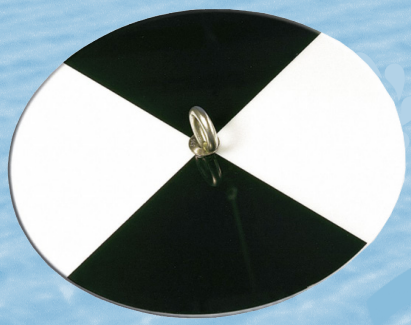
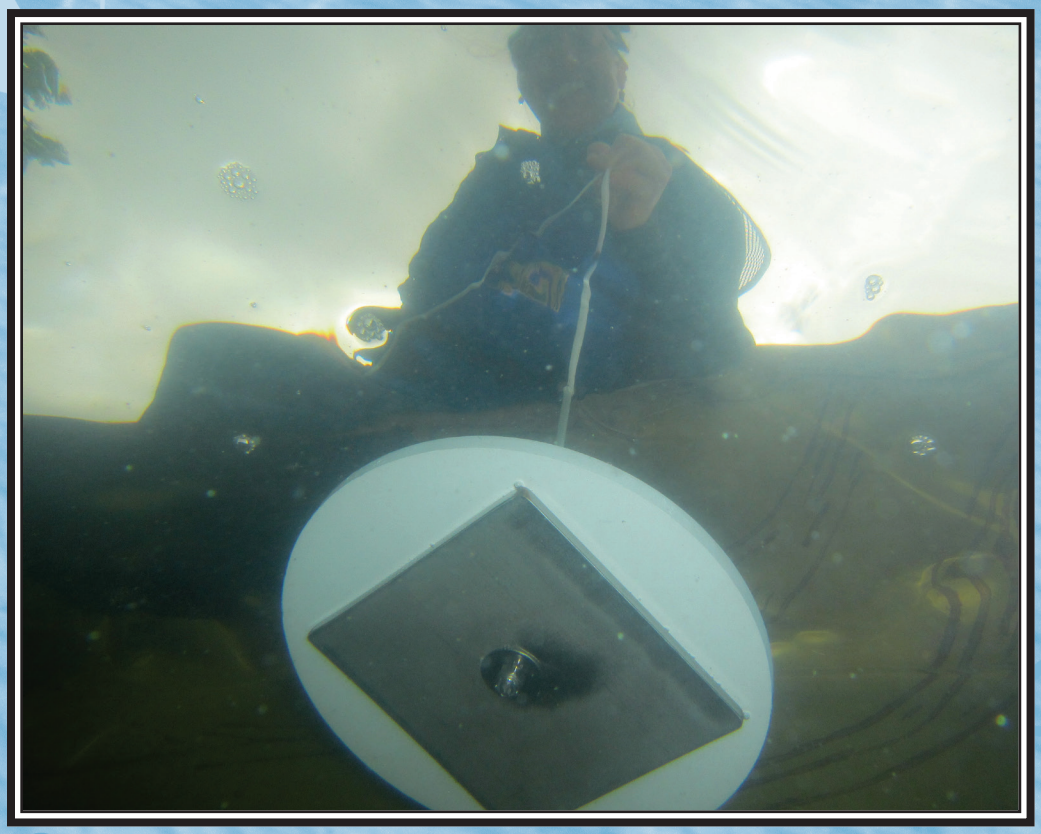


Wisconsin Citizen Lake Monitoring Training Manual

(Secchi Disc Procedures)



4th Edition

Written by
Carolyn Rumery Betz
and Patricia J. Howard

Revised by
Sandy Wickman, Laura Herman, and Paul Skawinski

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Mention of trade names and commercial products do not constitute endorsement of their use.

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Wisconsin Citizen Lake Monitoring Training Manual
(Secchi Disc Procedures)

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4th Edition

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Primary website for the Citizen Lake Monitoring Network (CLMN)
www.uwsp.edu/uwexlakes and click on the CLMN logo

Manuals | Datasheets | How-to Videos | Resources

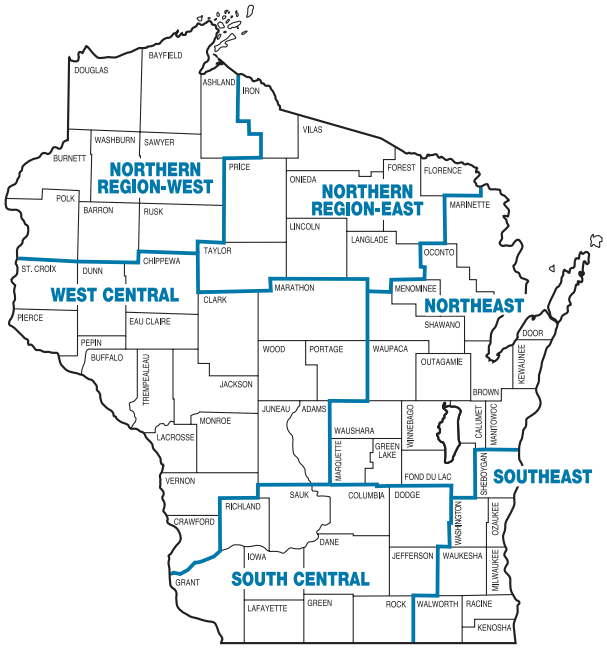
Satellite Schedule | Data Reports | Staff Contacts

Need Answers to Your Questions?

When questions arise, please contact the appropriate Citizen Lake Monitoring Network numbers listed below. There are two websites that may help you with questions: **www.dnr.wi.gov/lakes/CLMN** or **www.uwsp.edu/uwexlakes**.

If you are interested in becoming a citizen lake monitoring volunteer, or have questions about training, refresher courses, or other monitoring opportunities, please contact Paul Skawinski, Citizen Lake Monitoring Network Statewide Educator, at (715) 346-4853 or by email **Paul.Skawinski@uwsp.edu**.

For questions about the database, reporting data, or annual reports please contact the UW-Stevens Point Extension Lakes volunteer support team by email at **LakesSupport@uwsp.edu**



For questions about equipment, sampling procedures, or interpreting your water quality data, please contact your regional coordinator. You can visit **www.dnr.wi.gov/lakes/CLMN/** for a current listing of Citizen Lake Monitoring Network coordinators or call the number below.

Location	**Phone Number**
Northern Region-West	(715) 661-8175
Northern Region-East	(715) 365-8951
Northeast Region	(920) 360-3167
West Central Region	(715) 491-4131
Southeast Region & South Central Region	(414) 507-1413

Contents

Introduction

THANK YOU for joining the Citizen Lake Monitoring Network (CLMN or Network). You are one of over a thousand citizen volunteers currently monitoring Wisconsin's lakes. Over one million acres of Wisconsin is covered by water. Wisconsin's 15,000 lakes contribute significantly to the economy of individual communities and the state. In addition, these lakes offer diverse recreational opportunities and provide important habitat for fish, waterfowl, and other wildlife. The volunteer monitoring network provides an opportunity for citizens to take an active role in monitoring and maintaining water quality. Through this volunteer network, you can learn about your lake and help the Wisconsin Lakes Partnership gain a better understanding of our state's lakes. More importantly, you can share your knowledge and the information you gather with your **lake association** and other lake residents.

The partnering of concerned citizens and the Wisconsin Department of Natural Resources (Wisconsin DNR) was initiated in 1986. In the Network's first year, volunteers throughout the state monitored 113 lakes. Since then, the Network has grown to include over 1,000 volunteers per year! Some volunteers monitor more than one lake and some larger lakes are monitored at more than one location. Many volunteers share monitoring responsibilities with a friend or a group of friends.

Since 1986, the partnership has grown to include volunteers, the Wisconsin DNR, UWSP Extension Lakes, and Wisconsin Lakes. CLMN offers volunteers the opportunity to collect many types of data. The types of data you collect will depend on your concerns and interests, as well as the amount of time you wish to spend monitoring. **Secchi disc** monitoring is the backbone of CLMN and is the most common type of monitoring. Secchi volunteers collect water clarity information on their lakes throughout the open water season. After collecting Secchi data for one or more years, some volunteers choose to get involved in other types of monitoring. Secchi volunteers may also be interested in collecting chemistry data on their lake. Chemistry volunteers collect **phosphorus** and **chlorophyll** samples four times per

A full glossary of highlighted terms is provided on page 29 of this manual.

LAKE ASSOCIATION • A voluntary organization with a membership generally comprised of those who own land on or near a lake. The goals of lake associations usually include maintaining, protecting, and improving the quality of a lake, its fisheries, and its watershed.

SECCHI DISC • A 20-cm (8-inch) diameter disc painted white and black in alternating quadrants. It is used to measure light transparency in lakes.

PHOSPHORUS • The major nutrient influencing plant and algal growth in more than 80% of Wisconsin lakes. Soluble reactive phosphorus refers to the amount of phosphorus in solution that is available to plants and algae. Total phosphorus refers to the amount of phosphorus in solution (reactive) and in particulate forms (non-reactive).

CHLOROPHYLL • Green pigment present in all plant life and necessary for photosynthesis. The amount of chlorophyll present in lake water depends on the amount of algae and is used as a common indicator of water quality.

DISSOLVED OXYGEN • A measure of the amount of oxygen gas dissolved in water and available for use by fish and other aquatic animals. Dissolved oxygen is produced by aquatic plants and algae as part of photosynthesis.

LAKE CLASSIFICATION • A way of placing lakes into categories with management strategies best suited to the types of lakes found in each category. For example, lakes can be classified to apply varying shoreland development standards. They can be grouped based on hydrology, average depth, surface area, shoreline configuration, as well as sensitivity to pollutants and recreational use.

Children of a culture born in a water-rich environment, we have never really learned how important water is to us. We understand it, but we do not respect it.

–William Ashworth

LINDA POHLOD

year *in addition to* collecting Secchi data. This more extensive volunteer monitoring allows Wisconsin DNR lake managers to assess the nutrient enrichment state of their lakes. In addition, some volunteers also collect temperature and **dissolved oxygen** (DO) data for their lakes. Other types of monitoring activities include aquatic invasive species monitoring and native aquatic plant monitoring. Ideally, all volunteers will be able to find a level of involvement that suits their interests and abilities.

The partnership between the volunteer monitors and the Wisconsin DNR has resulted in an extensive volunteer monitoring database. Data collected by volunteers has been published in numerous reports and is frequently used by limnologists (scientists who study lakes) and water resource planners for a variety of purposes. In addition, volunteer data is reported to the U.S. Environmental Protection Agency (EPA) on a regular basis.

What is Expected of Me?

What we need most from you is your time and your keen powers of observation! As a Secchi volunteer, you will determine how the water clarity of your lake compares to similar lakes statewide and watch for long-term changes. The Network will provide all of the equipment that you will need to collect your data. You may be asked to participate in refresher sessions. These sessions provide an opportunity to meet other volunteers and to ask Wisconsin DNR staff questions about monitoring and lake issues as well as ensuring that all volunteers are following CLMN monitoring protocols.

There are some things that may influence your enjoyment when participating as a citizen volunteer: the type of boat you use, and whether or not you have a sampling partner. A fishing-type boat or pontoon boat is ideal for sampling work and will be safer and more comfortable than a canoe or kayak, although these small boats can work too. A sampling partner will make your job safer, easier, and faster as one person can record data while the other collects Secchi readings or water samples.

HOW IS CLMN DATA USED?

All citizen volunteers can view an annual data summary report for their lake by using the WDNR's Water Explorer (WEx) tool online. Volunteers may also request that a printed copy be mailed to them. Most volunteers share this information with other lake residents who are interested in learning more about lake water quality. Lake groups, DNR, and county land conservation offices use CLMN data to support water quality projects such as shoreland restoration, lake classification, shoreland zoning, and nutrient diversion projects. All lake data is available to the public at https://dnr.wisconsin.gov/topic/lakes/clmn.

Every two years, Section 303(d) of the Clean Water Act requires states to publish a list of all waters that do not meet water quality standards. CLMN data is used in the Impaired Waters listing process.

Fish biologists and lake managers use volunteer data to

- support general lake management decisions,
- support lake planning and protection grants,
- craft aquatic invasive species management decisions,
- determine lake health,
- examine winterkill or summer anoxic conditions,
- supplement statewide long-term trend data to analyze trends, lake issues, and climate change impacts, and
- establish "baseline" data to look at water quality changes and trends through time.

CLMN data is widely used to research water quality trends, to assist with remote sensing research, to investigate climate change impacts, and to further wildlife research.

Volunteer data are provided to other organizations, the state legislature, and federal, tribal, and local agencies that in turn may use these data to help determine funding for grants and programs targeting water quality or aquatic invasive species issues. Citizen-generated data is used every two years to report trends in Wisconsin lakes and to identify needs to the Federal government.

Volunteer data are also used by Earth Echo Water Challenge™, an international education and outreach program that builds public awareness and involvement in protecting water resources around the world by engaging citizens to conduct basic monitoring of their local water bodies.

Volunteer data are incorporated into the Secchi Dip-In. The Secchi Dip-In is a demonstration of the potential of volunteer monitors to gather environmentally important information on our lakes, rivers, and estuaries. Volunteers have been submitting information during the annual Dip In since 1994. It's an international effort to track changes in water quality. The Dip-In website is nalms.org/secchidipin

WHAT IS THE REMOTE SENSING PROGRAM?

The development of capabilities for the remote sensing of water quality in Wisconsin started in 1999 when Citizen Lake Monitoring Network (CLMN) volunteers assisted in a collaborative research effort with the University of Wisconsin-Madison Environmental Remote Sensing Center (ERSC) to develop a model for the retrieval of water clarity data from satellite images. CLMN volunteers collected on-the-ground Secchi depth data when the satellites were overhead to calibrate this model for each satellite image and water clarity data was retrieved for over 8,000 lakes statewide between 1999 and 2001. This research effort provided the foundation for the operational remote sensing of water clarity at the Wisconsin DNR in subsequent years. Today, remote sensing data from the NASA/USGS Landsat Program are used by the Wisconsin DNR to provide satellite-retrieved Secchi depth data for thousands of lakes annually with the support of CLMN volunteers. Different weather conditions and atmospheric effects on satellite images and challenges in the atmospheric correction of satellite images mean on-the-ground Secchi depth data are still needed to calibrate this model for each satellite image. Your CLMN volunteer coordinator will send you a list of Landsat 7 flyover dates for your lake if you are one of our Secchi volunteers and want to support our operational efforts. The satellite image-specific algorithms will translate your data to data for hundreds of lakes within the same satellite image if you collect it on a clear satellite flyover date for your lake! Find out more about remote sensing at https://dnr.wisconsin.gov/topic/lakes/clmn/remotesensing

Sample Schedule

A typical year of volunteer monitoring may look something like this:

February

Volunteers can view a summary report of their data from the previous year. Volunteers who do not have a computer or Internet access can request a paper copy of their data report in the mail.

March

Spring monitoring supplies are mailed out to volunteers. Volunteers with Internet access can print off their own data sheets and find their remote sensing schedule. The annual Wisconsin Lakes Convention is held in March or April.

April

Some volunteers begin monitoring as soon as the ice is off the lake. Secchi volunteers continue taking readings every 10 to 14 days throughout the open water season.

May

New volunteers are trained. Some volunteers begin their monitoring season.

June

Invasive Species Awareness Month.

Some lakes are selected to be part of the CLMN Quality Assurance Project.

July

Secchi readings are taken in conjunction with satellite dates when possible.

Secchi Dip-In.

Some lakes are selected to be part of the CLMN Quality Assurance Project.

August

Secchi readings taken in conjunction with satellite dates when possible.

September

Secchi readings taken in conjunction with satellite dates when possible. Some volunteers wrap up Secchi monitoring for the season.

October

Volunteers wrap up Secchi monitoring for the season.

November

Volunteers ensure that all data has been submitted. If data has been entered into SWIMS you do not need to submit a paper copy.

December

Volunteers send any comments or needs (such as repair needs) to their regional coordinator.

THE CITIZEN LAKE MONITORING NETWORK PARTNERSHIP

Volunteer citizen lake monitoring is a team effort with many players including citizen volunteers, Wisconsin DNR, UW-Stevens Point Extension Lakes, and Wisconsin Lakes.

The citizen volunteer is the most important player in the lake monitoring network

You know your lake on a day-to-day basis. You may know the best spots to fish and which birds visit or nest on the lake. You know when the lake freezes over, when the ice goes out, and you know your neighbors and friends who love and use the lake. You volunteer to participate because of your genuine concern for the lake and your desire to learn more about it. Collecting water quality data is a step in the right direction to gaining a better understanding of your lake.

We depend on volunteers to share the information that they learn about their lakes with their Lake Association, Lake District, or other residents on the lake. You have the best access to your neighbors. Many volunteers share a lake status report every year at annual meetings. Your lake summary report, graphs, and narrative will help you to prepare this report. Your CLMN regional coordinator or Wisconsin DNR lakes coordinator are available to assist you if you need help providing this information to your lake group.

Another member of the partnership is the Wisconsin DNR CLMN Regional Coordinator and local staff

Local staff are located in several Wisconsin DNR regional offices around the state. As a citizen volunteer, you may already know them or have worked with them in the past. If you have any questions about your lake and your monitoring duties, these are the first people you should contact to help answer your questions.

Wisconsin DNR CLMN staff located in Madison

Staff help maintain and analyze the volunteer data, keep track of awards, produce reports, and logistically keep the Network running smoothly.

By the conclusion of the sampling season, you will receive an email reminding you that reports about your lake are available online at the Wisconsin DNR website. The reports summarize previous years' data collected on your lake and include text and graphs that help you understand how the data you collected in the past year relates to your lake.

Extension Lakes staff

Extension Lakes staff ensure that trainers (Wisconsin DNR regional staff, and outside agency trainers) follow the Network's protocols when volunteers are trained. This ensures statewide consistency in data collected. Extension Lakes staff help with monitoring protocols and outreach.

Citizen volunteers can also sign up to receive *Lake Tides*, a printed or electronic quarterly newsletter published by the Wisconsin Lakes Partnership. A shorter E-newsletter called *Lake Ripples* is also available.

The Lake Leaders Institute was established to assist citizens in developing and enhancing their technical skills to preserve and protect Wisconsin Waters. To learn more, visit https://www.uwsp.edu/uwexlakes/ and click on Lake Leaders

THE CLMN LAKE MONITORING NETWORK HAS TEN PRIMARY GOALS

1. Quality and Accessible Data

   Following collection protocols will enable you to collect quality data on your lake. Recording your Secchi disc readings and water chemistry data carefully, regularly, and according to procedures will provide valuable information about your lake. When you report your data to the Network, it is readily available through an online database. The Wisconsin DNR relies on your data. Without your help, very few lakes could be monitored.

2. Document Water Quality Changes Over Time

   The Network's aim is to document water quality changes over time by summarizing the data that you collect and sharing that data with other volunteers and organizations. This is particularly important for those lakes where little or no data exists. You will be collecting baseline data that cannot be captured again in the future; and that will be used for decades to come. You will be able to compare your lake to hundreds of others using the statewide Summary Report. After several years of monitoring, your regional coordinator can work with you or your Lake Association to determine whether or not your lake should receive more intensive monitoring or management attention.

3. Educated and Informed Citizen Monitors

   The Network's goal is to help you learn more about basic limnology. By collecting, summarizing, and reviewing your data, you will increase your understanding of your lake's overall water quality and will be able to share this information with your Lake Association or other lake residents. The information you collect can be used to help make decisions about your lake (e.g., use restrictions, watershed management decisions, aquatic plant management, etc.).

4. Greater Number and Frequency of Lakes Monitored

   The Wisconsin DNR relies on citizen volunteers for most of its data. In a given year, Wisconsin DNR staff can only get out to a limited number of lakes, and often only get to these lakes once a year or once every five years. Your help allows many more lakes to be monitored on a much more frequent basis.

5. Enhanced Participation in Statewide Network of Volunteer Monitors

   The Network is a partner in a statewide network with other Wisconsin monitoring groups, such as LoonWatch, Water Action Volunteers Stream Monitoring, and others.

6. Quality Support

   Support staff, located in Madison and Stevens Point, are available to help you with database or data reporting questions and awards. Each region of the state has a regional coordinator who trains volunteers and answers questions about equipment and sampling procedures, and annual reports.

7. Reduced Administrative Overhead (state, community, and citizen)

Volunteer help reduces the Wisconsin DNR's operating costs and helps streamline workflow. When volunteers sample lakes that need to be monitored, the Wisconsin DNR saves time and money involved in having staff travel to those lakes to collect the data. Those staff can then collect data on additional lakes. It is the Network's goal to keep monitoring and data reporting as simple and efficient as possible for the citizen volunteer.

8. Engage Others in Support of the Network

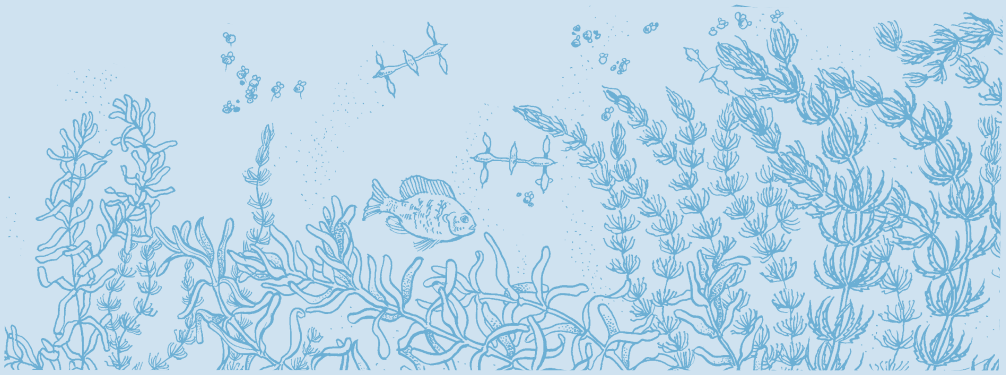
The Network is supported through a partnership, not just the Wisconsin DNR. Extension Lakes, counties, and a variety of local organizations are engaged in providing support and services to the statewide network. Volunteers often serve as mentors or trainers for other volunteers.

9. Tie-in to National Lake Research and Monitoring

CLMN data are often used for lake research. For example, volunteer data have been used to successfully derive water clarity data on thousands of lakes from satellite imagery. CLMN data are also shared with the international Secchi Dip-In. For more information, visit https://www.nalms.org/secchidipin/

10. Recognize and Appreciate Citizen Involvement

At the end of each monitoring season, the Network conducts a prize drawing and sends out awards to long-term volunteers. Certificates of participation and metal hat pins are available upon request. Other perks of being a volunteer are offered throughout the year.



CAROL WATKINS, UW-EXTENSION, ENVIRONMENTAL RESOURCES CENTER

LIMNOLOGY • The study of inland lakes and waters, including the biological, chemical, and physical parameters of lakes and rivers.

WATERSHED • The area of land draining into a specific stream, river, lake or other body of water.

What Types of Monitoring Can I Participate in?

If you have an interest in any of the following monitoring activities, please contact your regional coordinator.

Secchi

Father Pietro Angelo Secchi was an Italian astrophysicist and the scientific advisor to the Pope. In 1865, he was asked by the head of the Papal Navy to develop a way to measure transparency in the Mediterranean Sea. Secchi used white discs to measure the clarity of water. The Secchi disc was adopted for use by limnologists as a way to measure water clarity and to set a numerical value to water quality.

A Secchi depth reading is intended to give a general picture of your lake's water clarity. The sampling is easy to do and does not require sophisticated, high-maintenance equipment nor demand a background in science, chemistry, or engineering. One Secchi reading will not tell you a great deal about your lake but Secchi disc readings taken over a period of time will tell a story about your lake – is your water clarity improving, declining, or remaining the same?

Wisconsin CLMN uses a Secchi disc that is 8 inches in diameter, black and white, and weighted with a stainless steel or zinc plate. CLMN protocols must be followed closely so that the data that you collect can be compared to other lakes. The Secchi disc is lowered into the water on a marked rope until it just disappears from view. That point is marked with a clothespin at the water's surface. Volunteers then lower the disc a couple of feet further into the water. They then slowly raise the disc until they can see it again. That point is also marked with a clothespin. The average of these two measurements is recorded. Doing the two measurements using the "clothespin method" gives a more accurate reading. Measuring the water clarity or transparency of lakes over time provides a "pulse" on the health of these lakes, and is a crucial record for long-range planning.

Water Chemistry

After one year of water clarity monitoring, you may be eligible to participate in water chemistry monitoring. Chemistry volunteers, in addition to measuring water clarity and temperature, collect water samples for analysis of phosphorus and chlorophyll levels four times per year. Volunteer-collected samples are sent to the **Wisconsin State Laboratory of Hygiene (WSLH)** for analysis. The information volunteers collect when monitoring both water clarity and chemistry is used to determine the **trophic state** of the lake. Training and equipment for chemistry monitoring are provided by the Wisconsin DNR. Secchi volunteers who have participated in the Network for at least one sampling season and are interested in becoming a chemistry volunteer should contact their CLMN regional coordinator. The number of chemistry lakes that are added each year is limited due to the cost of equipment and the cost of sample analysis by WSLH. Because of budget limitations, lakes are prioritized according to the need for information.

Temperature and Dissolved Oxygen

Water temperature impacts many organisms living in the lake. It drives reproduction, metabolic rate, and survival of fish and other aquatic animals; plant and algal growth and biomass; and nutrient cycling. Long-term data are needed to understand temperature trends.

DNR Fisheries Biologists and Lake Coordinators may ask you to collect a dissolved oxygen profile. Temperature and dissolved oxygen

profiles are collected at three-foot intervals at the deep hole.

A Van Dorn water sample bottle is used to collect the water sample from the various depths for dissolved oxygen testing. The collection profile will be determined by your regional coordinator. Winkler titration kits are available through CLMN.

Electronic dissolved oxygen meters are very fast and easy but are not provided by CLMN. Your CLMN Coordinator may know of meters that are available to the public.

Native Aquatic Plant Monitoring

Aquatic plants are a good indicator of lake health. Over time, the type of vegetation and size of plant beds may change and/or move in response to changes in water quality, invasives, and human activity. Aquatic plant monitoring is tailored to each volunteer's ability, interest, and time commitment and can vary from lake to lake. Some volunteers choose to identify and map plant beds on the lake, keeping track of beds based on whether the plants are submergent, emergent, or floating.

Other volunteers wish to have a more comprehensive list of the aquatic plants that are present on their lake. They identify, collect, and press their lake's aquatic plants and map the plants' locations. All plants collected by volunteers are verified.

Aquatic Invasive Species (AIS) Monitoring

Citizen volunteer monitoring protocols for AIS and invasive species information can be found on the CLMN website.

If you think you have found an invasive species, please contact your local CLMN coordinator so they can verify the specimen. The DNR website lists the

AQUATIC INVASIVE SPECIES (AIS) • A species of plant or animal that is not native to a particular region and may cause economic or environmental harm or harm to human health. Wisconsin law prohibits launching or transporting a boat if aquatic plants or animals are attached to the boat.

PUBLIC PERCEPTION OF WATER QUALITY

As part of your Secchi data collection, the Network is interested in your opinion of the lake's water quality when you are sampling. Using these observations, a public opinion assessment of water clarity can be made. This information will help determine water quality standards for lakes. There is no right or wrong answer to these questions and your answer can change throughout the summer or in subsequent years. Specifically, citizen volunteers will be asked to note the algal content of the water. Is there so much algae that you want to shower after swimming? Would you not swim in the water at all? In addition to the Secchi disc readings that you measure, the Network is concerned with your opinion of what constitutes good or poor water quality.

The Network predicts that this information will reveal that people living in a specific area of the state will have similar perceptions of what they consider to be acceptable water quality, but this may vary across the state. The Network hopes to share this information with other states in anticipation of creating a regional map of public perceptions of water quality.

STATE LABORATORY OF HYGIENE (WSLH) • The state of Wisconsin's public health and environmental laboratory.

TROPHIC STATE • The extent to which the process of eutrophication has occurred is reflected in a lake's trophic classification or state. The three major trophic states are oligotrophic, mesotrophic, and eutrophic.

pH • The measure of acidity or alkalinity of a solution. Neutral solutions are defined as having a pH of 7.0. Solutions which are known as acidic have a pH lower than 7. Solutions which are known as basic or alkaline have a pH greater than 7.


Paul Skawinski

Eurasian Water-milfoil


SUSAN KNIGHT

Curly-leaf Pondweed


Paul Skawinski

Zebra Mussel


BOB KORTH

Quagga Mussel


Paul Skawinski

Spiny Waterflea

Eurasian Water-milfoil (EWM) Watch

All volunteers are encouraged to monitor their lake for Eurasian water-milfoil (*Myriophyllum spicatum*). EWM is an aquatic plant that is not native to the United States and continues to populate many lakes throughout Wisconsin.

Curly-leaf Pondweed Watch

In Wisconsin, curly-leaf pondweed (*Potamogeton crispus*) usually completes its life cycle by June or July. Volunteers are asked to check plant beds on calm, clear days from ice off until mid-July.

Zebra and Quagga Mussel Watch

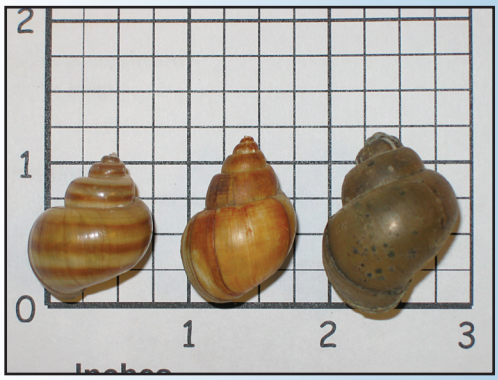
The zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena rostriformis bugensis*) are two non-native mussel species that can spread rapidly and change food webs.

Spiny Waterflea Watch

Spiny waterfleas (*Bythotrephes longimanus*) and fish hook waterfleas (*Cercopagis pengoi*) are small crustaceans distantly related to shrimp. Both species of waterflea entered the Great Lakes in ship ballast water from Europe. One or both of the species are now found in all of the Great Lakes. Spiny waterfleas are found in some inland lakes in Wisconsin. Both species tend to gather on fishing lines so anglers may be the first to discover a new infestation.

Chinese and Banded Mystery Snail Monitoring

There are three species of mystery snails in Wisconsin. Only one of these species, the brown mystery snail (*Campeloma decisum*) is native to Wisconsin. The Chinese mystery snail (*Bellamya chinensis*) is native to Asia. The banded mystery snail (*Viviparus georgianus*) is native to the southeastern United States.



LAURA HERMAN

Banded mystery snail (left), brown mystery snail, native to Wisconsin (center), and Chinese mystery snail (right).

Factors that Affect Water Clarity

Water clarity is a measure of the amount of particles in the water, or the extent to which light can travel through the water. There are many ways to express water clarity, including Secchi disc depth, turbidity, color, suspended solids, or light extinction. Chlorophyll-a, collected by water chemistry volunteers, is a measurement of the amount of **algae** that is in the water.

Water clarity is important for a number of reasons. It affects the depth to which aquatic plants can grow, dissolved oxygen content, and water temperature. Fish and loons and other wildlife depend on good water clarity to find food. Water clarity is often used as a measure of trophic status, or an indicator of ecosystem health. Water clarity is important aesthetically and can affect property values and recreational use of a water body.

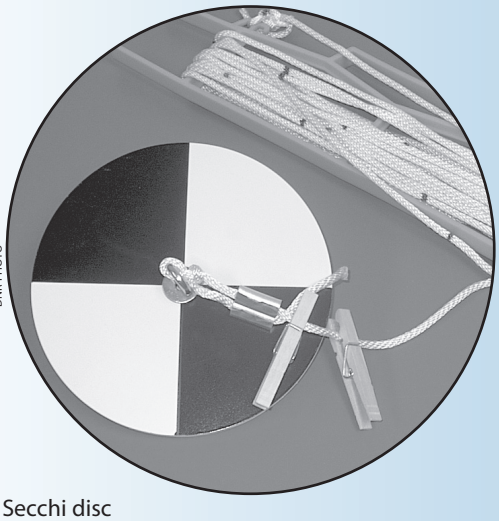
Suspended sediments, algal growth, runoff, shoreline erosion, wind mixing of the lake bottom, and tannic and humic acids from wetlands can all affect water clarity. Water clarity often fluctuates seasonally and can be affected by storms, wind, normal cycles in food webs, and even fish such as common carp.

Suspended Sediments

Sediment may enter the lake from a river or stream. Sediment may also come from land use activities in the **watershed** including erosion from cropland and **runoff** from barnyards, construction sites, and city streets. In a shallow lake, sediment from the lake bottom can be suspended throughout the water column during heavy winds. Additionally, certain fish species (e.g., carp) may stir up bottom sediments and make the lake appear muddy. A lake with a lot of suspended sediment will appear cloudy, muddy, or brown. As a result, the Secchi disc may disappear from view within a few feet of the water's surface.

Algae

Phytoplankton (various free-floating algae) are a vital part of the food chain in aquatic systems. They provide the food base for **zooplankton** (microscopic animals) that eventually are eaten by fish, ducks, and other



DNR PHOTO

Secchi disc

ALGAE • Tiny, unrooted aquatic plants containing chlorophyll that occur as single cells or multi-celled colonies. Algae form the base of the food chain in an aquatic environment.

WATERSHED • The area of land draining into a specific stream, river, lake, or other body of water.

RUNOFF • Water from rain, snow melt, or irrigation that flows over the ground surface and into streams or lakes.

PHYTOPLANKTON • Very small free-floating aquatic plants, such as one-celled algae. Their abundance, as measured by the amount of chlorophyll a in a water sample, is commonly used to classify the trophic status of a lake.

ZOOPLANKTON • Plankton that is made up of microscopic animals that eat algae. These suspended plankton are an important component of the lake food chain and ecosystem. For many fish and crustaceans, they are the primary source of food.

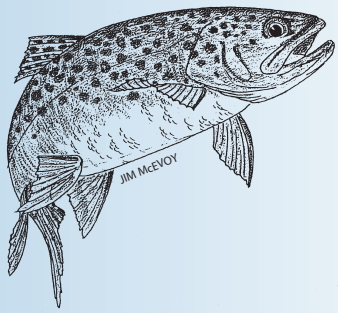
STRATIFICATION • The layering of water due to differences in temperature and density.

EPILIMNION • The uppermost circulating layer of warm water that occurs in stratified lakes in summer because of the differences in water density. Water's greatest density occurs at 39°F. In lakes that stratify, as water warms during the summer, it remains near the surface while the colder water remains near the bottom. The depth of the epilimnion is determined by wind and lake surface area, and usually extends about 15-25 feet below the surface.

THERMOCLINE • Sometimes referred to as the metalimnion. The narrow transition zone between the epilimnion and the hypolimnion that occurs in stratified lakes.

METALIMNION • See thermocline.

HYPOLIMNION • The cold, deepest layer of a lake that is removed from surface influences during stratification.



animals. Too much phytoplankton can disrupt the natural balance of a lake ecosystem, make the lake unsightly, and make swimming and other activities less enjoyable.

Blue-green algae, also known as cyanobacteria, can grow very quickly in number if conditions are just right. Concerns associated with blue-green algae include discolored water, reduced light penetration, taste and odor problems, dissolved oxygen depletions during die-off, and toxin production. If your lake has little turbidity due to sediment, the Secchi disc data you provide will give a relative estimate of how much algae is present in your lake. It will not identify which specific types of algae are present.

Water Color

Some lakes, especially those near acidic wetlands such as bogs, may be stained brown like tea. This is an indication that the water contains tannic acid that leached from the surrounding vegetation. Since light does not penetrate as well through dark-colored water, Secchi depth may be low although algae may be less abundant. Plant densities may be lower in stained lakes since sunlight is not able to penetrate very deep into the water column. You may also notice a change in water color over the sampling season. Seasonal color changes most likely reflect changes in algae productivity. If your lake turns unusually green, brown, or orange for a few weeks during the summer months, the change is probably the result of an algal bloom. To fully understand variations in Secchi depth, water color observations over time must be recorded.

Mixing and Stratification

A lake's water quality and ability to support fish are affected by the extent to which the water mixes. Mixing will also impact your Secchi disc reading. The depth, size, and shape of a lake are the most important factors influencing mixing, although climate, lakeshore topography, inflow from streams, and vegetation also play a role (Shaw et al. 2000).

Water density peaks at 39°F. It is lighter when either warmer or colder than 39°F. Variations in water density caused by different temperatures can prevent warm and cold water from mixing (Shaw et

al. 2000). When lake ice melts in early spring, the temperature and density of lake water will be similar from top to bottom. This uniform water density allows the lake to mix completely, recharging the bottom water with oxygen and bringing nutrients to the surface (Shaw et al. 2000). This mixing process is called spring turnover. As surface water warms in the spring, it loses density. Due to physics, wind and waves can usually only circulate the warmed water 20 to 30 feet deep, so deeper areas are not mixed. If the lake is shallow (less than 20 feet), the water may stay completely mixed all summer (Shaw et al. 2000).

During the summer, lakes more than 20 feet deep usually experience a layering called **stratification**. Depending on their shape, small lakes can stratify even if they are less than 20 feet deep. In larger lakes, the wind may continuously mix the water to a depth of 30 feet or more. Lake shallows do not form layers, though deeper areas may stratify. Summer stratification, as pictured in Figure 1, divides a lake into three zones: **epilimnion** (warm surface layer), **thermocline** or **metalimnion** (transition zone between warm and cold water), and **hypolimnion** (cold bottom water). Stratification traps nutrients released from the bottom sediments within the hypolimnion (Shaw et al. 2000).

In the fall, the surface cools until the water temperature evens out from top to bottom, which again allows mixing (fall overturn). A fall algae bloom often appears when nutrients mix and rise to the surface. Winter stratification, with a temperature difference of only 7°F (39°F on the lake bottom versus 32°F right below the ice), remains stable because the ice cover prevents wind and waves from mixing the water (Shaw et al. 2000).

The lake's orientation to prevailing winds can affect the amount of mixing that occurs. Some

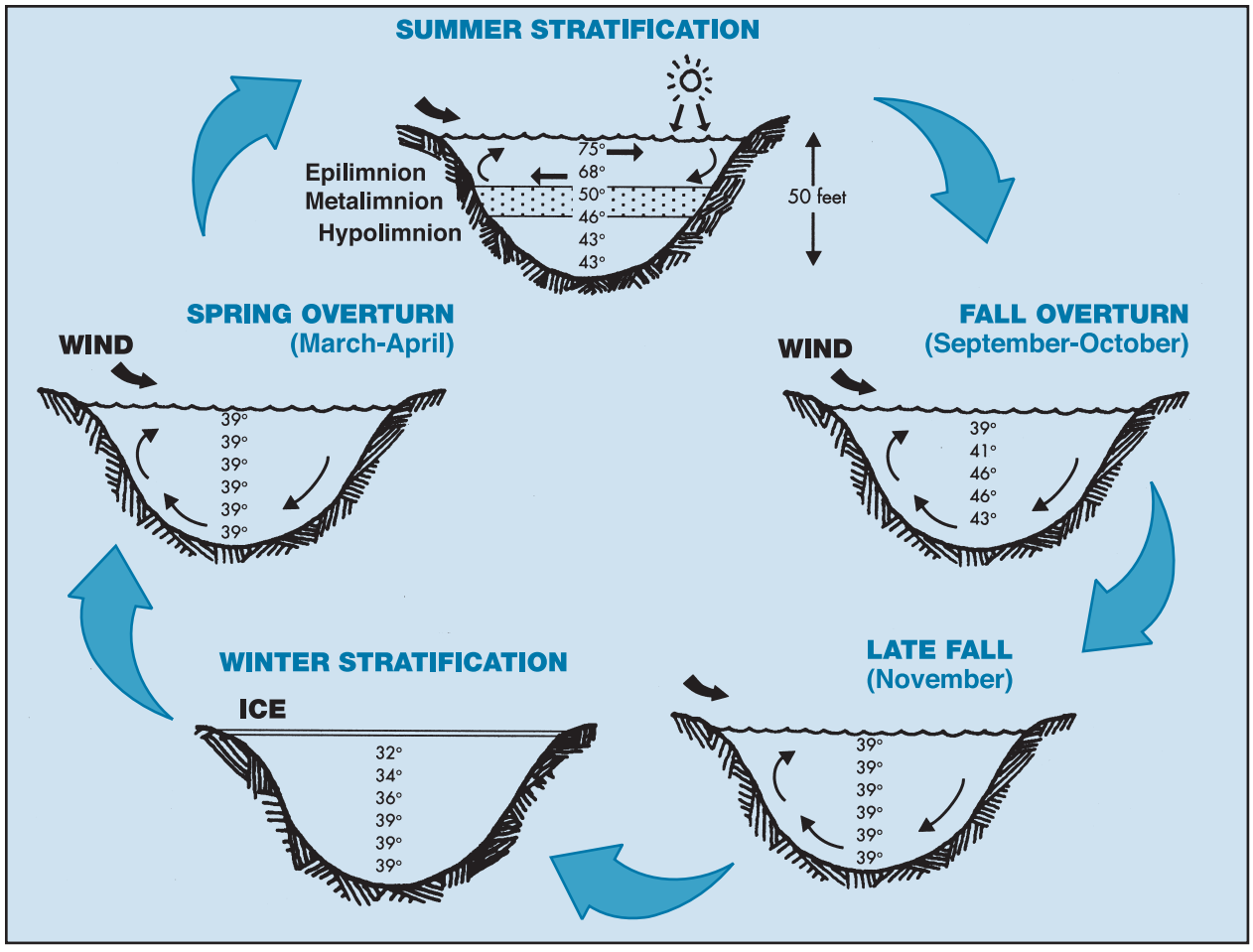
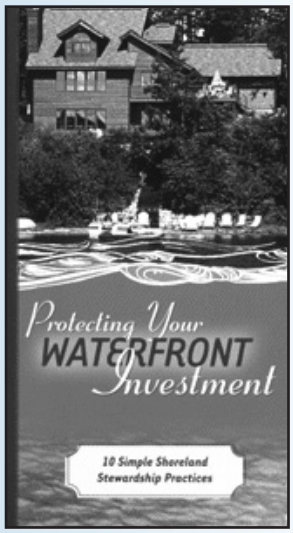


Figure 1. Seasonal Stratification of Lakes. (Taken from Shaw et al. 2000 "Understanding Lake Data")



Protecting Your Waterfront Investment

Protecting Your Waterfront Investment is a handy booklet designed to provide you with 10 simple shoreland stewardship practices you can do to protect your watershed and lake.

Free with a small handling fee from UWSP Extension Lakes

SEEPAGE LAKES • Lakes without a significant inlet or outlet, fed by rainfall and groundwater.

ALGAL BLOOM • A heavy growth of algae in and on a body of water as a result of high nutrient concentrations.

small, deep lakes may not undergo complete mixing in the spring or fall if there is not enough wind action. The mixing that takes place in the bays of a large lake will more closely resemble that of a small lake because the irregular shoreline blocks the wind (Shaw et al. 2000). Because mixing distributes oxygen throughout a lake, lakes that don't mix may have low oxygen levels in the hypolimnion, which can harm fish. Some fish species require lake stratification. The cold water in the hypolimnion can hold more oxygen than the warmer water in the epilimnion and thus provide a summer refuge for cold water fish (e.g., trout). If the lake produces too much algae that falls onto the lake bottom to decay, oxygen in this part of the lake will become depleted since the steep temperature gradient in the metalimnion will prevent any surface water with dissolved oxygen from reaching the bottom (Shaw et al. 2000).

Water Levels

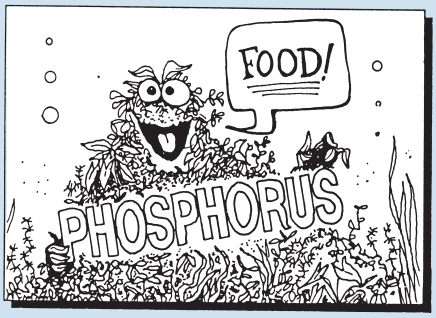
Lake water levels naturally fluctuate over time on approximately a 13-year cycle. Many factors influence water levels on lakes:

- Natural variability due to weather
- Decadal climate cycles (dry and wet periods)
- Climate change
- Dams
- Human use (water withdrawals)
- Lake morphology and hydrology
    - o Lakes with gradual sloping shorelines will have more lake bed exposed during drought than lakes with steep shorelines
    - o Seepage lakes respond more dramatically to drought than drainage lakes

Natural lake level fluctuations can be important for maintaining healthy riparian plants and habitat. At extreme low and high lake levels, there can be negative impacts to both lake health and recreation. As water levels decline, critical littoral habitat for fish and aquatic life is stranded above water in lakes. The loss of this habitat can lower diversity and decrease productivity, particularly for slow-growing aquatic plants that may not be able to retreat as quickly as the water retreats. In some lakes, low water levels have left piers hundreds of feet from shore and rendered boat landings unusable.

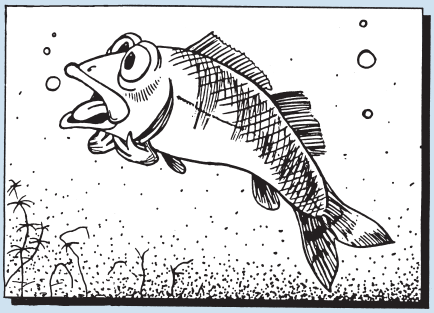
Conversely, high water levels can lead to shoreline

FAMILIAR SIGNS OF RUNOFF POLLUTION

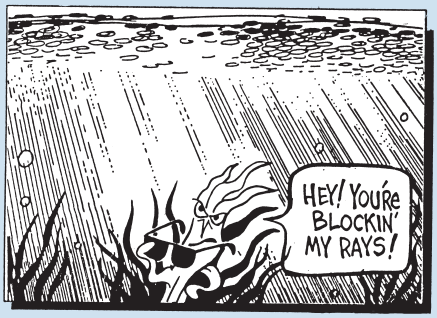


ALGAE

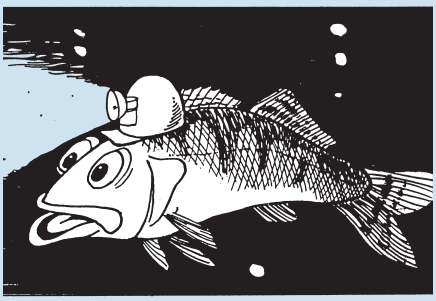
Nutrients, such as phosphorus and nitrogen, come from sediments, manure, pet wastes, improperly maintained septic systems, and misapplication of fertilizers on lawns or farm fields. Phosphorus contributes to the eutrophication (over-fertilization) of lakes. This leads to an increase in aquatic macrophyte and algae growth. Excess aquatic macrophytes and algae are harmful to fish and make a lake less attractive for swimming, boating, and other activities (UW Extension 2001).



When algae and aquatic weeds die they are broken down by bacteria. Bacteria consume oxygen during decomposition and make it difficult for fish and other aquatic life to survive. Excess aquatic macrophytes also contribute to winter fish kills in shallow lakes (UW Extension 2001).



Excess algae can reduce populations of bottom-rooted plants by blocking sunlight. Bottom-rooted plants provide food and habitat for fish and waterfowl (UW Extension 2001).



SEDIMENT

Sediments can cause water to become cloudy, or "turbid", making it difficult for fish to see and feed properly. Sediments can also damage fish gills and impair the feeding and breathing processes in aquatic insects (UW Extension 2001).

Sediments cloud the water and cover plant leaves, reducing sunlight penetration and inhibiting photosynthesis. Without photosynthesis, desirable plant populations are reduced, leaving fewer habitats for fish and small organisms (UW Extension 2001).

EUTROPHICATION • The process by which lakes and streams are enriched by nutrients causing an increase in plant and algae growth. This process includes physical, chemical, and biological changes that take place after a lake receives inputs for plant nutrients (mostly nitrates and phosphates) from natural erosion and runoff from the surrounding land basin. The extent this process occurs is reflected in a lake's trophic classification. Lakes can be classified as being oligotrophic (nutrient poor), mesotrophic (moderately productive), or eutrophic (very productive and fertile).

NITROGEN • One of the major nutrients required for the growth of aquatic plants and algae. Various forms of nitrogen can be found in water: organic nitrogen, most of which eventually decomposes to ammonia; ammonia, produced from organic decay by bacteria and fungi; nitrite, produced from ammonia by nitrite bacteria; and nitrate, the form which is most readily available for use by plants. Nitrate is produced from nitrous oxide by nitrate bacteria. In some ecosystems, nitrogen is the nutrient that limits algae growth.

erosion, increased nutrient inputs, and flooding of piers, homes, and boat landings. Slow-no-wake boating ordinances may be introduced to protect lake shorelines during the high-water period.

Water level monitoring has been added to CLMN to monitor statewide lake levels over time to address growing concern for health of aquatic life due to drought, changing climate, and groundwater withdrawals. Although long-term water level records exist, current monitoring efforts are disjointed and do not cover all areas of the state.

Professionals (e.g., county surveyors) survey and install staff gauges to lakes shortly after ice-out in spring and then survey and remove staff gauges in late fall. Citizen volunteers record and report lake levels preferably weekly, but at least monthly. Seventeen lakes began monitoring water levels in summer 2015 as a pilot and additional lakes have joined the program. All staff gauges are surveyed to at least three reference marks and tied to a datum. This ensures that the data record may continue long into the future even if all reference marks are lost.

Wind-generated Waves, Sun Position, and Cloud Cover

Wind-generated waves and boat wakes stir up sediments in shallow water areas. Unprotected shorelines can erode and contribute suspended particles to the water. These shoreline and shallow water impacts contribute to turbidity and can block out sunlight and affect photosynthesis.

A 1998 study conducted by Larson and Buktenica found that when the lake surface was calm and skies were clear or had high haze, differences between descending and ascending Secchi observations decreased slightly with increased disc depth. Waves from tour boats, drops of water from the research vessel, and wind generated ripples and chop decreased disc readings as much as 5 meters relative to readings recorded when the lake surface was calm. Furthermore, documenting the variation caused by slightly disturbed lake surface conditions relative to calm surface conditions and among trained observers ensures consistent interpretation of the long-term data (Larson and Buktenica 1998).

The distance of the observer from the water surface, weather conditions, waves, the height of the sun on the horizon, and glare at the water's surface all affect your Secchi disc reading. CLMN monitoring protocols are set up to make sure that lake data is comparable and to eliminate as many extenuating circumstances as possible.

Motor Boat Activity

Propellers of boats may disturb the lake or river bottom directly or indirectly through the wash or turbulence they produce, especially in shallow water. This may affect water clarity by increasing the amount of sediment particles in the water or may cause nutrients that are stored in the sediments, such as phosphorus, to become available for algal growth. Waves created by watercraft may contribute to shoreline erosion, which can cloud the water. Boats have been

HELP STOP THE SPREAD OF INVASIVE SPECIES

Wisconsin law requires that you:

Inspect your boat, trailer and equipment.

Remove any attached aquatic plants or animals (before launching, after loading and before transporting on a public highway).

Drain all water from boats, motors and all equipment

Don't move live fish away from a waterbody.

Buy minnows from a Wisconsin bait dealer and USE leftover minnows only under certain conditions* (See fishingwisconsin.org for more information).

In addition, you can:

Rinse boat and equipment with hot or high pressure water and dry for at least five days.

Learn to easily recognize Eurasian water-milfoil. Monitor boat landings, marinas, and inlets on a regular basis for the first sign of an invasion. Report new sightings to your nearest Wisconsin DNR office.

Work with your local lake association to develop an aquatic plant management program for your lake including contingency plans in case Eurasian water-milfoil is found in the lake.

Dispose of unwanted live bait in the trash.

shown to affect water clarity and can be a source of nutrients and algal growth in aquatic ecosystems. Shallow lakes, shallow parts of lakes and rivers, and channels connecting lakes are the most susceptible to impacts. Depth of impact varies depending upon many factors including boat size, engine size, speed, and substrate type. Few impacts have been noted at depths greater than 10 feet (Asplund 2000).

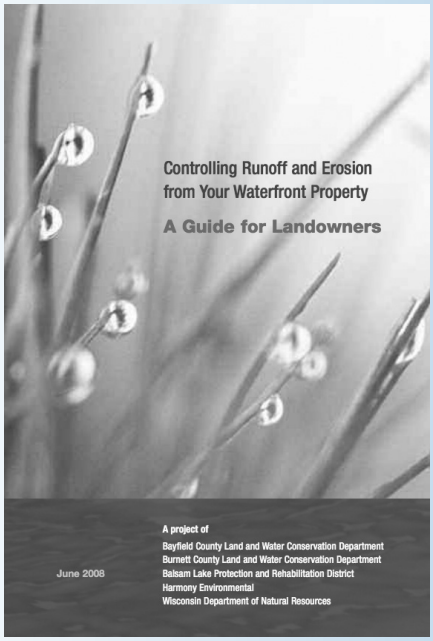
A variety of How-To videos are available on the CLMN website:

www.uwsp.edu/uwexlakes

and click on the CLMN logo

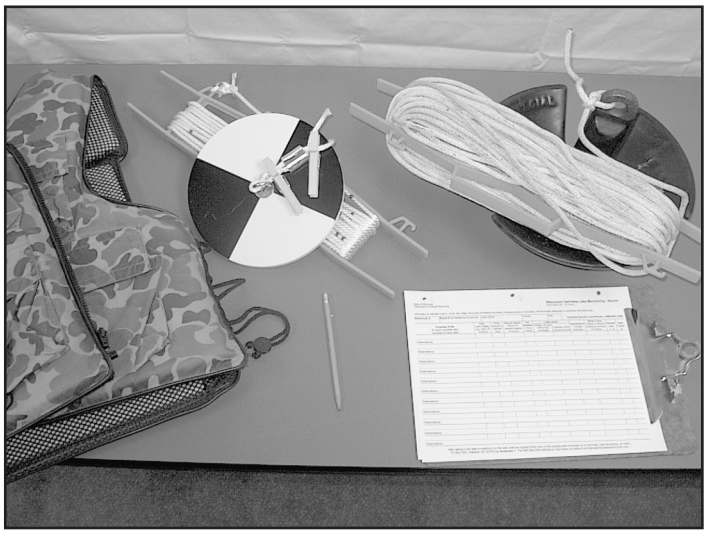
Want to know what water clarity monitoring entails? Haven't used your Secchi disc in a while and want to refresh your memory? Check out this great how-to video!

The Secchi disc visibility world record of 262 feet was set in the eastern Weddell Sea, Antarctica in 1986. Even the clearest of lakes in Wisconsin have a maximum water clarity of 25-55 feet. These include the aptly named Crystal Lake in Sheboygan County with a water clarity of 32.5 feet in March 2012, Maiden Lake in Oconto County with a water clarity reading of 47.5 feet in May 2009 and Black Oak Lake in Vilas County with a water clarity of 53.5 feet in June 2012. These lakes stand in stark contrast to some of the more turbid lakes we find in Wisconsin. Lake Wissota in Chippewa County had a Secchi reading of 0.25 feet in June 2012 and Lake Winnebago with a clarity reading of 0 to 0.25 feet in July 2012.



1. SECCHI (Water Clarity)

Before you start sampling, be sure to read the following pages to familiarize yourself with the equipment and the procedures that you will be using. All of the procedures that you will follow in sampling your lake are done for specific reasons. It is very important that you follow the sampling procedures exactly as they are laid out in the following pages to ensure good, consistent, high-quality data. The following pages will provide you with sufficient background on the design of the equipment and proper procedures to use.



DNR PHOTO

After sampling, it is very important to rinse all of your equipment and allow it to air dry.

What Equipment Will You Need?

At your training session, your CLMN regional coordinator will outline and provide all of the equipment that you will need to successfully monitor your lake.

- Secchi disc (with rope and holder)
- Two clothespins
- Lake map with sampling site marked
- Life jackets (you provide)
- Anchor and rope (you provide)
- Boat (you provide)
- Field data sheets
- Pencil

SHOULD I COLLECT SECCHI DATA IN THE WINTER?

Secchi measurements taken through the ice are highly variable depending on the amount of snow on the ice and ice clarity (i.e. did it freeze fast or was there slush on the lake that froze and created "cloudy" ice). These are the main factors that determine the amount of light that can get through the ice which allows you to take accurate measurements. Since algae production is at a minimum under the ice, these data have no real value for Network use.

Waterbody # or WBIC (Waterbody Identification Code) • A unique identification number the Wisconsin DNR uses to identify each waterbody in the state. Every one of the 15,000 lakes in Wisconsin has a unique WBIC.

Station # • A number assigned to sampling locations on a waterbody. The station identification number makes it easy to track secchi and chemistry data. Each sampling site on a lake will have a separate station identification number.

How Do You Prepare to Sample?

The Day You Sample

On the day you plan to sample, complete the top portion of your field data sheet by filling in the waterbody # (or WBIC) and Station # sections. Enter the name of each volunteer who will be sampling. If you do not know these numbers, contact your CLMN regional coordinator. Before you launch your boat, make sure you have your Secchi disc, an anchor, and personal flotation devices (life jackets) in your boat before proceeding to your sampling site.

Sampling Overview

When to Take Your Secchi Readings

The weather can affect the depth at which you can no longer see the Secchi disc. Wind-generated waves, sun position, and cloud cover are major weather factors that can affect the accuracy of your readings.

- Secchi readings should be taken every 10 to 14 days.
- Secchi readings should be taken on clear, calm days between 10 am and 4 pm.
- Anchor the boat.
- Secchi disc readings are taken on the shady side of the boat.
- Kneel or sit so you are close to the surface of the water.
- Remove your sunglasses – sunglasses can increase the depth that you can see your Secchi disc. For consistency and so we can compare data from one lake to another, please remove your sunglasses.
- Use clothespin method to determine accurate reading.
- For color and clear/murky determination, hold Secchi disc one foot below the surface of the water and look at the white portions of the disc.

To make sampling regular and convenient, try to make it a part of your weekly routine. You can include it as part of your weekend fishing trip or family outing on the lake. The most important time to collect your Secchi data is in July and August. These are the prime months for lake recreation and the time when algae is the most prevalent. Statewide water clarity analysis relies on information from these months and will appear in your statewide summary. Averages of Secchi data recorded during July and August will appear in your statewide summary report. Due to seasonal variation, the entire year's Secchi disc data cannot be averaged.

The Secchi readings you take in the spring and fall will tell a story about your lake. These readings can tell you when spring runoff occurs in your lake or when there are algal blooms. For this reason, many Secchi volunteers may start collecting data in April and continue through November.

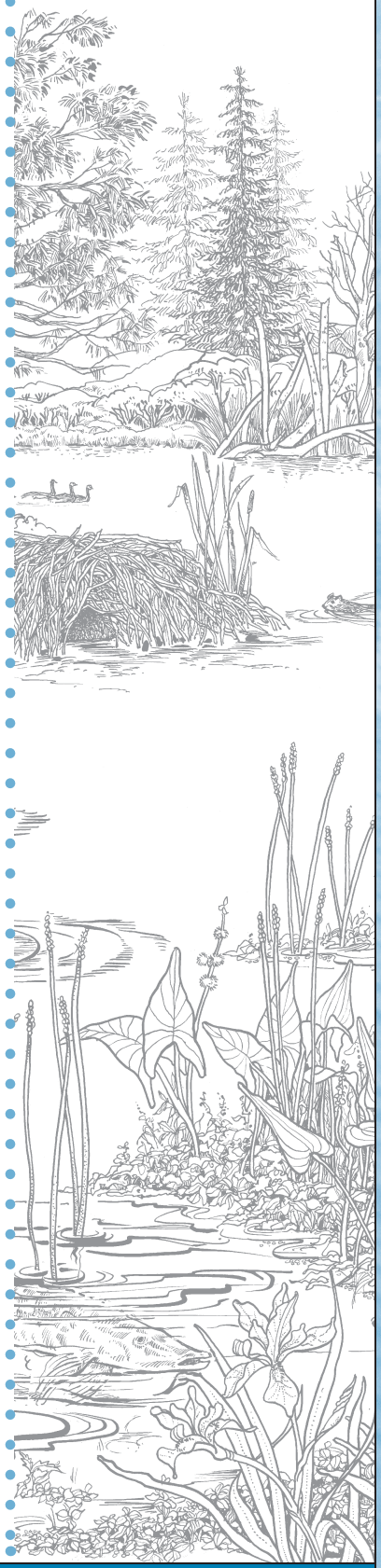
If you are unable to sample during your normally scheduled sampling time, do not worry about it! Just try to sample as soon as possible after that time. However, if you think that you will not be able to continue monitoring your lake due to illness, schedule conflicts, or other problems, please contact your CLMN regional coordinator as soon as you can.

Remote Sensing Project

Today, remote sensing data from the NASA/USGS Landsat Program are used by the Wisconsin DNR to provide satellite-retrieved Secchi depth data for thousands of lakes annually with the support of CLMN volunteers. Different weather conditions and atmospheric effects on satellite images and challenges in the atmospheric correction of satellite images mean on-the-ground Secchi depth data is still needed to calibrate this model for each satellite image. Your CLMN volunteer coordinator will send you a list of Landsat satellite flyover dates for your lake. If you collect a water clarity reading on a clear satellite flyover date, estimates of water clarity can be generated for hundreds of other nearby lakes based on satellite images. Find out more about remote sensing at https://dnr.wisconsin.gov/topic/lakes/clmn/remotesensing

WHAT IS THE SATELLITE-RETRIEVED WATER CLARITY DATA USED FOR?

Satellite-retrieved water clarity data are used by the Wisconsin DNR to assess trophic state for lakes across the state. The results are shared with lake organizations and the public, and are published in the DNR's biennial water quality report to the U.S. Environmental Protection Agency. Summer water clarity maps are shared through the Wisconsin Lakes & Aquatic Invasive Species Mapping Tool and GIS data portal. We hope to expand satellite monitoring to include total suspended solids (TSS) and chlorophyll-a estimates.



CAROL WATKINS, UW-EXTENSION, ENVIRONMENTAL RESOURCES CENTER

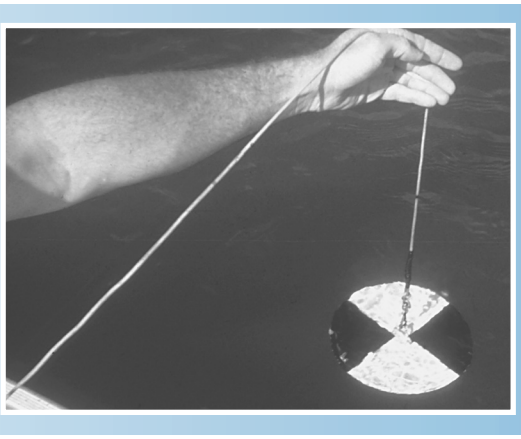
ON LAKE PROCEDURES

STEP 1. Before going out to take your Secchi disc readings, be sure the conditions are right for sampling. Ideal weather conditions include sunny or partly sunny skies; calm winds (there should be no whitecaps on the lake). Collect Secchi measurements between 10 am and 4 pm. If possible, try to collect Secchi readings on dates when the satellite is overhead.

STEP 2. Your CLMN regional coordinator will provide you with a lake map with the sampling site marked. Be sure you have a station ID number for each site you are monitoring.

STEP 3. Anchor your boat at your sampling site to prevent drifting. Be careful not to disturb the sediments on the lake bottom when anchoring since this could cloud the water. Remove your sunglasses. Wearing sunglasses will give you an unfair advantage over others taking readings on your lake without sunglasses, and we want the data to be comparable. Unwind the Secchi disc rope from the holder.

STEP 4. Lean over the shady side of the boat and slowly lower the Secchi disc into the water until you can no longer see it. If you are sampling in a pontoon boat, be sure to kneel down on the floor of the boat when you take your readings so you are closer to the surface of the water. Be as close to the surface of the water as you can safely be. Secchi disc readings are taken on the shady side of the boat to reduce glare.



STEP 5. When the Secchi disc barely disappears from your view, mark the rope at the surface of the water with a clothespin.

- Secchi values vary by about 6% due to change in sun's angle in midsummer.
- 5" waves can decrease Secchi reading by 10%.

DNR PHOTOS

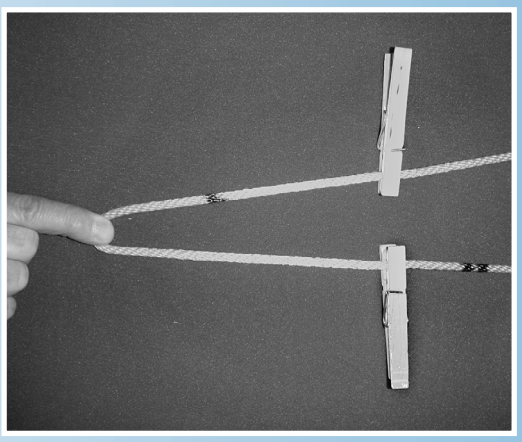
ON LAKE PROCEDURES

STEP 6. After you have marked this spot with the clothespin, lower the disc a few more feet into the water. Slowly raise the disc. When the Secchi disc reappears, mark the rope at the surface of the water with the second clothespin. The clothespin marks may be at the same spot, or several inches or even several feet apart. The average of the two readings will be a more accurate result.

DNR PHOTO

STEP 7. Bring the Secchi disc back into the boat.

STEP 8. Average your two Secchi disc readings by forming a loop between the two clothespins. Slide one clothespin into the center of the loop to mark it. Remove the other clothespin. The remaining clothespin mark will be your Secchi reading.



JIM KLOSIEWSKI

STEP 9. Your rope is marked in 1-foot increments. The red lines indicate five, fifteen, and twenty-five feet. The double black lines indicate ten, twenty, and thirty feet. Some lines are marked with black lines indicating 1-foot increments, and black blocks indicating 5-foot increments. Carefully measure the number of feet from the disc until you reach your clothespin mark. Round to the nearest quarter foot.

STEP 10. Record this measurement on your data sheet and then fill out the rest of your data sheet.

(continued on next page)

ON LAKE PROCEDURES

STEP 11. Record your perception of water color and water appearance. Hold the Secchi disc one foot under the surface of the water to determine color and appearance. Record your perception score. This is your perception of the amount of algae that is in the water at the deep hole.

Perception Score

1 - Beautiful, could not be any nicer.

2 - Very minor aesthetic problems, excellent for swimming and boating.

3 - Swimming and aesthetic enjoyment of lake slightly impaired.

4 - Desire to swim and level of enjoyment of lake substantially reduced because of algae (would not swim, but boating is okay).

5 - Swimming and aesthetic enjoyment of the lake substantially reduced because of algae level.

STEP 12. If you are taking Secchi readings at more than one site or lake, proceed to your next location and repeat steps 1 through 10 above (step 11, perception, is recorded at the deep hole only.)

STEP 13. Report your data. Data can be submitted electronically into the SWIMS database. Instructions for entering data are in Appendix 2 of this manual and how-to videos for entering data are available on the CLMN website. If you enter data online, you do not need to submit data sheets by mail.

For those without Internet access – data sheets can be mailed to your CLMN regional coordinator to be entered into the database.

Taking Care of Data

Once you are back on shore, transfer any remaining data and notes to the data form. This form will make it easier for you to enter your data online. After entering your data into the DNR database, fill in the column labeled "*Date Entered*" on your data form. This will allow you to keep track of what data you have already entered.

Online

The web address to enter your data online is **apps.dnr.wi.gov/swims**. You will need a user name and password to enter data. Instructions for obtaining a user name and password are found at the CLMN website. If you enter your data online, there is no need to mail in a paper copy.

All data for the year should be entered online by November 1st to guarantee that it will be included in reports and analyses done in the winter and spring. If you find unentered data after this date, you can still enter your data online or you can mail your data sheets to your CLMN Coordinator. Your coordinator will make sure your data gets included.

CLMN lake summary reports are found in the Wisconsin Water Explorer (WEx). You can access your summary report at the DNR CLMN web site at **https://dnr.wisconsin.gov/topic/lakes/clmn.** Always check your report with a copy of your original data sheet to verify your data.

The Wisconsin Water Explorer (WEx)

In addition to viewing your lake data report, you can also use this tool to explore watershed characteristics like land use, geology, and soils. You may also view conditions and trends in lake water quality and run nutrient loading models for lakes and streams. WEx can be accessed by going to the Wisconsin DNR Lakes Pages at https://dnr.wisconsin.gov/topic/Lakes, clicking on the Lake Water Quality button, choosing your county, and then finding your lake on the list. Find the "Deep Hole" location and click "Details" on the right side. Then click the "Open the Water Explorer (WEx)" button. We have a quick 5-minute video on how to use the Water Explorer to download or print a data report. Find that video by going to our Extension Lakes channel on YouTube and searching for Water Explorer Tool Demonstration, or scan the QR code below with your phone.

The Shoreland Habitat Disturbance Viewer

Use this tool to view the condition of habitat along lake shorelines. You may view the overall condition of lakeshore habitat at the scale of the entire lake or individual parcels. The tool also recommends actions for protecting and restoring habitat based on the lake's or parcel's condition. You may access the tool by clicking the "Lake Shoreland Habitat" icon on the DNR Lakes Pages.

Lake Level Monitoring in Wisconsin

Use this tool to observe lake level data through time on select Wisconsin lakes. To access this tool, go to this webpage or click the Lake Levels icon on the DNR Lakes Pages.

The left QR code will take you to the DNR Lakes Pages, where you can access the tools described above. The right QR code will go directly to the Water Explorer Demonstration Video.

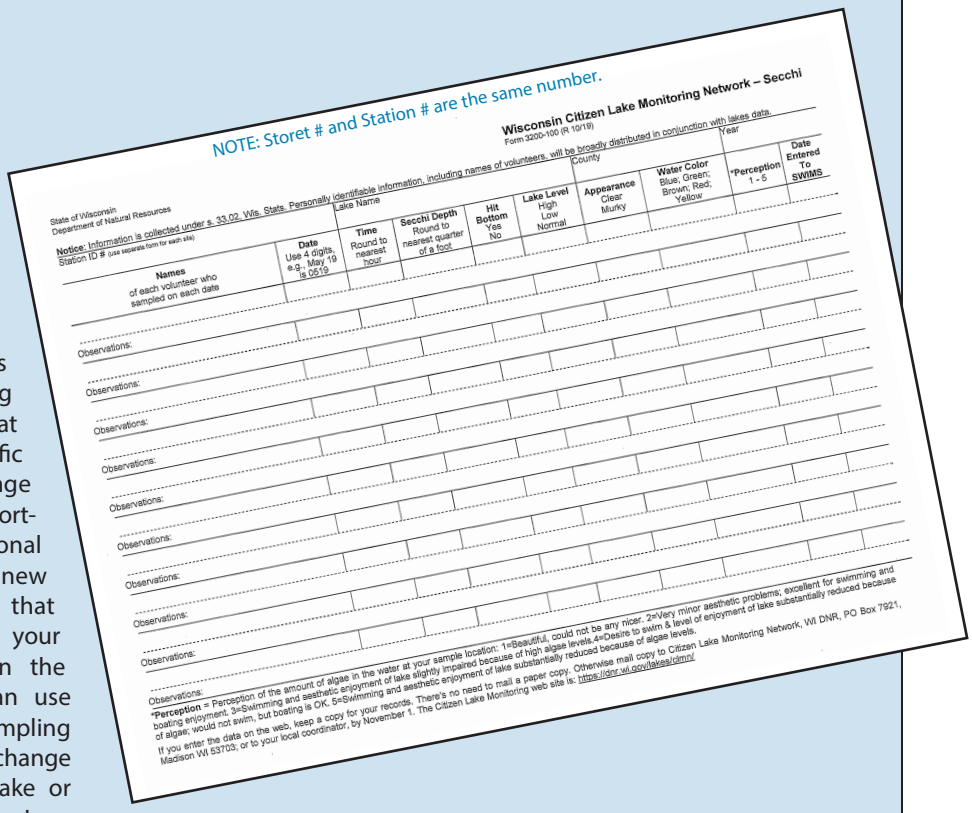
DNR PHOTO

HOW TO FILL OUT YOUR FIELD DATA SHEET

During your training session, you should have received:

- A waterbody identification code (WBIC)
- Station #

The WBIC is a number assigned to your lake and allows the Citizen Lake Monitoring Network to know exactly which lake you are monitoring. The Station # is assigned to the specific monitoring site on your lake and the data that you collect is tied to that specific number. If you decide to change your sampling site, it is very important that you contact your regional coordinator right away so a new Station # can be assigned for that site. While you are sampling on your lake, record all of your data on the white "Field Data Form". You can use this same form for repeated sampling days until it is filled up. If you change sampling site locations within a lake or change lakes, you must use a new form!


NOTE: Storet # and Station # are the same number.

Wisconsin Citizen Lake Monitoring Network – Secchi

Form 3200-100 (R 10/19)

State of Wisconsin
Department of Natural Resources

Notice: Information is collected under s. 33.02, Wis. Stats. Personally identifiable information, including names of volunteers, will be broadly distributed in conjunction with lakes data.

Station ID # (use separate form for each site) | Lake Name | County | Year

Names of each volunteer who sampled on each date	Date Use 4 digits, e.g., May 19 is 0519	Time Round to nearest hour	Secchi Depth Round to nearest quarter of a foot	Hit Bottom Yes No	Lake Level High Low Normal	Appearance Clear Murky	Water Color Blue; Green; Brown; Red; Yellow	*Perception 1 - 5	Date Entered To SWIMS

Observations:

*Perception = Perception of the amount of algae in the water at your sample location: 1=Beautiful, could not be any nicer. 2=Very minor aesthetic problems; excellent for swimming and boating enjoyment. 3=Swimming and aesthetic enjoyment of lake slightly impaired because of high algae levels. 4=Desire to swim & level of enjoyment of lake substantially reduced because of algae; would not swim, but boating is OK. 5=Swimming and aesthetic enjoyment of lake substantially reduced because of high algae levels.

If you enter the data on the web, keep a copy for your records. There's no need to mail a paper copy. Otherwise mail copy to Citizen Lake Monitoring Network, WI DNR, PO Box 7921, Madison WI 53703; or to your local coordinator, by November 1. The Citizen Lake Monitoring web site is: https://dnr.wi.gov/lakes/clmn/

The following descriptions represent the portions of your data sheet that can be filled out while you are on the shoreline or before you get into your boat. Data sheets can be found online at the CLMN web site.

Date

When recording the date it is only necessary to use 4 digits. For example, if you sampled on May 19th, you would record this on your data form as "0519"; July 6th would be "0706", etc. You do not need to include the year since your data is submitted annually.

Time

Record the time you started your sampling. You can use a 12hr clock (AM/PM) or 24hr clock format.

Lake Level

Record the water level on your lake. It helps to use the shoreline or your pier as a guide to indicate whether your lake level is high, low, or normal. If you are able to determine the water level using a staff gauge on the lake, indicate this on the data sheet and record the numerical value in the space provided.

The following descriptions should be filled out while you are on the water at your sampling site so the observations are fresh in your mind.

Secchi Depth

When recording your Secchi disc reading, round off to the nearest quarter foot. Record fractions of a foot as a decimal since this is how it will be entered online. For example, 12 ¼ feet is 12.25 feet. It is possible that the Secchi disc will be visible even when it is resting on the bottom of the lake. If this is the case, record the depth as you always would, but make sure you record a "Yes" in the "Hit Bottom" field of your data sheet.

Appearance

To determine if the water appearance is clear or murky, hold your Secchi disc one foot under the surface of the water and observe how the white part of the disc appears.

Water Color

The water color is determined at your site using the Secchi disc as a guide. After lowering the disc about a foot into the water, ask yourself the question, "Does the white part of the Secchi disc look white, or does it appear green or brown?" If it appears white, then the water color is "blue." If it appears green, then the water color is "green" and so on. The online data entry form will only accept one color. If the water appears "bluish-green," you will have to select the one color (blue or green) that best describes your water color.

Perceptions

Indicate your perception of the water quality for your lake at the deep hole. Refer only to the condition of the water itself. You can record information on aquatic plants around the shoreline or other problems you perceive in the observation section of the data sheet. On a scale of 1 to 5 (1 being the best and 5 being the worst), your perception of the water should reflect how much algae is in the water.

1 - Beautiful, could not be any nicer

2 - Very minor aesthetic problems; excellent for swimming and boating enjoyment

3 - Swimming and aesthetic enjoyment of lake slightly impaired because of high algae levels

4 - Desire to swim and level of enjoyment of lake substantially reduced because of algae (would not swim, but boating is OK)

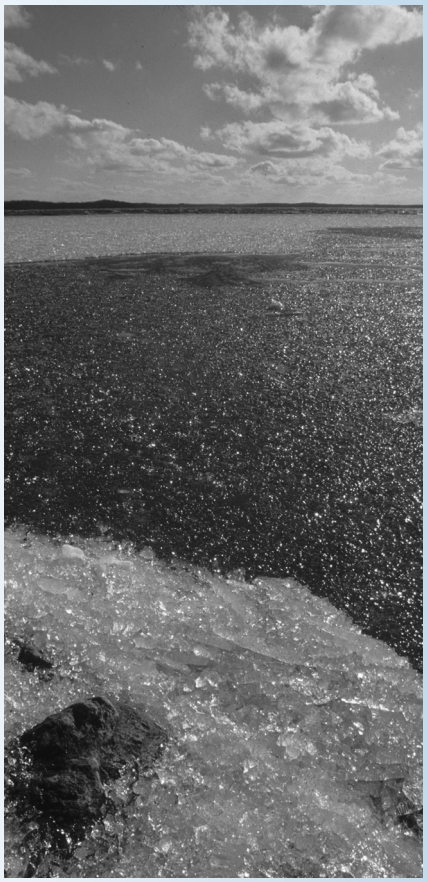
5 - Swimming and aesthetic enjoyment of lake substantially reduced because of algae levels

Observations

In the observation section of the data sheet, you can include any comments about the weather, water conditions, wildlife sightings, plant densities, or other information you want to include that you think will help to better understand your lake, or may explain your data from that day. For example, recent heavy rains or boat activity may help explain why your Secchi depth was less than normal. If you need more data sheets, have questions or problems, you may also include those comments in this section. Feel free to attach additional observations on a separate sheet of paper. You can enter as much information as you'd like. The database is capable of holding a very long entry.

HOW TO REPORT ICE ON/OFF INFORMATION

You can report your ice observations online through SWIMS. After you log in, choose the Ice Observations project for your lake.



ROBERT QUEEN

TABLE 1. The Trophic State Index (TSI) continuum.

TSI less than 30
Classic oligotrophic lake characterized by clear water, oxygen throughout the year in bottom water. These lakes may contain some fish species that require cold, oxygen-rich waters, such as trout or ciscoes. Excellent water quality.

TSI 30-40
Deeper lakes will still be oligotrophic, but the bottom waters of some shallower lakes may become oxygen-depleted during the summer.

TSI 40-50
Classic mesotrophic lake. characterized by moderately clear water, but increasing chance of low dissolved oxygen in deep water during the summer.

TSI 50-60
Lake becoming eutrophic characterized by decreased clarity, and oxygen-depleted bottom waters during the summer. Plant overgrowth evident, supporting only warm-water fisheries.

TSI 60-70
Becoming very eutrophic. Blue-green algae may become dominant with possible algal scums. Extensive plant growth is likely.

TSI 70-80
Lake becoming hypereutrophic, characterized by heavy algal blooms throughout summer, with dense plant beds limited to shallow waters by light penetration.

TSI > 80
Hypereutrophic lake with very poor water quality, algal scums, summer fish kills, and few plants.

OLIGOTROPHIC • Lakes characterized by low nutrient inputs and low productivity. They are generally deep with high water clarity.

MESOTROPHIC • Lakes characterized by moderately fertile nutrient levels. Falls between the oligotrophic and eutrophic levels of nutrient enrichment.

EUTROPHIC • Lakes characterized by high nutrient inputs, high productivity, often experiencing algal blooms and abundant plant growth.

Understanding Your Data

One of the ways we estimate the condition of a lake is with a Trophic State Index (TSI) score. Very low TSI scores indicate very clear, nutrient-poor lakes (oligotrophic), and very high TSI scores indicate lakes with high nutrient levels and poor water clarity (eutrophic). Mesotrophic lakes have moderate clarity and nutrient levels, and fall in the middle with a TSI score of approximately 40-50. After a few years of collecting Secchi data, you will be able to answer two important questions about your lake:

1. *What is the trophic state of my lake based on water clarity data alone - is my lake generally more **eutrophic**, **mesotrophic**, or more **oligotrophic**?*
2. *Is the water quality of my lake improving, declining, or remaining the same over time?*

A natural aging process occurs in all lakes, causing them to change from oligotrophic to eutrophic over time. Human activity can accelerate this aging process. "Cultural eutrophication" is a term coined by ecologists to define human activity impacts on a lake's trophic state.

Although trophic states are labeled for the purposes of discussion, keep in mind that in nature, the categories make smooth transitions into each other. Data from one date may show your lake as being eutrophic, and the next date as being mesotrophic.

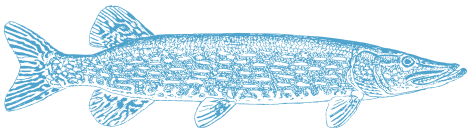
If your lake has many rooted aquatic plants and relatively clear water, the TSI could be a mischaracterization of the true nutrient status of your lake. Lakes dominated by aquatic plants tend to have high amounts of phosphorus in the bottom sediments and relatively low amounts of phosphorus in the water column. On the other hand, lakes that grow mostly algae have high amounts of phosphorus in the water column. The TSI only measures the portion of nutrients that are found in the water column, as evidenced by the amount of algae. So if most of the nutrients are held in the sediments and the lake is loaded with aquatic plants, the true total nutrient status would not be accurately measured using the TSI.

A study of over 1,000 waterfront properties in Minnesota found that when all other factors were equal, properties on lakes with clearer water commanded significantly higher property prices (Krysel, 2003).

What you and your neighbors do to maintain or improve water quality will improve resale potential.

Here are some things that you can do to improve water quality:

- Agricultural producers should apply best management practices to reduce the amount of nutrient runoff to lakes. Your local Land & Water Conservation Department can offer assistance.
- A healthy, diverse aquatic plant community stabilizes shorelines, reduces erosion, and provides habitat for fish and wildlife.
- Protect or restore your shoreland buffer.
- Plant native trees and shrubs or protect your wooded areas.
- Capture and cleanse pollutant- and sediment-carrying runoff before it reaches the waterway – with shoreland buffers, rain barrels or rain gardens.
- Try to maintain as much woody habitat as possible. Fish use submerged trees to spawn on and they provide cover to young and old alike.
- Declines in submerged tree habitats have been linked to reduced abundance of young smallmouth bass and yellow perch.
- Inspect and maintain your septic system and well regularly.
- Reduce the hard surfaces and driveways on your property. Pervious pavers are an option for areas that do not have heavy traffic. To reduce runoff, diversion practices such as rock infiltration can be installed.
- Monitor your lake for aquatic invasive species.
- Assess your property and participate in Healthy Lakes and Rivers. The goal is to protect and improve the health of our lakes and rivers by increasing shoreland property owner participation in habitat restoration, runoff reduction, and erosion control projects. Check out the Healthy Lakes and Rivers web site at https://healthylakeswi.com.
- If your lake does not have a lake association or lake district, consider forming one. Dealing with a broad range of issues (aquatic invasive species, water quality, etc.) can be overwhelming for one person. Working as an organized group that shares a common goal can make even the most difficult problems easier to tackle.
- Plan a lake fair or event. A lake fair is an educational and social event that blends a sense of discovery and entertainment. These events provide an opportunity for participants to get hands-on experience, talk with lake experts in an informal setting, meet lake neighbors and build relationships.
- Become a Lake Leader. The Lake Leaders Institute is designed to stretch the mind by exploring new ideas about lake management and the human use of lakes. Graduates of this program develop a network to share experiences and learn from each other.
- The Wisconsin Lakes and Rivers Convention is an annual event that gives educators, lake lovers, and professionals a chance to get together and discuss lake issues.



Glossary

Algae. Tiny, unrooted aquatic plants containing chlorophyll that occur as a single cells or multi-celled colonies. Algae form the base of the food chain in an aquatic environment.

Algal bloom. A heavy growth of algae in and on a body of water as a result of high nutrient concentrations.

Aquatic Invasive Species (AIS). Refers to species of plant or animal that are not native to a particular region into which they have moved or invaded. Zebra mussels and Eurasian water-milfoil are examples of AIS.

Bathymetric map. A map showing depth contours in a water body. Bottom contours are usually presented as lines of equal depth, in meters or feet. Often called a hydrographic map.

Chlorophyll. Green pigment present in all plant life and necessary for photosynthesis. The amount of chlorophyll present in lake water depends on the amount of algae and is used as a common indicator of water quality.

Cultural eutrophication. Accelerated eutrophication of a lake that occurs as a result of human activities in the watershed. These activities increase nutrient loads in runoff water that drains into lakes.

Decomposition. The act of breaking down organic matter from a complex form to a simpler form, mainly through the action of fungi and bacteria.

Deionized water. Water that has been purified to remove ions present.

Distilled water. Water that is boiled in a still and the condensate collected and distributed. Distillation removes both ionic and nonionic organic contaminants.

Dissolved oxygen. A measure of the amount of oxygen gas dissolved in water and available for use by microorganisms and fish. Dissolved oxygen is produced by aquatic plants and algae as part of photosynthesis.

Drainage lake. Lakes fed primarily by streams and with outlets into streams or rivers. They are more subject to surface runoff problems but generally have shorter residence times than seepage lakes. Watershed protection is usually needed to manage lake water quality.

Epilimnion. The uppermost circulating layer of warm water that occurs in stratified lakes in summer because of the differences in water density.

Euphotic zone. That part of a water body where light penetration is sufficient to maintain photosynthesis.

Eutrophic. Lakes characterized by high nutrient inputs and high productivity, and may experience algal blooms and abundant weed growth. This term can also refer to a nutrient-rich lake, as large amounts of algae and weeds characterize a eutrophic lake.

Eutrophication. The process by which lakes and streams are enriched by nutrients causing an increase in plant and algae growth.

Georegion. Wisconsin's lake "georegions" originated from a grouping of lakes made in the early 1980s by Wisconsin DNR senior limnologists. These groupings are based on the best professional judgment of the scientists most familiar with Wisconsin's lake resources. The georegions roughly reflect "hydro-chemical lake regions" which are based on the state's bedrock geology, glacial geology and soil type, and the more recently described "ecoregions" which are based on geological characteristics as well as the dominant vegetation.

Hypolimnion. The cold, deepest layer of a lake that is removed from surface influences during stratification.

Lake association. A voluntary organization with a membership generally comprised of those who own land on or near a lake. The goals of lake associations usually include maintaining, protecting, and improving the quality of a lake, its fisheries, and its watershed.

Lake classification. A way of placing lakes into categories with management strategies best suited to the types of lakes found in each category. For example, lakes can be classified to apply varying shoreland development standards. They can be grouped based on hydrology, average depth, surface area, shoreline configuration, as well as sensitivity to pollutants and recreational use.

Lake district. A special-purpose unit of government with the cause of maintaining, protecting, and improving the quality of a lake and its watershed for the mutual good of the members and the lake environment.

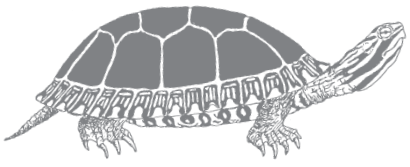
Limnology. The study of inland lakes and waters. The study of the interactions of the biological, chemical, and physical parameters of lakes and rivers.

Macrophyte. Large, rooted or floating aquatic plants that may bear flowers and seeds.

Meniscus. The curved upper surface of a still liquid in a tube caused by surface tension.

Mesotrophic. Lakes characterized by their moderately fertile nutrient levels. Falls in between the oligotrophic and eutrophic levels of nutrient enrichment.

Metalimnion. Sometimes referred to as the thermocline. The narrow transition zone between the epilimnion and the hypolimnion that occurs in stratified lakes.



Nitrogen. One of the major nutrients required for the growth of aquatic plants and algae.

Oligotrophic. Lakes characterized by low nutrient inputs and low productivity. They are generally deep with high water clarity.

Parts per million (ppm). An expression of concentration of a substance within a solution or mixture. Milligrams per liter (mg/l) is an equivalent unit.

pH. The measure of the acidity or alkalinity of a solution. Neutral solutions are defined as having a pH of 7.0. Solutions which are known as acidic have a pH lower than 7. Solutions which are known as basic have a pH greater than 7.

Phosphorus. The major nutrient influencing plant and algal growth in more than 80% of Wisconsin lakes. Soluble reactive phosphorus refers to the amount of phosphorus in solution that is available to plants and algae. Total phosphorus refers to the amount of phosphorus in solution (reactive) and in particulate forms (non-reactive.)

Photic zone. The surface and underwater lighted zone in a lake that usually has a depth around 1.7 times the Secchi reading.

Photosynthesis. Process by which green plants convert carbon dioxide (CO_2) dissolved in water to sugar and oxygen using sunlight for energy. Photosynthesis is essential in producing a lake's food base and is an important source of oxygen for many lakes.

Phytoplankton. Very small free-floating aquatic plants, such as one-celled algae. Their abundance, as measured by the amount of chlorophyll-a in a water sample, is commonly used to classify the trophic status of a lake.

Qualified Lake Association. A lake association meeting standards set out in section 281.68 of the Wisconsin statutes that is eligible for state lake planning, protection, and recreational boating facilities grants.

(Glossary continued on next page)

Respiration. The reverse reaction of photosynthesis. The complex process that occurs in the cells of plants and animals in which nutrient organic molecules, such as glucose, combine with oxygen to produce carbon dioxide, water, and energy. Respiration consumes oxygen and releases carbon dioxide. This process also takes place during decomposition as bacterial respiration increases.

Runoff. Water from rain, snow melt, or irrigation that flows over the ground surface and into streams or lakes.

Secchi disc. A 20-cm (8-inch) diameter disc painted white and black in alternating quadrants. It is used to measure light transparency in lakes.

Seepage lakes. Lakes without a significant inlet or outlet, fed by rainfall and groundwater.

Spring lakes. Lakes that have no inlet, but have an outlet. The primary source of water for spring lakes is groundwater flowing into the bottom of the lake from inside and outside the immediate surface drainage area. Spring lakes are found at the headwaters of many streams and are a fairly common type of lake in northern Wisconsin.

State Laboratory of Hygiene. The State of Wisconsin's public health and environmental laboratory.

Station #. A number assigned to a sampling location on a waterbody. The Station # makes it easy to track Secchi and chemistry data. Each sampling site on a lake will have a separate Station #.

Stratification. The layering of water due to differences in temperature and density.

SWIMS. Surface Water Integrated Monitoring System. The database where all CLMN data and other water quality data are stored.

Tannins. Natural pigments found in organic matter such as leaves and bark.

Thermocline. Sometimes referred to as the metalimnion. The narrow transition zone between the epilimnion and the hypolimnion that occurs in stratified lakes.

Trophic state. The extent to which the process of eutrophication has occurred is reflected in a lake's trophic classification or state. The three major trophic states are oligotrophic, mesotrophic, and eutrophic.

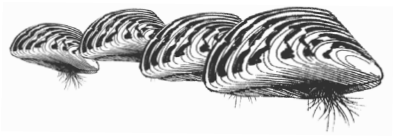
µg/L. micrograms per liter is an expression of concentration indicating weight of a substance in a volume of one liter. Parts per billion (ppb) is an equivalent unit.

Waterbody # or WBIC (Waterbody Identification Code). A unique identification number the Wisconsin DNR uses to identify each waterbody in the state. Every one of the 15,000 lakes in Wisconsin has a unique WBIC.

Watershed. The area of land draining into a specific stream, river, lake, or other body of water.

Zebra mussel. A tiny, bottom-dwelling mollusk native to Europe and invasive in WI.

Zooplankton. Plankton that is made up of microscopic animals, that eat algae or sometimes, other zooplankton. These suspended plankton are an important component of the lake food chain and ecosystem. For many fish and aquatic animals, they are the primary source of food.



Appendix 1 Secchi Collection Summary Sheet

1. Contact your Citizen Lake Monitoring Network coordinator for waterbody # or WBIC (Waterbody Identification Code) and Station #. The Station # identifies the sample site on the lake - usually the deepest part of the lake (the deep hole).
2. Before going out to collect a Secchi reading, be sure that conditions are right and safe for sampling.
   - Sunny to partly sunny skies
   - Wind calm to breezy – there should be no whitecaps on the lake
   - Between 10:00 am and 4:00 pm
3. Gather your reporting form, lake map with the sample site marked, PFD and Secchi disc. Motor to the deep hole or other designated sampling site. Anchor boat.
4. Mark time and date on your data sheet.
5. Remove sunglasses. Secchi reading is taken from the shady side of the boat.
6. Unwind the Secchi disc rope from the holder. Lean over the shady side of the boat and slowly lower the Secchi disc into the water until you can no longer see it. You should be as close to the surface of the water as is safe. If you are sampling from a pontoon boat, kneel down on the floor of the boat.
7. When the Secchi disc barely disappears from view, mark the rope at the water level with a clothespin.
8. Lower the Secchi disc a few more feet into the water. Slowly raise the disc. When the Secchi disc reappears, mark the rope at the water level with the second clothespin. The clothespin may be at the same spot or there may be several inches to several feet difference.
9. Bring the Secchi disc back into the boat. Average the two Secchi readings by forming a loop between the two clothespins. Slide one clothespin into the center of the loop to mark it. Remove the other clothespin. The remaining clothespin will be your Secchi reading.
10. Count the number of feet from the disc until you reach your clothespin. Round off to the nearest quarter foot and record that number on your data sheet.
11. Complete water aesthetics survey on your worksheet. Water level should be recorded using the ordinary high water mark as the norm.
12. To determine if the water appearance is clear or murky, hold your Secchi disc **one foot** under the surface of the water and observe how the white part of the disc appears.
13. To determine water color, hold your Secchi disc **one foot** under the surface of the water and observe the water against the white of the disc. Clear water should be recorded as "blue."
14. Indicate your perception of the water quality **at the deep hole**. On a scale of 1 to 5 (1 being the best and 5 being the worst) record your perception of the amount of algae in the water.
15. Record weather and other observations.

Appendix 2 How to Report Data Online

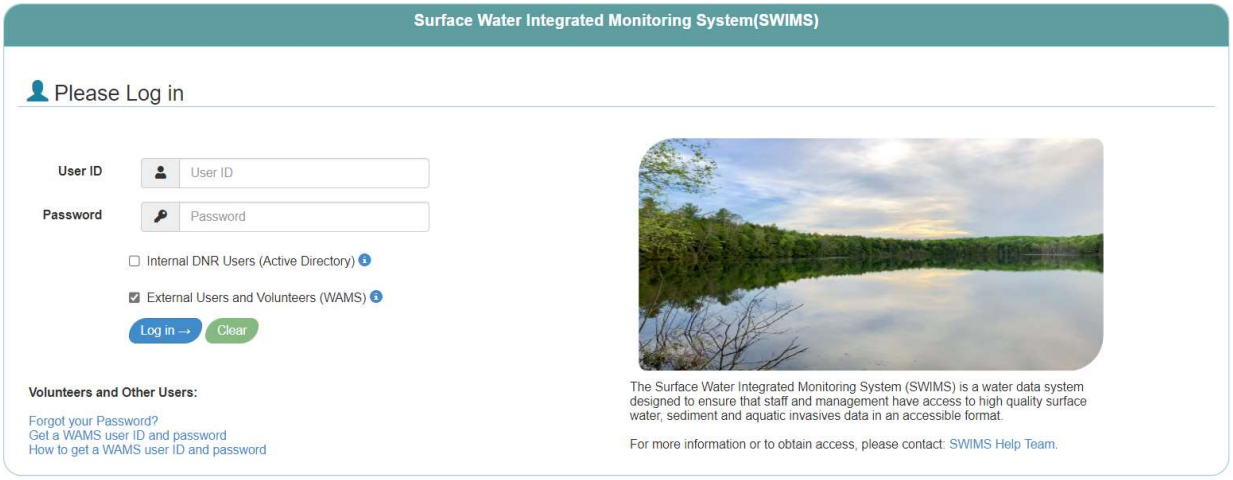
Citizen Lake Monitoring

How to Report Data

We have a 4-minute video available that will walk you through the steps below. Find that video on the CLMN website by clicking on the Data Entry Resources button, or by scanning this QR code.

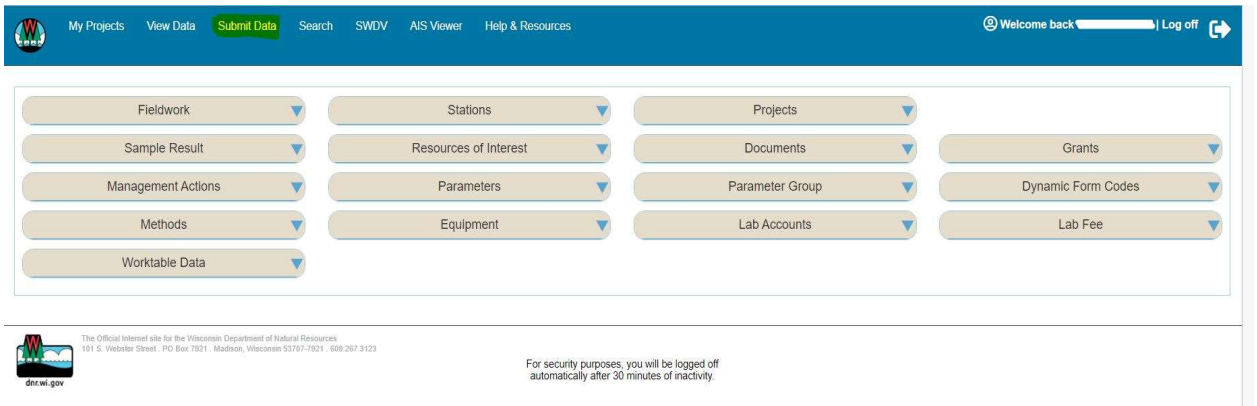
How to Enter Data

1. Log in at https://apps.dnr.wi.gov/swims/Account/LoginSWIMS

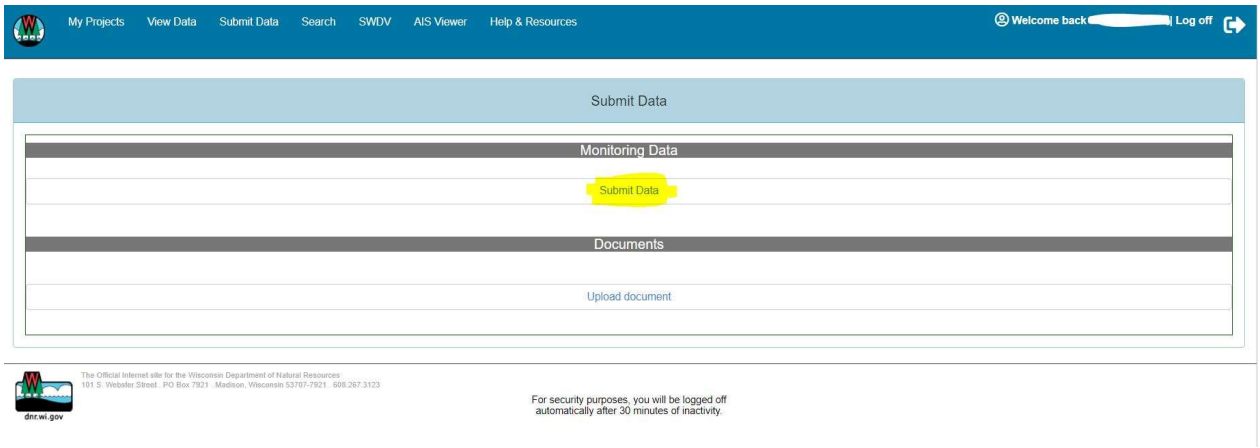


Tip/hint: Click the External Users and Volunteers (WAMS) box, as login page will default to internal DNR users.

2. Click on Submit Data tab along top of page



3. Under Monitoring Data, hit **Submit Data** link

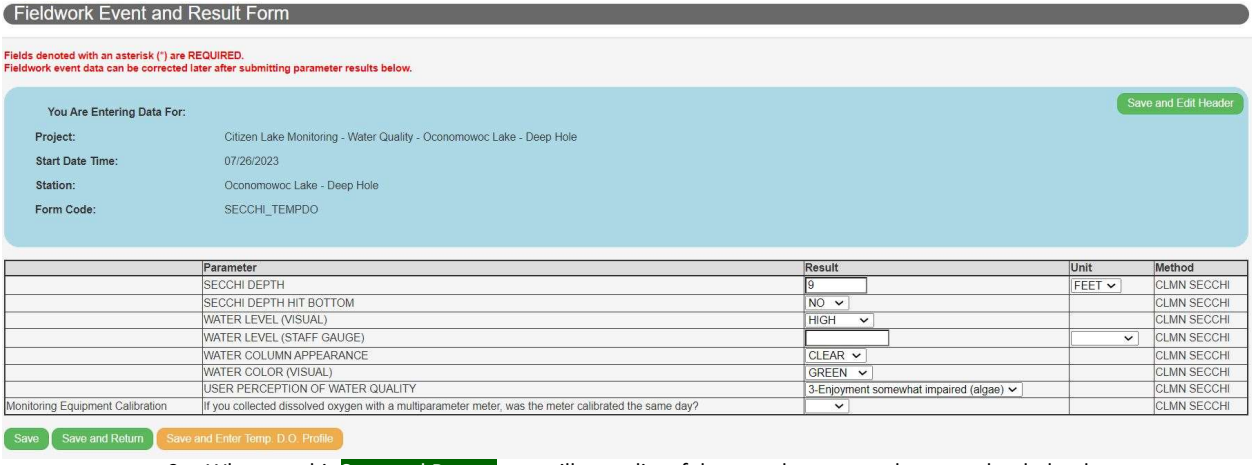


4. Then, select the data collector/s and monitoring station (they should be prefilled with your information).
5. Enter the date and time you monitored.
6. Enter your written observations in the fieldwork comments box
7. Click **Next** button at top

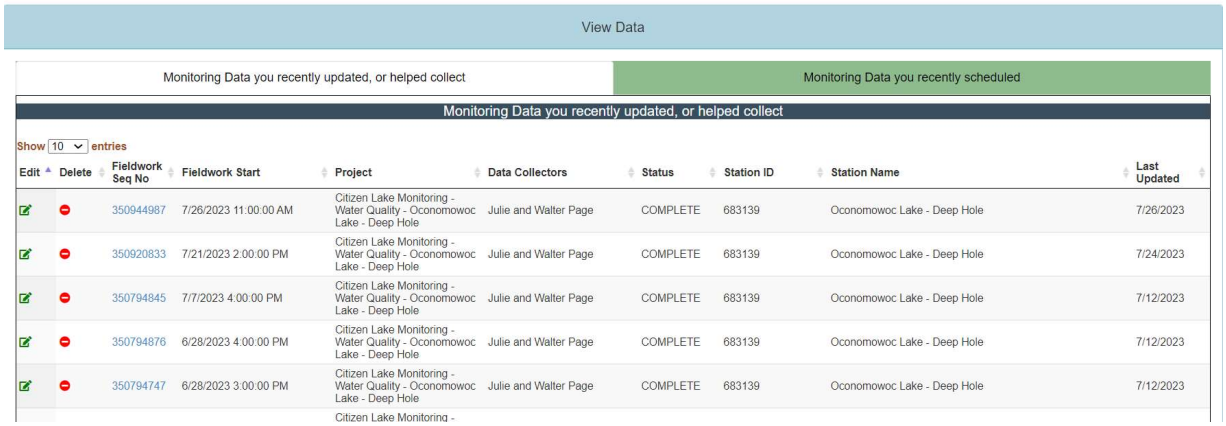
Tip/hint: Use drop down menus and calendars to prevent more errors from occurring.

Also if you monitor multiple sites you may have a drop down menu under the project line. Make sure to check the project if you cannot find your station.

8. Fill in your results. To enter a Temperature and or Dissolved Oxygen profile, click on the **Save and Enter Temp D.O. Profile** button. If you are done, click on the Save and Return button.



9. When you hit Save and Return you will see a list of data you have recently entered or helped collect.



10. Repeat steps above if you have more than one date and/or station to enter data for.

Additional Resources

CLMN Website: www.dnr.wi.gov/lakes/CLMN and www.uwsp.edu/uwexlakes
CBCW Website: www.uwsp.edu/uwexlakes
Extension Lakes Web Site: www.uwsp.edu/uwexlakes

The following resources and many other limnology-related books can be found on the web or at your local or University library. Used textbooks often can be found at college bookstores for a reduced price.

Understanding Lake Data
This booklet will help you understand how lakes work and what your data means for your lake. The CLMN web site can also provide links to other lake information.

Wisconsin Lakes [PUBL-FM-800 91]
This book published by the Wisconsin DNR lists Wisconsin's lakes, their area, depth, if they have public access, and which fish species they support.

Through the Looking Glass... A Field Guide to Aquatic Plants
This book is a field guide to aquatic plants and uses beautiful line drawings to illustrate each species. Available from the UW-Stevens Point Extension Lakes online bookstore.

Aquatic Plants of the Upper Midwest: a photographic field guide to our underwater forests
This book is a full-color, photographic field guide to aquatic plants of our region. Available from the UW-Stevens Point Extension Lakes online bookstore.

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