Preface

This booklet has been prepared to help answer any questions that new or veteran volunteer monitors might have about the Citizen Lake-Monitoring Program and/or monitoring in general. Did you know that participants in the Citizen Lake-Monitoring Program belong to the longest-running volunteer lake monitoring program in the nation? Volunteer lake monitors are one of Minnesota's most important lake water quality tracking systems. The Minnesota Pollution Control Agency thanks the volunteer monitors for all their hard work and dedication toward protecting and improving the surface waters of Minnesota. It is our hope that you will find this booklet useful as well as informative.

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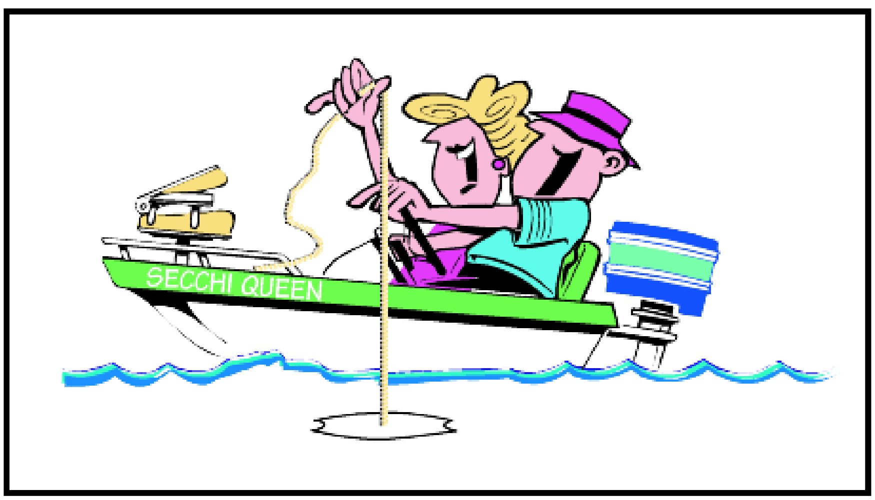
Introduction

Because lakes are so central to Minnesota's economy and way of life, it is imperative that we try to maintain and improve their water quality. The Citizen Lake-Monitoring Program (CLMP) requires minimal time and expense, yet it provides data that is essential for achieving these goals. The CLMP is a cooperative program combining the technical resources of the Minnesota Pollution Control Agency (MPCA) and the volunteer efforts of citizens statewide who collect water quality data on their lakes. The Citizen Lake-Monitoring Program (CLMP) was first initiated in 1973 at the University of Minnesota by Dr. Joe Shapiro. During that first year, volunteers monitored 74 lakes. Administration of the CLMP was transferred to the Minnesota Pollution Control Agency (MPCA) in 1978. This program continues to be a cost-effective mechanism for obtaining good basic water quality data on many of our State's lakes.

The CLMP involves voluntary participation of citizens residing on or near lakes or those who are frequent lake users. These participants are asked to take weekly transparency measurements on their lake during the summer using a Secchi disk. At least eight to ten readings per season are required in order to adequately define each summer's water quality. Data from the CLMP are entered into the U.S. Environmental Protection Agency's water quality database (called STORET) along with all other water quality data collected by the Minnesota Pollution Control Agency (MPCA). For many lakes, CLMP data is the only water quality information available. Information about the water quality of Minnesota's lakes is vital for assessing their physical condition and recreational suitability. Since tourism in Minnesota is largely water-based, good water quality is very important. These data are used to analyze water quality trends, characterize trophic status, and provide a basis for water quality goal setting. The participation of citizen volunteer monitors in the CLMP effectively increases the monitoring capabilities of the state. They provide the state and others with valuable information on the water quality of Minnesota's lakes. Through this process, the volunteers can learn about the water quality of lakes in their area and gain a greater awareness of the causes and effects of lake degradation.



What is a Secchi disk?

A Secchi disk is a circular metal plate attached to a calibrated rope. It is probably the least expensive and easiest to use tool in water quality monitoring. One of the best aspects of the Secchi disk is that the information provided by the Secchi disk is easily interpreted by volunteers and can be used to detect water quality trends in lakes.

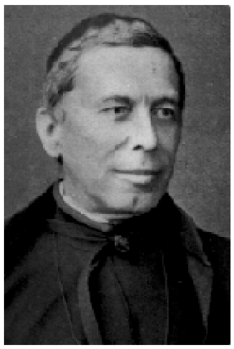
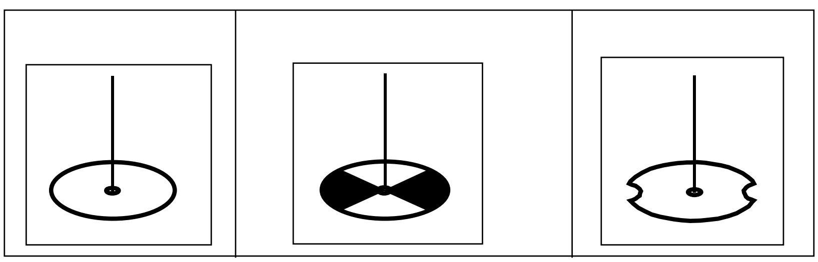


Figure 1.
Pietro Angelo Secchi
(1818-1878)

The Secchi disk is named after Fr. Pietro Angelo Secchi (Figure 1), scientific advisor to the Pope and astrophysicist. Secchi was asked by Commander Cialdi, head of the Papal Navy, to measure the transparency in the Mediterranean Sea. The first disk was lowered from the papal yacht, *l'immacolata Concezion* (Immaculate Conception), on April 20, 1865 (Carlson and Simpson, 1996). There have been many revisions to the first disks used by Secchi in terms of size and color. The two most common colors variations in use today are the all-white disk and the black and white quadrant version disk (Figure 2). In Minnesota, we use an all-white, 8 inch diameter metal disk with notched sides for rope storage when the disk is not in use.

Figure 2. Secchi Disk Color and Style Varieties



All-White **Black & White Quadrant** **Minnesota's**

What does a Secchi disk Measure?

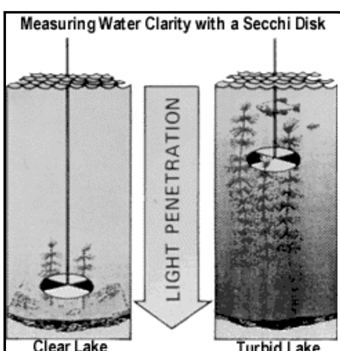
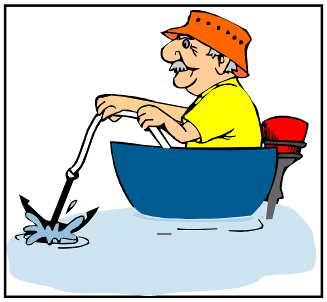


Figure 3.

Water transparency is a quick and easy measurement that tells scientists a lot about a lake's water quality. First, it indicates the amount of light penetration into a lake (Figure 3). Second, Secchi transparency provides an indirect measure of the amount of suspended material in the water, which in many cases is an indication of the amount of algae in the water. Long-term transparency monitoring by CLMP volunteers provides a valuable basis for detecting trends in water quality. Generally, the sooner water-quality problems are detected, the easier and less expensive it is to restore the lake to its previous state.

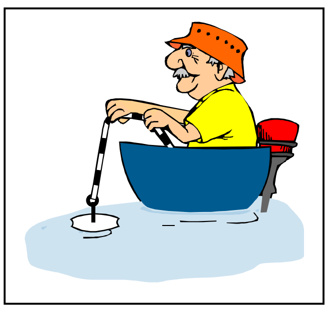
How to Take and Record Secchi Readings

Readings should ideally be taken once a week, at least three days apart, primarily during the months of June through September between 10 a.m. and 3 p.m. on bright, calm days. A minimum of one reading per month is needed to provide meaningful information about your lake. You should select **ONE** location, well off-shore and in a deep part of the lake, and continue monitoring at that one site throughout the summer (See page 5 on selecting a monitoring location).

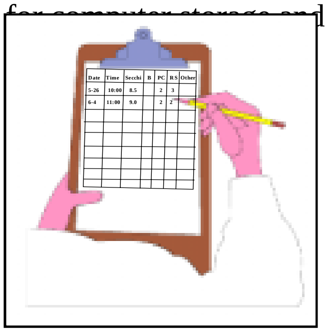


Travel to your designated monitoring location and then anchor your boat.

Do **not** wear sunglasses while making a reading, as this affects the accuracy of your reading. If you wear photogradient prescription eyeglasses, please try to prevent them from darkening by wearing a hat or visor with a wide brim.



Lower the Secchi disk into the lake on the shaded side of the boat, until the disk just disappears completely from view. (If you can see the disk on the lake bottom and cannot find deeper water, please write a capital **B** in the column after the 'Secchi Transparency' column. If the lake is choppy, try taking the reading from the stern).
Note the disk's depth using the marks on the cord. Lower the disk a bit farther and then raise it until it just reappears, then note this depth. Average the two depths to the nearest 1/2 foot to get the Transparency Reading. (More exact readings are difficult to convert for computer storage and retrieval reasons, but are still welcome.)



Record this average in the appropriate column on the Secchi Datasheet. Also record the date and time of this reading. [If you monitor more than one location (site) on a lake, each site must have a **SEPARATE and DIFFERENT** time recorded.]

You may find that your lake is exceptionally clear and that the rope is not long enough. If so, feel free to add more line. Dacron, or other polyester, is the preferred cord material as nylon has a tendency to stretch when wet as well as being adversely affected by repeated exposure to sunlight. However, be careful when marking it at the half-foot and foot intervals to make sure that the new segment matches the original cord. If the markings on the line become indistinct, re-mark them with a water-proof felt pen or with yarn threaded through the line. It is always a good idea to calibrate your Secchi disk rope before beginning each monitoring season to be sure your rope markings reflect accurate measures. Your disk will last longer and give better service if it is kept clean and protected from scratches and direct sunlight which can damage the paint.

Additional Lake Monitoring Information

Following the "Transparency" column, are columns for recording additional information that will help to accurately denote what is taking place in and around your lake. The first two columns ask for an assessment of the amount of algae present and for its effect on the recreational suitability of the. **It is important to note that if you do fill out these columns, you should do so <u>before</u> you take your Secchi reading to keep your observations from being biased by your knowledge of the transparency.**

<u>Physical Condition</u>

Please use the ONE number, each day that you sample, that best describes the physical condition of the lake water AT YOUR SAMPLING SITE. **It is important that you fill out this column <u>before</u> you take your Secchi reading.**

1 = Crystal clear water
2 = Not quite crystal clear - a little algae present/visible
3 = Definite algae green, yellow, or brown color apparent
4 = High algal levels with limited clarity and/or mild odor apparent
5 = Severely high algae levels with one or more of the following: massive floating scums on the lake or washed up on shore, strong, foul odor, fish kill

<u>Suitability for Recreation</u>

Please use the ONE number, each day that you sample, that best describes your opinion of how suitable the lake is for recreation and aesthetic enjoyment. **It is important that you fill out this column <u>before</u> you take your Secchi reading.**

1 = Beautiful, could NOT be better
2 = Very minor aesthetic problems; excellent for swimming, boating
3 = Swimming and aesthetic enjoyment slightly impaired because of algae levels
4 = Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels (i.e., would not swim, but boating is okay)
5 = Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels

<u>Color of Lake Water</u>

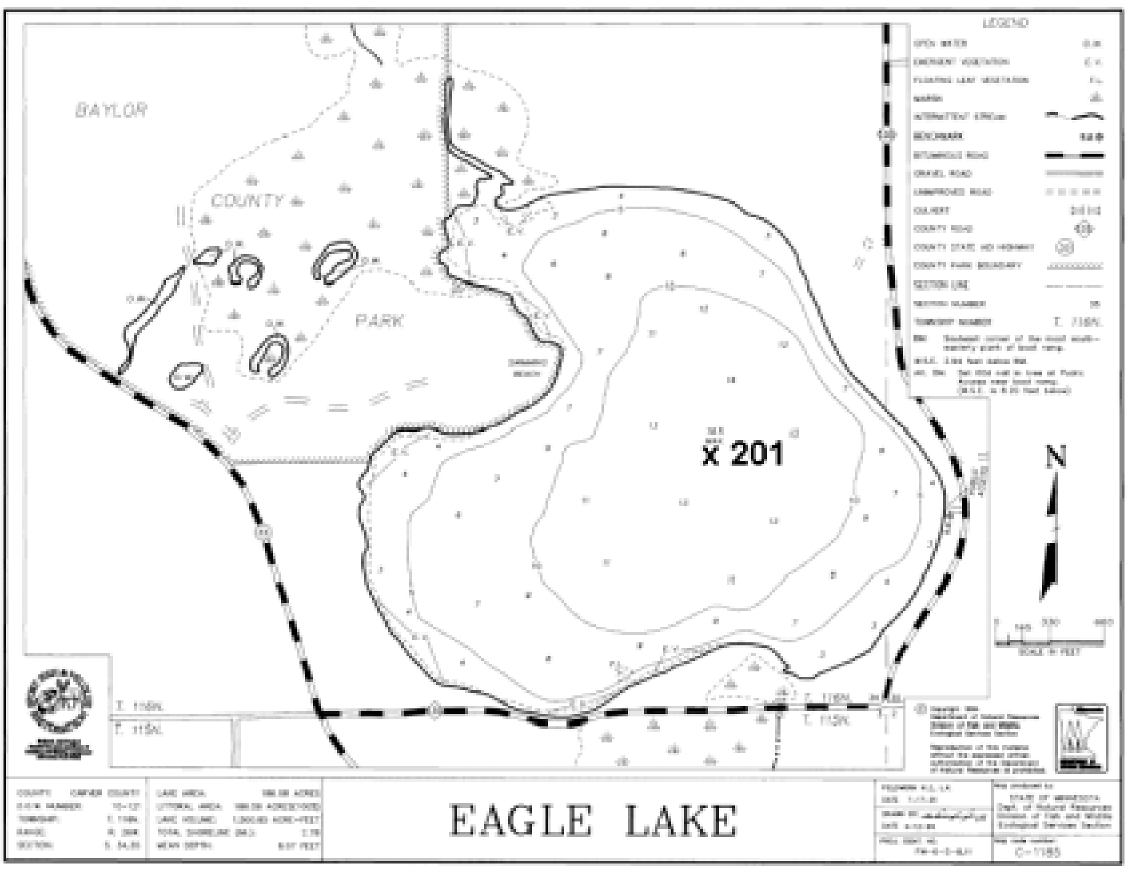
The "Color of Lake Water" column is to record the color of the lake water at your sampling site. Please write down the color (i.e., clear, green, tea-stained...etc.) that best describes the lake, at your sampling site, each and every time that you take a Secchi disk reading.

<u>Other Notes</u>
The last column is for you to record information about that sampling day for your own use, such as-- saw three loons today, slightly cloudy with wind from NE, lake treated with copper sulfate.

Selecting a Monitoring Location

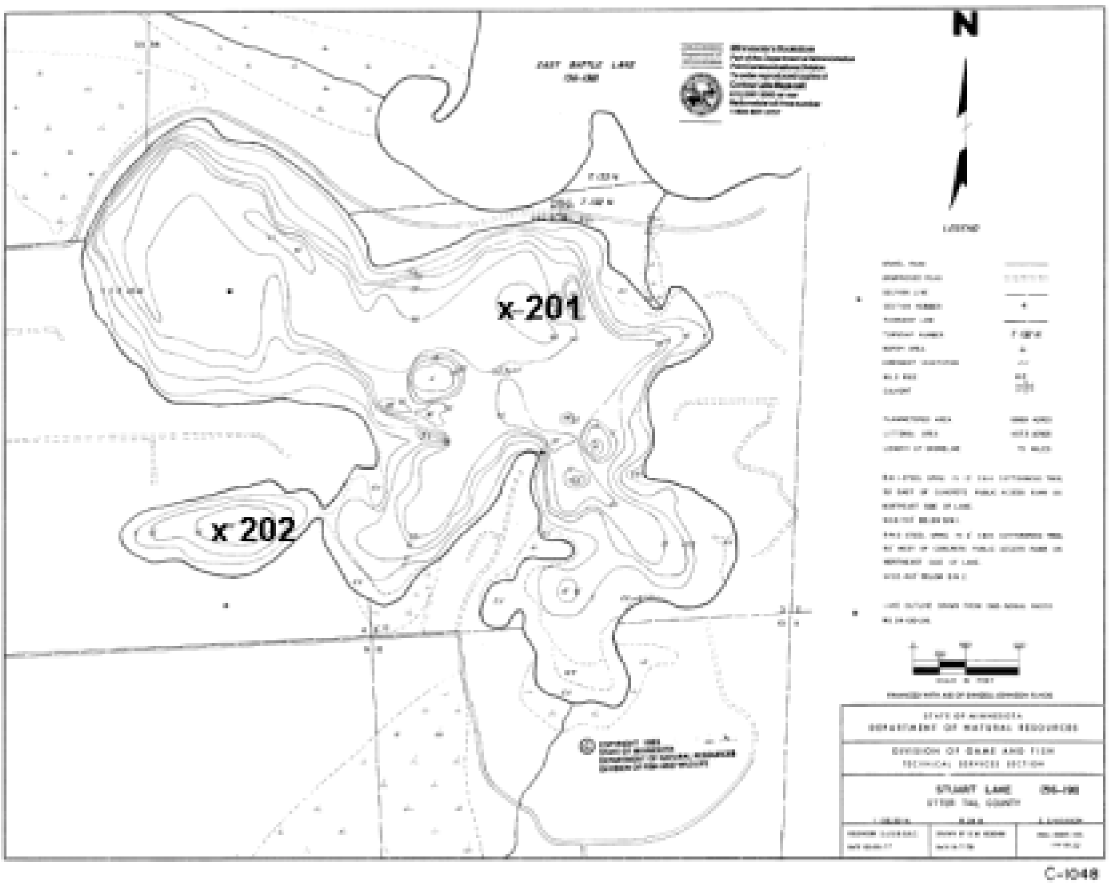
Some Secchi transparency monitoring sites have been selected based on their convenience (e.g. out in front of the cabin), rather than on how representative of the lake they were. However, when selecting a monitoring site, try to pick a location that represents or depicts the water quality of the whole lake. This can be accomplished by studying a depth contour map (bathymetric map) of the lake and choosing a location that is deep and centrally located in the lake (Figure 4). The site should be away from the shoreline, weed beds, underwater bars, points, islands, and river or stream inlets; as these areas may influence the water transparency.

Figure 4. Representative Site Centrally Located on Eagle Lake, Carver County



Some lakes may have two or more significant bays or basins. In these cases, we identify the main basin (that portion of the lake with the largest area and water volume) and pick the most representative site (primary site). We then select representative sites in the remaining significant basins (secondary sites) (Figure 5). Secondary sites are important because water quality can vary between the different bays or parts of a lake, and the primary site may only truly represent the water quality of the main basin. By monitoring the secondary sites we can determine if differences in water quality exist between the various basins.

Figure 5. Representative Sites for Multiple Site Selection
Stuart Lake, Otter Tail County

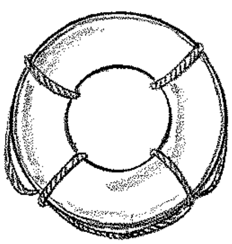


If you would like help in selecting a monitoring site, please contact the CLMP Program Coordinator or your regional office staff for assistance (Appendix). It is important to remember that consistent monitoring at the same site increases the ability to detect trends in water quality. When traveling to your site, use equipment such as a depth finder or GPS (Global Positioning Satellite) units on your initial trips until you become familiar with shoreline landmarks. This will make it easier to accurately find your site(s) the next time you monitor.

Site Number System

Within each lake, the MPCA has a unique site numbering system to track sites over time. All lake monitoring locations are marked on a series of lake maps and stored in 3-ring binders in the St. Paul office. Monitoring sites are denoted with a number prefix for each organization/group that conducts monitoring activities. For example: if the site number was 104, the "100" prefix indicates that the monitoring was done by MPCA staff. All locations monitored by CLMP participants begin with a "200" prefix number (e.g. 201, 202, 203…etc.). By looking at the site number, one can quickly find out not only *who* did the monitoring, but also *where* on the lake that monitoring site is located. The numbers are assigned on a "first come, first served" or rather, "first monitored, first numbered" basis. For example: John Smith is the first person to monitor his lake. His site is located in the northern end of the lake (Site 201). The following year, Mark Doe begins monitoring on the same lake directly in the middle of the lake at a second site (Site 202). Remember, consistency is the key to detecting long-term water quality trends. When you start monitoring at a specific site, please try to return to that same site each following year. If you participate in more than one monitoring group, such as CLMP or COLA (Coalition of Lake Association), you need to be sure you are writing down the correct site number for that group's data. If you have any questions, you can always contact the CLMP Program Coordinator or one of the regional office staff in your area.

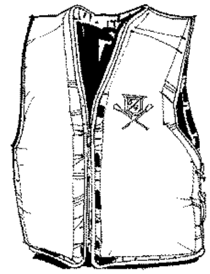
Safety Issues



Please remember to always take the appropriate safety precautions when conducting your monitoring activities. What may seem like simple, routine monitoring can turn dangerous very quickly. Using the "buddy system" is not only be more fun when conducting monitoring activities, it can also reduce danger in case of an emergency. Following are some safety tips to ensure your safety while conducting your monitoring activities:

1. Always know and follow all boating rules.
2. Learn how to swim.
3. Always make sure you and all occupants of your boat (especially children) wear their PFD-personal floatation device (life jacket) at all times.
4. If your boat should tip over and it still floats, stay with it. If it capsizes, try to right it and re-board. If you cannot right your boat, climb on top and hang on. Immersion in cold water can rapidly cause hypothermia.
5. Always obey signs and keep away from lock and dam structures on river systems.
6. Never consume alcohol while boating – this can potentially be a deadly combination.
7. Watch out for other boaters to avoid collisions – for your safety as well as theirs.
8. Minnesota weather can change quickly, so be alert to current weather conditions. Watch for wind shifts or distant lightening.
9. Tell someone where and when you are going and when you expect to return. This will help authorities looking for you find you faster.

10. If you get caught in rough waters, head to shore making sure to head into heavy waves at an angle.



Taking appropriate safety precautions refers to not only following safety boating tips, but also having safety equipment along that can help you in times of emergency. Some equipment listed below is optional and some is actually required by Minnesota boating laws, depending upon watercraft and waterbody size. Check your Minnesota Boating Guide booklet to see what equipment is required for your boat.

1. Personal Flotation Devices (PFD's). Make sure you have a PFD for each passenger, and the right types for your watercraft, including throwable devices such as buoyant boat cushions and ring buoys.
2. Navigational Lights.
3. Fire Extinguishers – especially for motorized boats.
4. Signaling System. A whistle, horn, bell, flags or flares work well as distress signals.
5. Bailing Device. A coffee can, ice cream pail or minnow bucket can work well.
6. Anchor and Line.
7. Paddle and/or Oars.
8. Flashlight.
9. Small Tool Kit. Carry a few basics such as screwdriver, pliers, hammer, and wrench along with a few common spare parts for your particular motor.
10. First Aid Kit.
11. Radio. A portable or two-way radio to catch weather reports can be a handy piece of equipment.
12. Compass and charts (or portable GPS unit) can be useful on unfamiliar or large bodies of water.

The Minnesota Department of Natural Resources (MDNR) offers boating safety information. Some of the free publications you can get include: Minnesota Boating Guide, Hypothermia: The Cold Facts and Danger-Thin ice. Call the Boat & Water Safety Section of the MDNR at (651)-296-6157 or toll-free at (888)-MINNDNR for more information.

Trophic State Index

Secchi transparency data can be used to convey information on the quality of lakes and allow for estimation of the amount of algae (chlorophyll a) and nutrient (phosphorus) status of a lake. Carlson's Trophic State Index (TSI) is a common means for characterizing a lake's trophic state (overall health) and associating Secchi, chlorophyll a, and phosphorus measurements. Comparing phosphorus, chlorophyll-a and Secchi transparency on Carlson's Trophic State Index scale can establish current trophic status and establish interrelationships between these three variables. It is assumed that Secchi is a good estimator of trophic status (overall health or productivity) for your lake and comparing these variables on the scale will help to confirm this assumption.

The term "trophic status" refers to the level of productivity in a lake. Carlson's Trophic State Index (TSI, Carlson 1977) is one means available to examine the relationship between total phosphorus, chlorophyll a, and Secchi disk readings in a lake and its trophic status (overall health). Individual TSI values can be calculated from the following equations:

Total phosphorus TSI (TSIP) = 14.42*[ln(TP average)] + 4.15

Chlorophyll a TSI (TSIC) = 9.81*[ln(Chlorophyll a average)] + 30.6

Secchi disk TSI (TSIS) = 60 - (14.41*[ln(Secchi average)])

Total phosphorus and chlorophyll a are measured in micrograms per liter (μg/L) and Secchi disk transparency is measured in meters (3.281 feet per meter). The ln function in these equations is the "natural log" which is different than the "log" function. [The ln key is generally found next to the log key on most calculators.] The TSI scale ranges from 0 (ultra-oligotrophic) to 100 (hypereutrophic). Low trophic values (oligotrophic) are often associated with very clean and clear lakes such as those found in the Boundary Waters Canoe Area. High and or increasing trophic status values indicate more eutrophic (greener, less healthy) conditions. Although total phosphorus and chlorophyll a concentrations are not measured in the CLMP, the summer-mean Secchi transparency generally provides a good indication of trophic status for Minnesota's lakes and can be used to estimate likely ranges of total phosphorus and chlorophyll a for your lake (Figure 6).

Trends

Detecting trends in lake water quality over time is a primary goal for many lake managers and a concern for local units of government and citizens. Detecting trends requires taking numerous measurements over several years. For lakes, a minimum of 8-10 years of data (with 4 or more readings per season) are typically required to detect trends in trophic status. Secchi transparency is one of the best parameters for characterizing lake trophic status and detecting trends. It provides an economical means to assess water quality, estimate lake trophic status, and document water quality trends over time. Transparency is the preferred parameter for many reasons: low cost, easily incorporated into volunteer lake monitoring programs, and it allows for the collection of a large number of samples in a given sampling period on many different lakes.

Figure 6. Carlson's Trophic State Index
R.E. Carlson

TSI < 30 Classical Oligotrophy: Clear water, oxygen throughout the year in the hypolimnion, salmonid fisheries in deep lakes.

TSI 30 - 40 Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.

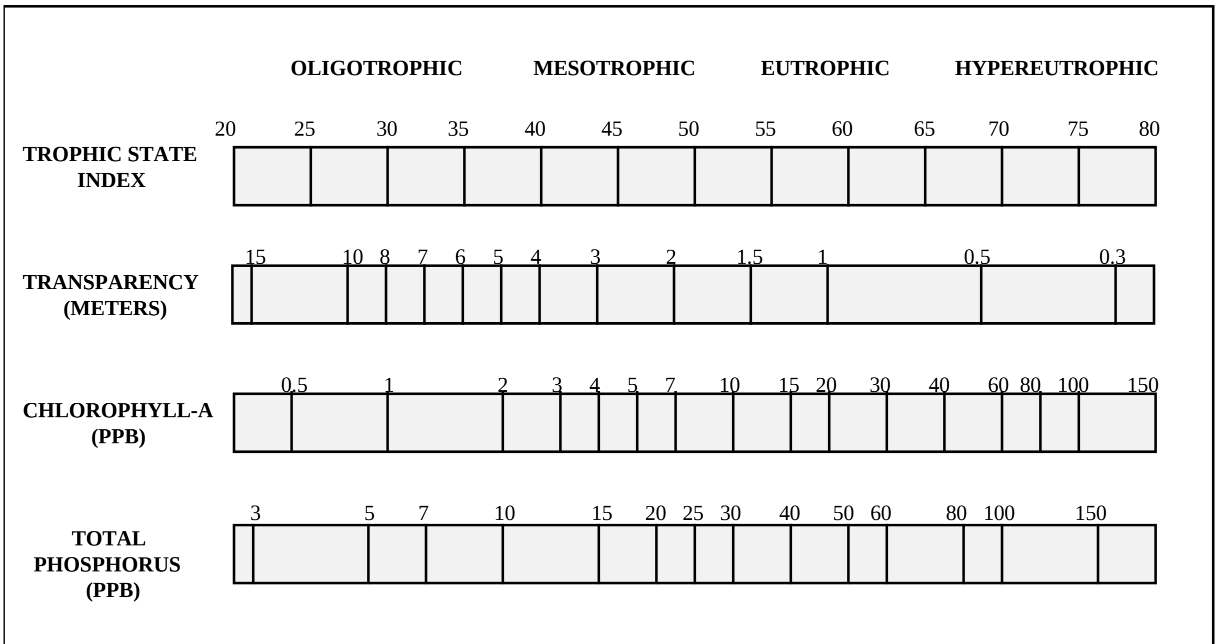
TSI 40 - 50 Water moderately clear, but increasing probability of anoxia in hypolimnion during summer.

TSI 50 - 60 Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evident, warm-water fisheries only.

TSI 60 - 70 Dominance of blue-green algae, algal scums probable, extensive macrophyte problems.

TSI 70 - 80 Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration. Often would be classified as hypereutrophic.

TSI > 80 Algal scums, summer fish kills, few macrophytes, dominance of rough fish.



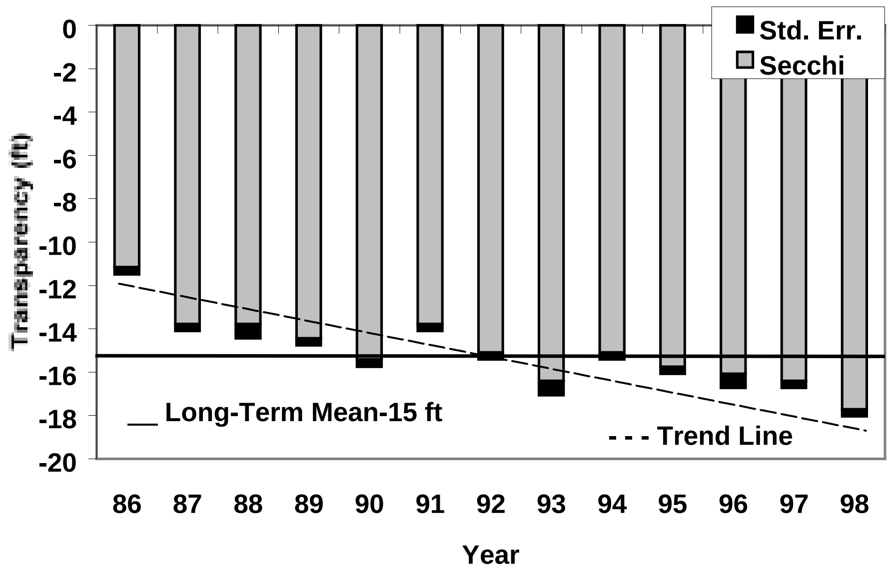
After Moore, l. and K. Thornton, [Ed.]1988. Lake and Reservoir Restoration Guidance Manual. USEPA>EPA 440/5-88-002.

Plotting the summer-mean transparency readings of a lake over time is one means for identifying patterns or trends over time (Figure 7). Summer-mean transparency of a lake often varies from year to year in response to changes in the amount of algae. Variation in the amount of algae may be caused by changes in amounts of nutrient reaching a lake, fisheries composition, and/or climatic changes. It is important to consider these factors when trying to determine if significant long-term changes have occurred or if changes are merely natural variation in a living system. Based on an analysis of several lakes with long-term Secchi transparency data, yearly mean transparencies tend to vary within one to two feet (or about 20 percent) of the long-term mean (Heiskary and Lindbloom, 1993). Consistent variation of more than 20 percent of the long-term mean (or consistent increasing or decreasing summer-means) may be indicative of a trend.

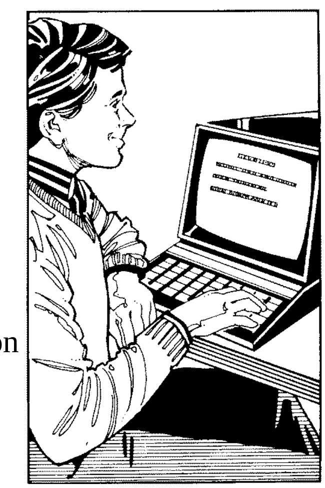
In addition to plotting the data, it is helpful to statistically analyze the data. Kendall's tau-b is a non-parametric statistical test that has been used by MPCA to assess trends in Secchi transparency over time. The Kendall's tau-b (R_k) ranges from -1 to 1. The closer the value is to ± 1, the stronger the trend. A probability level (p) ≤ 0.1 was used as a basis for identifying significant trends in transparency. At this p level, there is a 10 percent chance of identifying a trend when none exists. Simply stated, the smaller the p value for our analysis, the more likely the trend is real. When performing trend analysis, it is important to consider the strength of the correlation, p-level, and number of years of data before determining if the trend is "significant"; and if further investigation, including additional monitoring, is warranted.

What's the next step after you've identified a possible trend? Gathering historic data on the lake and its watershed is a good place to start. This can include reviewing existing water quality data as well as information on land uses within the watershed of the lake. Examining activities in the watershed may provide anecdotal and perhaps quantitative information which might help substantiate or explain why a trend has occurred. Collecting additional water chemistry, in particular additional trophic status data -- phosphorus and chlorophyll-a, is helpful as well. Comparing current water quality data to historic data can also help to understand trend findings. It is important to develop a monitoring plan before collecting additional chemistry data. This plan should help you decide what questions you are trying to answer and what parameters and sampling frequency will best help you answer those questions. It should be developed cooperatively by a committee of representatives from state agencies such as the Minnesota Department of Natural Resources and MPCA, local units of government, and lake association members.

Figure 7. Summer Mean Secchi Transparency
Big Turtle Lake (31-0725), Itasca County



Entering Data On-Line via the Web



The following is a option for volunteers who have <u>completed at least one year</u> in the program. Volunteers need to complete at least one year in the program because their 200-series site number is assigned after the first year of monitoring. Following are some "Helpful Hints" on filling out the On-Line Data Entry Report Form. This on-line entry form is divided into two sections: Personal Data and Secchi Data. You will need to enter information in both sections to ensure accurate and rapid entry of your data. Some information is required (this is noted on the form) and your data cannot be stored without it. Please refer to your personalized colored insert(s) of On-Line Web Entry Information for data entry ease.

<u>Filling out the Personal Data Section</u>

Once you are in the system, the first thing you'll need to do is choose your name from the listbox of names provided. This information is a "REQUIRED" field. If your name is not in the list, you'll have to call Jennifer Klang at 1-800-657-3864. In some cases, a company or group name will appear (ex: Carver Co. Environmental Services, Wolf Ridge Environmental Learning Center). If you belong to this group, select this name and type your own name in the column "Name of person taking reading."

Next you will need to fill in your password. This information is a “REQUIRED” field and you will not be able to store data without it. This number has been provided to you on a colored insert. It is the same number as your CLMP ID number which is the last four digits in the Bar-code that appears over your name on your data sheet. If you don’t know your CLMP ID number, please contact Jennifer Klang at (651)282-2618 or 1-800-657-3864.

Now fill in the Lake ID number for your lake. This information is a “REQUIRED” field and is provided for you on a colored insert.

Type in your Lake Name in the space provided. This information is provided to you on a colored insert. This information is also a “REQUIRED” field.

Next type in the Site #. This information is a “REQUIRED” field. This is a 200 series number (ex: 201, 202) which tells us where you took your Secchi readings. It is provided for you on a colored insert.

If your sampling location this year is approximately the same as last year’s location, please indicated this by checking the “Same site as last year?” box.

Please enter the depth of the lake at your monitoring location in the “Lake depth at sampling site” box.

This completes the Personal Data Section. You are now ready to enter data in the Secchi Data Section.

Filling out the Secchi Data Section

This is the section where you fill out your individual Secchi readings. The first thing you will need to do is enter the “Date”. This is **not** today's date. It is the date on which your Secchi reading was taken and must be entered in the format: mm/dd/yy.

Now enter the time at which you took your Secchi reading. Please round this value to the nearest quarter hour (ex: 1:00, 1:15, 1:30, 1:45...etc.) and select whether your time was in the morning (a.m.) or evening (p.m.). **Please note that Secchi readings collected at 12:00 noon are considered 12:00 p.m.**

Next you need to enter your Secchi value in feet and inches. If you click on the “Feet” box, a long list of numbers from 0-100 will appear. Go through the list until you find the number that represents your reading. If your Secchi reading includes additional inches, click on the “Inches” box and a list of numbers from 0-11 will appear. Select the correct inches value for your reading from this list. For example: You measured a Secchi reading of 7 ft, 6 inches. You would enter 7 in the “Feet” box and 6 in the “Inches” box.

If your Secchi disk is sitting on the bottom of the lake where you are taking your reading, check the “Disk on Bottom?” box to the right of the “Feet” box.

Now enter your opinion of the physical condition of the lake water at your sampling location using the 1-5 rating scale provided in the listbox for “Physical Condition”.

Then enter your opinion of how suitable the lake is for recreation and aesthetic enjoyment at your sampling location using the 1-5 rating scale provided in the listbox for “Recreational Suitability”.

Record in the “Color of Lake Water” box your opinion of the color (clear, green, tea or bog stained.....etc.) that best describes the color of the lake water at your sampling location. This information will not be stored with the other data, but is used when examining trend information.

Record in the “Other Notes” box any other observations or additional information about that sampling day for your own use. This information is not stored like the other data, but is used when examining trend information. Examples of the type of information written here are:

- Saw three loons today
- Rained 1 inch yesterday
- Other weather conditions: air temp, cloud cover, wind speed and direction
- Lake treated with copper sulfate today

<u>I’ve entered my data...NOW WHAT?</u>

When you are all finished entering data, click the “Submit” button. This will let you review the data you have entered. If you would like to make any changes in the data you have previously entered, click on the “Back” button on the tool bar and make the necessary changes. After you have made sure that all the entered data is correct, submit the data for final entry.

<u>I have more than one day’s worth of data...what do I do?</u>

If you have more than one day’s worth of data to enter, simply click on the “Back” button on the tool bar to get back to the data entry form. Your Personal Data information should still be there and does not need to be re-entered. Simply make the changes you need to in the Secchi Data Section and re-submit the new data.

<u>I am experiencing difficulty with the web page…what do I do?</u>

As with any computer program, you may experience problems when entering your data on-line. Following are some tips to correct the common problems.

- Hit the “RELOAD” or “REFRESH” button on your browser toolbar.
- Shut down any other programs/applications you have running (such as games) to increase your RAM.
- You may need to update your browser if you are operating on an older version.
- Try shutting down your system and rebooting it.

If these do not work for you, then please let us know by calling or e-mailing the CLMP Program Coordinator with your specific problem.

Appendix of Supplemental Information

References

Carlson, R.E. 1977. A Trophic State Index for Lakes. Limnology and Oceanography 22:361-369.

Carlson, R.E. and Simpson, J. 1996. A Coordinators Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society, Madison, Wisconsin.

Heiskary, S.A. and Lindbloom, J.L. 1993. Lake Water Quality Trends in Minnesota. MPCA. St. Paul, Minnesota.

Web Sites of Interest:

www.pca.state.mn.us
www.pca.state.mn.us/water/clmp.html
www.dnr.state.mn.us
www.mnlakesassn.org

Additional Information and Further Reading

You can find additional information on lakes from these publications. They cover information for both the beginner and advanced lake enthusiast from identifying lake and watershed characteristics to advanced monitoring practices.

1. *A Citizen's Guide to Lake Protection*. A free publication available from the Minnesota Pollution Control Agency at (651)296-6300 or toll-free at (800)-657-3864. Quantities are limited.
2. *Minnesota Lake and Watershed Data Collection Manual.* Available from the Minnesota Lakes Association at (800)-515-LAKE(5253) or www.mnlakesassn.org. Please check for current pricing and availability information.

Additional MPCA Monitoring Programs

Citizen Stream-Monitoring Program – Statewide volunteer stream monitoring program. Modeled after the Citizen Lake-Monitoring Program, this program focuses on monitoring streams and rivers throughout Minnesota. Contact: Laurie Sovell, Mankato MPCA at (800)-657-3864 or (507)389-1925 or laurie.sovell@pca.state.mn.us for further information.

Lake Assessment Program – A cooperative study of a lake involving MPCA staff and local citizens, such as a lake association or municipality and local resource managers. LAP studies serve to characterize a lake's condition and provide some basic information regarding the lake and its watershed. Contact: Steve Heiskary at (800)-657-3864 or (651)296-7217 or steven.heiskary@pca.state.mn.us.

Clean Water Partnerships - The Clean Water Partnership and Clean Lakes Programs provide matching grants to local units of government to protect and improve lakes, streams, and ground water that are affected by nonpoint source pollution. These programs provide a detailed characterization of in-lake water quality and information to develop a detailed nutrient and water budget for the lake. For more information about the Clean Lakes Program, contact Cathy Jensen at (800)-657-3864 or (651)297-8383 or cathy.jensen@pca.state.mn.us. For information about Clean Water Partnership, contact Gaylen Reetz at (800)-657-3864 or (651)296-8856 or gaylen.reetz@pca.state.mn.us.

Local Monitoring Data Coordinator Staff

For information or assistance with your monitoring projects, contact any of the MPCA staff listed below by dialing (800)-657-3864 or call them at their direct line listed below.

Jesse Anderson-Duluth Office: (218)529-6218 or jesse.anderson@pca.state.mn.us
Jennifer Klang – Metro/Central Office: (651)282-2618 or jennifer.klang@pca.state.mn.us
Mike Vavricka – Detroit Lakes Office: (218)846-0776 or michael.vavricka@pca.state.mn.us
Laurie Sovell – Mankato Office: (507)389-1925 or laurie.sovell@pca.state.mn.us

Glossary of Important Lake-Related Terms

Acid Rain: Rain with a higher than normal acid range (low pH). Caused when polluted air mixes with cloud moisture. Can damage fish populations.

Algal Bloom: An unusual or excessive abundance of algae.

Alkalinity: Capacity of a lake to neutralize acid.

Bioaccumulation: Build-up of toxic substances in fish flesh. Toxic effects may be passed on to humans eating the fish.

Biomanipulation: Adjusting the fish species composition in a lake as a restoration technique.

Dimictic: Lakes which thermally stratify and mix (turnover) once in spring and fall.

Ecoregion: Areas of relative homogeneity. EPA ecoregions have been defined for Minnesota based on land use, soils, landform, and potential natural vegetation.

Ecosystem: A community of interaction among animals, plants, and microorganisms, and the physical and chemical environment in which they live.

Epilimnion: Most lakes form three distinct layers of water during summertime weather. The epilimnion is the upper layer and is characterized by warmer and lighter water.

Eutrophication: The aging process by which lakes are fertilized with nutrients. *Natural eutrophication* will very gradually change the character of a lake. *Cultural eutrophication* is the accelerated aging of a lake as a result of human activities.

Eutrophic Lake: A nutrient-rich lake – usually shallow, "green" and with limited oxygen in the bottom layer of water.

Fall Turnover: Cooling surface waters, activated by wind action, sink to mix with lower levels of water. As in spring turnover, all water is now at the same temperature.

Hypolimnion: The bottom layer of lake water during the summer months. The water in the hypolimnion is denser and much colder than the water in the upper two layers.

Lake Management: A process that involves study, assessment of problems, and decisions on how to maintain a lake as a thriving ecosystem.

Lake Restoration: Actions directed toward improving the quality of a lake.

Lake Stewardship: An attitude that recognizes the vulnerability of lakes and the need for citizens, both individually and collectively, to assume responsibility for their care.

Limnetic Community: The area of open water in a lake providing the habitat for phytoplankton, zooplankton and fish.

Littoral Community: The shallow areas around a lake's shoreline, dominated by aquatic plants. The plants produce oxygen and provide food and shelter for animal life.

Mesotrophic Lake: Midway in nutrient levels between the eutrophic and oligotrophic lakes

Nonpoint Source: Polluted runoff – nutrients and pollution sources not discharged from a single point: e.g. runoff from agricultural fields or feedlots.

Oligotrophic Lake: A relatively nutrient- poor lake, it is clear and deep with bottom waters high in dissolved oxygen.

pH Scale: A measure of acidity.

Photosynthesis: The process by which green plants produce oxygen from sunlight, water and carbon dioxide.

Phytoplankton: Algae – the base of the lake's food chain, it also produces oxygen.

Point Sources: Specific sources of nutrient or polluted discharge to a lake: e.g. stormwater outlets.

Polymictic: A lake which does not thermally stratify in the summer. Tends to mix periodically throughout summer via wind and wave action.

Profundal Community: The area below the limnetic zone where light does not penetrate. This area roughly corresponds to the hypolimnion layer of water and is home to organisms that break down or consume organic matter.

Respiration: Oxygen consumption

Secchi Disk: A device measuring the depth of light penetration in water.

Sedimentation: The addition of soils to lakes, a part of the natural aging process, makes lakes shallower. The process can be greatly accelerated by human activities.

Spring Turnover: After ice melts in spring, warming surface water sinks to mix with deeper water. At this time of year, all water is the same temperature.

Thermocline: During summertime, the middle layer of lake water. Lying below the epilimnion, this water rapidly loses warmth.

Trophic Status: The level of growth or productivity of a lake as measured by phosphorus content, algae abundance, and depth of light penetration.

Turbidity: Particles in solution (e.g. soil or algae) which scatter light and reduce transparency.

Water Density: Water is most dense at 39 degrees F (4 degrees C) and expands (becomes less dense) at both higher and lower temperatures.

Watershed: The surrounding land area that drains into a lake, river or river system.

Zooplankton: Microscopic animals.