Quality Assurance Project Plan

For

Citizen Lake Monitoring Network

For

Water Clarity, Water Chemistry, Dissolved Oxygen and Native Aquatic Plant Monitoring

Prepared by:
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Prepared for:
U. S. Environmental Protection Agency, Region V

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Signature/Approval Page

Approved by:

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Wisconsin Citizen Lake Monitoring Network
Quality Assurance Plan

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What is A Quality Assurance Project Plan?

"The Quality Assurance Plan (QAPP) outlines the procedures a monitoring project will use to ensure that the sample participants collect and analyze, the data they store and manage, and the reports they write are of high enough quality to meet project needs." (*The Volunteer Monitor's Guide to Quality Assurance Project Plans*, US EPA 1996). This general QAPP addresses monitoring activities related to water clarity, water chemistry, temperature, dissolved oxygen and monitoring for native aquatic plants. A QAPP for aquatic invasive species will be covered under a separate document.

Distribution List.

Wisconsin Department of Natural Resources (WDNR) Citizen Water Monitoring Sub-team members
University of Wisconsin – Extension (UWEX), Lakes Program – University of Wisconsin – Stevens Point
WDNR Monitoring and Management Section Chief, Greg Searle
WDNR Quality Assurance Coordinator, Barb Zellmer
WDNR Water Evaluation Section Chief, Robert Masnado
WDNR Watershed Management Bureau Director, Russ Rassmussen
WDNR Water Division Administrator, Todd Ambs
WDNR Citizen Lake Monitoring Network program staff
WDNR SWIMS File Manager for Lakes, Jennifer Filbert
US EPA Region V Quality Assurance Manager, Al Alwan

Project Organization

The Wisconsin Citizen Lake Monitoring Network (CLMN) (formerly known as the Self Help Program) is administered by the Wisconsin Department of Natural Resources (WDNR), Wisconsin Association of Lakes, and the University of Wisconsin Extension. The WDNR has partnered with citizen volunteers since 1986. More recently, additional partners including Land Conservation offices, nature centers and schools have been added. The current project is funded through a contract from the WDNR using state funds derived from a portion of the excise tax on gasoline available for water conservation.

Initial leadership and coordination for CLMN is provided by the WI WDNR, through central office (database, budgets, reporting) and regional (training, equipment maintenance and ordering) staff. Funding for the statewide CLMN Educator and additional staff is through the UWEX. Oversight of the CLMN is by the Lakes Partnership.

The capacity for expanding or strengthening CLMN is limited by staff availability and resources, even in a time where demand and interest from citizens has been high and the State has expressed a greater reliance on citizen-based monitoring data.

Key individuals Within Citizen Lake Monitoring Network.

Citizen Volunteers throughout Wisconsin – Sample, perform field analyses, assist with data entry, perform aquatic invasive species monitoring. Perform native aquatic plant monitoring. Trained volunteers sometimes assist with trainings.

Statewide CLMN Educator – responsible for Train the Trainer program. The Educator trains a statewide team of trainers who recruit and instruct water clarity and aquatic invasive species volunteers. Provides program oversight and advice. Coordinates with Lakes Monitoring Advisory Committee. Edits and creates manuals. Work with WDNR and UW – Extension staff to assess and report progress of CLMN program. Promote CLMN to DNR staff, potential new volunteers, lake associations and government agencies via outreach activities.

CLMN outreach coordinator (1/2 time) – Ordering and constructing equipment used in CLMN, assists with Quality Assurance program. Promote CLMN to DNR staff, potential new volunteers and lake associations via outreach efforts. Edits and creates manuals. Work closely with citizen monitors to understand their monitoring

goals, assess their skills and commitment levels, determine equipment needs, track progress, and provide appropriate level of support.

Statewide Limnologist – Provides technical program oversight and oversees Quality Assurance program. Oversees protocol development within CLMN and WDNR and oversees water quality training sessions for coordinators. Works to keep the program aligned with goals laid out in Wisconsin DNR's Water Resources Monitoring Strategy. Help with overall program development and long-term planning.

Data Management Coordinator – Maintains the data systems for the program (the Surface Water Integrated Monitoring System (SWIMS)) and produces lake summary reports for each lake. The Data Management Coordinator produces water quality and aquatic invasive species monitoring data forms and maintains the CLMN web site. Assists volunteers with data entry.

Lab Coordinator – Makes arrangements with State Lab of Hygiene (SLOH) to perform analyses. Ensures correct procedures are used and holding times are met. Lab Coordinator leads hazardous materials shipping training sessions and is responsible for certification of field coordinators.

Lake Coordinators throughout WI – Meet with Lakes Monitoring Advisory Committee. Oversee and advise CLMN. Meet with Lake Association, recruit volunteers, meet with volunteers to discuss monitoring data.

CLMN field Coordinators throughout Wisconsin – Seven regional CLMN Coordinators are located throughout the State and are responsible for volunteer recruitment as well as training and supervising volunteers in field work. Coordinators ensure that field forms are properly filled out and train volunteers to make sure that samples are mailed to the SLOH as needed. Coordinators perform quality control checks to make sure procedures are followed or corrected as needed. Coordinators manage and oversee the day-to-day program activities and are responsible for database management, equipment procurement, distribution of lake summary reports and water quality data interpretation and quality assurance protocols.

University of Wisconsin – Extension, Lakes Program – staff provides technical support for CLMN. Staff helps to oversee lake monitoring program by providing support to volunteers and budgeting.

Lakes Team – Made up of WDNR Section Chief, Lakes and Wetlands and Lakes Team Leader and University of Wisconsin – Extension Lakes Specialists and Outreach Specialists and Wisconsin Association of Lakes.

Citizen Based Water Monitoring Team:
Tom Aartila, Wisconsin DNR, Park Falls, WI
Jeff Bode, Wisconsin DNR, Madison, WI
Jim Congdon, Wisconsin DNR, Horicon, WI
Steve Galarneau, Wisconsin DNR, Plymouth, WI
Greg Searle, Wisconsin DNR, Madison, WI
Dan Helsel, Wisconsin DNR, Black River Falls, WI
Laura Herman, UW – Extension, Rhinelander, WI
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Lori Grant, River Alliance of Wisconsin – La Crosse, WI
Kris Stepenuck, UW-Extension and Wisconsin DNR, Madison, WI
Chris Clayton, UW-Extension and Wisconsin DNR, Madison, WI
This team is charged with developing a Citizen Monitoring Network. Provide input and decision-making to issues of program growth and development.

Project Background and Description

In the early 1980's, WDNR personnel realized that there was little chance that water sampling could be done on even a small number of Wisconsin's 15,000 lakes – there wasn't enough staff or funding to gather more high quality water quality data. Development of lake property was reaching a fever pitch and there was little baseline data to track water quality trends. WDNR staff reasoned that lake residents have a great investment in their lake and have the opportunity to monitor their lake and collect baseline data when conditions are optimal. Volunteers could easily measure water clarity and provide trend data relatively inexpensively, reduce administrative overhead and the number of field staff needed to collect data.

Wisconsin's Self-Help Citizen Lake Monitoring Program was organized in 1986. By the end of the first year there were 138 volunteers monitoring water clarity at 127 stations. Two WDNR personnel in the central office in Madison were responsible for training clarity volunteers throughout Wisconsin. The water clarity monitoring program grew annually. By 2008 there were almost 1000 volunteers measuring water clarity at 806 monitoring stations. Volunteers had collected 107,793 Secchi readings by August of 2009.

Water clarity data is collected by volunteers throughout the open water season following specific protocols. Volunteers are encouraged to take Secchi disc readings every 10-14 days throughout the open water season. Water clarity data is typically collected at the deepest part of the lake. Volunteers are asked to submit the data that they collect to the WDNR by November 1 of each year. All data collected is entered into SWIMS. SWIMS is a data system designed to ensure that staff, management, volunteers and the public have access to high quality surface water, sediment and aquatic invasive species (AIS) in an accessible format.

The SWIMS database produces an annual lake summary report which is distributed to the volunteer. Lake summary reports are public and available on the WDNR web site. Data collected by volunteers as well as agency personnel is available at:
http://WDNR.wi.gov/lakes/CLMN/

The lake summary report (Appendix 1) includes graphs showing water clarity trends and a narrative describing the trophic class of the lake. Data is used with Carlson's Trophic State Index (TSI) to quantitatively determine lake productivity. Carlson's Trophic State Index has been modified for use on Wisconsin lakes.

By 1993 citizen involvement had grown and there was sufficient interest to expand the Self Help program to include more extensive water quality sampling. Volunteers who collect clarity data for at least a year are eligible to collect expanded TSI or "chemistry" data on their lake. Chemistry sampling is done at the deepest part of the lake, the "deep hole". Volunteers are trained to collect water samples for analysis by the Wisconsin State Lab of Hygiene at Madison.

Volunteers 4 samples a year for total phosphorus and 3 samples annually for chlorophyll-a analysis.
Total phosphorus and chlorophyll-a data is collected to assess the state of nutrient enrichment. Chemistry volunteers also collect a temperature profile at the deep hole. The 1993 expansion included training for dissolved oxygen collection, native aquatic plant monitoring and aquatic invasive species monitoring.

Aspects of CLMN have evolved in the last 23 years to meet changing needs, goals and monetary considerations.

- Monitoring water clarity has remained relatively unchanged – the current manual is more detailed and has more information on limnology than the first manual in 1986.
- The current chemistry manual is more detailed and has more information on limnology.
- Early chemistry volunteers collected five total phosphorus samples and 4 chlorophyll-a samples. In the early years, volunteers collected a total phosphorus sample from 3 feet below the surface as well as one foot off the bottom of the lake. The bottom sample was phased out in the late 1990's.
- The first water samples were collected using a Van Dorn water sample bottle. In 2000 a new integrated sampler was introduced for volunteers on lakes greater than 10 feet. The integrated sampler saved money and is thought to collect more comprehensive chlorophyll-a sample.
- Prior to 2000, the water temperature profile was collected using the Van Dorn water sample bottle. On lakes where the integrated sampler is used, the temperature profile is now collected using an electronic meter.

- For dissolved oxygen monitoring – the CHEMets colorimetric kit was used for a short time but has now been phased out. The Winkler titration method using the La Motte test kit is now the only accepted method of collecting dissolved oxygen that CLMN supports. Lake groups can purchase a dissolved oxygen meter (either by lake management planning grant or using their own funds) to collect a dissolved oxygen profile. Both meter and titration data will be accepted into the SWIMS database.
- Native aquatic plant monitoring has evolved as volunteers became more proficient in identifying macrophytes. Some lake groups now become involved in more difficult point intercept surveys.
- Aquatic invasive species (AIS) has become a focal point for lake monitoring in Wisconsin. Trained citizen volunteers currently find most of the new infestations on lakes and are instrumental in sharing knowledge of AIS with their fellow lake residents.
- New species of AIS are added with monitoring protocols as the need arises.
- The Lake Assessment Working Group is reviewing the "deep hole" methodology. On large impoundments especially, shallow bays may have different water quality than the deepest part of the lake. The deep hole may not always be representative of the lake as a whole.

Problem Definition/Background

Wisconsin has nearly 15,000 lakes of such great diversity in origin, configuration and chemical and biological composition that they almost defy categorization and classification. ..inland lakes range in size from less than an acre to 137,000 acres, and in depth from a few feet to 230 feet (Limnological Characteristics of Wisconsin Lakes, 1983).

Wisconsin lakes are under stress from pollution, loss of habitat and more recently aquatic invasive species. The state has too few resources to monitor all 15,000 lakes and for decades has depended on citizen data. Retention and the term length of volunteers are excellent. Twenty four volunteers are still actively participating after 20 years.

CLMN Data is Used by:

National information and statewide reporting –
Water quality reports to Congress: Citizen generated information is used every two years to report trends in Wisconsin lakes and to identify needs to the federal government.

Great American Secchi Dip-in: Citizen data is collected and analyzed with other data collected nationally to report lake clarity.

Lake and basin assessment and planning –
Numerous lake diagnostic and feasibility studies: Citizen data is used for before and after documentation, as well as to show severity of water quality problems and to set restoration goals.

Annual condition reports to individual lake groups and media: Citizen data is summarized and presented annually by volunteers to lake organizations and to the local media to show water quality trends.

Watershed and Basin Plan preparation: Citizen lake data is summarized in tables and used to express lake water quality conditions and trends. This information is used to set priorities for lake protection, restoration, and funding.

Requests to Wisconsin legislature –
Request for a phosphorus water quality standard: Citizen data was used to show trophic status of WI lakes to demonstrate the need to limit the phosphorus being discharged from wastewater treatment facilities and to support a ban on phosphate detergents in WI. Legislation passed.

Request Aquatic Invasive Species Funding and Legislative Language: Volunteer data was utilized to help prepare statewide lists and maps of new populations of zebra mussels and Eurasian water- milfoil in support of the department's request for funding and policy. The state was successful in gaining $300,000 per year for watercraft inspection, invasive species education, monitoring and biological control of purple loosestrife; and strong legislation prohibiting the transport of watercraft with plants or animals attached.

A primary goal of data collection is to produce data of known and documented quality, in support of state water body health assessments. CLM Section 303(d) of the federal Clean Water Act requires states to develop a list of impaired waters ("303(d) list"). CLMN data is used to determine if the current water quality meets the numeric or narrative criteria in a water quality standard.

CLMN data contributes to the data set used to develop TMDLs for any water of the state.

Satellite research –
The University of Wisconsin's Environmental Remote Sensing Center (ERSC) and Citizen Lake Monitoring Network have been partners in Remote Sensing research since 2000. ERSC is using satellite images in conjunction with CLMN data to develop a set of algorithms to predict basic water quality parameters from LANDSAT data. Collecting sufficient lake data on the variables of interest on dates concurrent with satellite overpass dates would be impossible without volunteer involvement.

WDNR Research -
Long Term Ecological Trends of Northern Temperate Lakes by Kathy Webster, Ph.D. UW-Madison. Ms. Webster's research used 11+ years of Self-Help data from a set of 50 Wisconsin Long Term Trend Lakes. The data was analyzed to look for trends in individual lakes over the 11-year period.

Loon Research and Climate Change – CLMN data is used by WI WDNR and USGS to look at the correlation between trophic state and loon use of northern lakes. Research is also investigating how projected climate change (IPCC and UW Atmospheric Sciences models) may change lakes and lake dependent wildlife populations in Vilas County.

Public education and outreach -
This objective is to train and engage volunteers to develop a better understanding of the importance of water resources and to encourage their fellow citizens to take an active role in the preservation and restoration of their local water bodies and watersheds.

The mission of CLMN is to collect credible, high quality data, educate and empower volunteers, and share this data and knowledge. The volunteers often act as a conduit of information for lake issues between the WDNR and lake residents. The program goal is to coordinate statewide methods for conducting water transparency and water chemistry sampling and native aquatic plant monitoring.

Project/Task Description

1) To understand and estimate the trophic state of Wisconsin lakes through water clarity measurements.
2) To track water quality changes through time to establish trends in water quality. Water quality trends are established when seven consecutive years of data are collected.
3) Collect perceptual data that describe water conditions and may affect qualitative measurements.
4) To understand and estimate the trophic state of Wisconsin lakes through total phosphorus and chlorophyll-a measurements.
5) Collect dissolved oxygen and temperature profile to determine amount of oxygen available for aquatic life and determine if stratification occurs.
6) To assist volunteers in becoming more familiar with water quality on their lake and to help these volunteers teach other lake residents about water quality.
7) To have CLMN participants record data measurements on standardized forms and report data. If information cannot be easily entered and quality assured by the volunteer or is not complementary to other data in SWIMS, we do not support it.
8) To collect native aquatic plant information in order to monitor water quality trends and to foster an appreciation of aquatic plants and aquatic plant communities.
9) To monitor for aquatic invasive species.
10) To insure that the collection and reporting methods and techniques are appropriate for citizen volunteers. Skilled performance and safety are the objectives of CLMN. As stated in the Water

Resources Monitoring Strategy for Wisconsin, “If citizens follow defined methodology and quality assurance procedures their data will be stored in a Department database and used in the same manner as any Department-collected data for status and trends monitoring defined in the strategy.”

Water Quality Parameter, Measurement Range, Accuracy and Precision

Parameter	Measurement Range	Accuracy	Instrument	Precision
Water clarity	0-30 feet	NA	Secchi disc	
Dissolved Oxygen concentration	0-20 mg/L	0.1 mg/L	LaMotte kit Winkler titration	
Dissolved Oxygen concentration	0-20 mg/L	+/-0.3 or +/-2% of reading, whichever is greater	YSI 550A	
Dissolved Oxygen concentration	0-20 mg/L	TIM?	Hach HQ30d	
Total phosphorus	Up to 0.05 mg/L	92.6-110.0%	EPA-365.1	+ or – 0.005 mg/L
Total phosphorus	>0.05 mg/L	92.6-110.0%	EPA-365.1	+ or – 6.1%
Chlorophyll-a	up to 2.6 ug/L	NA	EPA-445	+ or – 0.29 ug/L
Chlorophyll-a	>2.6 ug/L	NA	EPA-445	+ or – 10%
Temperature	32-100 ° F	+/- 1° F	Doric meter	

Comparability

Water clarity and water chemistry volunteers use the same standardized methods as WDNR to ensure that data collected by these two entities can be compared. Volunteers use standardized taxonomic keys to identify macrophytes to the genus level.

Completeness

CLMN staff asks that water clarity monitoring be done every 10-14 days throughout the open water season. Some volunteers choose to monitor more frequently. Water chemistry volunteers monitor 4 times per year following protocol. The number of monitoring sites assigned to each individual may be variable but generally is one site. It is expected that chemistry samples will be collected from at least 10% of the stations.

Volunteer Selection and Requirements

Volunteer Qualifications

- Chemistry volunteers must have one season of clarity monitoring experience.
- No science background is needed to be a CLMN volunteer. Training is provided to those who are interested and able.
- Volunteers must be able to get in and out of boat and motor to monitoring site.
- Aquatic plant monitors need ability to walk along the lake shore and enter the water to gather plants and use a rake to gather plants in deeper water.
- Volunteers should enjoy being outdoors.

Volunteer Monitor Responsibilities

Volunteers who are new participants of the program must:

- Attend a 1-6 hour training session (depending on level of activity). Trainings generally have both a field and classroom component and are often done on the lake.
- Collect water clarity, chemistry, dissolved oxygen and aquatic plant data using WDNR methods and time table.
- Attend a refresher course once every three years.

- Pick up annual monitoring equipment every spring (sulfuric acid, lab forms, dissolved oxygen reagents, merchandise return labels, labels, filters).
- Adhere to a pre-determined monitoring schedule.
- Enter the data either by phone, on-line or by mail.
- Volunteers are often asked by Lake Association to present annual data and to interpret data.
- Return equipment to Coordinator for maintenance or if retiring from program.

Training Requirements

All volunteers are required to complete a training session. The length of time the training session takes depends on the level of training and the volunteer's background.
Water clarity training takes approximately one hour.
Chemistry training takes approximately two hours.
Learning how to collect dissolved oxygen data takes approximately one hour.
Learning how to monitor for native aquatic plants takes between two and six hours.

Training reviews standard protocols and provides the volunteer with the knowledge necessary to collect the necessary data as well as how to complete the data sheet and enter data into SWIMS. Volunteers are instructed to retain copies of the data sheets for their own record. This allows the CLMN Coordinator to verify data when needed. Equipment and manual are provided by the WDNR. The volunteer learns how to interpret the data that they collect and learn about trophic class and basic limnology principles.

Native aquatic plant monitors learn how to press and identify basic aquatic plants and learn to create a herbarium for their lake. The training on macrophyte monitoring may include aquatic plant adaptations, AIS identification, the value of aquatic plants and/or how to use a key to identify aquatic plants.

Volunteers are periodically checked by observation of their techniques. Feedback is provided to correct any problems using equipment and recording perceptual observations. If the volunteer is not following the appropriate methods the Coordinator or Trainer will retrain the volunteer in the method in which there is error.

Chemistry volunteers are required to attend a quality assurance workshop once every three years. The workshops are offered annually and some volunteers attend every year. Monitoring equipment is distributed at the workshop and monitoring protocols are reviewed. Secchi monitoring protocols are reviewed with the chemistry volunteers as well.

Train the Trainer

The Statewide CLMN Educator may train additional individuals so that they may be entrusted with the primary responsibility of training new water clarity volunteers. Guidelines for "train the trainer" model include:

- Only those trainers trained by CLMN Educator are able to train new secchi volunteers.
- Trainers will notify the Educator of each new person trained.
- Trainers will attend refresher courses offered by WDNR.
- Only those volunteers who complete an official training session will be allowed to enter data into SWIMS.

Documentation and Records

At each training session, volunteers complete a liability waiver that also contains their contact information. Each volunteer is issued a volunteer identification number that ties all data collected back to them. A station identification number identifies the monitoring site on the lake. Each lake in Wisconsin is assigned a master waterbody identification number. The volunteer identification number, station id number and master waterbody identification number are provided to the volunteer during training. The station id number and water body identification number are necessary in order for volunteers to enter data into SWIMS.

Contact information for volunteers, Trainers and Coordinators can be found in SWIMS. SWIMS contains winter, summer and email address and phone number for each individual. A project is assigned to each volunteer that describes the volunteer activity (water quality monitoring, AIS monitoring, loon research, ice observations, etc.) and the waterbody identification number and station identification number associated with that volunteer. Correspondence with each volunteer can be recorded in SWIMS – training, schedule conflicts, monitoring partners, inactivation are examples of correspondence that would be maintained in SWIMS.

The format of the data sheets mirrors the organization of data forms in the SWIMS database. Volunteers record time and date of collection on the data sheet, the Secchi depth, water color and water level. A space is provided for wildlife and weather observations and other things that would impact water clarity such as recreational use. Once data has been collected on the lake it can be entered into SWIMS by mailing in the data sheets, by phoning in the data or by entering the data via the internet. Data must be received by November 1. All data is electronically archived in a password protected, internet-accessible database. Only trained volunteers are given permission to submit data to SWIMS. There is not yet a place in SWIMS for volunteers to record native aquatic plant collection data – that will be done in the future.

Volunteers monitoring dissolved oxygen profiles using a dissolved oxygen meter are instructed to complete a DO meter calibration log in addition to the data recording form. Volunteers retain paper copies of this form for their records and send a hard copy to the program coordinator at the end of each sampling season.

Lake summary reports are regularly used by WDNR Lake Coordinators and Integrated Science Services staff, water resource professionals, Consultants and County staff. The data is reviewed continually by the SWIMS database manager and state limnologist as well as the CLMN coordinator for signs of confusion or errors that may indicate lack of training or manual ambiguities. Most regional WDNR and county offices maintain paper copies of the lake summary reports.

Sampling Site Selection and Documentation

Secchi and water chemistry data is typically collected at the deepest part of the lake (the deep hole). Water quality at the deep hole is generally representative of water quality in the lake as a whole. Large lakes or those with distinct basins have data collected at more than one spot. Lakes with management issues or water quality issues may have specific monitoring sites assigned. The WDNR Lake Assessment Working Group is reviewing monitoring protocol on large shallow impoundments. Often water quality in shallow basins is much different than water quality at the deep hole. A different monitoring strategy may be recommended for some water bodies. Monitoring locations are found using WI WDNR lake maps (when available), commercial lake maps, depth finder as well as the collective knowledge of WDNR staff and lake residents. GPS locations of the deep hole and other sampling locations are maintained in the SWIMS database. If you search the database a map of the lake is provided with the monitoring location indicated.

Each monitoring activity has a separate manual which are revised as needed. Revisions to the manual are provided to volunteers by mail or on-line to those with an e-mail address. Training, manuals and equipment are all provided to the volunteer by the Wisconsin WDNR.

Monitoring Process Design, Methods and Protocols

Sampling Plan

The CLMN water clarity and water chemistry monitoring plan is consistent with statewide baseline monitoring guidelines laid out in the WDNR's Water Resources Monitoring Strategy for Wisconsin.

- Any lake or flowage in Wisconsin can be monitored for water clarity.
- Volunteers are asked to monitor clarity throughout the open water season – preferably every 10-14 days.
- The monitoring location for water clarity and water chemistry is chosen by the WDNR.
- Sampling protocols must be followed for all levels of sampling.
- Volunteers are asked to monitor water chemistry four times per year (two weeks after ice off and during the last two weeks of June, July and August).
- Dissolved oxygen monitoring can be done throughout the open water season and may be done during the winter in conjunction with aerator placement.
- Aquatic plant monitoring is done primarily during the months of July and August but can also entail monitoring for *Potamogeton crispus* which would be done in May or June.
- At the end of each monitoring season, all data are entered into the database by November 1.

Water Quality Parameters

The sampling of all water quality parameters will conform to accepted WDNR methodology using equipment provided and approved by the CLMN. Dissolved oxygen meters will not be provided by CLMN but if used by a lake group must be calibrated and maintained in order to provide good quality data. Technical assistance and

oversight is provided by DNR staff under a lake management planning grant that guides lake users purchasing a dissolved oxygen meter.

CLMN volunteers collect information for the following parameters:

- Transparency
- Total phosphorus and chlorophyll-a concentration
- Temperature profile
- Dissolved oxygen (concentration)
- Macrophyte species presence/absence
- Macrophyte species – relative abundance

Equipment for Secchi Disc Monitoring

- Manual with datasheet (field sheets and carbonless forms)
- Pencil
- Weighted Secchi disc with two clothespins

The Secchi disc manual contains protocol, contact information, data sheets and information on how to interpret the data. Manual revisions are listed on line. Volunteers with access to the web page can print off revisions and include them in their manual. Hard copies of updates and revisions are sent to volunteers annually if needed. Manuals have clear, step by step directions with pictures showing proper technique.

Secchi discs have been purchased through the same vendor, Aquatic Research Instruments, since 1986 and are supplied to each volunteer by the WDNR to ensure consistency. The eight inch acrylic Secchi disc is weighted with a two-pound stainless steel weight. A thirty foot rope is attached to the disc and marked in foot increments with water proof marker. The five, fifteen and twenty-five foot marks are marked with red marker, and ten, twenty and thirty foot marks are a double black ring. Each Secchi disc rope is measured prior to distribution to volunteers for accuracy. An error of 3 inches is permitted on each weighted rope.

Secchi Disc Monitoring Protocol

The Secchi disc is slowly lowered until it disappears – this is one data point that is marked with a clothespin at the water surface. The disc is then lowered several feet and slowly raised. Its reappearance gives another data point which is again marked with a clothespin. The mid point between these two data points is recorded as the Secchi depth to the nearest quarter foot. The mid point is the clarity reading for that day and is recorded on the data sheet.

We estimate that when procedures are followed correctly, CLMN Secchi measurements may have a 15% error (from observer to observer). Measurement variability and lack of standardization is a concern with Secchi disc readings – but this is a concern with WDNR personnel readings as well. CLMN volunteers are recording Secchi readings for trend analysis and all data is tied back to that individual through their volunteer id number to minimize discrepancies in observer vision characteristics.

1. Secchi discs and manuals are supplied to each volunteer by the WDNR to ensure consistency. Trained "trainers" train new water clarity volunteers.
2. Volunteers are to take Secchi readings when conditions are optimal at the assigned site with an anchored boat following the protocol outlined in the manual (*Appendix 2*).
3. Secchi readings are collected on a calm, mostly clear day between the hours of 10:00 am and 4:00 pm.
4. The Secchi reading is measured on the shady side of the boat to the nearest quarter foot.
5. Remove sunglasses before taking Secchi reading and collect the Secchi reading as close to the surface of the water as is safe.
6. Note if Secchi disc hits lake bottom on data reporting form. If the Secchi disc hits bottom and you are still able to see it the TSI may not be an accurate representation of lake.
7. Carlson's TSI is the methodology used to determine trophic state of oligotrophic, mesotrophic, eutrophic or hypereutrophic.

Volunteers collect perceptual data that describe water conditions and may affect qualitative measurements.

1. Describe wave height.

2. Color and transparency are determined by lowering the Secchi disc one foot into the water and observing lake water against the white of the quadrant. The estimated water color distinguishes between sediment and algae-influenced transparency.
3. Record weather conditions that may influence data collection; rainfall, cloud cover, wind direction.
4. Record unusual turbidity and factors that may have caused them.
5. Record perception of the amount of algae present in the water at the deep hole and the impact of algae levels on recreation.

Equipment for Water Chemistry

Each chemistry volunteer is supplied standardized equipment purchased and maintained by the WDNR during the training session. Volunteers cannot supply their own equipment for monitoring. Each kit contains the following:

- Chemistry manual (Appendix 3)
- Lake map with monitoring site indicated
- Data sheet and pencil
- Doric electronic digital temperature meter with standard cable marked in foot increments. A 2 ounce brass weight is attached to the cable to reduce drift.
- Integrated water sampler which has been constructed for use in program (Appendix 8).
- Water collection bottle that has been modified to accept integrated water sampler.
- 1000 ml flask
- Magnetic filter cup
- Vacuum hand pump with plastic hose
- Plastic unitary wash bottle for distilled water
- 250 or 500 ml graduated cylinder
- Safety goggle and gloves
- pH testing paper and waxed paper
- Screw type vial containing 18 drops of sulfuric acid for sample preservation. Vials are replaced annually.
- filter membranes – replaced annually. Blue spacer sheets have been removed prior to distribution to volunteers.
- Styrofoam mailer supplied by SLOH (with plastic bags, 250 ml sterile collection bottle, tube for chlorophyll filter).
- Packing tape

Expanded TSI (Chemistry) Monitoring Protocol

Chemistry manual contains step by step instruction and protocol, contact information, data sheets and information on how to interpret the data. Manual revisions are listed on line. Volunteers with access to the web page can print off the revisions and include them in their manual. Hard copies of updates and revisions are sent to volunteers annually if needed.

The chemistry manual contains the standard operating procedures for these standard elements;

- Sampling site, dates and times
- Number of samples
- Procedures for collecting samples
- Preservation protocol
- Number of field blanks and duplicates to meet data quality objectives
- Sample packaging and shipping protocol
- Data entry protocol

All chemistry equipment is rinsed with distilled water after use and air dried. Volunteers are asked to contact their regional coordinator if equipment is damaged or lost.

Volunteers are trained by the Regional Coordinator on a one to one basis or in small groups. In most cases the trainer and volunteer go out in the volunteer's boat to the "deep hole", collect the sample, process the samples and learn how preserve and mail the samples.

1. A Secchi disc reading is done before performing water chemistry tasks.
2. Four total phosphorus and three chlorophyll-a samples are collected annually following protocol outlined in CLMN chemistry manual.

3. Chlorophyll-a concentration is an estimate of algal populations.
4. Collect water for total phosphorus and chlorophyll-a analysis with an integrated water sampler on lakes 10 feet or greater. On lakes less than 10 feet in depth use a Van Dorn water sample bottle.
5. Both integrated samplers and Van Dorn water sampler bottles are triple rinsed in ambient water immediately prior to sample collected and are cleaned following sample collection with distilled water and air dried.
6. Care must be taken to avoid contact between fingers and inside surfaces of containers, including bottle caps.
7. A Doric electronic temperature meter is used for temperature profile. Each cable is marked in foot increments and with wire markers every 3 and every 5 feet. A two-ounce weight prevents drift.
8. Phosphorus and chlorophyll-a samples are sent on ice to the State Lab of Hygiene (SLOH) for analysis. Samples must be sent early in the week so that the SLOH receives them before the ice in the cooler has melted.
9. The phosphorus sample is preserved with 2 ml sulfuric acid (4.4N) prior to shipping to prevent any transformations (uptake by algae or bacteria) or sorption to the walls of the container during storage. Five vials are provided to each volunteer annually. Unused acid and unopened vials are collected by the CLMN Coordinator and disposed of.
10. The pH of each phosphorus sample is tested with pH paper supplied to each volunteer. The pH of the sample must be 2 or less. Volunteers sign and initial the lab form stating that the phosphorus sample has a pH of 2 or less.
11. Each sample collected is accompanied by a lab form provided for that lake.
12. Each total phosphorus sample is sent by the volunteer to the SLOH in a clean 250 ml bottle and marked with a label that indicates the lake name, the county, the collection site and the date. The clean bottle is supplied by the SLOH.
13. Each chlorophyll-a sample is sent by the volunteer to the SLOH in a clean tube supplied by the SLOH and identified by a label that indicates the lake name, the county and the amount of water filtered.
14. Filter forceps are used to place filter on filter cup and to remove filter to tube after filtering.
15. Volunteers must send total phosphorus and chlorophyll-a sample as soon as practicable after collection. We advise volunteers not to hold samples longer than 48 hours. Total phosphorus sample is kept in the refrigerator until mailing. Chlorophyll-a sample is kept in the freezer until mailing.
16. Bottles, tubes, plastic bags and cooler are provided by the SLOH.
17. Lab forms are printed and sent to the volunteer before the start of the season. The annual volunteer mailing includes labels, merchandise return labels (for mailing costs), 47mm cellulose filters.
18. The lab form is completed with a waterproof pen and identifies the name of the volunteer, contact information for the volunteer, the station and waterbody identification number, the volume of water filtered for the chlorophyll-a sample and asks if the phosphorus sample has been acidified.
19. Samples are placed in plastic bags along with lab forms and placed in the cooler along with 3 trays of ice cubes. Samples cooled to 4 degrees C. and acidified can be held up to 30 days by the SLOH.
20. A standard merchandise return label has address of SLOH.
21. An annual letter is sent to each volunteer alerting them to protocol changes and to mailing or shipping changes.
22. All equipment used by volunteers is standardized and has been supplied by the WI WDNR.
23. Equipment is rinsed with distilled water and air dried.
24. SLOH data is shared with SWIMS.

Factors That Contribute to Measurement Error – Water Chemistry

- Contaminant in sampler
- Human error
- Not following protocol
- Sample becoming too warm / holding time too long before being analyzed
- Lab analysis error
- Samples are not labeled in the field

Equipment for Dissolved Oxygen Monitoring

- Chemistry manual, Chapter 6 - Using the Titration Method
- Lake map with monitoring site indicated
- Data sheet and pencil

- Van Dorn or Kemmerer water sample bottle
- LaMotte dissolved oxygen test kit (reagents are replaced annually)
- 25-ml graduated cylinder
- Glass vial with lid
- Syringe
- Dissolved oxygen sample bottles labeled with appropriate depth and kept in a bottle rack.
- Safety goggles and disposable gloves

Factors That Contribute to Measurement Error – Dissolved Oxygen – Winkler Titration

- Not taking special precaution to avoid entrainment or solution of atmospheric oxygen or loss of dissolved oxygen
- Drain tube not inserted to bottom of sampling bottle
- Human error
- Not following protocol
- Holding samples too long. There is no holding time until samples are fixed.
- Fixed samples must be titrated as soon as volunteer returns to shore with samples.

State Lab of Hygiene

The SLOH provides analytical services for the Department of Natural Resources and for CLMN as required by Section 36.35(11), Wisconsin Statutes. These services are provided on a contract basis and under a Memorandum of Agreement. SLOH is accredited by the State of Wisconsin. Under this accreditation program the laboratory has an on-site evaluation every two years. Sample bottles, preservatives, collection and field measurement procedures are consistent among volunteers and all WDNR programs. The Field Procedures Manual for WDNR staff mirrors the standard operating procedures of the volunteer collection program.

Spiked samples are done in the laboratory to measure accuracy.

Quality data can only be obtained from environmental samples that are properly collected, preserved and promptly shipped to the laboratory for analysis. Sample handling and preservation, bottle size, blank and replicate sample preparation and sample packaging and shipping are standardized and protocol outlined in both the CLMN chemistry manual and WDNR Field Procedures Manual.

The standardized shipping package for the samples conforms to the conditions and limitations specified in 49CFR173.4. The shipping container is large enough to accommodate enough ice to maintain the samples at 4°C. for about 24 hours, the routine shipping time.

Dissolved Oxygen Monitoring Protocol

When volunteer sampling opportunities were expanded in 1990 to include water chemistry, the opportunity for volunteers to collect a dissolved oxygen profile was added. Originally the Winkler titration method of collection was the only option offered. From 2000 through 2007, the CHEMets colormetric kit was used to collect dissolved oxygen data on area lakes. This kit was used primarily for educational purposes since the data collected is somewhat subjective. The CHEMets colorimetric kits have since been phased out.

The manual contains step by step instructions that mirror the WI DNR Field Procedures Manual that outlines standard operating procedures for all DNR programs. All dissolved oxygen equipment is rinsed with distilled water after use and air dried. Volunteers are asked to contact their regional coordinator if equipment is damaged or lost.

Volunteers are trained on a one to one basis or in small groups by the regional coordinator. In most cases the trainer and volunteer go out to the “deep hole”, collect samples and go through the titration process. Protocol advises volunteers to take care not to add bubbles or to agitate the sample and to insert the drain tube on the sampler to the bottom of the glass sample bottle. If done correctly, the Winkler titration is a precise and reliable method of D.O. measurement. A precision of approximately 20 micrograms per liter in distilled water is quoted in Standard Methods.

1. Volunteers are trained by regional Coordinators following protocol in manual.

2. A Van Dorn water sample bottle is used at the deep hole to collect water from specified depths. Typically dissolved oxygen and temperature is recorded at 3 foot depth intervals.
3. A Doric electronic temperature meter is used to record the temperature.
4. LaMotte reagents are replaced annually.
5. Samples are fixed on site.
6. Volunteers are trained to take special precautions to avoid solution of atmospheric oxygen or loss of dissolved oxygen.

Due to the difficulty and time involved in using the Winkler titration kit, lake groups may purchase a dissolved oxygen meter. CLMN does not offer dissolved oxygen meters to volunteers although meters can be purchased through participation in a small scale grant. In order to maintain consistency and reduce user error, CLMN currently supports the use of a YSI 550 or Hach HQ30d. The latter is attractive because there is no membrane to change. Volunteers using the YSI 550 meter are advised to use a document called "Meter Tips" (Appendix 9) and provided a log for calibration (Appendix 10).

Because of cost considerations, it is necessary to restrict the use of dissolved oxygen meters as well as LaMotte titration kits. If there is a need for dissolved oxygen information the volunteer is asked to collect a profile in one of two ways - either by the Winkler titration or by an electronic meter.

In all cases volunteers are instructed to check equipment prior to use and in the case of a dissolved oxygen meter, to calibrate the instrument prior to each monitoring event; to follow all protocol while monitoring and to complete the required documentation.

Historical Information

When chemistry monitoring was first offered in 1993, water samples for phosphorus and chlorophyll-a analysis were collected using a Van Dorn or Kemmerer water collection bottle from the three foot water depth. A bottom phosphorus sample was collected from one foot above the bottom of the lake.

In 2000, a pilot program was launched to find a better way to collect water samples. WDNR Research was concerned that the 3-foot grab sample might be missing algal blooms since some species of algae migrate in water column. The water sample bottles were difficult to use, required frequent repair and expensive to replace.

Jim Klosiewski (WDNR) designed the first integrated sampler in 2000. During the 2000 CLMN field season, we asked fifty CLMN volunteers to collect samples as they had done in the past plus collect samples with a new 6 foot integrated sampler. The fifty lakes were selected at random and both samples gathered were analyzed by SLOH. Dr. Kathy Webster, University of Wisconsin – Madison analyzed the data and determined that there was no statistical difference between the two methods of collection. This meant that historical data could still be compared to recently collected data. The integrated sampler was adopted by CLMN to collect water samples for chemistry analysis on lakes with depth greater than ten feet.

Until 2000, temperature profiles were collected using a thermometer in the Van Dorn water collection bottle. In 2000 a pilot program was launched to find an accurate inexpensive electronic temperature meter that could be used by volunteers to collect a temperature profile. The old method was time consuming, laborious and of questionable accuracy because of the potential change in temperature as the sample is pulled through the water column. CLMN staff looked at nearly 30 temperature collection units and narrowed the selection down to three. Dr. Webster's lake sampling teams evaluated the performance, ease of use and consistency to a standardized thermometer and decided that the Doric electronic temperature meter should be adopted for use. The accuracy of the Doric electronic meter is + or – one degree Fahrenheit.

Volunteers collecting water samples for the Winkler titration continue to use a Van Dorn water collection bottle.

Equipment for Native Aquatic Plant Monitoring

- Manual (appendix 6)
- Data sheets
- Zip lock plastic bags
- Water proof marker
- Plant press with blotting paper and cardboard
- Plastic tub for equipment and to "float" and rinse plants

- Herbarium paper
- Herbarium labels
- Through the Looking Glass – A Field Guide to Aquatic Plants by Susan Borman, Robert Korth and Jo Temte – A publication of the Wisconsin Lakes Partnership
- Lake Plants You Should Know – A Visual Field Guide (A publication designed specifically for UW-Extension Lakes Partnership, the Citizens Lake Monitoring Network and the Clean Boats, Clean Waters Program).
- Hand lens and ruler
- Lake map
- GPS unit (provided by volunteer)
- Rake with rope

Factors That Contribute to Error

- Collecting at wrong time of year (seeds and/or flowers may not be present)
- Insufficient equipment available (might need a microscope to properly see) or a ruler to measure
- Insufficient experience to recognize macrophyte
- Unable to collect the entire plant (hard to collect roots of plant when collecting with a rake from 15 feet of water)

Native Aquatic Plant Monitoring Protocol

A manual for monitoring native aquatic plants is provided to each volunteer. The manual contains step by step protocol, contact information, data sheets and information on how to identify aquatic plants. Manual revisions are listed on line. Volunteers with access to the web page can print off revisions and include them in their manual. Hard copies of updates and revisions are sent to each volunteer.

Native aquatic plant training is done on a one to one basis. Monitoring is based on a volunteer's needs and time commitment. Training takes from 2 to 6 hours.

There are different levels of involvement that the volunteer may choose. Some simply map plant beds (emergent, submergent and floating leaf plants) using a GPS unit; some collect, press and identify the plant species present in the lake; and some measure the abundance and composition of plant beds by doing either a transect survey or floristic quality index. All plants that are collected by the volunteer are verified and vouchered by Dr. Robert Freckmann, plant taxonomist, at the University of Wisconsin – Stevens Point. Volunteers collect two specimens of each plant – one for their Lake Association and one for the herbarium at the University of Wisconsin – Stevens Point.

1. Collect baseline aquatic plant information on individual lakes. Water quality trends can be monitored by changes in aquatic plant abundance and community.
2. Volunteers are trained by CLMN Coordinator and provided with a manual that outlines the protocol to map emergent, submergent and floating leaf communities.
3. Volunteers are trained by CLMN Coordinator and provided with a manual that outlines the protocol to collect, press and identify aquatic plants found below the ordinary high water mark.
4. Volunteers have an option to attend an aquatic plant training session at the annual Wisconsin Lakes Convention. The intensive plant training session is hosted by Dr. Susan Knight, University of Wisconsin Center for Limnology and WI-WDNR Science Services.
5. Volunteers are asked to collect all part of the plant; roots, stems, leaves, flowers if possible and to make sure all collections are well labeled.
6. All plants collected by volunteers are verified by a plant taxonomist at the University of Wisconsin – Stevens Point.
7. Voucher specimens are housed at the Freckmann Herbarium at the University of Wisconsin – Stevens Point.
8. Native aquatic plant monitoring verifies the presence of a particular species, not necessarily the density of the species. Information on more detailed plant monitoring can be provided to lake residents if they wish to go beyond CLMN monitoring.
9. If species are collected by the volunteer that are pioneer aquatic invasive species the WDNR Lakes Coordinator or WDNR Aquatic Plant Management Specialist are contacted and work with the volunteer and lake group to resolve issue.

Summary of CLMN Data Collection Schedule

Parameters	April / May	June	July	August	September	October
Secchi	Every 10-14 days	Every 10-14 days	Every 10-14 days check satellite dates	Every 10-14 days check satellite dates	Every 10-14 days check satellite dates	1 to 3 times if possible
Phosphorus	X – 2 weeks after ice off	X – last 2 weeks of June	X – last 2 weeks of July	X – last 2 weeks of August	No	No
Chlorophyll-a	No	X – last 2 weeks of June	X – last 2 weeks of July	X – last 2 weeks of August	No	No
Temp. Profile	X	X	X	X	X	Optional
D.O. Profile	X	X	X	X	X	Optional
Native Aquatic Plant Monitoring		X	X	X		

Quality Control Requirements

Addressing Abnormal Results

Water quality monitoring results are influenced by multiple factors that can be challenging for volunteers to understand. During the training session volunteers are provided information on expected data ranges. Lake summary reports are reviewed by volunteers, regional Coordinators, Lake Coordinators and CLMN Data Manager and these people are always available to respond to the volunteer's request for assistance and interpretation. Abnormal results are generally flagged and reviewed. Unfortunately, the task of reviewing lake summary reports may take months to complete.

The Secchi and chemistry manual as well as the accompanying publication "Understanding Lake Data" discuss water quality monitoring results and the fluctuations that can occur seasonally and daily in water clarity, total phosphorus and chlorophyll amounts. Volunteers are trained to understand that some parameters can vary significantly (following a rain event or during a drought for instance) – and are trained to record these events on their data sheet.

Calibration and instrument errors are the greatest cause of abnormal results when using a dissolved oxygen meter. DNR staff can assist volunteers in determining whether abnormal dissolved oxygen results are due to physical, chemical or biological factors once calibration and instrument errors are ruled out.

Training of Trainers

Regional CLMN Coordinators are trained by the Statewide CLMN Educator and Statewide Limnologist at a bi-annual training. Wisconsin WDNR uses trainers in county positions such as the Land Conservation Department. All trainers and coordinators must attend a training sessions led by the Statewide CLMN Educator and must attend a biannual refresher course.

Quality Assurance – Water Chemistry

CLMN monitors the accuracy and precision of the field data collected by volunteers. These tests document the accuracy and precision of the data collected and look at natural variability and sampling error. Ten percent of stations that are monitored for total phosphorus (TP) and chlorophyll are chosen randomly each year to participate in collection of quality assurance samples. This exercise consists of field blank and sequential field

duplicates. A field blank for total phosphorus and duplicate samples of total phosphorus and chlorophyll-a are submitted by the volunteer along with the samples normally collected for that monitoring event. The coordinator visits each volunteer participating in the quality assurance event and distributes extra phosphorus bottles, extra chlorophyll tube, two extra vials of sulfuric acid, extra filters and labels and lab forms and reviews the instructions for participating in the quality assurance sampling (Appendix 12).

Lab forms and labels for samples are color coded to insure that each sample is handled appropriately (the blank sample lab slip and label are blue. The duplicate lab form and duplicate label for total phosphorus and chlorophyll-a are green and the regular total phosphorus and chlorophyll-a sample labels and lab forms are white).

Annual checks for phosphorus of the cubitainers and carboys (used to transport deionized water from the SLOH and to the volunteers) and water collection bottles (used on site to collect water from integrated sampler) is done. The results have been negative for the presence of phosphorus.

Results of the blank and replicate exercise are reviewed by the state DNR limnologist. Volunteers that submitted samples outside the expected data range are contacted and their monitoring protocol reviewed. The reason for the sample anomaly is generally discovered (contaminated equipment, protocol etc.) and corrected.

Water chemistry volunteers are asked to attend a workshop that reviews monitoring protocols once every three years. Some regions with smaller numbers of volunteers are able to visit each volunteer individually and do side-by-side sampling in lieu of an organized workshop. Those regions that have greater volunteer numbers rely on annual workshops to review monitoring protocols and meet with volunteers to check equipment and distribute sulfuric acid ampoules or new dissolved oxygen reagents. Annual letters are sent to all volunteers. The annual letter asks volunteers to check their monitoring equipment and check the measurement of the rope on their secchi disk or van dorn. The rope should be re-marked or replaced if there is wear and tear, shrinking or stretching. Volunteers should make sure that quadrants of Secchi disc are bright and clean and disc is free of scratches. New discs are provided to those who need them.

The annual letter, workshop or visit reminds volunteers to:

- Calibrate their Doric electronic temperature meter against a known sample (ice water)
- Change the 9 volt battery in the temperature meter annually
- Replace sulfuric acid ampoules annually
- Replace dissolved oxygen reagents annually
- Calibrate DO meter and keep a calibration log
- Pick up new distilled water
- Pick up new lab forms annually

Database reports

The Data Manager runs annual queries to find volunteers who have not been submitting data regularly and to make certain that data is being entered in a timely fashion and also to check for outliers. A list is generated and given to each Regional Coordinator for follow-up.

Equipment Testing, Maintenance and Use Protocols

Secchi Disc Monitoring Protocol

The CLMN Educator distributed a study to check Secchi variability during a two year time frame. Volunteers were asked to collect six Secchi readings (3 ascending readings and 3 descending readings) at one time and record these six readings on a separate data sheet (Appendix 11). Only the average of these six readings was recorded on the official data sheet. These six readings were analyzed. The conclusions from this study were:

- Variability in readings is less when averages are taken as compared to taking only a descending or ascending reading. Volunteers should use “clothespin protocol as outlined in manual”.
- Secchi depth readings can change up to 17% of the maximum reading if the average is not used. The percentage of difference can be important for assessment purposes and will be more important for lakes with low Secchi depth readings.

- Repeat the process. Taking two or three measurements will result in a more accurate reading.

In 1999-2000 CLMN made an attempt to quantify the color of the water that was recorded by volunteers. We know that determining the factors that may be influencing transparency is essential to successful lake management practices. Currently, volunteers have a choice of recording blue (clear), green, brown, red or yellow as water colors. Veteran volunteers who had collected data for five or more years were asked to use the Custer color chart. The color chart had a range of colors numbered from 1 to 11. We found that volunteers had a difficult time assigning a number from the Custer color chart to the color of their water – perhaps because of the great variety of lakes found throughout Wisconsin. CLMN hopes to find color charts that can be used by volunteers to quantify color more accurately.

Water Chemistry Monitoring

Before use, the Doric temperature meter is tested to make certain that it is working. Replacement 9-volt battery or replacement unit is available from the Regional Coordinator. Check to make sure that integrated sampler and water collection bottle are clean. Check to make sure that sulfuric acid vials have been replaced annually and that mailer is available with clean 250 ml bottle and tube from SLOH. Check to make sure that labels and filters are available and that there is distilled water in unitary bottle.

Dissolved Oxygen Monitoring

Before use, the Doric temperature meter is tested to make certain that it is working. Replacement 9-volt battery or replacement of unit is available from the Regional Coordinator. All DO kits are checked to sure all reagents, bottles and syringe are clean and in good working order. Reagents are replaced annually according to manufacturer's recommendations. Reagents and replacement bottles are available from Regional Coordinator.

Native Aquatic Plant Monitoring

Before going out to monitor, volunteers check to make sure that they have zip-lock bags, water proof marker, macrophyte identification keys and/or books, and plant press.

Instrument Calibration and Frequency

Volunteers using a dissolved oxygen meter calibrate the instrument at the beginning of each monitoring day, prior to sampling. Forms are provided to each volunteer to record specific calibration details.

Inspection/Acceptance Requirement for Supplies

All equipment and supplies are delivered to volunteers in good working order. Prior to use, all equipment and supplies are inspected and, if applicable, calibrated.

Secchi discs, integrated samplers and Doric temperature meters are assembled by University of Wisconsin – Extension staff. After assembly, all equipment is inspected and tested.

Data Management

All data management responsibilities ultimately fall to the Data Manager. Data management occurs in a manner that facilitates the collection and storage of quality data by citizens in SWIMS.

Sample results captured by the State Lab of Hygiene are made available to the WDNR SWIMS database through the Lab Data Entry System. Same day access to sample results is available. Data is transferred to the WDNR computer for long term storage and manipulation.

Volunteers use standardized CLMN data sheets to report all data and all data is reported via web site, by phone or by mail by November 1 of each year. Suspect data are compared to historical data in the database. The Regional Coordinator contacts the volunteer who collected the data if inconsistencies are identified in the reported data.

Assessment and Response Actions

Volunteers have the opportunity to evaluate their training session and the program as a whole. Annual results of completed evaluations will be reported to the Citizen Based Water Monitoring team so that appropriate actions can be taken to revise and/or further develop support given to volunteers.

Reports

After the data entry is complete a lake summary report is supplied to the volunteer. The volunteer will receive either a hard copy in the mail or a notice by email that the lake summary report is available to them on line. Data is validated by the volunteer. The lake summary report contains raw data, a calculated TSI for each sampling event, and a narrative describing the trophic state. A trend analysis graph shows the trend in transparency changes per year. Volunteer perceptions of lake level, clarity, color and perception of algal levels are listed for verification by volunteer. Summary report also contains Secchi disc minimum and maximum values and the number of readings taken during a season. Average Secchi disc reading is calculated using July and August readings.

Data from SLOH is recorded on summary report for chemistry lakes. The actual phosphorus and chlorophyll-a amount is listed in ug/l. Each of the values for phosphorus and chlorophyll-a is converted to a TSI value. A trophic state index graph is provided that displays average summer (July-August) trophic state index values for Secchi, chlorophyll-a a and total phosphorus by year.

Data Review, Validation and Verification Requirements

Data collected by CLMN volunteers are reviewed by WDNR and other CLMN staff to determine if the data meet the QAPP data quality objectives and goals of the program. If a particular volunteer does not meet the expectations of CLMN than it is left to the discretion of the regional coordinator to consider further training for the volunteer.

This QAPP establishes the basic requirements regarding sampling methods and protocol, data reporting and documentation. If those requirements are not met by a volunteer, a decision can be made to reject or flag the data.

Validation and Verification Methods

Volunteers are asked to double check their data before entering it into the SWIMS database. Volunteers are asked to compare their computer entry or their phone entry on the lake summary report to field data sheets. After data are entered into SWIMS, the Data Manager looks for data completeness, data gaps and outlying values by running queries on the data and searching for outliers.

Volunteers who obtain monitoring results that are outside the normal range of results are asked to review their sampling protocol as stated in the CLMN water clarity or water chemistry manual. If sampling protocol was followed then the sampling results are reviewed by the Regional Coordinator, Lakes Coordinator, DNR Limnologist, algal or macrophyte specialist. CLMN is supported by a wide variety of experts in various fields that help to resolve the issue. Any chemistry sample that is outside of the expected range can be reported to the Regional Coordinator and the WDNR can repeat the sampling process to verify the condition.

The SLOH reports matrix spikes in the lake summary report and this data is available to both the volunteer and WDNR staff.

Aquatic plants are collected and pressed and preserved. If a volunteer collects an aquatic invasive species such as *Potamogeton crispus* or *Myriophyllum spicatum* or *Lythrum salicaria* the species is verified by Dr. Robert Freckmann, Plant Taxonomist with the University of Wisconsin – Stevens Point and vouchered. Knowledge of these invasive species on a water body is shared with the Lakes Coordinator and Aquatic Plant Management Coordinator and a course of action is decided.

Reconciliation with Data Quality Objectives

Data that do not meet quality objectives outlined in the Data Quality Objectives section of this document will be flagged in the database by the Data Manager or Regional Coordinator. If the data results are determined to be questionable, then the QC Code for that fieldwork event will be changed from Standard Sample to Questionable Data. Also, a note will be placed in the sample description to specify the parameter that are questionable and the reasons for being so.

The Regional Coordinator has the ability and knowledge to know if a volunteer should be retrained prior to his/her next sampling date and can work with the Data Manager to recommend discarding egregious data. If the failure to meet quality objectives is due to equipment malfunctions, then the equipment will be replaced and repaired immediately.

If failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season. Revisions will be submitted to the state and EPA quality assurance officers for approval.

APPENDIX 7

Larry Bresina, a CLMN volunteer, has conducted a study to reduce the effects of glitter and glare on Secchi disc readings. His paper “Secchi Depth Measurement Variability – Minimizing Effects of Glitter and Glare with a Viewer Box” is available on the CLMN web site at:

Mr. Bresina took Secchi depth measurements from the deep spot of a small Wisconsin lake every two weeks from May through September in 2006 and 2007. He compared measurements taken on the sunny side of the watercraft, shade side of the watercraft, naked eye and viewer box.

Factors which contribute to measurement error: (Source: Larry Bresina)

- Whiteness (and blackness) of the disc
- Sun position
- Surface ripples and waves (which cause glitter effects)
- Shadow of the boat or observer
- Surface reflections off the water (which cause glare effects)
- Clearness of the sky
- Time of day
- Observer vision characteristics (e.g., abnormalities, adaptation, sun glasses, etc.)
- Is protocol being followed?
- Is clothespin methodology being used?
- Condition of Secchi disc
- Stretching or shrinking of the rope

Conclusions of Bresina Study:

1. Measurements on the shady side produced an average 5% increase over the sunny side
2. Viewer box measurements averaged about 15% greater than naked eye measurements
3. Variability of consecutive measurements with the naked eye averaged almost two times greater than the variability of measurement with a viewer box
4. The % difference between viewer box and naked eye Secchi depth measurements increases as wave height increases.
5. Using a viewer box in windy conditions seems to approximate Secchi depth the naked eye when the lake becomes calm.

Mr. Bresina recommends that a two year study be implemented in CLMN. The objective would be to see if a closed end viewer box and naked eye measurements are consistent under wave/ripple conditions. Mr. Bresina is a proponent of using a closed end viewer scope to obtain more accurate Secchi readings.

CLMN has twenty-four years of baseline volunteer data and WDNR has at least thirty years of Secchi data. Data using a new Secchi technique might not be comparable to this historical data.

References:

Limonological Characteristics of Wisconsin Lakes, Technical Bulletin No. 138, WI DNR, Madison, WI. 1983

The Volunteer Monitor's Guide to Quality Assurance Project Plans, US EPA. 1996