4	3.5	0.8	43
Clam	Antrim	050101	<1.0	<1.0	1.6	2.7	1.2	1.3	1.2	0.9	32
Clark	Jackson	380173	<1.0	<1.0	2.2	1.8	2.2	1.4	1.8	0.9	36
Cobb	Barry	080259	<1.0	<1.0	1.5	1.0	2.0	1.1	1.0	0.7	31
Vol/Rep			<1.0								
Cora	Van Buren	800260	2.7	<1.0	2.4	1.7	2.1	1.9	2.1	0.9	38
Corey	St Joseph	750142	<1.0	f	1.7	3.1	1.9	1.8	1.8	1.1	36
Crockery	Ottawa	700422	*	7.3	4.8	*	*				
Crooked (Upper)	Barry	080071	3.0	7.1	2.0	1.3	2.1	3.1	2.1	2.3	38
Vol/Rep			4.1								
Crooked	Kalamazoo	390599	2.8	1.9	5.0	3.5	3.6	3.4	3.5	1.1	43
Crystal	Benzie	100066	1.5	<1.0	<1.0	<1.0	<1.0	0.7	0.5	0.4	<31
Crystal	Montcalm	590105	<1.0	<1.0	<1.0	2.4	<1.0	0.9	0.5	0.8	<31
Crystal	Oceana	640062	3.8	2.3	2.5	4.2	8.5	4.3	3.8	2.5	44
Deer	Alger	020127	4.3	1.9	2.2	2.1	2.1	2.5	2.1	1.0	38
Deer	Oakland	631128	<1.0	<1.0	1.2	<1.0	<1.0	0.6	0.5	0.3	<31
Vol/Rep					<1.0						

APPENDIX 3
2012 COOPERATIVE LAKES MONITORING PROGRAM
CHLOROPHYLL RESULTS

Lake	County	Site ID Number	Chlorophyll *a* (μg/L) May	June	July	Aug	Sept	Mean	Median	Std. Dev.	Carlson TSI_{CHL}
Derby	Montcalm	590144	<1.0	2.7	2.0	1.1	1.5	1.6	1.5	0.8	35
Vol/Rep						1.2					
MDEQ							1.7				
Devils	Lenawee	460179	<1.0	1.1	1.9	3.2	1.4b	1.6	1.4	1.0	34
Diamond	Cass	140039	<1.0	<1.0b,e	1.8	<1.0	2.5b	1.2	0.5	0.9	<31
Duck	Muskegon	610778	4.3	6.2	3.8	*	7.8	5.5	5.3	1.8	47
Duncan	Barry	080096	1.7	20.0	13.0	24.0	19.0	15.5	19.0	8.7	59
Eagle	Allegan	030259	2.2	3.0	3.4	5.2	4.5	3.7	3.4	1.2	43
Eagle	Cass	140057	1.6	3.9	5.8	5.0	3.4	3.9	3.9	1.6	44
Vol/Rep							3.3				
Eagle	Kalkaska	400130	<1.0	4.0	3.2	2.1	5.6	3.1	3.2	1.9	42
Earl	Livingston	470554	21.0	6.9	15.0	6.2	4.3	10.7	6.9	7.1	50
Emerald	Kent	410709	1.2	3.1	5.0	3.4	4.1	3.4	3.4	1.4	43
Evans	Lenawee	460309	*	1.7	2.6	2.6	4.6	2.9	2.6	1.2	40
Fair	Barry	080260	6.8	5.4	6.9	14.0	1.1	6.8	6.8	4.6	49
Farwell	Jackson	380454	<1.0	<1.0	1.9	1.2	1.3	1.1	1.2	0.6	32
Fisher (Big)	Leelanau	450224	<1.0	<1.0	<1.0	<1.0	*	0.5	0.5	0.0	<31
Fishers	St Joseph	750139	2.9	4.3	4.0	2.7a	1.9a	3.2	2.9	1.0	41
Freska	Kent	410702	7.5	6.6	4.2	6.0	22.0	9.3	6.6	7.2	49
George	Clare	180056	2.2	2.8	3.4	2.5	1.5	2.5	2.5	0.7	40
Glen (Big)	Leelanau	450049	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.0	<31
Glen (Little)	Leelanau	450050	<1.0	<1.0	<1.0	1.3	1.5	0.9	0.5	0.5	<31
Gull	Kalamazoo	390210	1.1	*	1.9	2.7	3.4	2.3	2.3	1.0	39

APPENDIX 3
2012 COOPERATIVE LAKES MONITORING PROGRAM
CHLOROPHYLL RESULTS

Lake	County	Site ID Number	May	June	July	Aug	Sept	Mean	Median	Std. Dev.	Carlson TSI_{CHL}
			Chlorophyll *a* (µg/L)								
Hamlin (Lower)	Mason	530073	2.5	2.7	6.8	12.0	9.7	6.7	6.8	4.2	49
Hamlin (Upper)	Mason	530074	16.0	4.2	16.0	17.0	29.0	16.4	16.0	8.8	58
Hicks	Osceola	670062	*	24.0	18.0	15.0	26.0	20.8	21.0	5.1	60
Vol/Rep				12.0							
Higgins (N. Basin)	Roscommon	720026	<1.0	<1.0b	<1.0	<1.0	<1.0	0.5	0.5	0.0	<31
Higgins (S. Basin)	Roscommon	720028	<1.0	<1.0b	<1.0	<1.0	<1.0	0.5	0.5	0.0	<31
High	Kent	410703	5.0	5.8	1.4	8.2	2.6	4.6	5.0	2.7	46
Vol/Rep				5.5							
Horsehead	Mecosta	540085	1.5	4.9	5.4	4.2	3.5	3.9	4.2	1.5	45
Houghton (Cut River)	Roscommon	720163	5.2	2.2	3.7	6.4	6	4.6	4.9	2.0	46
Houghton (Denton)	Roscommon	720164	1.6	2.8	3	5.1	5.6	4.1	4.1	1.4	44
Hubbard	Alcona	010106	<1.0	<1.0	1.1	1.0	1.7	1.0	1.0	0.5	31
Independence	Marquette	520149	1.4	*	<1.0	*	2.4				
Indian	Kalamazoo	390305	<1.0	1.3	<1.0	2.2	1.3	1.2	1.3	0.7	33
Indian	Kalkaska	400015	1.0	2.8	3.8	2.1	1.2	2.2	2.1	1.2	38
Indian	Osceola	670227	10.0	1.7	4.7	*	*				
Island	Grand Traverse	280164	<1.0	1.9	1.8	2.8	3.0	2.0	1.9	1.0	37
Vol/Rep					1.9						
Island (Little)	Iosco	350245	<1.0	2.8	5.6	6.7	5.1	4.1	5.1	2.5	47
Juno	Cass	140058	3.5	5.3	5.4	10.0	4.1	5.7	5.3	2.6	47
Klinger	St Joseph	750136	<1.0	<1.0	1.6	2.8	2.5	1.6	1.6	1.1	35
Lakeville	Oakland	630670	2.4	<1.0	1.5	4.2	5.2	2.8	2.4	1.9	39
Lancelot	Gladwin	260104	2.5	3.3	2.2	5.8	4.7	3.7	3.3	1.5	42
Lancer	Gladwin	260116	1.6	3.0	2.3	6.6	5.2	3.7	3.0	2.1	41

APPENDIX 3
2012 COOPERATIVE LAKES MONITORING PROGRAM
CHLOROPHYLL RESULTS

Lake	County	Site ID Number	May	June	July	Aug	Sept	Mean	Median	Std. Dev.	Carlson TSI_{CHL}
			Chlorophyll *a* (µg/L)								
Leelanau (North)	Leelanau	450236	<1.0	<1.0b	<1.0	<1.0	<1.0	0.5	0.5	0.0	<31
Leelanau (South)	Leelanau	450235	<1.0	2.3b	1.4	<1.0	1.2	1.2	1.2	0.7	32
Long	Iosco	350076	1.5	1.4	2.1	2.0	1.4	1.7	1.5	0.3	35
Long (Little)	Barry	080279	1.8	1.1	2.8	1.4	2.9	2.0	1.8	0.8	36
Magician	Cass	140065	<1.0	3.2	3.9	<1.0	2.8	2.2	2.8	1.6	41
Margrethe	Crawford	200157	*	<1.0	1.9	2.8	1.9	1.8	1.9	1.0	37
MDEQ						1.7					
Mary	Iron	360071	3.1	3.1	3.1	5.9	6.7	4.4	3.1	1.8	42
Vol/Rep						5.8					
Maston	Kent	410764	<1.0	<1.0	2.4	2.4	2.8	1.7	2.4	1.1	39
Maynard	Alcona	010126	*	*	*	*	*				
Mecosta	Mecosta	540057	1.6	1.8	2.9	3.0	<1.0	2.0	1.8	1.0	36
Moon	Gogebic	270120	2.5	3.3	3.2	6.3	7.8	4.6	3.3	2.3	42
MDEQ						6.2					
Murray	Kent	410268	<1.0	<1.0	1.0	2.1	1.1	1.0	1.0	0.7	31
Muskellunge	Kent	410765	2.5	1.6	5.6	9.6	1.9	4.2	2.5	3.4	40
Nepessing	Lapeer	440220	2.9	1.5	2.9	2.6	14.0	4.8	2.9	5.2	41
Ore	Livingston	470100	*	4.8	*	1.4	4.1				
Orion	Oakland	630554	4.9	3.8	3.6	2.0	1.3	3.1	3.6	1.5	43
Osterhout	Allegan	030263	1.9	3.6	3.6	2.7	2.9b	2.9	2.9	0.7	41
Oxbow	Oakland	630666	1.2	<1.0	2.7	*	2.4	1.7	1.8	1.0	36
Painter	Cass	140108	1.8	4.5	14.0	18.0	6.4	8.9	6.4	6.8	49
Parke	Oakland	631119	<1.0	5.5b	2.8	2.4	4.1	3.1	2.8	1.9	41
Pentwater	Oceana	640089	8.3	13.0	13.0	21.0	7.6	12.6	13.0	5.3	56

APPENDIX 3
2012 COOPERATIVE LAKES MONITORING PROGRAM
CHLOROPHYLL RESULTS

Lake	County	Site ID Number	Chlorophyll *a* (µg/L) May	June	July	Aug	Sept	Mean	Median	Std. Dev.	Carlson TSI_{CHL}
Perch	Iron	360046	1.4	4.2	2.1	6.1	5.6	3.9	4.2	2.1	45
Pine Island (Big)	Kent	410437	3.1	4.4	5.6	7.6	6.5	5.4	5.6	1.8	48
Pleasant	Wexford	830183	*	4.6	2.8	3.4	3.1	3.5	3.3	0.8	42
Round	Jackson/Lenawee	460249	4.0	9.6	13.0	9.6	10.0	9.2	9.6	3.3	53
Round	Lenawee	460304	<1.0	<1.0	1.4	1.5	<1.0	0.9	0.5	0.5	<31
Round	Livingston	470546	1.8	6.7	5.4	5.7	4.6	4.8	5.4	1.9	47
Round	Mecosta	540073	3.5	1.5	3.8	3.2	4.8	3.4	3.5	1.2	43
School Section	Mecosta	540080	3.6	3.6	2.0	4.4	2.7	3.3	3.6	0.9	43
Sherman	Kalamazoo	390382	1.1	*	4.0	14.0	7.2	6.6	5.6	5.5	48
Shingle	Clare	180108	1.8	2.6	3.4	10.0	7.2	5.0	3.4	3.5	43
Silver	Oceana	640341	1.9	4.3	2.0	11.0	17.0	7.2	4.3	6.6	45
Spider	Grand Traverse	280395	1.3	2.1	<1.0	3.1	2.7	1.9	2.1	1.1	38
Stony	Oceana	640049	9.5	3.7	5.2	15.0	11.0	8.9	9.5	4.5	53
Strawberry	Livingston	470213	2.3	2.1	4.6	6.5	<1.0	3.2	2.3	2.4	39
Sweezey	Jackson	380470	<1.0	1.3	c	1.2	1.7	1.2	1.3	0.5	33
Templene	St Joseph	750322	*	*	*	*	*				
Torch (North)	Antrim	050055	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.0	<31
Torch (South)	Antrim	050240	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.0	<31
Triangle	Livingston	470591	1.1	4.9	4.9	14.0	4.2	5.8	4.9	4.8	46
Twin (West)	Montmorency	600014	<1.0	1.4	2.8	2.1	3.0	2.0	2.1	1.0	38
Vol/Rep				1.8							
Twin (Big)	Kalkaska	400025	3.6	1.0	1.8	<1.0	1.3	1.6	1.3	1.2	33
Twin (East)	Montmorency	600013	6.4	14.0	11.0	11.0	7.6	10.0	11.0	3.0	54
Van Etten	Iosco	350201	4.5	3.1	6.4	14.0	22.0	10.0	6.4	7.9	49

APPENDIX 3
2012 COOPERATIVE LAKES MONITORING PROGRAM
CHLOROPHYLL RESULTS

Lake	County	Site ID Number	May	June	July	Aug	Sept	Mean	Median	Std. Dev.	Carlson TSI_{CHL}
			Chlorophyll *a* (µg/L)								
Viking	Otsego	690136	3.4	5.2	7.3	13.0	20.0	9.8	7.3	6.8	50
Vineyard	Jackson	380263	<1.0b	1.1b	2.0	1.9	1.3	1.4	1.3	0.6	33
Wildwood	Cheboygan	160230	3.2	*	3.7	4.2	2.3	3.4	3.5	0.8	43
Windover	Clare	180069	<1.0	1.1	2.6	2.6	<1.0	1.5	1.1	1.1	32
Vol/Rep			<1.0								
Woods	Kalamazoo	390542	5.5	7.0	23.0	9.0	11.0	11.1	9.0	7.0	52

Results Codes:

< Sample value is less than limit of quantification (1 ug/l)

* No sample received

a No data sheet submitted with sample

b Sample not collected within the designated sampling window

c Sample not collected at proper time - sample not processed

d Sample poorly or not covered by aluminum foil - sample not processed

e Dates on field sheet and vial labels do not match

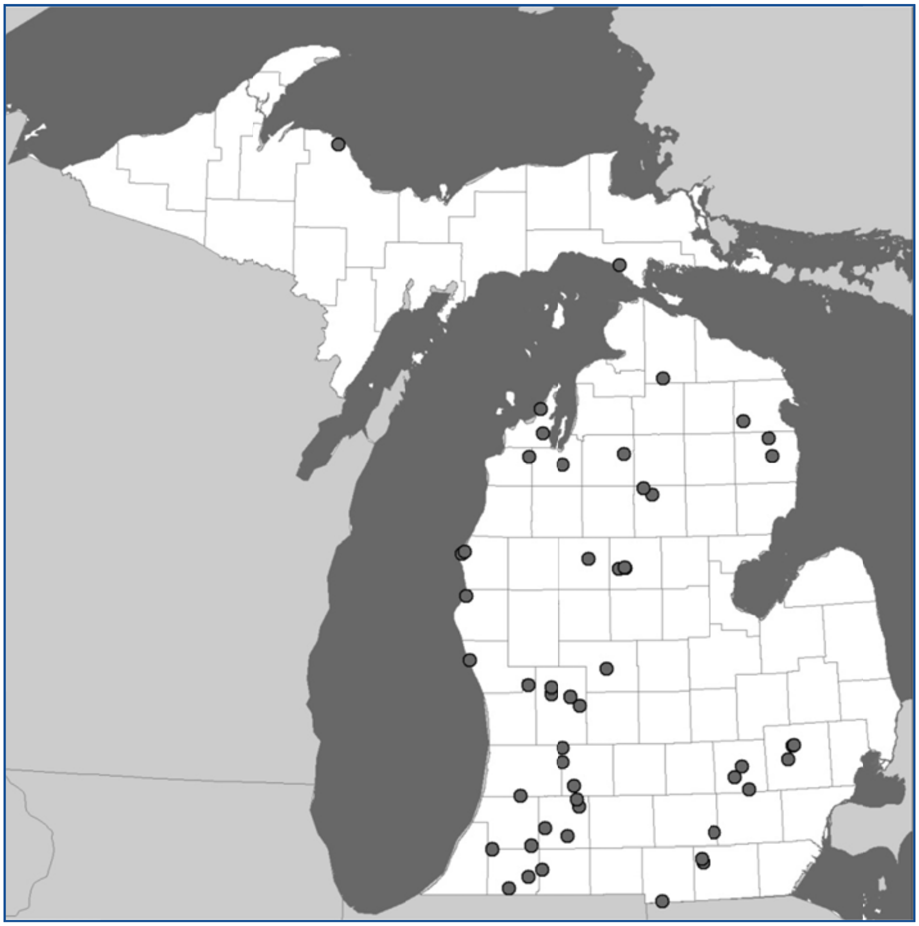
f Separator sheets used instead of filter - sample not processed

g No MgCO3 used to preserve the sample

x No filter; received vial filled with water

D Results determined from a dilution

Appendix 4
2012 Cooperative Lakes Monitoring Program
Dissolved Oxygen and Temperature Results



Map above shows the distribution of the 59 lakes enrolled in Dissolved Oxygen and Temperature monitoring in the 2012 CLMP Program.

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APPENDIX 4
2012 COOPERATIVE LAKES MONITORING PROGRAM
DISSOLVED OXYGEN AND TEMPERATURE RESULTS

County	Participating Lakes	Site ID
Alcona	Hubbard	010106
Allegan	Eagle	030259
Alpena	Beaver	044097
Barry	Cobb*	080259
	Duncan	080096
	Little Long	080299
Benzie	Ann	100082
Cass	Christiana	140055
	Eagle	140057
	Juno	140058
	Painter*	140108
Clare	Windover	180069
Grand Traverse	Arbutus	280109
Jackson	Sweezey*	380470
Kalamazoo	Gull	390210
	Sherman*	390382
Kalkaska	Bear	400026
Kent	Bostwick	410322
	Freska	410702
Leelanau	Leelanau (North)	450236
	Leelanau (South)	450235
Lenawee	Devils	460179
	Round	460304
Livingston	Earl	470554
	Triangle	470591
Marquette	Chabenau	520508
	Independence	520149

APPENDIX 4
2012 COOPERATIVE LAKES MONITORING PROGRAM
DISSOLVED OXYGEN AND TEMPERATURE RESULTS

County	Participating Lakes	Site ID
Mason	Hamlin (Lower)	530073
	Hamlin (Upper)	530074
Montcalm	Crystal	590105
	Derby	590144
Muskegon	Duck	610778
Oakland	Angelus	631227
	Deer	631128
	Parke	631119
Oceana	Silver	640341
	Stony	640049
Osceola	Hicks	670062
Roscommon	Higgins (N. Basin)*	720026
	Higgins (S. Basin)	720028
St. Joseph	Corey	750142
	Fishers	750139
Van Buren	Cora	800260

Profile featured below.

APPENDIX 4
2012 COOPERATIVE LAKES MONITORING PROGRAM
DISSOLVED OXYGEN AND TEMPERATURE RESULTS

On the following pages five representative dissolved oxygen/temperature patterns are illustrated.

The first is of a very high quality oligotrophic lake, which has a very large hypolimnion volume. The lake maintains high oxygen levels in the hypolimnion all summer.

The second pattern represents a good quality mesotrophic lake with a moderate hypolimnion volume. This lake keeps some dissolved oxygen in the hypolimnion through early summer, but by late summer the entire hypolimnion is devoid of oxygen.

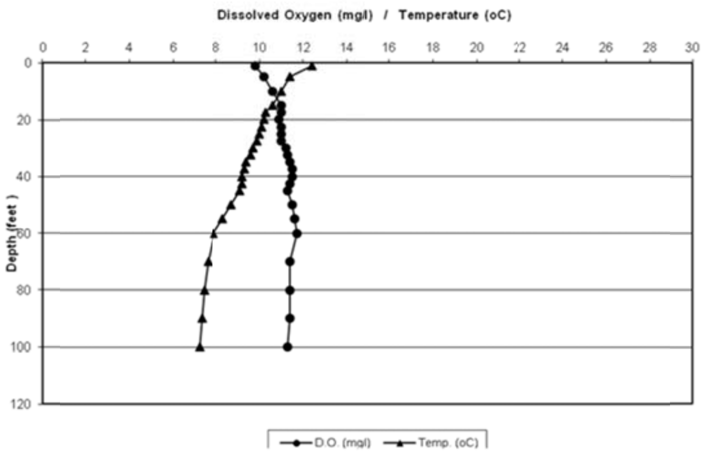
The third pattern is a mesotrophic/eutrophic lake with a small sized hypolimnion. Within a few weeks of spring overturn the hypolimnion has lost all oxygen. This anaerobic condition persists all summer.

The fourth pattern is a mesotrophic lake, which is too shallow to maintain stratification. It could lose oxygen in the deeper water, but summer storms cause mixing though the deepest parts of the lake, renewing the oxygen supply to these waters.

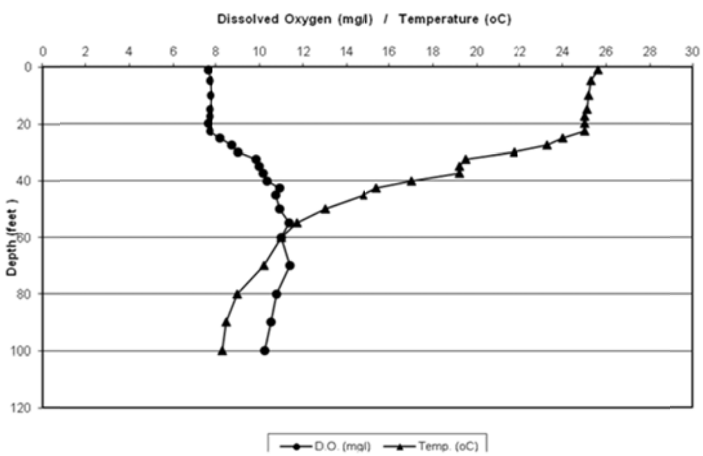
The fifth example is a mesotrophic lake that has dissolved oxygen spikes in the thermocline. This graph is included because many people will see this in the data from their lake.

Oligotrophic Lake with a Very Large Volume Hypolimnion

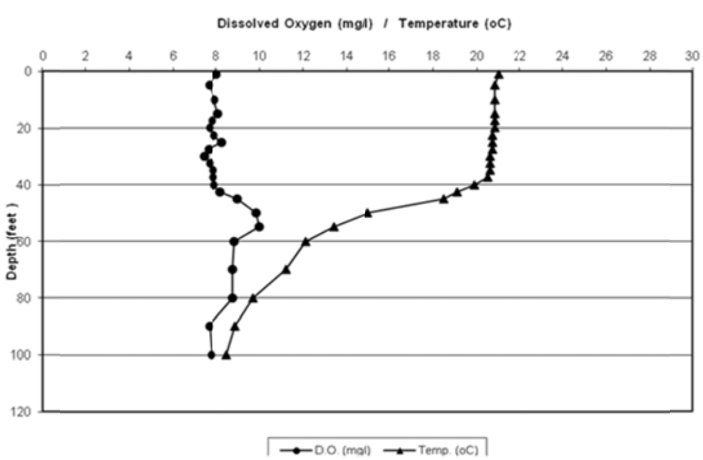
Higgins Lake in Roscommon County is an oligotrophic lake with a large volume hypolimnion. As an oligotrophic lake, it produces less organic material that must be decomposed as compared to a mesotrophic or eutrophic lake. Its large volume hypolimnion has a substantial oxygen supply that is not reduced significantly by the decomposition of the limited organic material, which falls into the hypolimnion during the summer. Consequently, dissolved oxygen levels remain high in the hypolimnion all summer long. In fact, dissolved oxygen levels are actually higher in the upper hypolimnion than at the water surface. The colder hypolimnion water is able to hold more oxygen than the warmer epilimnion (surface) waters.



May 17, 2012



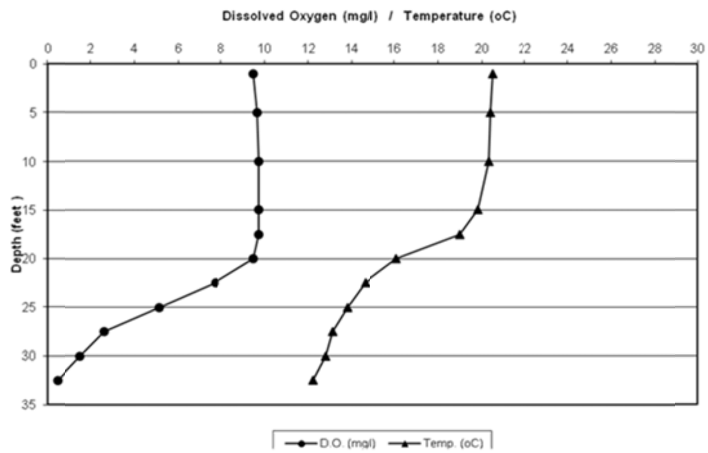
July 16, 2012



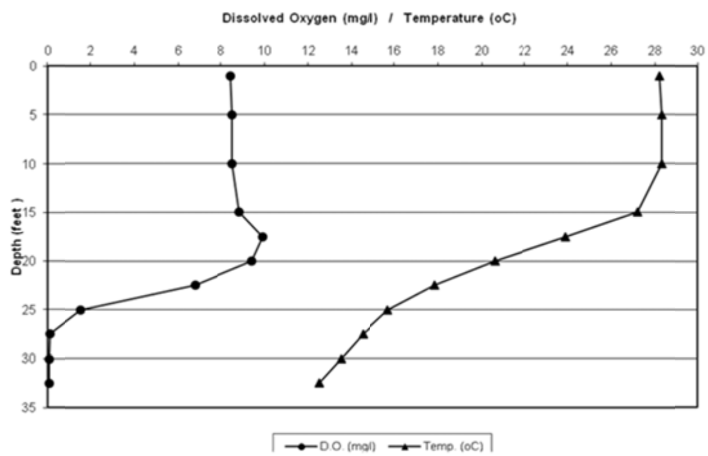
September 10, 2012

Mesotrophic Lake with a Medium Volume Hypolimnion

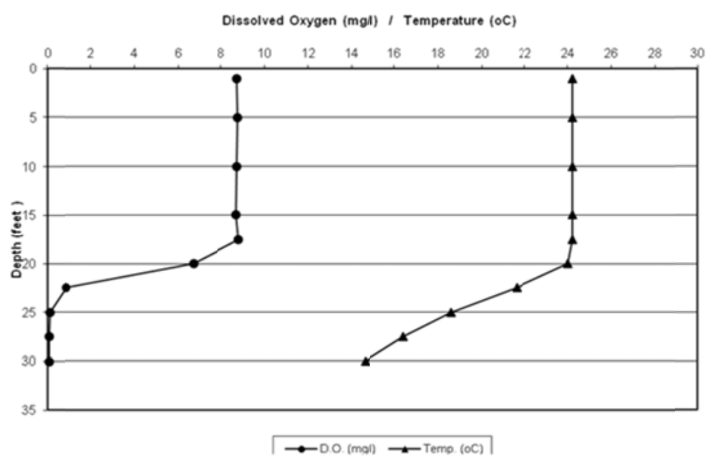
Sherman Lake in Kalamazoo County is a mesotrophic lake with a medium volume hypolimnion. As a mesotrophic lake it produces moderate amounts of organic material that must be decomposed. Its hypolimnion has a limited oxygen supply that is gradually depleted by the decomposition of the organic material, which falls into the hypolimnion during the summer. Dissolved oxygen levels remain in the hypolimnion through the early summer, but by mid-July oxygen is gone in the deepest waters, and the hypolimnion does not regain oxygen until fall turn-over.



June 5, 2012



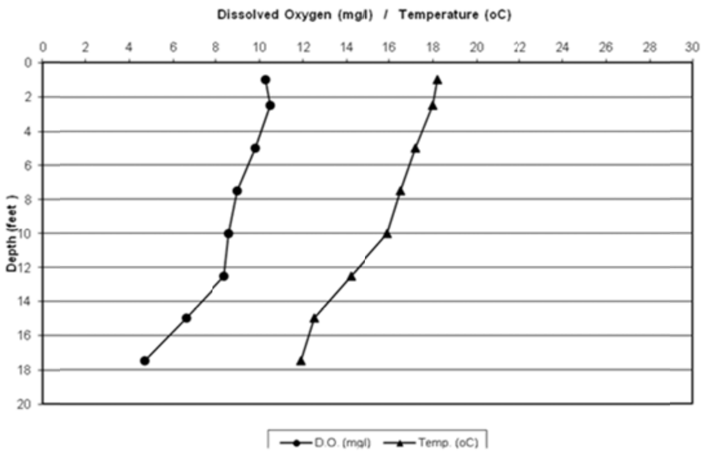
July 14, 2012



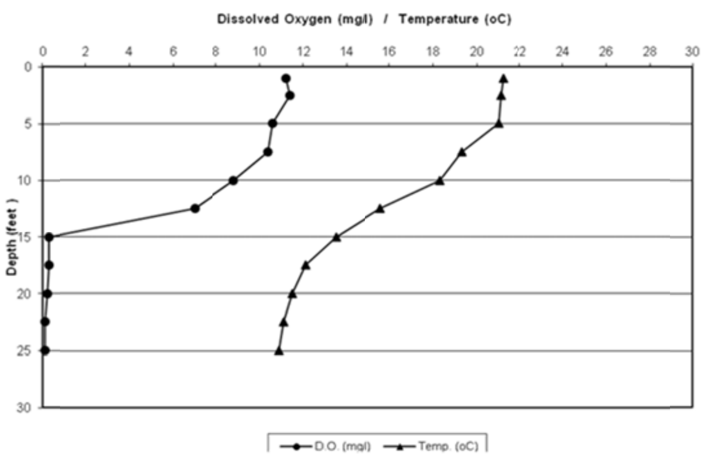
September 9, 2012

Mesotrophic/Eutrophic Lake with a Small Volume Hypolimnion

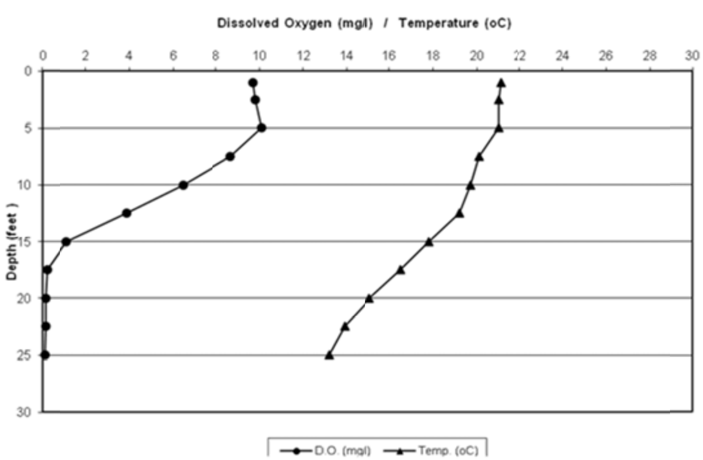
Painter Lake in Cass County is a borderline mesotrophic/eutrophic lake with a small volume hypolimnion. As a productive lake it produces abundant amounts of organic material that must be decomposed. Its hypolimnion has a moderate oxygen supply that is rapidly depleted by the decomposition of the organic material, which falls into the hypolimnion during the summer. Dissolved oxygen levels in the hypolimnion often drop to near zero even before summer starts. With no oxygen re-supply from the upper waters and atmosphere, the hypolimnion is devoid of oxygen through the whole summer until fall turn-over.



May 13, 2012



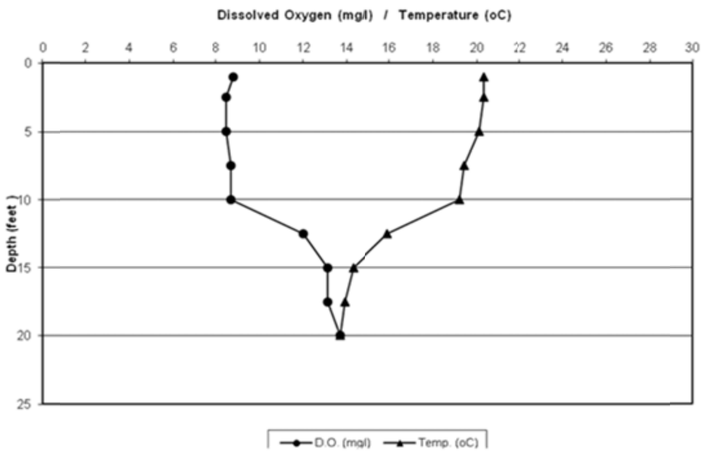
July 7, 2012



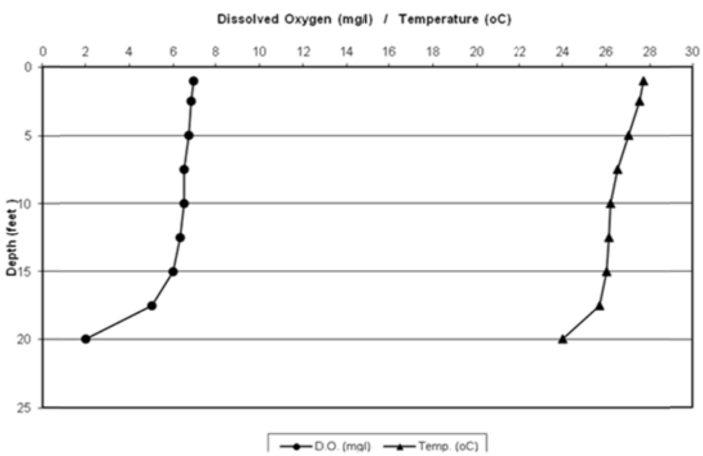
September 9, 2012

Shallow Mesotrophic Lake that Does Not Maintain Summer Stratification

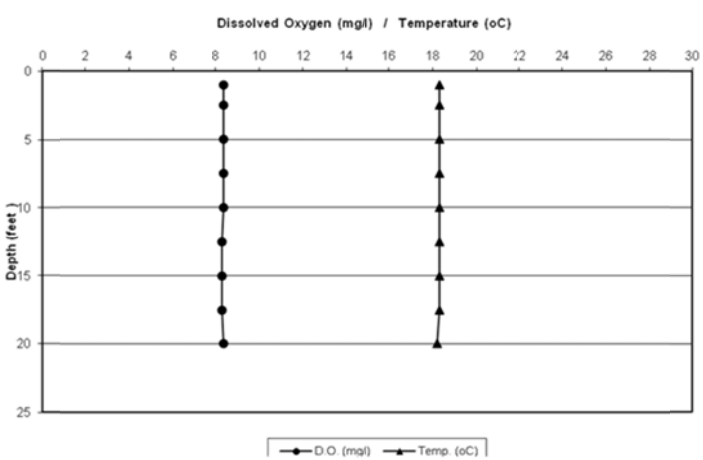
Sweezey Lake in Jackson County is a shallow, oligotrophic/ mesotrophic lake basin with insufficient depth to maintain stratification all summer. Its hypolimnion, if present, has a small oxygen supply that is depleted by the decomposition of the organic material, which falls into the deeper parts of the lake during the summer. It is possible that dissolved oxygen levels in the deeper water can drop to zero by mid-summer. However, because the lake is shallow, summer storms can drive wave energy into the deepest parts of the lake breaking up any stratification present and re-supplying the deep water with oxygen.



May 28, 2012



July 29, 2012

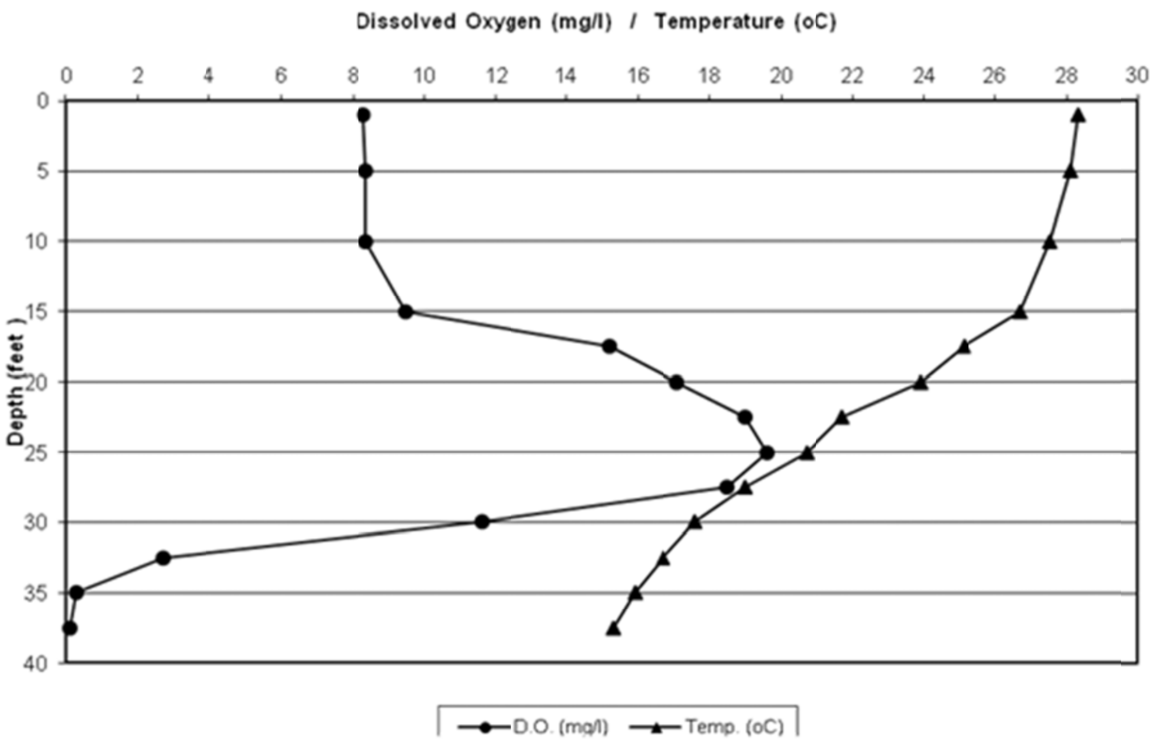


September 22, 2012

Lake with Dissolved Oxygen Spike in the Thermocline

Cobb Lake in Barry County is a oligotrophic lake with a medium volume hypolimnion. It is not unusual to see dissolved oxygen levels spike in the area of the thermocline (the depth where the water temperature declines rapidly). The thermocline can be an area of high biological productivity and algal oxygen production can cause these spikes. It is not unusual to see the oxygen reach supersaturated levels, either, as seen below.

July 15, 2012



Appendix 5
2012 Cooperative Lakes Monitoring Program
Exotic Aquatic Plant Watch

Map above shows the distribution of the 26 lakes enrolled in Exotic Aquatic Plant Watch in the 2012 CLMP Program.

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APPENDIX 5
2012 COOPERATIVE LAKES MONITORING PROGRAM
EXOTIC AQUATIC PLANT WATCH RESULTS

Lake	County	Site ID Number	Species Found[1]
Brooks	Leelanau	450222	None
Cedar	Leelanau	450234	Eurasian watermilfoil
Center	Osceola	670238	Eurasian watermilfoil
Cora	VanBuren	800260	None
Crooked (Big)	Kent	410714	*
Duck	Muskegon	610778	*
Eagle	Cass	140057	Eurasian watermilfoil, Curly-leaf pondweed
Fisher (Big)	Leelanau	450224	None
Fishers	St. Joseph	750139	*
Glen (Big)	Leelanau	450049	None
Glen (Little)	Leelanau	450050	None
Hannah Webb	Iron	360165	*
Herring, Upper	Benzie	100247	None
Kelsey	Cass	140190	*
Leelanau (North)	Leelanau	450236	*
Leelanau (South)	Leelanau	450235	*
Long (Upper)	Oakland	631117	*
Maceday/Lotus	Oakland	630415	*
Mary	Dickinson	220039	*
Park	Clinton	190099	Eurasian watermilfoil, Starry stonewort
Silver	Oceana	640341	Eurasian watermilfoil
Stony	Oceana	640040	Eurasian watermilfoil, Curly-leaf pondweed
Tahoe	Oceana	640332	None
Twin (Big)	Kalkaska	400012	None
White	Oakland	630684	*

* No survey results reported

[1]For species location information, including maps, see the MiCorps Data Exchange at www.micorps.net.