Sigurd Olson Environmental Institute

NORTHLAND COLLEGE

Water Quality for Lakes
Field Operations Protocol

Version 1.0, March 2014

NOTE

The Sigurd Olson Environmental Institute (SOEI) at Northland College provides applied learning opportunities for students to assist natural resource professionals in lake management planning through researching the relationship between lakes physical, biological, chemical and social processes and lake use and watershed activities. The SOEI conducts water quality monitoring, baseline aquatic plant monitoring following Wisconsin Department of Natural Resources procedures, and shoreline habitat assessments to collect and analyze data for development of lake specific, comprehensive Lake Management Plans for lakes across Northern Wisconsin. This SOEI Water Quality for Lakes Field Operation Protocol documents operating procedures of inland lakes and Chequamegon Bay to assess change in the baseline limnological parameters, aquatic macrophytes, and shoreline habitat for the purpose of monitoring changes in water quality, aquatic vegetation, and shoreline habitat over time. This protocol includes Sample Design; Field Season Preparation; Training and Safety Procedures; Data Recording; Pre-Departure Activities, Monitoring Site Methods; Shoreline and Littoral Habitat Assessment; Baseline Monitoring of Aquatic Plants; End of Season Procedures, Quality Assurance Quality Control; and Data Entry, Analysis and Reporting measures that all staff and researchers follow in implementing the lake program.

The protocol also contains Standard Operating Procedures (SOPs) to follow at the office, laboratory and on-lake sites, including procedures for Field Season Preparation, Training and Safety, Using the GPS, Decontamination and Cleaning of Equipment, Calibration of Multi-probe sampler, Field Measurements and Water Sample Collection, Secchi Disk Sampling, Processing Water Samples and Laboratory Requirements, Shoreline and Littoral Habitat Assessment, Baseline Monitoring of Aquatic Plants, Data Entry and Management, Data Analysis, Reporting, Post-Season Procedures, Quality Assurance/Quality Control Standard.

The SOEI Northland College Water Quality for Lakes Monitoring Protocol consists of the following:

1. Protocol
2. Standard Operating Procedures

SOP #1: Field Season Preparation
SOP #2: Training and Safety
SOP #3: Using the GPS
SOP #4: Decontamination & Cleaning of Equipment
SOP #5: Calibration of Multi-probe YSI Sampler
SOP #6: Field Measurements and Water Sample Collection
SOP #7: Secchi Disk Sampling
SOP #8: Processing Water Samples and Analytical Laboratory Requirements
SOP #9: Habitat Assessment
SOP #10: Baseline Monitoring of Aquatic Plants in Wisconsin
SOP #11: Data Entry and Management
SOP #12: Data Analysis
SOP #13: Reporting
SOP #14: Post-Season Procedures
SOP #15: Quality Assurance/Quality Control Standard

Content

Background and Objectives

This protocol includes Sample Design; Field Season Preparation; Training and Safety Procedures; Data Recording; Pre-Departure Activities, Monitoring Site Methods; Shoreline and Littoral Habitat Assessment; Baseline Monitoring of Aquatic Plants; End of Season Procedures, Quality Assurance Quality Control; and Data Entry, Analysis and Reporting measures that all staff and researchers follow in implementing the lake program.

The protocol also contains Standard Operating Procedures (SOPs) that will be followed at the office, laboratory and on-lake sites, including procedures for Field Season Preparation, Training and Safety, Using the GPS, Decontamination and Cleaning of Equipment, Calibration of Multi-probe sampler, Field Measurements and Water Sample Collection, Secchi Disk Sampling, Processing Water Samples and Laboratory Requirements, Shoreline and Littoral Habitat Assessment, Baseline Monitoring of Aquatic Plants, Data Entry and Management, Data Analysis, Reporting, Post-Season Procedures, Quality Assurance/Quality Control Standard.

Measurable Objectives

The overall goal is to develop a program for monitoring water quality, aquatic macrophyte communities and shoreline habitat in inland lakes that will result in better understanding of the relationship between the lake physical, biological, chemical and social processes and lake use and watershed activities. Program objectives include development of Lake Management Plans on individual lakes.

Quality Assurance and Quality Control

Quality control is the planned and systematic pattern of all actions necessary to provide confidence that a project outcome fulfills expectations. Quality assurance is the systematic monitoring and evaluation of various aspects of a project to ensure that standards are being met. Together, quality assurance/quality control (QA/QC) is a significant part of any monitoring program. The objective is to ensure that the data generated are meaningful, representative, precise, accurate, comparable, and defendable.

This protocol includes standard QA/QC measures that will be followed for all procedures including field preparation, training and safety, GPS use, cleaning equipment and decontamination, equipment calibration and maintenance logs , field sampling measurements, water sample collection and processing, secchi sampling, shoreline habitat assessment, aquatic plant monitoring, data entry and management, data analysis, reporting, and post-season procedures. Each Standard Operating Procedure includes specific QA/QC measures for each procedure. See standard operating procedure (SOP) #12 for QA/QC details.

Logistics

The Sigurd Olson Environmental Institute Lake Program Coordinator is responsible for supervising the Lake Research Scientists/Technicians sampling activities and overall progress throughout the field season and assisting them with field work and questions concerning logistics, equipment, and supplies. The coordinator will also review entered data and submitted water samples to ensure accuracy.

SAMPLE DESIGN

Frequency of Sampling

The Sigurd Olson Environmental Institute collects water quality data several times during the ice-free season, which usually extends from approximately May through. Frequently collected data aid in understanding important issues, such as the onset of blooms of noxious algae and temporal patterns in temperature and dissolved oxygen.

Location of Sites

A single sampling site, typically located in the deepest part of the lake, will be the routine location for measuring all water quality variables. Water quality at the deep hole is generally representative of water quality in the lake as a whole. Large lakes of those with several basins have data collected at more than one sample site which accounts for physical, chemical, or biological variations among basins and provides better understanding for managing the system.

Depths of Sampling

The depth of sampling for laboratory analyses of water chemistry varies among sample sites. The SOEI samples with a 0 - 2 m integrated sampler tube. We will collect a near-bottom sample (~1 m from bottom) via Kemmerer sampler during the summer, when lakes are stratified, for analysis of TP.

Timing of Sampling

We will attempt to visit a given lake at approximately the same time of day each time we sample to minimize variation due to diurnal fluctuations.

Field Season Preparation and Equipment Setup

(Summary of SOP #1: Pre-Season Preparations)

The program coordinator will conduct the following activities in the months prior to field season (checklists are located in the appropriate SOP). If needed, replacement equipment or supplies should be ordered in advance.

Checklist of activities to be conducted prior to the start of sampling season:

- Review sampling methods
- Schedule site visits
- Review checklists of all equipment and supplies
- Charge/replace batteries
- Calibrate and test equipment, repair/replace probes and meter as needed
- Check expiration dates of reagents and calibration standards
- Prepare list of items to be ordered; order supplies
- Update site binders
- Hire and train students
- Prepare/copy field data forms, chain of custody, calibration sheets, sample bottle labels
- Review sample collection, processing and documentation information

Training, Safety, Data Recording

The role of program coordinator is to train student interns hired for the Lake Program to:

1) Properly use, calibrate and maintain field and water quality sampling equipment.
2) Facilitate daily field preparation activities and inventory of supplies.
3) Collect and record data and samples through controlled and standardized procedures.
4) Regularly inspect vehicles, boats and trailers for secure hitches and straps, to ensure proper working order, and to check that no aquatic plants or animals are attached.
5) Safely and thoroughly execute duties and project activities.

The responsibility of the program coordinator and student researchers is to conduct all field work related to the lake program. Responsibilities and training for all field staff include:

- Completion of all pre-field season preparation
- Completion of Northland College Van and Trailer and Wisconsin Boat Safety Certifications
- Calibration of equipment according to protocols and manufacturers' directions
- Field sampling, collection handling and data recording performed according to SOPs
- Assurance that all QA/QC procedures are implemented
- Communication of progress/accomplishments with the Lake Coordinator
- Download, entry, and verification of data into databases
- Documentation and maintenance of data collection details, accurate field data and office notes
- Scanning hard copies of data forms and storing electronically on a regular basis
- Represent Northland College in a professional manner while maintaining positive communication among the College, resource professionals, and the public

Student researchers need a background/coursework in biology, chemistry, or other related physical or biological science. Prior field experience, boat and motor operation, and laboratory experience is preferred. All students must be physically fit and able to swim, move heavy equipment, work long hours in inclement weather, and must wear a personal flotation device (PFD) on the lake.

Training Procedures

Prior to field sampling and data collection, students must become familiar with the use, calibration, and maintenance of all meters, probes and equipment planned for use in the monitoring project. A combination of classroom and field training will occur at the start of each field season. SOEI research assistants, who have demonstrated proficiency in basic technical skills, will participate in the review of all methods and techniques and will assist in training on new research technicians.

Specific details of the training procedures are covered in SOP #2 and include:

- Basic limnology concepts and field sampling equipment
- Review of all SOPs for the project
- Calibration, acceptable criteria, operation, and maintenance of all meters, probes, and GPS equipment
- Troubleshooting tips for equipment
- Completion of calibration and lab sheets, sample labels, field data forms, and Chain of Custody
- Methods for sample collection, handling and preservation
- Methods for equipment decontamination and cleaning

Safety Procedures

All students are trained on the following topics to ensure safety of all field staff:

- Van and Trailer Certification through Northland College
- Wisconsin Boating Safety Certification
- Proper field clothing and gear (including PFD use) for weather conditions
- Handling of chemicals and other hazardous material
- Proper safety practices and clothing for all lab and field procedures
- Equipment and boat training, safety check, and maintenance
- First aid kits in daily field equipment and vehicles
- Allergies to bee stings, other insects, or plants must have personal precautions
- Field visits require at least two staff at all times

Field Data Sheets Recording

- Record data only on the appropriate SOEI field sheet: Lake Water Quality Monitoring Field Data Sheet, Lake Habitat Assessment or Aquatic Plant Survey
- Print neat and legible (as big as possible) with a **PEN**. Clearly distinguish letters/numbers.
- If you make an error when recording data, cross out the error with a single line, rewrite the correct information, and initial the correction.
- Accurately and completely record all information on all data sheets.
- Record information on first and last lines, and then connect using a wavy vertical line.
- Record comments **legibly** in the "Comments" field only and do not doodle on the forms.

Water Sample Collection Labels and Data Sheet Recording

Prior to field visit:

- Label water sample bottles prior to lab departure with a **permanent marker** that leaves fine, clear text to fill out **ALL** information on sample bottles.

In the field:

- Record the time of sample on each sample bottle with permanent marker.

Quality Assurance and Quality Control

QA/QC is integrated into routine and standard methods, ensuring that project deliverables/expectations are surpassed, and that data are precise, representative, meaningful, and repeatable. These include:

- Standardized training and Standard Operating Procedures for all methods
- Maintenance, review and updates of lake program field sampling methods
- Lake Monitoring Field Binder: GPS coordinates for site verification, lake maps with sites, data sheets (WQ, habitat, or aquatic plant survey), copies of previous data for comparison
- Equipment Calibration Log and Accepted Criteria for multi-probe YSI (sonde)
- Replicate water samples/field measures, re-assessment for shoreline habitat/aquatic plants
- Field data forms and database electronically maintained

Further QA/QC measures on calibration frequency and data management are at the end of this protocol. Method specific QA/QC are listed in each SOP or Standard Operating Procedures #12.

Pre-Departure Activities

The following section describes activities that take place at the SOEI office and Applied Research and Environmental Laboratory (ARE Lab) at Northland both before departure to the lake site(s) and upon return from the field. Close attention to details ensures that student researchers have verified sampling locations, properly calibrated equipment, and that their collected water samples are labeled, handled and checked in to the lab according to protocol.

Pre-departure checklist:

- Refuel vehicle(s) and conduct maintenance activities the night before
- Discuss daily itinerary, verify lake and maps
- Calibrate instrument and complete log according to SOP #5: Calibration of Multi-probe YSI
- Label water sample bottles and draft Chain-of-Custody form
- Lake WQ Monitoring, Habitat Assessment or Aquatic Plant Survey Field Binder including data sheets and lake maps
- Water Quality Monitoring checklist and field equipment
- Pack YSI, (duplicate sampler if necessary) and sampling gear safely for transport
- Load equipment/gear into vehicle (use of checklists is highly recommended)
- Inspect trailer lights, turn signals, and brake lights before every departure.
- Make sure trailer hitch, electrical connections, and boat straps are secure before departure.

Instrument Checks and Calibration

Field equipment will be charged, checked and/or calibrated daily prior to field visits. Backup instruments will be maintained including multi-probe YSI, depth finder and GPS units.

Multi-probe Sonde and Depth Finders

- Multi-probe YSI calibrated daily prior to field visits following YSI manufacturer instructions.
- Routine quality control calibration checks and a maintenance schedule will be implemented and logged as described in the SOP #5: Calibration of Multi-probe sampler.
- New batteries installed in all field equipment including depth finders and multi-probe sampler at beginning of the field season and checked routinely during season.

GPS Units

- GPS units will be charged daily prior to departure and checked for proper lake maps including point intercept, navigation or parcel maps.
- Map datum checked for NAD83.
- Extra battery stored in field gear and a backup instruments will be maintained.
- Perform manufacturer checks as necessary.

Water Sample Collection Preparation

Water sample bottles will be labeled with computer printed Avery labels and packaged into coolers prior to departure. Sample labels include: Lake id code, parameter, date, collector and time (collector and time left blank to be filled in at actual time of collection). Chain-of Custody form may be drafted prior to lab departure or completed upon post-sampling return to lab.

Lake Field Binder

Field binder includes GPS coordinates for site verification, lake maps with sample sites located, and either the SOEI Lake WQ Monitoring data and lab sheets and copies of previous data for comparison, or Lake Habitat Assessment data sheets, or Aquatic Plant Monitoring field sheets.

Water Quality Monitoring Equipment and Supplies Checklist:

- Water sample bottles, acid ampoules, safety goggles and gloves
- Multi-probe YSI (and duplicate sampler if necessary)
- Kemmerer
- Carboy
- 2 meter Integrated sampler tube
- Lake WQ Sampling (Habitat Assessment or Aquatic Plant Survey) data folder with sheets
- GPS unit
- Secchi disk
- Pens
- Permanent marker (for label bottles)
- Personal gear including: water, food, sunblock, sunglasses, proper/protective clothing, etc.

Lake Water Quality Monitoring Site Activities / Methods

This section summarizes field measurements and sampling techniques. Specific details are described in the Standard Operating Procedures (SOPs) #6: Field Measurements and Water Sample Collection, SOP #7: Secchi Disk Sampling, and SOP #11: Post-Season Procedures. The section ends with an overview of quality assurance and quality control (QA/QC) procedures, which pertain to all aspects of sampling. The details of QA/QC are presented in SOP #12.

Daily Field Activities, Field Measurements and Collecting Samples

The following is a sequence of activities during a water quality monitoring field day:

1) Complete pre-departure activities checklist.
2) Review the checklist of field gear.
3) Drive to boat landing. Load boat with sampling gear, launch boat, and navigate to monitoring site. Set up on the boat for sampling.
4) Verify correct monitoring site location with depth or GPS coordinates.
5) Fill out a SOEI Northland College WQ Monitoring Field Data Sheet (below) for each monitoring site, printed on waterproof paper.
6) Implement field methods and water samples per SOP #6: Field Measurements and Water Sample Collection. Collect water samples from the greatest depth last (usually the bottom).
7) Be sure that all samples are correctly labeled and preserved on ice.
8) Verify that the field form is completely filled out, and initial the form.
9) If sampling from more than one monitoring station in a day, go back to step 4.
10) Upon return to shore, inspect boat, trailer, and all equipment that has come into contact with the water for invasive species. Follow decontamination procedures per SOP #4.
11) Return to office or lab.
12) Clean sampling equipment per SOP # 4: Decontamination & Cleaning of Equipment. Rinse sensors with deionized water.

13) Processing samples per SOP # 8: Processing Water Samples and Analytical Laboratory Requirements. Refrigerate or freeze samples, as required.
14) Enter data into SWIMS as soon as possible after collecting field data and receiving results of laboratory analyses.

Monitoring Site Methods and Recording Field Information

Upon arrival at the monitoring site(s) (see drawing on page 18), observations and data measurements will be recorded, and water samples will be collected. Record the following on the Lakes WQ Monitoring Field Sheet:

- Lake and Site Location (such as "Deep Hole," "South Basin DH", etc.).
- Landing Time: Launch and Departure
- Depth at Location (accurately measure the depth using the hand-held depth finder)
- Date and Sampling Site Time: Arrived/Departed
- Field Staff
- Secchi readings
- Instrument and Calibration (Cal) Date
- Barometric Pressure (mmHg) and Air Temp (C)
- Water Sample Type: (I-tube, Grad sample, Kemmerer)
- Kemmerer Depths (m)
- Water Sample Times

In addition, you will record general observations which may be useful in interpreting water quality information. These include:

- Water Condition (cond.): clear or murky (high amount of suspended matter) and water color
- Odor detected (Y/N) such as sulfur, mustiness, sewage, chemical, or other.
- Profile measurements at 1 meter intervals for temperature, DO, pH and conductivity.
- Current weather including percent Sky cover and Wind condition.
- Recent rainfall and wind events (within past 48 hours) that may have impacted water quality including: cold front, lack of precipitation, or heavy precipitation.
- Biological activity including wildlife observations (such as fish, birds, or spawning) and excessive aquatic plant or algal growth. The observation of water color and excessive algal growth is important in explaining high chlorophyll-*a* values.
- Lake activities such as inlet/outlet stream activity, shoreline mowing, new construction, high densities of fast moving boats or personal water craft close to shore, irrigation, etc.

Measurement of Field Parameters: Depth Profile and Secchi Transparency

Field measurements must be collected from an undisturbed area. The multi-probe YSI must be calibrated daily and allowed to stabilize at the field site prior to data recording. QC measures include replicate field measurements and water samples once a month for each sample site conducted through side-by-side simultaneous comparisons. Acceptable comparisons to originals are listed below:

Replicate Parameter	Acceptable Criteria
Temperature	±1° C
Dissolved Oxygen	±10%
Specific Conductance	±10%
pH	±10%
Secchi	±10%

Summary of Depth Profile Method

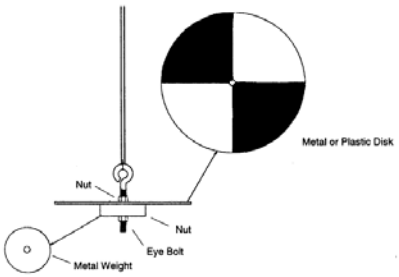
Specific details are described in the SOP #6: Field Measurements and Water Sample Collection. Record site information, general observations, weather, and wind conditions. Use a multi-parameter YSI to measure temperature, DO, pH and conductivity at 1 meter (m) intervals at the deepest hole in the lake and any additional monitoring sites. Turn the equipment on and enter the proper lake, site location and date. Attach the sonde cable to a measured rope in 0.5 m increments. Lower the sonde into the water just below the surface. Wait for the DO value to stabilize. Since DO takes the longest to stabilize this assures all parameters have equilibrated. Record the measurements for temperature, DO, pH and conductivity from just below the surface, at 1m intervals, down to 0.5 m above the bottom. Upon completion, take a final DO measurement at the surface and compare it to the initial reading to see if the probe is holding calibration. Record this on the data sheet. If the lake is thermally stratified (accepted change of ≥1° C per meter depth) note the top and bottom depths of the metalimnion based on the temperature. The probes are delicate; take care to avoid putting the probe into contact with the bottom. For quality control, compare sonde measurements against an independent sampler, or repeat sample, once a month per site.

Equipment and Supplies

- SOEI – Northland college Lake Water Quality Monitoring Field Data Sheet (see next page)
- Depth Finder (hand-held or boat mounted sonar)
- Measured rope (30 m, marked in 0.5 m intervals)
- Multi-parameter sampler or sonde including temperature, pH, DO, and Conductivity probes

Secchi Disk Transparency Method

A Secchi disk is a black and white patterned disk used to measure a lake's clarity.



Use a 20 cm black and white Secchi disk. Do not wear sunglasses during the measurement. Lower the disk vertically into the water on the shaded side of the boat until it disappears, then raise it up until it reappears. The mid-point between the two, measured to the nearest 0.1m, is the 1st reading. Repeat and record as the 2nd reading. Then average the two readings and this is the day's depth of clarity. At a minimum, replicate Secchi readings once a month at each monitoring site. For the first round of sampling, all field crew members should practice the secchi measurement at each site The crew should not reveal their value until all are finished and then all values should be recorded and compared. Values should agree within ± 10% for measurements <5 m and ± 0.5 m for greater depth values.

Equipment

- SOEI Lake WQ Monitoring Field Data Sheet
- Secchi disk with attached rope 18m rope marked to 10 m in 0.1 and 1.0 m increments

SOEI Northland College Water Quality for Lakes Monitoring Data Sheet

______ Initials

Lake _________ Site_______ Landing Arrival Time: ______ Landing Departure: _______

Depth at Site ___________ Day & Date_____________ Site Arrival Time:______ Departure: ______

GPS ___________________ Secchi (m) 1st _____ 2nd _____ Average ____

Field staff _________________ Secchi reading condition: excellent 1 moderate 2 poor 3

Sampler ____ Cal Date _____ Water Clarity: Clear / Murky Color: (Brown,blue,green)_______ Odor: Y / N

Barometic Pres. _____mm Hg Water Sample type: I-tube Grab Kemmerer

Air Temp (°C) _______ Kemmerer Depths (m): Metalimnion ________ Bottom: ________

Lake Water Level: Water Sample Time: Surface _______ Metalimnion _______ Bottom _______

High Average Low Phytoplankton Sample Depth (0.5 m off bottom):_______ Sample Time: ________

D.O. Surface Reading @ Profile Completion_____ Matches initial reading Y / N

Lake Strata: S=Surface B=Bottom M=Metalimnion Q=QA/QC

Strata	Depth (m)	Temp (°C)	DO (%sat)	DO (mg/L)	SPC (µS/cm)	pH	SKY	WIND

Current weather:	**Past 48 hours rainfall & wind:**
Weather Observations- List code in columns above.	**Shore/Land Use:**

Sky Cover	Code	**Wind Condition**	Code	**Wildlife / Notes:**
Clear: <10%	0	Smoke rises vertical	0	
Scattered: 10% to 50%	1	Leaves rustle	1	
Broken: 51% to 90%	2	Wind felt on face	2	
Overcast: > 90%	3	Flag extended, leaves move	3	
Light Mist / Fog	4	Small branches move	4	
Heavy Fog / Precipitation	5	Small trees begin to sway	5	

Water Sample Collection

Collect surface water sample(s) with an integrated sampling tube for 0-2 m samples and a Kemmerer for metalimnion and near-bottom samples. On the field data sheet, record information related to the sample collection.

Always keep the following in mind:

- Sample containers should be labeled in advance with computer printed Avery labels or permanent marker. On the first line: lake name, basin (if applicable), lake horizon (surface, middle or bottom), month and on the second line with: collector name, time of collection, and parameter.
- To ensure the integrity of the sample, be aware of possible sources of contamination.
- Use appropriate procedures and quality-assurance measures that ensure sample representativeness and integrity and that meet study criteria.

Summary of Method

Rinse all surface water bottles and caps three times by removing cap, filling bottle with approximately 50mL of surface water, capping it and shaking the bottle. Pour water off down wind. Rinse the 10L Nalgene carboy accordingly. Collect surface water samples using an integrated sampler. The device is a PVC tube 6.6 feet (2 meters) long with an inside diameter of 1.24 inches fitted with a PVC cap on one end. This allows water collection from the upper two meters of the water column (within euphotic zone).

Remove the cap and rinse the sampler by submerging it vertically in the lake three times. With the cap off, slowly lower the sampler into the water as vertically as possible until the upper end is just below the surface. Cap and slowly raise the sampler. Dispense the contents of the sampler into the rinsed 10L carboy. Use the spigot on the carboy to fill the surface water sample bottles. Pour into one 1 L sample bottle for ***chlorophyll-a*** filtering, one 500 mL bottle for the ***Total Nitrogen***, one 250 mL sample bottle for ***Total phosphorus.*** Place samples on ice in cooler.

Use Kemmerer to collect middle and bottom lake samples. Pull the top and bottom of Kemmerer in opposite directions until it snaps in the open position. Make sure that the valve is closed on the bottom. Lower the Kemmerer into the metalimnion layer and then 0.5m from the bottom for bottom sample. Send the messenger weight down the rope line to close the kemmerer. Rinse sample bottles with middle and bottom water 3 times. Fill bottles close to the top. With gloves and safety goggles on, add acid ampoule to phosphorus sample and shake. Store samples in cooler on ice.

Equipment and Supplies

- SOEI Lake WQ Monitoring Field Data Sheet
- Depth Finder (hand-held or boat mounted sonar)
- Measured rope (30 m, marked in 0.5 m intervals)
- 2-meter Integrated Sampler Tube
- HDPE bottle (60 mL, white, wide-mouth)
- HDPE bottle (250 mL, brown, wide-mouth) – nutrients
- HDPE bottle (1 L, white, narrow-mouth) – phytoplankton
- Poly bottle (2 L, brown, labeled INDEX) – chlorophyll A
- Wet ice & Cooler

Water Sample Preservation, Handling, Transport to Lab

General Steps for Sample Preservation and Transport back to the Lab:

1. Ensure that all samples are labeled and all labels are completely filled in.
2. Record all sample collection dates on sample bottles and field data sheets.
3. Seal all caps tightly. Place in cooler and surround and cover the samples with wet ice.
4. For the nutrients sample, when you return to the lab, add acid from an ampoule to the water to stabilize the sample. Dispose of ampoule properly.

All data should be recorded clearly on SOEI Lake WQ Field Data Sheet. If an incorrect entry is made, a single line should be drawn through the incorrect entry and the correction made. All corrections should be initialed and dated.

Zooplankton Collection

The objective is to sample a sufficient volume of water to obtain at least 300 organisms per sample from all but the most oligotrophic lakes.

Summary of Method

A single tow is taken of the sample site water column using a mesh (63 μm) Wisconsin net with sample bucket attached at the end and a single tow is taken of the sample site water column using a mesh (20 μm) Wisconsin net with sample bucket attached at the end. Carefully inspect the net and bucket for holes or tears. Carefully lower the net over the side of the boat in a constant upright position to within 0.5 m of the bottom. Raise the net vertically back to the surface at a slow, steady rate. At the surface, dip the net up and down in the water without submerging to rinse the contents into the bucket. Spray lake water against the outside of the net with a squirt bottle to release organisms inside the net into the bucket. If additional rinsing is needed inside the net, use de-ionized water. Transfer the sample from the bucket to a 125 mL sample container. Narcotize the organisms with carbon dioxide and preserve each sample with 95% ethanol. If the sample site is less than 2 meters deep and the Secchi disk can be seen at the bottom, a second tow is made and the samples are combined.

Equipment and Supplies

- SOEI Lake WQ Monitoring Field Data Sheet
- Depth Finder (hand-held or boat mounted sonar)
- Measured rope (30 m, marked in 0.5 m intervals)
- Plankton Net (63 μm) and collection bucket
- Plankton Net (20 μm) and collection bucket
- Squirt Bottle (1 L Nalgene) – de-ionized water and Squirt Bottle (1 L Nalgene) – lake water
- Pail (narcotization chamber) and CO_2 (Alka seltzer) tablets
- HDPE bottle (125 mL, white, wide-mouth)
- Ethanol (95%)
- Funnel, Wet ice & Cooler

QA/QC (Should I call this section: Re-Sampling (do we even need to re-sample?))

At resample site lakes, collect additional zooplankton samples following the method described above and detailed in SOP # (different net design, mesh sized, and cumulative tow length). Results from this set of samples will be compared to previous zooplankton. Do we need this?

Summary of Zooplankton Sample Preservation, Handling, Transport to Lab

Set collection bucket in a pail half full of lake water. Add two CO_2 (alka-seltzer) tablets to narcotize the zooplankton prior to preservation. When movement has stopped, squirt a small amount of DI water to rinse the majority of zooplankton into a 125 mL polyethylene bottle. Fill the bottle to the shoulder (use funnel) with 95% ethanol to preserve the sample. In some cases, the zooplankton collected may exceed 125 mL. Do not try to force the entire sample into a single bottle. Fill the first bottle half full, then use another bottle to preserve remaining. Complete the label, and print in the sample number assigned to the first container on the second label. On data sheet, record 2 jars in "No Jars" field.

General Steps for Sample Preservation and Transport back to the Lab:

1. Ensure that all samples bottles and field data sheet have sample collection ID and dates recorded.
2. Check on the Lake WQ Monitoring Data Sheet that sample(s) is preserved.
3. Seal all caps tightly and place in the cooler and surround and cover the samples with wet ice.

All data should be recorded clearly on SOEI Lake WQ Field Data Sheet. If an incorrect entry is made, a single line should be drawn through error, correction made and initialed and dated.

Post Field Collection, Site Departure, Arrival at SOEI

The following is a sequence of activities for site departure:

1. Ensure that all data fields lake have been filled in and are accurate and legible. After reviewing each form, initial the upper right corner of the form.
2. Ensure that all sample labels are filled in with the collection time and collector initials.
3. Return to boat landing and load the boat on to the trailer.
4. Inspect the boat, motor, trailer, and all equipment for any aquatic plants and animals as thoroughly as possible and remove as necessary before leaving the launch site.
5. If traveling to a different lake, NOT connected to original lake, g site on the same day, disinfect and decontaminate the boat, motor, trailer, ropes and equipment per SOP #4: Decontamination to Remove Exotics Species
6. Load all field gear and samples into vehicle and drive back to the SOEI and ARELab.
7. Upon arrival at SOEI, decontaminate the boat, trailer, anchor lines and ropes with a 5% bleach solution per SOP #4: Decontamination to Remove Exotic Species.
8. Clean equipment in the lab per SOP #4: Decontamination & Cleaning of Equipment.
9. Transport water samples to lab for processing.
10. Enter data from field sheets into SWIMS.

ARE Lab Water Sample Processing

Water samples will be processed at Northland's state-certified Applied Research and Environmental Laboratory (ARE Lab). This will require filtering and preserving samples according to lab requirements. Standard operating procedure (SOP) #8: Processing Water Samples and Analytical Laboratory Requirements provides detailed instructions on the handling and processing of water samples prior to analysis. These procedures ensure that maximum holding times are not exceeded.

Summary of Analytical Methods

The table below summarizes samples to be analyzed by the ARE Lab including the analytic, volumes, preservation techniques, and holding times for water samples addressed in this protocol.

Examples of analytic, volume requirement, preservation method, and holding times.

Analytic	Volume (mL)	Preservation	Hold Time
Chlorophyll a	≤ 1 L	Freeze filter	30 day
DOC	125	pH < 4 H_2SO_4 4°C	28 days
TP	120 mL	MgCl 4°C 4°C /H_2SO_4 pH < 2 HNO_3	30 days 48 h / 30 days 6 months
TN	120 mL	4°C /H_2SO_4 4°C Filter	48 h / 30 days 7 days 100 days

The frequency at which water samples will be collected and the collection depths of those samples depths at which samples will be collected. Surface samples will be a 0 - 2 m integrated sample. Bottom samples will be collected during mid-summer, if a lake is stratified.

Water Quality Variables	Monitoring Frequency
Total phosphorus (TP)	2x/ month Surface & bottom
Total Nitrogen (TN)	2 x/mo, surface
Dissolved organic carbon (DOC)	1x/yr; surface
Total chlorophyll-*a*	3x/yr; surface

Sample Handling and Processing Procedures

The following general techniques will be implemented back at ARE lab.

1. Complete and sign the Chain-of-Custody Sheet for all water samples collected.
2. Add acid to each phosphorous sample for stabilization. Dispose of ampoule properly.
3. Place all samples in the refrigerator except Total Nitrogen goes in the freezer.
4. Follow lab instructions for any samples shipped to a contract laboratory.
5. Keep all water samples cool and dark until processing is complete and samples are shipped to the analytical laboratory.
6. Use only new, clean sample bottles supplied by the analytical laboratory or purchased pre-cleaned from a supplier.
7. Rinse filtration equipment with deionized water (DIW) three times between samples.
8. Avoid touching the inside of sample bottles and filtering apparatus, tips of forceps, and filters to prevent contamination of the samples.
9. When filtering samples in the field, use an enclosed filtering apparatus to minimize

contamination from airborne sources.

10. Wear disposable, powderless gloves when working with acids and other preservatives.
11. Filter samples in the order of anticipated phosphorus concentrations, from low to high.

    After filtering a water sample that is expected to contain high nutrient concentrations, rinse the apparatus three times with 0.1N HCl followed by three times with DIW water before processing the next sample.
12. Prepare QA/QC samples in the same manner as regular samples, using water from the same sample collection container.
13. Rinse all reusable equipment with DIW immediately, before equipment dries.
14. Ensure all sample bottles are labeled correctly, completely, and legibly.
15. Check laboratory equipment and supplies list (Table 3) and ensure equipment is clean and ready for use and supplies are adequate.
16. Prepare a temperature check bottle for each anticipated cooler, if recommended by the contract analytical laboratory. Use tap water to fill an extra bottle of the same size used for one of the analytes and label as "Temperature Check". Store this check bottle in refrigerator with other samples; package and send to the analytical laboratory with the other samples.

Table 3. Laboratory equipment and supplies list.

- Filtration towers and manifold (4.7 mm) plastic
- Vacuum pump with pressure gauge and extra filtering flask as a water trap to protect the pump in case of overflow
- Graduated cylinders, plastic 250, 500 and 1000 mL
- Whatman GF/C filters (4.7 cm diameter)
- 0.45 μm Millipore membrane filters (4.7 cm diameter)
- Filter forceps with broad tips
- Aluminum foil
- Labeling tape, permanent markers
- Deionized water (ASTM grade 1 or 2; 1-10 megohm)
- Acid for preservation (according to contract laboratory specifications)
- Freezer
- Plastic storage bags
- Sample bottles (provided by analytical laboratory)
- Insulated ice chest, ice, and ice packs
- Saturated MgCO3 solution (for chlorophyll *a*), depending on laboratory method
- Adjustable automatic pipettes: 1-5 mL ; 0.2-1 mL; 0.02 -0.1 mL
- Parafin paper roll
- Wash (squirt) bottles – 500 mL
- Kim wipes

The following sections detail the procedures to be followed when processing water samples for particular analysis.

Total Chlorophyll-*a*

1. Fit rinsed filtering device with a Whatman GF/C glass fiber filter using forceps, smooth side down (curl is up).

2. Agitate water sample (always shake well to minimize subsampling error for solids).

3. Set pump vacuum to $\leq$ 0.5 atmospheres (7.5 PSI or 380 mm Hg). If using a hand pump, maintain pressure at or below 10 PSI.

4. Use a glass or plastic graduated cylinder to measure 100 - 1000 mLs of water sample. Filter sample. If water is very turbid, filter small aliquots (100 mLs) to avoid clogging the filter. Sufficient volume has been filtered when a green, brown, or tan color is clearly visible on the filter and the flow decreases to a few drops/second.

5. Add 0.15mls (~3 drops) of saturated $MgCO_3$ during the last 30 mLs of filtering to buffer the filter, if required by the method used by the contract analytical laboratory.

6. Rinse graduated cylinder and filtering apparatus with DIW and pass through filter to include any algae that may have adhered to the sides of the cylinder.

7. Record volume filtered on data sheet (excluding DIW rinse).

8. Use forceps to fold filter into quarters with sample on the inside; do not touch filter with fingers.

9. Wrap filter in foil; label foil with sample location, date and time sample was collected, and volume filtered. Place foil in small, sealable baggie with standard laboratory label.

10. Refrigerate immediately and freeze as soon as possible. Place small baggies with foils together in a large, sealable freezer bag. A third watertight container may be used for shipping to ensure that melt water in transport will not corrupt the samples.

Unfiltered (Raw) Samples

11. Rinse sample bottle provided by analytical laboratory 1x with sample water.
12. Fill sample bottle with sample water (fill to neck if sample will be frozen).
13. Refrigerate or freeze, as per laboratory instructions, until packaging for transport to analytical laboratory.

Filtered Samples

14. Using clean forceps, place a 0.45µm Millipore cellulose membrane filter in the filtration apparatus. Rinse with 100 mL DIW into a cleaned (0.1N HCl and DIW rinsed as per sample bottle cleaning) filtering flask (glass or plastic). Rinse flask with filtrate and discard filtrate.
15. Filter a small amount (~50 ml) of sample water; rinse filtering flask with filtrate and discard filtrate.
16. Filter enough of the sample to produce the required amount of filtrate to be tested.
17. Dispense the filtrate into separate bottles provided by the analytical laboratory as follows:
    - Unpreserved constituents – rinse bottle with small amount of filtrate (~10 ml) and discard; fill bottle to neck, refrigerate or freeze as per laboratory instructions.
    - Preserved constituents - if pre-loaded with preservative by the analytical laboratory, fill bottle and store at room temperature or refrigerate. If bottle does not come pre- loaded

with preservative, rinse bottle with small of amount of filtrate (~10 ml) and discard, fill bottle approximately ¾ full, add the preservative (ampule provided by laboratory) and continue to fill bottle until full. Gently roll bottle to mix. Store at room temperature or refrigerate.

Zooplankton Sampling Handling and Processing

Data and Records Management

Complete and accurate record keeping of field-derived data is an essential component of monitoring water quality. Field technicians, crew leaders, and project leaders share responsibility for collecting, verifying, and documenting data according to the guidelines in this monitoring protocol and all applicable standard operating procedures. Data and records management include the following responsibilities:

1. Refer to the Data Management Plan for overall guidance.

2. Follow the QA/QC procedures in SOP #8 for specific instructions on data entry, management, verification, and validation.

3. Record and verify observed or measured data values, including completing paper forms and entering data into NPSTORET and/or other electronic databases. NPSTORET maintains the necessary relationships between data values, equipment configuration and calibration, procedures, methods, and metadata.

4. Schedule and perform regular data transfer and backup. Data will be protected from loss or damage by daily backup when possible, or on a feasible schedule approved by the project leader and the data manager.

5. Review, verify, and correct field data and sample processing information as soon as possible after the actual survey (see SOP #8 for more details).

6. Prepare data and procedural documentation, especially deviations from the protocol or study plan, including metadata forms in NPSTORET and additional documentation requested by the project manager or data manager.

7. Ensure that field forms, field notebooks, and other hardcopy records are secure, organized, and available for viewing, reproduction, or transfer upon request.

8 The completed field forms will be maintained in the Lake WQ Monitoring binder until the data is entered into SWIMS and SOEI database, then data sheets are scanned and electronically filed. Field data are reviewed regularly by personnel (see SOP #11: Data Entry and Management, for details).

Quality Assurance/Quality Control

Quality assurance and quality control are ensured through:

- Standardized training and Standard Operating Procedures for all methods
- Maintenance, review and updates of lake program field sampling methods

- Lake Monitoring Field Binder: GPS coordinates for site verification, lake maps with sites, data sheets (WQ, habitat, or aquatic plant survey), copies of previous data for comparison
- Equipment calibration schedule and Accepted Criteria
- Calibration logs for multi-parameter sonde probes
- Replicate water samples/field measures/zooplankton collection, re-assessment for shoreline habitat/aquatic plants
- Field data forms and database electronically maintained

The most important aspects of quality control in the collection of water quality samples are: 1) Samples collected should represent the lake site at the time the samples are collected, such that the samples meet the objectives of the project; and 2) the integrity of the samples collected is not compromised by contamination, misidentification, or improper sample handling or preservation.

To help meet these quality control aspects, transport and tracking of the samples from the field to the analytical laboratory that performs the chemistry analyses is critical. Each set of samples should include a Chain of Custody Form (COC). To prevent water damage to paperwork, all field sheets are copied onto Rite-in-the Rain paper. Copies of the completed COC forms in the office binder. See SOP #12, Quality Assurance/Quality Control, for details. Specific QA/QC measures are listed in the SOP.

Before Leaving Field Sites:

- Review all field sheets for accuracy, completeness, and legibility.
- Verify that water sample labels have correct Sample ID numbers.
- Confirm that the sheets have been reviewed by recording your initials in the "initials" field on the Northland College Lake Water Quality Monitoring Field Data Sheet or name(s) in the "Observer" field(s) on the Lake Habitat Assessment and Aquatic Plant Survey field sheets.

Shoreline and Littoral Habitat Assessment

The Sigurd Olson Environmental Institute conducts shoreline and littoral vegetative habitat assessments to better understand and characterize the near-shore habitat on northern Wisconsin lakes. Vegetation conditions and characteristics are observed within a defined, visual transect on parcels. There are two types of habitat assessments conducted on each lake, the "Big 10" and the "All Parcel."

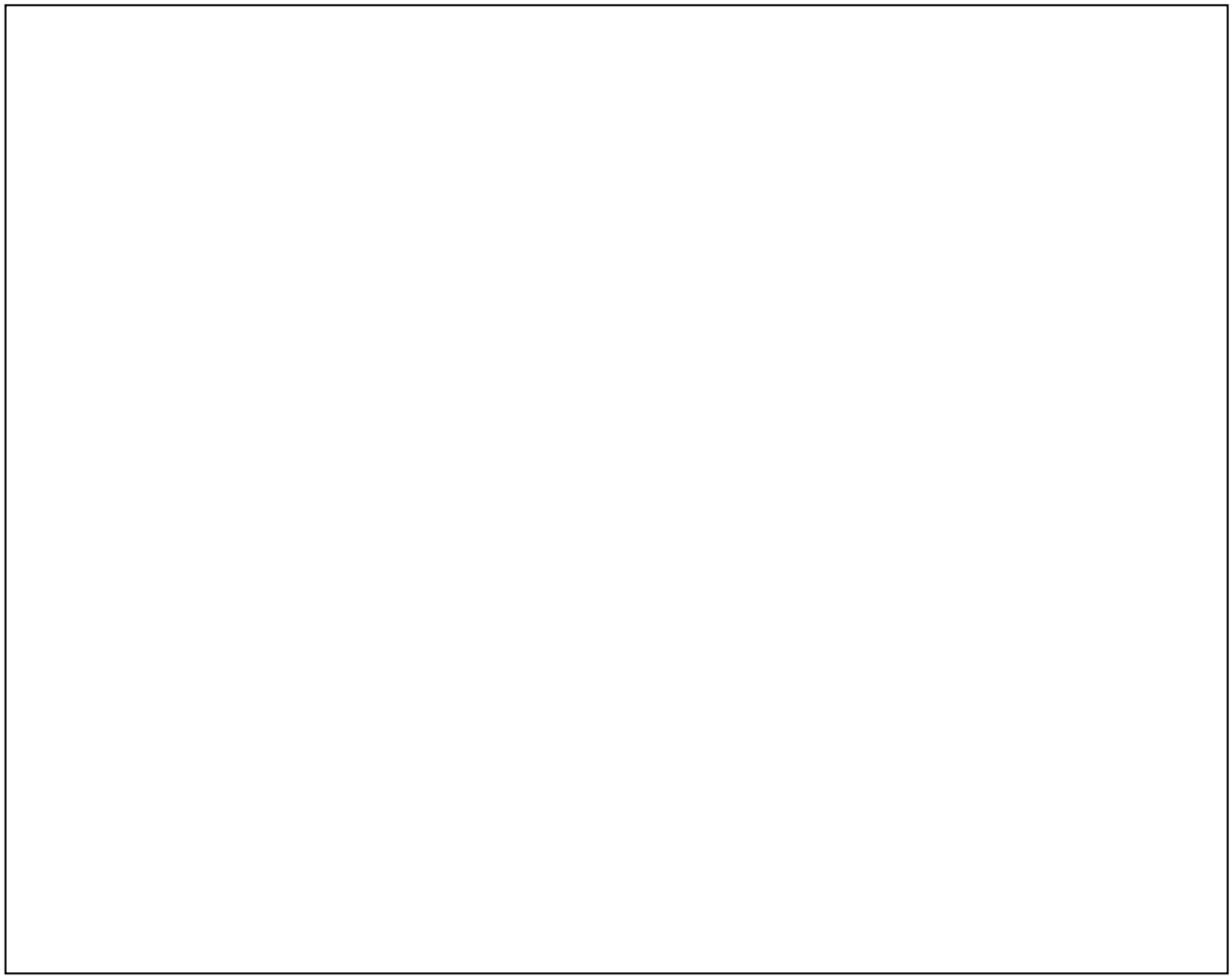
1. Big Ten - 10 Physical Habitat Stations (PHabs) are mapped evenly spaced around the lake, and detailed conditions of the littoral, shoreline, draw-down, and riparian habitat cover and structure are documented.
2. All Parcel – on each parcel, an Upland, Shoreline, and Littoral plot is observed and each area is ranked as Ideal, Very Good, Marginal, or Poor through a field assessment.

1. Physical Habitat "Big 10" Characterization

The first site is selected at random, and remaining stations are EVENLY spaced from one another, do this by GIS or digital mapping PRIOR to the sampling visit. Should re-assessment be random or back to the same sites? If Phab station is inaccessible, eliminate that site depending on the size of the lake.

Summary of Method

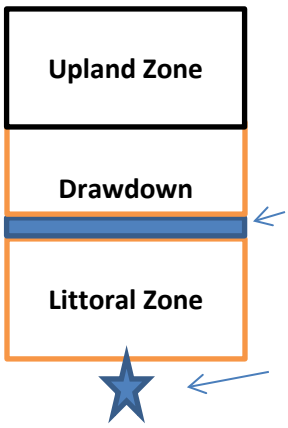
The drawing below displays an example of the Big 10 habitat stations around the lake.



Shorelin
At water

- Develop 10 evenly spaced PHabs on lake and assign a station letter of A-J.
- Load lake parcel maps on GPS with PHab Stations identified (A-J)
- Navigate by boat, to the 10 PHab sites and observe a 15 meter wide **VISUAL transect** that includes:
  1) Shoreline assessment 1 meter at the shore just above the present water line
  2) Littoral assessment extending 10m lake-ward from the shoreline
  3) Drawdown assessment extending inland from the water's edge to the Ordinary High Water Mark (OHWM), or place on the bank or a structure where water left a distinct mark
  4) Upland assessment extending from the OHWM inland 15 meters

15 meter wide transect:



15m landward from OHWM

Extends up from water's edge to normal OHWM

Shoreline – Extends from water's edge 1m inland

10m out from the shoreline

Where we observe

Field Observations (% estimate) to record on data sheets:

- Shoreline: Bank Angle/Surface
- Littoral: Substrate & Macrophytes
- Littoral: Structures, Alteration, etc
- Upland & Drawdown (if present): Canopy, Understory & Groundcover (% cover)

The Big 10 data sheets also ask for lake depth at the site and whether there is drawdown or shoreline flooding present. Drawdown refers to exposed lakebed where the water level has temporarily dropped. Shoreline flooding refers to areas periodically inundated with water (seasonal). Neither may exist.

2. Physical Habitat "All Parcel" Characterization

Every parcel on the lake is observed from a 15 meter wide **VISUAL** transect in the center of the parcel (same as for Big 10; see drawing above). The Upland, Shoreline, and Littoral plots are ranked by number based on the categorical conditions listed on the All Parcel Assessment Field Habitat Description sheet. Conditions account for presence/absence of canopy vegetation, shrub and groundcover coverage, human disturbance, and erosion. Each transect plot is ranked into a category of Ideal, Very Good, Marginal, or Poor through the field assessment.

Summary of Method

- Navigate to each parcels on the lake using the parcel maps that were loaded on the GPS
- Observe a 15 meter wide **VISUAL transect** that includes:
    1) Littoral assessment extending 10m lake-ward from the shoreline
    2) Shoreline assessment 1 meter at the shore just above the present water line
    3) Drawdown assessment extending inland from the water's edge to the Ordinary High Water Mark (OHWM), place on the bank where water has left a distinct mark
    4) Upland assessment extending from the OHWM inland 15 meters

Field Observations (assign number value) to record on data sheet:

- Rank each Upland, Shoreline/Riparian, Aquatic/ Littoral plot by number
- Number based on the categorical conditions All Parcel Habitat Description
- Categorize each plot based on the number assigned to it:
    - Ideal (10-12), Very Good (9-7), Marginal (6-4), Poor (3-1)

Basic Lake Information, Site Activities & Human Disturbance

This is completed at the end of the lake assessment. General information is recorded (Lake Type, Surface Odor, Boat Density, Surface Conditions, etc). Additional observations are assigned a number based on percent:

- Site Activities & Human Disturbance (Residential, Recreational, Agricultural, Industrial)
- Shoreline Characteristics (Forested, Wetlands, Developed, Agricultural, etc)
- Aquatic Vegetation (% Floating, Emergent, and Submerged)
- Waterbody Character (Pristine, Disturbed, etc)

Field Data Collection:

- Fill out each data sheet completely
- Big 10 Physical Habitat Assessment (Shoreline, Littoral, Upland & Drawdown plots)
- Big 10 Invasive Plant & Animal Assessment Form
- All Parcel Habitat Assessment Form
- Basic Lake Information, Site Activities & Human Disturbance (completed at end of assessment)

Equipment

- Boat & Personal Floatation Devices
- GPS
- Big 10 Shoreline & Littoral Habitat Assessment data sheet

- Big 10 Upland & Drawdown Habitat Assessment data sheet
- Big 10 Invasive Plant & Animal Assessment data sheet
- All Parcel Habitat Assessment data sheet
- All Parcel Habitat Assessment Field Description sheet
- Basic Lake Information, Site Activities & Human Disturbance data sheet

SOEI - NORTHLAND COLLEGE BIG 10 LITTORAL & SHORELINE ASSESSMENT

Lake: **Date:** **Observer(s) Name:**

SHORELINE ASSESSMENT

STATION	(parcel ID#)	Depth at Site:	GPS	*Shore Flooded? Y or N	*Drawdwn? Y or N	Bank Angle				Surface Film			
						Flat <5%	Gradual 5-30%	Steep 30-75%	Vertical >75%	None	Scum	Algae	Oily
A													
B													
C													
D													
E													
F													
G													
H													
I													
J													

25

***Note:** Drawdown refers to exposed lakebed where the water level has dropped. Shoreline Flooded refers to areas periodically inundated with water (seasonal).

LITTORAL ASSESSMENT

Scale *(apply to all assesments)* : 0 = Absent 1=Sparse 2=Moderate(10-40%) 3=Heavy 4=Extensive (>75%)

STATION	Substrate					Aquatic Macrophytes					Littoral	
	Bedrock	Boulder	Cobble	Sand/ Gravel	Silt/ Clay	*Woody/ Snag/ Organic	Emergent	Submerged	Floating	Total	*Overhanging Vegetation	Shore/ Lakebed Alteration	Structures (Boats, PWC, Dock, etc.)
A													
B													
C													
D													
E													
F													
G													
H													
I													
J													

***NOTE:** "Woody" refers to fallen trees, logs, stumps, & branches in the water. "Overhanging veg." refers to trees, shrubs, or low veg. providing shade & aq. habitat.

SOEI - NORTHLAND COLLEGE BIG 10 UPLAND & DRAWDOWN ASSESSMENT

Lake: **Date:** **Observer(s) Name:**

Scale *(applicable for all assesments)* : 0 = Absent 1=Sparse 2=Moderate(10-40%) 3=Heavy 4=Extensive (>75%)

UPLAND

STATION	Canopy Upland					Understory Upland					Groundcover Upland					
	Big Trees Trunk >.3m dBH	Small <.3m dBH	Decid.	Conifer	Mixed	Woody, Shrubs, & Saplings	Tall Herbs, Grasses, Forbes	Decid.	Conifer	Mixed	Woody Shrubs	Native Grasses, Forbes	Decid.	Conifer	Lawn	Mixed
A																
B																
C																
D																
E																
F																
G																
H																
I																
J																

***DRAWDOWN**

STATION	Canopy Drawdown					Understory Drawdown					Groundcover Drawdown					
	Big Trees Trunk >.3m dBH	Small <.3m dBH	Decid.	Conifer	Mixed	Woody, Shrubs, & Saplings	Tall Herbs, Grasses, Forbes	Decid.	Conifer	Mixed	Woody Shrubs	Native Grasses, Forbes	Decid.	Conifer	Lawn	Mixed
A																
B																
C																
D																
E																
F																
G																
H																
I																
J																

***Note:** Drawdown refers to exposed lakebed where the water level has dropped. Strike through the Station row if drawdown is **not** present.

SOEI - NORTHLAND COLLEGE BIG 10 INVASIVE PLANT/ANIMAL ASSESS

Lake: **Date:** **Observer(s) Name:**

STATIONS	A	B	C	D	E
SPECIES	Present	Present	Present	Present	Present
None Observed					
***Terrestrial**					
Canada thistle *(Cirsium arvense)*					
Cattail hybrid *(Typha x glauca)*					
Purple loosestrife *(Lythrum salicaria)*					
Garlic mustard *(Alliaria petiolata)*					
Giant hogweed *(Acleum mantegazzianum)*					
Giant knotweed *(Polygonum sachalinense)*					
Narrow-leaf cattail *(Typha angustifolia)*					
Japanese knotweed *(Polygonum cuspidatum)*					
Oriental bittersweet *(Celastrus orbiculatus)*					
Poison hemlock *(Conium maculatum)*					
Tartarian honeysuckle *(Lonicera tatarica)*					
Wild parsnip *(Pastinaca sativa)*					
Reed canary grass (*Phalaris arundinacea)*					
Glossy buckthorn *(Frangula alnus)*					
Common reed *(Phragmites australis)*					
****Aquatic**					
Curlyleaf pondweed (*Potamogeton crispus)*					
Eurasian watermilfoil (*Myriophyllum spicatum)*					
Flowering rush *(Butomus umbellatus)*					
Hydrilla *(Hydrilla verticillata)*					
Brittle waternymph *(Najas minor)*					
Fanwort *(Cabomba caroliniana)*					
Spiny water flea *(Bythotrephes longimanus)*					
Didymo/rock snot *(Didymosphenia geminata)*					
Chinese mystery snail *(Cipangopaludina sp)*					
Banded mystery snail *(Viviparus georgianus)*					
Zebra mussel *(Dreissena polymorpha)*					

Comments:

Data entered by:

* Note: Developed from WI DNR Terrestrial Invasive 64 Species Regulated by NR 40. Includes only terrestrial species documented in Ashland, Bayfield, Douglas, Iron , or Vilas Counties w/ ecological habitat threat to lake shores, wet meadows, ponds, stream, and freshwater marshes.

**Note: List compiled from NLA 2012 invasive plants list and WI DNR: 16 Aquatic Invasive Species Regulated by NR 40. Includes only species documented in Lake Superior, or Ashland, Bayfield, Douglas, Iron , or Vilas Counties w/ ecological habitat threat to aquatic resources.

BIG 10 INVASIVE PLANT/ANIMAL ASSESS					Page 4
STATIONS	**F**	**G**	**H**	**I**	**J**
SPECIES	Present	Present	Present	Present	Present
None Observed					
***Terrestrial**					
Canada thistle *(Cirsium arvense)*					
Cattail hybrid *(Typha x glauca)*					
Purple loosestrife *(Lythrum salicaria)*					
Garlic mustard *(Alliaria petiolata)*					
Giant hogweed *(Acleum mantegazzianum)*					
Giant knotweed *(Polygonum sachalinense)*					
Narrow-leaf cattail *(Typha angustifolia)*					
Japanese knotweed *(Polygonum cuspidatum)*					
Oriental bittersweet *(Celastrus orbiculatus)*					
Poison hemlock *(Conium maculatum)*					
Tartarian honeysuckle *(Lonicera tatarica)*					
Wild parsnip *(Pastinaca sativa)*					
Reed canary grass (*Phalaris arundinacea)*					
Glossy buckthorn *(Frangula alnus)*					
Common reed *(Phragmites australis)*					
****Aquatic**					
Curlyleaf pondweed (*Potamogeton crispus)*					
Eurasian watermilfoil (*Myriophyllum spicatum)*					
Flowering rush *(Butomus umbellatus)*					
Hydrilla *(Hydrilla verticillata)*					
Brittle waternymph *(Najas minor)*					
Fanwort *(Cabomba caroliniana)*					
Spiny water flea *(Bythotrephes longimanus)*					
Didymo/rock snot *(Didymosphenia geminata)*					
Chinese mystery snail *(Cipangopaludina sp)*					
Banded mystery snail *(Viviparus georgianus)*					
Zebra mussel *(Dreissena polymorpha)*					
Comments:					

NA= No measurement/observation made. **S**= Suspect measurement; re-measurement not possible.

* Note: Developed from WI DNR Terrestrial Invasive 64 Species Regulated by NR 40. Includes only terrestrial species documented in Ashland, Bayfield, Douglas, Iron , or Vilas Counties w/ ecological habitat threat to lake shores, wet meadows, ponds, stream, and freshwater marshes. **Note: List compiled from NLA 2012 invasive plants list and WI DNR: 16 Aquatic Invasive Species Regulated by NR 40. Includes only species documented in Lake Superior, or Ashland, Bayfield, Douglas, Iron, or Vilas Counties w/ ecological habitat threat to aquatic resources.

SOEI - ALL PARCEL HABITAT ASSESSMENT FIELD DESCRIPTION

Habitat parameters to be evaluated

Habitat Parameter	Condition Category: Ideal	Very Good	Marginal	Poor
Upland (OHWM inland 15m): tree canopy, shrubs, and groundcover species	90%+ upland area with dense native canopy trees, shrubs & ground species; or other natural features (such as rock outcrop) prevents establishment of vegetation. Less than 5% of lot is *impervious surface, minimal shoreland maintenance, no invasive species. Upland runoff/ erosion is not present.	Moderate to dense (70-90%) ground vegetation and canopy trees w/ shrub layer reduced; or few canopy trees with moderate to dense natural shrub layer, 5%-15% *impervious surfaces, less than 30% shoreland manicured, few or no invasives. Minimal or no runoff/erosion.	Established lawn with moderate-dense (30-70%) canopy trees; shrub layer absent; 15%-20% *impervious surface; 30%-50% or more of shoreland manicured/ maintained, invasive species present. Upland runoff/ erosion present to moderate.	Native tree canopy, shrubs and groundcover vegetation 0-30%; established lawn with few canopy trees, 20%-30% *impervious surface, more than 50% of shoreland manicured, invasive species present. Upland erosion moderate to substantial.
SCORE	12 11 10	9 8 7	6 5 4	3 2 1
Shoreline/ riparain buffer (water's edge inland 1m): tree, shrub and groundcovers along the shore where land & water meet	Littoral woody logs/snags 5+ per 30 m; overhanging vegetation; shore vegetated >90% w/ native groundcovers, shrubs and trees; no bare soil; little potential for future problems; or natural feature prevents vegetation; buffer extends 30'+ back from shore; human disturbance/shore alteration/access (tree removal, brushing, mowing, armored banks/riprap) <10m or not present.	Some littoral woody habitat; well-suited for organisms; overhanging vegetation; riparian buffer 10m deep covered 70-90% w/ native vegetation, but one class of plants not well established; disruption evident but not affecting potential; minimal bare soil (5-20%); minimal vegetation removed from 30'-75' feet inland; shore alteration/disturbance minimal 10-20m.	Littoral woody habitat minimal to absent; riparian buffer 5-10m deep covered with 50-70% vegetation but minimal or no shrub layer and tree canopy or buffer depth only 5-10m; disruption obvious; bare soil/closely cut veg. common; no extended buffer greater than 30' inland; moderate bare soil (30-60% of bank); moderate shore alteration (tree removal, mowing, established lawn, armored banks/ riprap).	Littoral woody habitat absent; riparian buffer with minimal or no shrub layer and tree canopy (<50% vegetation) or less than 5 m deep; no extended buffer 30' -75' feet inland; unstable shore 60-100% of bank/ exposed soil; moderate human disturbance and /or shore alteration (tree removal, mowing, established lawn, armored banks/ riprap).
SCORE	12 11 10	9 8 7	6 5 4	3 2 1
Aquatic/ littoral (shore-10m): abundance of emergent, submerged, and floating vegetation	Dense or abundant emergent, submerged or floating vegetation or rocky substrate unable to support vegetation; abundant fish habitat; minimal or no human disturbance including recreational use.	Scattered or patchy emergent, submerged or floating vegetation; minimal human disturbance including recreational use.	Lack of emergent or floating veg.; minimal submerged veg.; vegetation limited by rec. use (swimming, boating, etc); disturbed lakebed; invasives present or likely.	Minimal or no native aquatic vegetation present; invasives present or likely; lakebed altered (boat landing); several structures (dock/pier/PWC lifts) prevent aquatic plant growth, heavily used swimming area.
SCORE	12 11 10	9 8 7	6 5 4	3 2 1

***Note: impervious surface is defined as any surface that does not allow water to infiltrate (sidewalks, building, shed, hard packed parking,etc)**

SOEI - ALL PARCEL HABITAT ASSESSMENT

Data collected by:

Lake: Date:

STATIONS (parcel ID#)	Habitat Condition (Use scale for each plot)			
	Scale (for each plot)	**IDEAL (12, 11, 10)**	**VERY GOOD (9, 8, 7)**	**MARGINAL (6, 5, 4)** **POOR (3, 2, 1)**
	Upland / Terrestrial (OHWM inland 15m)	**Shoreline / Riparian Buffer (water's edge inland 1m)**		**Aquatic / Littoral (waterward 10m from shore)**

Comments:

Sampling Sites

This method employs a point-intercept grid of sampling sites distributed evenly over the entire lake surface (Figure 1).

WDNR staff will determine the number of sites and grid resolution based on the estimated size of the littoral and shape of the lake. Grids will be scaled to produce a greater number of sites on lakes that are larger and have more complex shorelines. A sampling map (Figure 1) and GPS text file containing the latitude and longitude information associated with each sample site will be provided electronically by the WDNR.

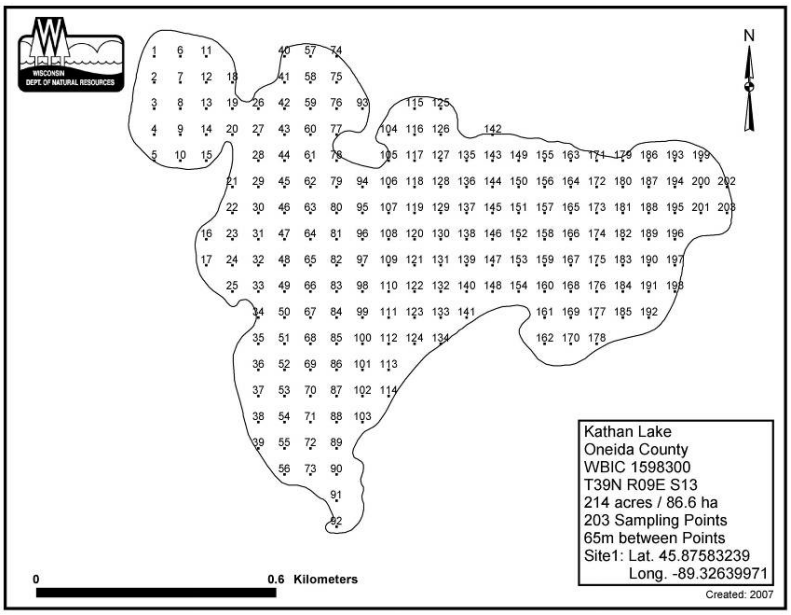


Figure 1: The point-intercept grid for Kathan Lake, Oneida County, WI, with 203 sampling sites.

Timing of Sampling

Surveys should be conducted between early July and mid-August. Plant community parameters (such as rake fullness and density) can change through the growing season. However, presence/absence data is less sensitive to seasonal variation. For many species, including Eurasian water milfoil (EWM), plant biomass and density may increase as the season progresses, whereas some species like curly-leaf pondweed (CLP), senesce much earlier in the sampling season. Rake fullness data for these species must be interpreted carefully with the sampling date in mind. If early-senescing species such as CLP are targets of management actions, please contact the WDNR Lake Coordinator in your region to coordinate the best possible sampling time.

Navigating to Sites

Accuracy

The location reported by the GPS receiver has an element of error that varies under different conditions. Navigate at no greater than an 80-foot zoom level and aim to completely cover the sampling site with the arrow. At 80-foot zoom, the locator arrow shown on the screen represents approximately 25 feet in length. In order to sample with acceptable accuracy, the arrow must completely cover the sampling site on screen.

Determining Maximum Depth of Plant Colonization

When sampling, you will have to determine the maximum depth at which the plants are rooted. The maximum depth of colonization (MDC) can vary greatly among lakes. When sampling a line of sites heading from shore out to deep water, take samples until plants are no longer found on the rake. Continue sampling at least two sites deeper to ensure you sampled well over the maximum depth of colonization. If no plants are found at these

sites, simply record the depth, sampling tool used, and dominant sediment type. Leave the rake fullness and species information blank. Use a depth finder and begin sampling again when the depth reaches that of the last (no plant) site sampled. By sampling in this way, over time you will begin to hone in on the maximum depth of plant colonization.

After working several rows crossing the edge of the littoral zone, estimate the maximum depth of colonization (e.g. 20 feet) and only continue to sample deeper sites within 6 feet of this estimation (all sites ≤ 26 feet). As you complete more rows and gain confidence in your estimation, you can then begin to gradually omit sampling depths that are too deep for plants to grow. Once you have sampled the deep end of your estimated maximum depth of colonization at least three times and have not found any plants, then you can discontinue sampling at anything deeper, but continue to sample any sites shallower.

Recording Data & Completing the Field Sheet

1. Complete the top portion of the "Field Sheet" with the lake name, county, WBIC, date, names of observers, and how many hours each person worked during the survey.
2. Each site number will have one row of data on the "Field Sheet"
3. Measure and record the depth to the nearest half-foot increment at each site sampled, regardless of whether vegetation is present. The pole mounted rake and rope sampler should be marked to measure the depth of water at a sample site. If you are using a depth finder, it is useful to know that the accuracy may decrease greatly in densely vegetated areas. Depth finders sometimes report the depth to the top of the vegetation. It is best to use depth markings on a pole-mounted rake for shallow sites.
4. At each sample site, record the dominant sediment type based on how the rake feels when in contact with the sediment surface as: mucky (M), sandy (S), or rocky (R).
5. Record whether the pole (P) rake or the rake-on-a-rope (R) was used to take the sample.
6. At each site, record the overall rake fullness that best estimates the coverage of plants on the rake (1-few, 2-moderate, 3-abundant; see Figure 3). Also identify the different species present on the rake and record a separate rake fullness rating for each. Include the rake fullness for filamentous algae, aquatic moss, freshwater sponge, and liverwort, but do not include these ratings when determining the overall rake fullness rating. At the site, perform a visual scan. If you observe any species within 6 feet of the sample site, but not collected with the rake, record these species as observed visually ("V") on the field sheet. These species will be included in total number of species observed.
7. The crew must write the species names in the columns the first time it is encountered. Names must be re-written on successive field sheets as they are found. Common or Latin names may be used as long as there is not ambiguity. Abbreviation can shorten the process. Latin name and abbreviation is preferred such as: Nyp. odo.
8. Fill out the Boat Survey datasheet.
9. It may be impossible to reach some sample sites. If this happens, leave the depth blank and record the appropriate comment on the field datasheet from the following list and remember to record it in the "Comments" column of data ENTRY database:

    a. NONNAVIGABLE (PLANTS)
        1. Sample site cannot be accessed due to thick plant growth. Aquatic plants that are visible within 6 feet of a non-navigable sample site (e.g. water lilies,

cattails, bulrushes, etc.) should be recorded as visuals (V) on the datasheet.

b. TERRESTRIAL
1. Sample site occurs on land (including islands).
2. Aquatic plants visible within 9 feet of a terrestrial sample site may be included in the general boat survey list, but should not be marked as visuals on the sheet.

c. SHALLOW
1. Sample site is in water that is too shallow to allow access. Aquatic plants that are visible within 6 feet of a shallow sample site should be recorded as visuals (V) on the datasheet.

d. ROCKS
1. Sample site is inaccessible due to the presence of rocks.

e. DOCK
1. Sample site is inaccessible due to the presence of a dock or pier.

f. SWIM AREA
1. Sample site is inaccessible due to the presence of a designated swimming area.

g. TEMPORARY OBSTACLE

h. NO INFORMATION
1. No information is available about the sample site because it was not traveled to (inaccessible channel, accidently omitted during survey, skipped due to time constraints, etc.)

i. OTHER
1. Site was not sampled for another reason; please provide a brief description.

Time Spent Sampling

Depending on the size of the lake, a survey may be completed in a few hours, or it may take several days. Ideally, a crew spends one to three minutes per sample site.

PREPARING FOR FIELD WORK

Field Equipment:

- Appropriate watercraft and equipment required by law
- Double-sided sampling rake on a 15-ft (4.6m) pole
- Weighted sampling rake attached to a 40-ft (12m) rope
- Handheld GPS with WDNR sample sites loaded
- Print-out of lake map with WDNR sample sites
- Print-out of WDNR field datasheets on waterproof paper
- Pens
- Sealable storage bags for voucher specimens
- Waterproof voucher sample labels
- Cooler(s) with ice for storing voucher specimens
- Depth finder
- Bathymetric map
- Plant ID references or guides to aid in plant identification
- Hand lens to aid in plant identification
- Digital camera for plant specimens or field pictures
- Underwater video camera for viewing the maximum depth of plant colonization

Constructing the Rake Samplers

The rake sampler is constructed of two landscape-rake heads welded together, bar-to-bar, to form a double-sided rake head on a 15 foot pole. The rake head is 13.8 inches long, with approximately 14 tines on each side. For sampling in water deeper than 15 feet, a double-sided rake head is attached to a rope, and a 5 pound weight is attached to the rake head.

Loading Sample Site Locations onto the GPS Receiver

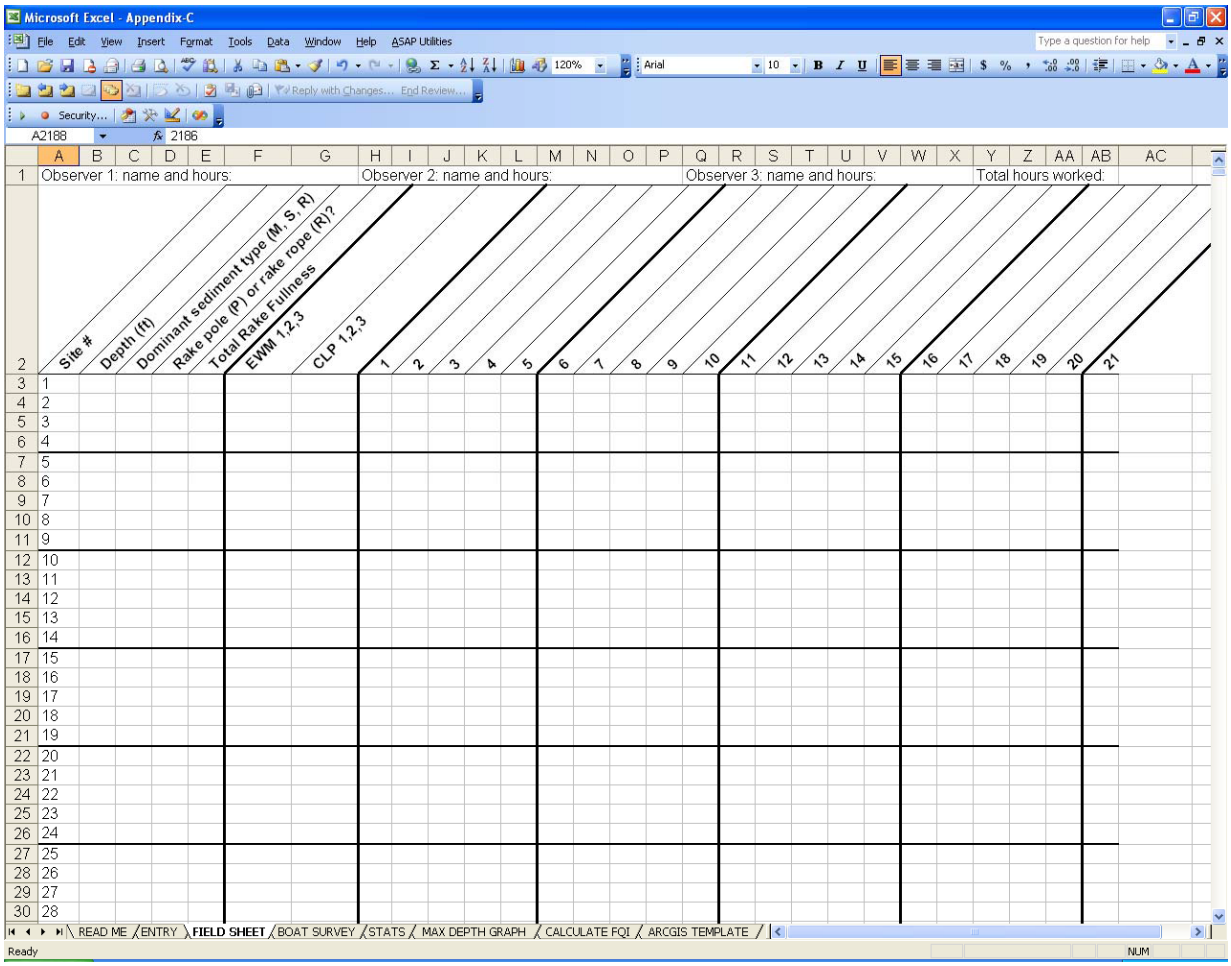
Detailed instructions on loading sample site locations onto the GPS receiver depend greatly on the type of GPS receiver as well as the software used to translate site location from the text file to "waypoints" in the receiver.

To upload waypoints from a GPS text file to the GPS receiver, you will need:

- **PC/laptop with WDNR Garmin GPS Tool.** Your IT administrator can help you obtain and install the software.
- **GPS text file (.txt extension).** A tab-delimited text file containing the sample sites and their geographical information.
- **A Garmin 76 model GPS receiver with external data port.**

Printing Datasheets

The data sheet can be found on the tab labeled "FIELD SHEET" in the Aquatic Plant Survey Data Workbook, downloadable from the University of Wisconsin Extension website (http://www.uwsp.edu/cnr/uwexlakes/ecology/APM/Appendix-C.xls). Print the field sheet on waterproof paper, using the "Print Area > Set Print Area" function under the "File" menu to set the appropriate number of rows to print. Under Header (View > Header and Footer > Custom Header) record lake name, Waterbody Identification Code (WBIC), county and survey date.


Microsoft Excel - Appendix-C
Observer 1: name and hours:
Observer 2: name and hours:
Observer 3: name and hours:
Total hours worked:
Site #
Depth (ft)
Dominant sediment type (M, S, R)
Rake pole (P) or rake rope (R)?
Total Rake Fullness
EWM 1,2,3
CLP 1,2,3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
READ ME
ENTRY
FIELD SHEET
BOAT SURVEY
STATS
MAX DEPTH GRAPH
CALCULATE FQI
ARCGIS TEMPLATE
Ready
NUM

Equipment Cleaning and Storage

Clean all boat and trailer and monitoring equipment per SOP #4: Decontamination and Cleaning of Equipment. Monitoring equipment should be cleaned and dried, then packed for storage in the storage case. Keep equipment and supplies properly organized and labeled so they can easily be inventoried using the checklists.

Data Management: Entry, Analysis, and Reporting

(Summary of SOP # 12: Data Analysis and SOP # 13: Reporting)
Water quality monitoring profile data will be entered weekly into the WI DNR SWIMS website. All field data including profile data sheets, habitat assessments and baseline aquatic plant surveys will be entered electronically or the data sheets will be scanned and filed electronically in the Ecological Solutions files as each project is completed. Project completion sheets will be completed and initialed for record tracking.

Data Entry, Verification, and Archival Procedures

Detailed instructions for the data entry procedures for this protocol are given in SOP #11 Data Entry and Management. As described in the Lake Water Quality Monitoring Site Activities methods, there are three types of water quality data collected. The first is field observations and profile measurement that are recorded on data sheets in the field, and then later entered into a digital form in SWIMS. The second type of data are the results of testing performed by Northland College's ARE Lab. And, the third type of water quality data is digital data collected with multiprobe sondes. This data will also be entered into a digital form in SWIMS.

Data verification starts with the QA/QC steps that are outlined in the SOPs associated with this protocol. If data being entered into SWIMS do not pass a QA/QC test, SWIMS prompts the user to make corrections and re-enter the data.

Quality assurance/quality control checks are performed as data are entered. Research Technicians will be trained to enter/edit data in SWIMS in order to protect the integrity of the data.

Data archiving provides a source to retrieve a copy of any dataset, and it provides a data record that is an essential part of the QA/QC process. The original data sheets are scanned and stored digitally in the Ecological Solutions Data Lake Program folder.

Routine Data Summaries

Data summaries of water quality profile and chemistry lab results; aquatic plant species richness and density characterizations for both submerged and floating leaf vegetation; and shoreline and littoral habitat characterizations for each lake in which sampling occurred will be performed following each sampling year after all QA/QC procedures have been completed. For chemistry variables, analysis will occur to assess proportion of nutrients present in the epilimnion, metalimnion, and hypolimnion of each lake. In addition, analytical approaches for all monitoring procedures will include graphic comparisons for the current year to previous years, qualitative analysis, and lake modeling. After at least three sampling seasons of monitoring data are collected at a given lake, more intensive analyses of change and long-term trends may be performed for each lake.

Reporting

The results and knowledge acquired through the Lake Program's water quality sampling, monitoring of aquatic plants, and shoreline and littoral habitat assessments will be shared with the Wisconsin DNR,

Lake Associations, resource partners, and interested citizens. The information gathered will be utilized in the development and implementation of lake specific Lake Management Plans for the lake. This program strives to convey our findings through meaningful deliverables in a timely manner. Because our monitoring data will be of interest to a broader community and natural resource managers, we will provide our data and reports as necessary. Findings will be presented to state agency resource managers and lake association members annually and may be presented at regional meetings or conferences.

Routine data summaries will be conducted annually for lakes sampled. Lake Management Plans will be produced with the primary audience being each Lake Association Board and lake stakeholders.

More comprehensive reports, with analysis of trends, may occur after repetitive sampling. The target audience of comprehensive analysis and reports will be WI Department of Natural Resources, Lake Associations and stakeholders, resource management partners, regulatory staff such as zoning departments, elected officials, and the broader scientific community.

Post Field Season Procedures

(Summary of SOP # 14: End-of-Field Season Procedures)

The proper maintenance and storage of field and laboratory equipment will prolong the life of the gear as well as simplify start-up procedures for the next field sampling season. Store calibration standards and electrolyte solutions in a temperature-controlled environment. Ensure that containers are dated upon receipt and upon opening; observe expiration dates.

Multiparameter YSI Equipment

When multi-parameter YSI probes are to be stored during the non-field season, clean and store the probe according to the manufacturer's manual, including:

- Thoroughly clean the sensors.
- Remove installed batteries.
- Fill the storage cap approximately one-fourth full of tap water.
- Store away from direct sunlight. Although the instrument should be able to be reliably reactivated for field use with a minimum of effort before field use, it should be checked out well in advance of scheduled surveys to allow time for repair or replacement.

Other Equipment:

- Clean all equipment following the procedures detailed in SOP #4: Decontamination and Cleaning of Equipment.
- Inspect all equipment for damage or wear that may need replacement.
- Lay out all ropes and lines to dry completely, then coil or roll back into their holders.
- Store field equipment in protective storage cases to avoid damage.
- Return all of the equipment and supplies to the proper storage area. Keep them organized so they can be inventoried using the equipment and supply checklists.
- Store calibration standards and electrolyte solutions in temperature-controlled area.
- Properly dispose of all chemical waste material.

Quality Assurance/Quality Control

(Summary of SOP # 15: Quality Assurance/Quality Control)

Standardized training and data forms provide the foundation that quality assurance/quality control (QA/QC) standards for field collected data are met and that the data are complete, concise, accurate,

representative, and comparable. The QA/QC procedures that pertain to sample collection and processing are focused on: 1) ensuring that any given field or laboratory measurement accurately represents the water resource at the time the sample was collected, 2) ensuring that water quality data are comparable across all sampling dates, and 3) verifying that no contamination has been introduced to the sample at any time.

One important aspect in the accuracy and precision of a water quality monitoring program is the correct calibration and maintenance schedule of probes for measuring field variables. The table below summarizes the ideal calibration frequency and minimum acceptance criteria for these parameters. Calibration logs for multi-parameter sondes are maintained in the ARE Lab and document the frequency of calibration and calibration checks. Staff will ensure that calibration standards are not used beyond expiration dates.

Calibration frequency and acceptance criteria for field instruments

Parameter	Frequency/Check	Acceptance	Corrective Action
Temperature	Annually, check with additional tool.	±1.0ºC	Replace faulty equipment
Specific Conductance	Daily, prior to lab departure; calibration check prior to each round of sampling; duplicate reading at each site once a month.	±5% RPD 10%	Re-test; check low battery battery; use different meter; use different standards
pH	Daily, prior to lab departure (three buffers selected including 4, 7 and 10, selected to check instrument performance); calibration check prior to each round of sampling; duplicate reading at each site once a month.	±0.05 pH ±0.1 pH RPD 10%	Re-test; check low battery; use different standards; repeat; don't move cords or cause friction/static
Dissolved Oxygen	Daily, prior to lab departure; check at the field site if barometric pressure changed since calibration; calibration check prior to each round of sampling; duplicate reading at each site once a month.	0.2 mg/L concentration or ±10% RPD 10%	Re-enter barometric pressure; re-test; check low battery; check for damage of membrane; replace membrane; use a different meter; repeat; allow more time to stabilize
Marked lines (Secchi, Kemmerer, Sonde Rope)	Check markings monthly for fade. Re-mark annually against meter tape.	±1%, 0–10 m ±2%, >10 m	Re-mark line.

The Sigurd Olson Environmental Institute's procedures include the following QA/QC routines:

1) Maintain WQ Sampling Site binder containing GPS coordinates for verification of sampling location(s), map of lake with sample site(s) marked, new Lake WQ Monitoring field forms, copies of previous field forms to compare field measurements to.
2) Keep Lakes Water Quality Protocol binder on hand including: QA/QC checklist, SOPs, equipment troubleshooting, blank field forms.
3) Maintain daily instrument calibration log for each instrument. Calibration schedule must be observed, using fresh calibration standards.

4) Maintain equipment calibration manual and Chain-of-Custody forms in the laboratory.
5) Submit duplicate water samples at each sample site once a month.
6) Replicate multiprobe field measurements at each sample site once a month. Calculate the relative percent difference to document precision of the multiprobe.
7) Keep copies of field data forms until all sheets have been scanned. Scan original Lake WQ Monitoring field forms and maintain electronic copies indefinitely. Save on K: drive in Ecological Solutions Data folder.
8) Require consistent measurement methods and detection limits
9) Sample preservation and minimum holding time- maintain water samples according to preservation and minimum holding time.
10) Chain-of-custody includes the form and all references to the sample, including information that allows tracing the sample back to its collection and handling until analytical results are received.
11) Laboratory methods – require consistent analytical methods and detection limits.

Quality Assurance and Quality Control for Data Entry and Management

Quality assurance/Quality control procedures are crucial in every step of data entry and management. QA/QC is detailed in SOP #11: Data Entry and Management.

Summary of QA/QC procedures pertaining to data management:

Procedure	Description
Instrument calibration logs	Each instrument must have a calibration log.
Field forms	Field forms are the only written record of field measurements, so copies are placed in project binders and originals must be kept on file indefinitely.
Estimating precision	The precision measurement is calculated using the Relative Percent Difference (RPD) between duplicate sample results per analytic. Precision estimates should be performed within 7 days of receipt of laboratory results.
Electronic data entry	At least 10% of electronic data entries should be checked on a random basis for errors. If errors are found, another 10% are spot checked. Program sampling data are filed and stored electronically in the Ecological Solutions Data Lake Program folder.
Data verification	Data verification documents that a data set qualifies as credible data.

Data will be archived according to SOP #11: (Data Entry and Management) for digital data, paper copies, and field forms. Field forms are maintained indefinitely. Characterizations of the data from each sample site will be completed annually after all QA/QC procedures have been completed.

Reporting

Routine data summaries will occur annually for lakes sampled within that year, and presented to the associated Lake Association or Board and the Wisconsin Department of Natural Resources Lake Management Coordinator through a data sharing meeting. These presentations will during the winter following the sampling season. A final Lake Management Plan will be developed for each lake for which monitoring occurs.

More comprehensive analyses of trends will occur for most parameters after three or more years of sampling. No previous monitoring has occurred, thus three or more years of data collection tends to be the minimum needed to establish a time series sufficiently powerful to detect meaningful levels of change. The target audience of the analysis and reporting will be the WDNR, Lake Associations, resource management partners, and the broader scientific community. Draft Lake Management Plans will be reviewed by a planning committee including stakeholders, Lake Association board members and WDNR.

Data Validation

Data validation is the method in which data are proven or disproved to be accurate. This process involves the review of the results of all measurements, samples, and QC samples. Field data sheets and laboratory data are reviewed for transcription errors, completeness, verification of calibration and quality control check samples or standards. Once data has been validated for completeness and accuracy, it is signed off by the Coordinator/Supervisor that the data qualifies as credible data.

Literature Cited

APHA (American Public Health Association). 1998. Standard methods for the examination of water and wastewater. 20th edition. L. S. Clesceri, A. E. Greenberg, and A. D. Eaton, editors. American Public Health Association, Washington, D.C.

Axler, R. P., E. Ruzycki, J. Henneck, and G. Host. 2006. Historical water quality data assessment of the Great Lakes Network. Natural Resources Research Institute Technical Report NRRI/TR-2006/05, University of Minnesota, Duluth, Minnesota.

Baker, J. R., D. V. Peck, and D. W. Sutton (editors). 1997. Environmental Monitoring and Assessment Program (EMAP) Surface Waters: Field Operations Manual for Lakes. EPA/620/R-97/001. U.S. Environmental Protection Agency, Washington, D.C.

Wetzel, R. G, and G. E. Likens. 2000. Limnological analyses. 3rd Edition. Springer-Verlag, New York.

Sigurd Olson Environmental Institute

NORTHLAND COLLEGE

Lake Program Training Checklist:

____ Introduction to program and basic limnology concepts

____ Northland College Van certified, if necessary

____ WI Boated Safety certification completed

____ Review of NC Water Quality for Lakes Monitoring Protocol & Standard Operating Procedures (SOPs)

____ Completed lab safety & Chain-of-Custody instruction

____ YSI calibration: operation, acceptable criteria, trouble shooting, calibration log

____ Student calibration of YSI (SOP #5) & completed calibration log

____ Review of WQ for Lakes field data sheets, water sample data sheets, phytoplankton field data sheets

____ Review Field Data Sheet and Water Sample Collection Label recording method

____ Field methods for profile sample, secchi sample, water sample collection, handling, preservation, and lab processing (SOPs #6-8)

____ Equipment decontamination and cleaning (SOP #4)

____ Shoreline and Littoral Habitat Assessment and data sheet review (SOP #9)

____ Aquatic Plant Monitoring and data sheet review (SOP #10)

____ On-land boat safety and inspection

____ On-water boat safety and inspection

____ GPS training

____ Download, entry and verification of data into databases

____ Lake Program data management (scanning data sheets & electronic storage)

____ Review WQ for Lakes Pre-Departure Checklist, Completion Checklist & Field Equipment Checklist

____ Review Baseline Monitoring of Aquatic Plants Checklist & Field Equipment

____ Water Quality Sample & Phytoplankton Sample Checklist

____ Review Shoreline & Littoral Habitat Assessment Checklist & Equipment

____ Completed Pre-Field Season Checklist

____ Discussed importance and routine of QA/QC

____ Discussed professional representation of NC, clothing/gear for lake & laboratory

(Over)

Upon training completion, student is able to:

____ Calibration YSI instrument, acceptable criteria, operation & trouble shooting

____ Use /calibrate YSI multiprobe sampler and maintenance log according to protocol

____ Understand daily field preparation responsibilities

____ Collect /record data and water samples in a controlled and standardized manner

____ Conduct daily inspection of vehicle, boat and trailer to assure secure hitch and straps and proper working order, and to assure no plants or animals are attached

____ Safe and thoroughly execute duties and project activities

QA/QC Validation

Student: Supervisor Signature: Date:

Sigurd Olson Environmental Institute
NORTHLAND COLLEGE

Water Quality for Lakes Monitoring
Pre-Departure Checklist:

____ IF NECESSARY: Prepared WQ samples for FedEx lab shipment (samples into cooler and FedEx label) and scheduled FedEx pickup
____ Vehicle(s) have been refueled and maintenance activities tended to
____ Discussed daily itinerary, verified lake and maps
____ Calibrated YSI instrument & completed/initialed calibration log
____ Labeled water sample bottles and drafted Chain-of-Custody form
____ Labeled zooplankton sample bottles and drafted Chain-of-Custody form
____ Packed WQ bottles and zooplankton bottles into cooler(s) with wet ice
____ Checked WQ for Lakes Monitoring Site checklist and loaded equipment
____ Loaded into vehicle: WQ sample cooler, zooplankton sample cooler, YSI, Carboy, Kemmerer, Integrated Sampler tube, Rope lines
____ Loaded into vehicle: Field Box: Field Binder for WQ for Lakes Monitoring Site, Habitat Assessment or Aquatic Plant Survey w/ data sheets & lake maps, depth finder, GPS, secchi disk, camera, first aid, pens, weather radio, extra batteries
____ Loaded life jackets, boat cushion, boat anchor, & oars
____ Packed personal gear (water, lunch, rain gear, sunblock, hat, sunglasses)
____ Checked boat & vehicle gasoline
____ Inspected trailer lights, turn signals, brake lights, trailer hitch, and boat straps

QA/QC Validation
Student Signature: Date:

Sigurd Olson Environmental Institute
NORTHLAND COLLEGE

Water Quality for Lakes Monitoring
Completion Checklist:

____ Pre-departure activities checklist complete

____ Field gear checklist complete

____ YSI and GPS batteries checked

____ Verified correct monitoring site location with depth or GPS coordinates

____ Implemented depth profile

____ Implemented secchi transparency

____ Collected water samples

____ Collected phytoplankton sample

____ Water samples correctly labeled and preserved on ice

____ Phytoplankton sample correctly labeled and preserved on ice

____ Water samples are consistent with Sample ID numbers listed on data sheets

____ SOEI NC Water Quality for Lakes Monitoring Data Sheet reviewed, legible, complete, and initialed **for each monitoring site**

____ Inspected boat, trailer, and all equipment for invasive species

Back at Northland:

____ Re-fueled boat and vehicle gas and addressed vehicle maintenance if necessary

____ Boat, ropes and equipment decontaminated and YSI sensors rinsed w/ DI water

____ Checked battery on YSI / ____ Plugged GPS in for recharge

____ WQ data entered data into SWIMS on _____ (date)

____ All data entered into SOEI database on _____ (date)

____ Field sheets scanned & filed electronically

QA/QC Validation
Student: Supervisor Signature: Date:

Sigurd Olson Environmental Institute
NORTHLAND COLLEGE

Water Quality for Lakes Monitoring Site
Field Equipment:

____ Multi-parameter YSI (sonde) or backup sampler
____ Kemmerer
____ Carboy
____ 2-meter integrated sampler tube
____ WQ for Lakes Monitoring (Habitat Assessment or Aquatic Plant) binder & sheets
____ GPS unit
____ Secchi disk with attached rope
____ Pens and permanent marker
____ Personal gear: water, food, sunblock, sunglasses, clothing/raingear, etc.
____ Depth Finder
____ Measured rope
____ HDPE bottle (1 L, white, narrow-mouth) – phytoplankton
____ Plankton net and collection bucket
____ Funnel
____ Squirt bottle (1L Nalgene) – DI water and squirt bottle (1L Nalgene) – lake water
____ CO_2 (Alka seltzer) tablets
____ Pail (narcotization chamber)
____ HDPE bottle (125 mL, white, wide-mouth)
____ Ethanol (95%)

Sigurd Olson Environmental Institute
NORTHLAND COLLEGE

Baseline Monitoring of Aquatic Plants
Completion Checklist:

____ Point intercept sampling grid supplied from WDNR downloaded to GPS

____ Aquatic plant monitoring survey: Completed _____ **OR** Ongoing _____

____ General site information completed including: lake name, country, WBIC, date, names of observers, and how many hours each person worked during the survey

____ Aquatic Plant Monitoring datasheet is complete including: depth, sediment type, pole vs rope, rake fullness, species name, and inaccessible sites with correct code

____ Data entered into SOEI database on _____ (date)

____ Field sheets scanned & filed electronically

Equipment

____ Boat, anchor, & Personal Floatation Devices

____ Double-sided sampling rake attached to 15-ft pole

____ Weighted sampling rake attached to a 40-ft rope

____ Handheld GPS receiver with WDNR sample sties loaded

____ Print-out of lakemap with WDNR sample sites

____ Print-out of WDNR field datasheets on waterproof paper

____ Rite-in-the-Rain pens

____ Sealable storage bags for voucher specimens

____ Waterproof voucher sample labels

____ Cooler(s) with ice for storing voucher specimens

____ Depth finder

____ Plant ID references or guides to aid in plant identification

____ Hand lens to aid in plant identification

____ Digital camera for plant specimens or field pictures

QA/QC Validation
Student: Supervisor Signature: Date:

Sigurd Olson Environmental Institute
NORTHLAND COLLEGE

Water Quality Sample & Phytoplankton Sample
Handling and Processing Completion Checklist:

____ Label all sample bottles correctly, completely, and legibly

____ Complete and sign the Chain-of-Custody Sheet for all samples collected

____ Add acid to phosphorus samples to stabilize and dispose of ampoule properly

____ Place all samples in the refrigerator except Total Nitrogen

____ Place Total Nitrogen samples in the freezer

____ Follow lab instructions for any samples shipped to a contact laboratory

QA/QC Validation
Student: Supervisor Signature: Date:

Sigurd Olson Environmental Institute
NORTHLAND COLLEGE

Shoreline & Littoral Habitat Assessment
Completion Checklist:

____ Fill out each data sheet completely and listed "observer" names on each sheet
____ Complete Big 10 Physical Habitat Assessment (Shore, Littoral, Upland, & Drawdown)
____ Complete Big 10 Invasive Plant & Animal Assessment Form
____ Complete All Parcel Habitat Assessment Form
____ Complete Basic Lake Information & Site Activities Form (after assessment)
____ Data entered into SOEI database on _____ (date)
____ Field sheets scanned & filed electronically

Field Equipment

____ Boat & Personal Flotation Devices
____ GPS
____ Big 10 Shoreline & Littoral Habitat Assessment data sheet
____ Big 10 Upland & Drawdown Habitat Assessment data sheet
____ Big 10 Invasive Plant & Animal Assessment data sheet
____ All Parcel Habitat Assessment data sheet
____ All Parcel Habitat Assessment Field Description sheet
____ Basic Lake Information, Site Activities & Human Disturbances data sheet

QA/QC Validation
Student: Supervisor Signature: Date:

Sigurd Olson Environmental Institute
NORTHLAND COLLEGE

WQ Monitoring, Aquatic Plant Survey & Shoreline Habitat Assessment
Field Measurement Validation

(one sheet per sample site)

Lake Name _____

Site Location _____

Sampling Unit/Equipment _____

Date Sampled _____

Field Crew _____

Date Reviewed _____

Reviewed by _____

_____ All field forms have been received (data sheet, flow, etc.)

_____ Multiprobe was calibrated correctly / GPR working correctly

_____ Multiprobe post-sample DO check was accurate

_____ Field measurement duplicates were within range (once per month)

_____ Water sample duplicates were within range (once per month)

_____ There were no obvious trends in data taken from any sensor during the sampling day

_____ Equipment blanks sent to lab included

QA/QC Validation
Supervisor Signature: Date:

Sigurd Olson Environmental Institute
NORTHLAND COLLEGE

Laboratory WQ Sample & Phytoplankton Data Validation

(one sheet per lake)

Lake Name _____

Date Sampled _____

Field Crew _____

Received by (at lab) _____
Reviewed by _____
Review date _____

_____Samples received by lab at proper temperature (look at COC copy from lab)
_____Holding time limits met
_____Analytical methods used in analyses were those agreed upon
_____Useable MDL and ML achieved in this analytical run
_____Calibration procedures were followed

QC samples control limits applicable to this analytical batch

Lab blank _____
Lab dup _____
Lab LCS _____
Lab spikes _____
Field dup _____ Eq
blank ___ CCVs _
_____

QC samples within range expected

Lab blank _____ Lab
dup _____ Lab
LCS ____ Lab spikes _
_____ Field
dup _____
Eq blank _____
CCVs _____

Lab notes or flags

Samples rejected

QA/QC Validation
Supervisor Signature: Date: