Atlantic Coastal Plain Flora Volunteer Water Quality Monitoring Protocol

Mersey Tobeatic Research Institute

Water-pennywort on Kejimkujik Lake, Photo Credit: Megan Crowley

DRAFT April 2011

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1. Background and Objectives

1.1. Introduction

Water quality is the condition of water, including its biological, chemical, and physical characteristics. Water enters a lake from many sources including rivers, streams, groundwater sources, and runoff from land after a rainfall. As the water flows, it picks up materials from land and air, changing the quality of the water. This means that many factors affect water quality, both human and non-human, including local bedrock and soil composition, atmospheric conditions, and land-use.

Water quality monitoring is the process by which data about the biological, chemical, and physical qualities of water are collected over time and interpreted with respect to how water quality may be changing. Water quality is important for the health of

plants and animals (including humans) living in or near the water, as well as for recreational purposes.

By monitoring water quality over a long period of time, it may be possible to detect changes in the health of the lake habitat, and recommend changes necessary to restore the water to natural conditions, safe for recreational and natural purposes.

Atlantic Coastal Plain Flora (ACPF), are a group of approximately 90 plant species typically found growing on or near lake shorelines and in wetlands along the flat sloping land of the Atlantic coastal plain. The low nutrient, high disturbance shorelines of Nova Scotia contain species of Atlantic Coastal Plain Flora found nowhere else in Canada. Many ACPF species are sensitive to changes in water quality, and can be out-competed by other plants when changes in water chemistry occur. For example, increases in nutrient levels leading to eutrophication threaten ACPF species, which tend to thrive in nutrient poor soils where most plants can't survive. As nutrient levels rise, more common and aggressive plants close in, against which ACPF are not able to compete.

The Mersey Tobeatic Research Institute (MTRI), volunteers, and community groups are interested in preserving and protecting our lakes and the life they support. Together, they have begun monitoring water quality on freshwater lakes important for ACPF species, and the communities they are part of.

This manual will provide the information needed by volunteers to participate in water quality data collection, and understand the importance of the information they are collecting, as well as basic water chemistry parameters and techniques used in this monitoring program.

This protocol was developed based on the feedback of experts and community members at an open meeting held in Yarmouth in June 2010. The goal of the meeting was to develop a collaborative and comprehensive water quality monitoring protocol that can be used in a volunteer-driven and community-based water sampling program.

1.2. Water Quality Monitoring as a Volunteer

As a volunteer water quality monitor, you will collect valuable data related to the health of aquatic ecosystems in the Tusket and Medway River watershed. In return for your efforts, you will gain an understanding of the factors that affect water quality and learn many techniques commonly used in its assessment.

The data you collect will contribute to a multi-year monitoring program that will help to establish baseline water quality data and identify existing or potential

problems. This data will be analyzed and reported on in the fall after the last sampling session in October, and will be presented to you in newsletters and at volunteer appreciation events.

1.3. The Value of Monitoring

Aquatic ecosystems are very dynamic, changing subtlety from season to season, and from year to year, with many factors interacting to establish conditions at any one time. By sampling water quality during a single visit, we capture what amounts to a snapshot of these conditions- an isolated picture of what the aquatic ecosystem is experiencing within a single moment in time. To gain a clear understanding of water quality, continuous, long-term monitoring is required. By sampling the same parameters within a water body over many seasons and years, it becomes possible to determine how much variation may be the result of genuine long term change as opposed to the natural variation between seasons and years, as well as any trends to be identified. Research shows that a realistic evaluation of changes in water quality requires data to be collected in a consistent manner over at least several years, and perhaps even decades.

By involving volunteers and using comparable methods of data collection, this project will allow us to develop a continuous, baseline data set that will help in the identification of warning signs for potential problems, as well as recognize improvements.

1.4. Monitoring Objectives

1. Develop a consistent and comparable method of water quality sampling in watersheds containing Atlantic Coastal Plain Flora (ACPF). This sampling protocol will produce data that will add to previously collected data, and create a water quality database for the region.

2. Provide baseline data to determine the current status of water quality on lakes containing rare ACPF species. This will act to provide a regional picture of water quality on lakes throughout the watershed and highlight the potential impacts for both the people and the plants that depend on this important resource.

3. Compare and assess newly collected data with existing water quality data from the area. This will be useful in detecting temporal changes in the trophic status of lakes in the study area that may be the result of eutrophication caused by changes in land-use activities within the watershed of lakes with ACPF.

4. Train, educate and involve volunteers and members of local community groups in water quality sampling.

1.5. Water Quality Parameters

Evaluation of water quality is a widely accepted and used measure for assessing and monitoring the health of fresh water ecosystems, and involves collecting water samples from a water body, in this case lakes. Very useful and valuable information can be obtained through regular measurement of a few very basic water quality parameters. It is not enough to sample a lake once as water quality can change with the seasons, and for this reason we will sample lakes four times per year over the course of multiple years.

The parameters chosen for assessment within this monitoring program have been selected on the basis of their relative importance in determining overall water quality, as well as their link to important monitoring questions such as eutrophication and land use changes. All of the parameters are relatively simple to measure and require a minimal amount of time for both field collection and laboratory analysis.

Table 1 lists the parameters selected for measurement along with a brief description of the general collection and analysis procedures. For detailed information on field collection and lab processing techniques for each parameter, see section 3.

Parameter	Field Methods	Laboratory Techniques
Weather conditions	Visual observation	none
Water temperature	YSI lowered at intervals	none
Water clarity	Secchi disk	none
Water colour *	Sample collection (clear bottle)	Keep chilled and send to lab for processing
pH	YSI lowered at intervals	none
Dissolved Oxygen	YSI lowered at intervals	none
Total Phosphorus	Sample collection (clear bottle)	Keep chilled and send to lab for processing
Nitrate and nitrite	Sample collection (clear bottle)	Keep chilled and send to lab for processing
Conductivity	YSI lowered at intervals	none
Salinity	YSI lowered at intervals	none
Alkalinity*	Sample collection (clear bottle)	Keep chilled and send to lab for processing
Chlorophyll *a*	Sample collection (brown bottle)	Membrane filtration; freeze filter paper and send to lab.
Turbidity	YSI lowered at intervals	none

Table 1: Water quality parameters to be measured. * Alkalinity only shows insignificant changes over the course of a year, and so will only be sampled once per year in October. Colour will be sampled at the same time as alkalinity, as it too, does not change over short periods of time.

A brief explanation of each parameter is provided below:

1.5.1. Weather conditions(precipitation, wind, cloud cover, and temperature)

Weather conditions at the time of sampling can influence the results obtained from samples. For example, strong winds may mix the water column, re-suspending bottom sediments, and as a result, decreasing water clarity. Heavy rains may wash soil or other materials into the lake, also reducing water clarity and increasing turbidity. It is therefore important to record weather conditions at the time of sampling, and any major weather events just prior to sampling.

1.5.2. Water temperature

Many aquatic organisms have specific temperature tolerances and are limited in their distribution to a certain range in temperature. They may die when the water temperature, for some reason, falls outside their tolerance range. Water temperature directly impacts aquatic organisms by affecting metabolic rate, and their sensitivity to toxic substances. The solubility of dissolved gases also changes with temperature. Oxygen, in particular, can be a concern as it is less soluble at higher temperatures.

1.5.3. Water clarity or turbidity

Water clarity, or turbidity, is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. The more suspended solids there are in the water, the murkier it seems and the higher the turbidity. There are many factors that may influence the clarity of water. A few are algae growth, re-suspended sediments from the bottom, sediments from erosion and waste discharge or other runoff. Water clarity is important for more than aesthetic reasons as it also has biological implications within the aquatic ecosystem. Fish like trout need to see their food to eat, suspended sediments may clog or otherwise damage the gills of fish, and particles that block the sun from penetrating the water column may severely limit photosynthesis the general productivity of the system. High levels of turbidity may also be an indication of sever erosion and potential siltation problems.

1.5.4. Water colour

Water colour is closely related to turbidity and depends on two factors: the nature of suspended particles in the water, and those actually dissolved in the water. The colour resulting from suspended mater is called apparent colour, and is caused by things such as algae, clay and silt particles. In contrast, the colour resulting dissolved matter is known as true colour, and is a product of various substances as they are leached from the surrounding soils and entre the water. For example, in Southwest Nova Scotia, many lakes are naturally very dark in colour. This is not a sign of poor water quality, but is a result of tannins from surrounding peat deposits staining the water.

1.5.5. pH

pH is a measure of a liquid's acidity on a scale of 0-14. A score of 0 is highly acidic while 14 is highly basic, with 7 (the pH of pure water) being neutral. pH values are based on a logarithmic scale. This means that a liquid with a pH of 5 is ten times more acidic than one with a pH of 6, and 100 times more acidic than one having a pH of 7. pH values for freshwater systems usually range between 5 and 8, though in our location in Southwest Nova Scotia, it is not unusual to find lakes with pH values below 5. This is a result of our local geology, as well as acid rain. Aquatic organisms tend to thrive only in specific pH ranges, which vary from organism to organism. This makes alkalinity (below) and its role stabilizing pH quite important.

1.5.6. Alkalinity

Alkalinity is very important in the aquatic environment because it reflects the capacity of the water to resist changes in pH (its buffering capacity). Higher alkalinity gives a water body more resistance to pH swings, a stability many aquatic organisms require to survive. Alkalinity is largely determined by the geologic characteristic of the local watershed, and also affects the amount of trace elements important for aquatic life that can remain in solution.

1.5.7. Total phosphorous

Total phosphorous is the measure of the total concentration of phosphorous present in a water sample. Phosphorous is an important nutrient for plant and animal growth and is present in every living creature on the planet. Too much phosphorous, resulting from various sources such as nutrient rich runoff (ex. from agricultural lands, urban areas, lawns, septic systems or other runoff sources) can be a problem though, resulting in excessive algae growth. However, phosphorous and nitrogen (below) can be co-limiting (one limits the abundance of the other, so if a balance can be achieved, so can good water quality).

1.5.8. Nitrate and nitrite

Nitrate and nitrite are nitrogen compounds. In nature nitrates are readily converted to nitrites and vice versa. Nitrate is naturally present in soil, water and food, and is an important part of the food chain, acting as food for plants, which in turn may be food for animals, which eat the plants and use the nitrate to produce protein. Nitrate is returned to the environment through animal feces and decomposition. In lakes, the growth of algae is often encouraged by excess nutrients such as nitrate. Excessive amounts of nitrate may enter a lake through septic systems, agricultural practices, and extensive land clearing. This leads to increases in nitrate being leached from the soil and ground cover in the form of runoff or seeping into groundwater. Increased levels of nitrates and nitrites in the water, combined with phosphorous can cause excessive plant and algal growth that depletes oxygen levels, making problems for fish and other organisms that need oxygen to breathe. Some algal blooms also produce toxins that can affect aquatic life or humans that consume them.

1.5.9. Dissolved oxygen

The amount of dissolved oxygen in an aquatic environment affects the diversity and number of organisms present in a given location, as oxygen is necessary for most forms of aquatic life to survive. As a result, low dissolved oxygen levels can limit the success of many species. Dissolved oxygen can become depleted when large algae blooms die off and are decomposed by aerobic bacteria, resulting in fish kills and the accumulation of toxic decomposition byproducts. The amount of oxygen dissolved in the water varies greatly with water temperature, with cooler water containing more oxygen than warmer water

1.5.10. Chlorophyll a

Chlorophyll *a* is a green pigment found in all plants, algae and cyanobacteria, and is vital for photosynthesis. Chlorphyll *a* is commonly used to measure the amount of algae in a water sample. Since nutrient levels (such as phosphorous and nitrogen) directly influence algal growth, the amount of algae in a water body can be used to determine the trophic status of the water body (the biological activity or productivity

of a lake is referred to as its trophic condition) as well as measure and monitor the process of eutrophication.

2. Sampling Design

The overall monitoring questions that this protocol aims to address are:

- What is the natural range of water quality variation for lakes within watersheds containing ACPF species, and are nutrient levels (i.e. eutrophication) increasing in these lakes and negatively impacting rare and endangered ACPF species and the people that live there? What is the current trophic status of these lakes?

2.5. Sampling Considerations

Some of the lakes that will be monitored this year (Appendix 1) were sampled for water quality in 2002 as a part of a Federal Habitat Stewardship Program project, undertaken by the Department of Natural Resources and Centre for Estuarine Research at Acadia University. Due to this, effort will be made to maintain previously established sampling locations, sampling times, parameters sampled, and collection methods in order for the data collected over the duration of this project to be as comparable as possible. This will allow us to determine if any changes in water quality have occurred over this time period. Please talk to us if you are interested in learning more about this project.

2.1.1. Lakes

Ten lakes have been chosen for sampling in the first year of the project based on their location in the watershed. Lakes and sampling locations are outlined in Appendix 1. These are a subset of the 36 lakes selected as high priority in the ACPF Recovery Strategy and were chosen to be representative of all high priority lakes and the watersheds they are concentrated in.

2.1.2. Sampling Times and Frequency

Each lake will be sampled four times per year. Samples will be collected in May and October, during spring and fall turnover when lake waters are well mixed and parameters well distributed, as well as July and August, during the summer growing season when lakes may become stratified. Samples are collected once during each of the specified months, the timing of which corresponds with the water quality data collected in 2002. Table 2 indicates the time frame in which the samples must be collected.

Month	Start Date	End Date
May	1	12
July	1	12
August	20	31
October	20	31

Table 2: Lake water quality sampling windows by month. All samples MUST be collected within these dates and delivered to the coordinator for shipping to the lab the same day.

As a water quality monitoring volunteer, a certain commitment on your part is required to obtain water quality samples during these time periods. If you are unable to collect samples on your lake during these dates, please contact the community coordinator (Appendix 4) so that they can make alternative arrangements. All volunteers must collect samples from their assigned location(s) on the date agreed upon with the community coordinator. The community coordinator will assist the volunteer's with sample collection and provide all necessary bottles, sampling equipment and support.

2.6. Quality Control

Quality assurance and quality control measures will include YSI calibration, thorough training of monitoring volunteers and the support of a capable community coordinator available to answer questions and assist in sample collection when needed. The community coordinator will also arrange for duplicate, and blank samples to be collected periodically. These will help confirm accuracy and precision of the data by allowing us to test for the purity of chemical preservatives, and check for possible sample contamination sources such as sample bottles, equipment, filter paper, or other errors that may occur within the sample collection and processing methods. One of each type of quality control sample (duplicate and blank) will be taken during the sampling season (May-October).

3. Field Methodology

3.1. Safety Working in and Around Water

As valuable volunteers, we are concerned with your safety while you are helping monitoring water quality. Since the water quality monitoring will be done during a specified time period, MTRI staff will be aware of the times you may be out on the water collecting data. You will never be asked to collect water quality data alone, and will always have the security of operating with a partner. It is important that you and your partner work as a team when collecting samples, both for your mutual safety, as

well as to improve the efficiency of data collection. In case of an emergency, be sure that at least one of you brings a cell phone, and a basic first aid kit.

When travelling by canoe, remember to wear a personal floatation device (pfd) at all times. Adhere to safety rules pertaining to canoeing, including ensuring that the boat is equipped with a bailer, spare paddles, whistles, and a buoyant heaving line. Bring sun block lotion, water and bug spray into the field when collecting data. Try not to lean over the side of the boat when collecting water samples from the lake. You may also be required to sign a volunteer waiver, and the community coordinator can provide you with one.

If you have an emergency situation while in the field please contact one of the emergency numbers included in your field kit.

Emergency Contact Numbers:

911 Emergency
MTRI: 902-682-2371

3.2. Equipment Checklist

Before heading out to the lake to collect samples and make other water quality observations, check this list to make sure you have everything you will need to make the most accurate and efficient observations possible and collect samples free from contaminants that may skew laboratory results.

Field Equipment (per-lake):

- GPS programmed with sampling location UTM coordinates
- 2-3 clear, 125ml plastic bottles
- 1 brown, 1 L plastic bottle
- Secchi disk, with measured line
- Latex gloves
- Van-Dorn water sampler
- Bailer (vertical water sampler)
- Clipboard
- Waterproof field data sheets
- Masking tape
- Pencils and sharpener
- Permanent marker
- Backpack to carry equipment to field

- Thermometer
- Cooler
- Freezer packs
- Bathymetric lake map showing sample locations
- YSI Sonde 650
- Anchor

3.3. Field Sampling Methods

For all water quality sampling and observations, follow this general procedure:

1. Use your handheld GPS to locate the sampling location. This will generally be the deepest part of the lake. Have your partner steady the boat in this location for the duration of the sampling session, or use an anchor if available. It is important that you sample the same location every time.

2. Record the date and time on the data sheet. See Appendix 3 for an example of a correctly completed data sheet

3. Make and record weather observations, including air temperature, on the data sheet. Check the box that is most applicable to the day's conditions, or make observations using the following guidelines:

- To make temperature observations, expose the thermometer to air out of direct sunlight and potentially hot objects. Once the thermometer has stabilized (i.e., repeated readings show no change) record the temperature on the data sheet.
- To make cloud cover observations, estimate cloud cover as the percent of the sky covered by clouds.
- To estimate wind strength, it can be helpful to look at the tops of trees.

4. Measure and record Secchi disk depths (see section 3.3.1).

5. Collect observations using the YSI Sonde (see section 3.3.2).

6. Collect water samples in the appropriate bottles (see section 3.3.3).

7. Make and record any general observations. This can include written observations and pictures. Pictures of you and your partner collecting water quality samples and observations are an important record of your efforts as well! Please email any pictures you would like to share to: lindsey.beals @merseytobeatic.ca

3.3.1. Secchi Disk Measurements

NOTE: When using the Secchi disk, work on the shady side of the boat, and do not wear sun glasses. Record depth measurements to the nearest 0.1 meter.

1. Slowly lower the Secchi disk into the water until you can no longer see it. Record the depth on the data sheet.
2. Slowly raise the Secchi disk until you can see it again and record the depth on the data sheet.
3. Average the depth at which it disappears and reappears and record this on the data sheet.

3.3.2. YSI Sonde Measured Parameters

The YSI Sonde 650 will be used to measure several important water quality parameters including turbidity, dissolved oxygen (DO mg/l; DO %), temperature (c°) and conductivity. At the same time, it will also measure pH and salinity. In order to learn as much as possible about the nature of the lakes we are monitoring, we will record all of these measurements each time we sample. In order to establish a depth profile for each lake, samples will be taken at several different depths. First, submerge the Sonde`s probes to a depth of 0.25m, allow it to acclimate before recording the readings. Next, submerge the probes to a depth equal to two times the Secchi disk depth, or 1.0m from the bottom, **whichever is farther from the bottom**, allow time for the Sonde to acclimate to the new conditions and record the readings. If at twice the Secchi depth the probes are more than 1.0m from the lake bottom, lower the probes to 1.0m from the lake bottom, allow time for the probes to acclimate and record the readings as before.

The attached Sonde calibration guidelines (Appendix 2) should be followed each day it will be used for sampling before leaving for the field. The Sonde should be allowed to acclimate to the water temperature before readings are recorded. When sampling in conditions of thick algal blooms or other murky conditions, rinse the probes in clean water after sampling to help ensure nothing damages the sensors by sticking to their surfaces.

3.3.3. Water Sample Collection

It is extremely important that the water samples be collected without being contaminated in any way. This includes fingers or gloves touching the insides of the bottle or its cap, or water from sources other than the sample location being introduced through transfer from sampling equipment. The nutrients being sampled for are present in very small quantities and the introduction of any

additional nutrients can result in readings that are not representative of the actual sample location. For this reason, it is important that all sampling equipment, such as the Van-Dorn water sampler, be rinsed thoroughly three times on the opposite side of the boat from the side you will collect samples from, before collecting samples and readings. Rinse equipment at least 25cm below the surface to avoid contamination by surface films.

Bottles are pre-labeled for the sample that they will be tested for. Before rinsing or filling the bottle, write the sample location ID and the date on the bottle (if you do this after the bottle has gotten wet it will be a lot harder to make the writing clear and permanent).

The following water samples will be collected as composite samples consisting of one-half water from 0.25m depth and one-half water from two times Secchi depth. In order to achieve this, lower the Van-Dorn sampler to 0.25m depth and allow it to fill with water. Use this water to fill the sample bottles half full. Re-submerge the sampler if more water is needed to half fill all the bottles. Empty the sampler of any remaining water and submerge it the a depth equal to two times the Secchi disk depth, or 1.0m from the bottom, **whichever is farther from the bottom.** Allow the sampler to fill with water, and use this water to fill the remaining space in the sample bottles. Make sure all bottles are full, tightly caped and well labeled before placing in the cooler and shipment to the lab.

Total Phosphorous, Sample: Do not rinse these bottles, as they are pre-treated with chemical preservatives to extend the holding time of the sample. Fill them to the top, taking care not to allow them to overflow, with a composite water sample as described above. Store the sample in a cooler with freezer packs.

Nitrate and Nitrite, Colour and Alkalinity Sample:
Rinse the bottle with water from at least 25cm below the surface, on the opposite side of the boat from which you will be collecting the sample. This will wash away any tiny bits of plastic that may contaminate the sample. Be sure that no part of your hands touches the inside of the bottle or bottle cap. Fill the bottle with a composite water sample as described above. Store the sample in a cooler with freezer packs.

Chlorophyll a Sample:
Rinse the opaque, brown sample bottle three times on the side of the boat opposite the side you will collect the sample. Be sure that no part of your hands touches the inside of the bottle or bottle cap. Rinse the bailer water sampler three times on the opposite side of sampling. Fill the bottle to the top with a water sample collected by holding the loop at the top of the bailer and quickly plunging the sampler straight down all the way into the water on the side of the boat opposite from

where it was rinsed. Allow the tube to fully fill with water, and poor this water into the brown bottle. Repeat this process until you have collected enough water to fully fill the bottle. Label the bottle by recording the lake, date, time, and your initials on a piece of masking tape and sticking it on the bottle. Store the sample in a cooler with freezer packs.

3.4. Laboratory Sample Processing

It is important to keep all samples chilled until they are either processed or sent on to the lab. Samples will degrade over time and this process is sped up if the sample is allowed to rest at room temperature or greater. Samples must be stored in a cooler with ice packs or in the refrigerator, and sent to the analytical lab for processing as soon as possible.

3.4.1. Chlorophyll a Sample Processing

The Chlorophyll *a* sample is the only sample that requires some processing before being sent to the lab for analysis. If you would like to help filter and preserve this sample, talk with the community coordinator for your area.

4. Data Handling, Analysis and Reporting

4.5. Data storage and Access

Data will be stored at the Mersey Tobeatic Research Institute (contact Brad Toms: brad.toms@merseytobeatic.ca), and available for public access through the online Lake Atlas (a web-based geographic information system linking lakes with associated data, currently a work in progress).

Data collected will be compiled in excel format as well as converted to formats compatible with GIS software used for mapping within the project. Until the completion of the online Lake Atlas, the data will be available upon request to any one who may wish to see or use it.

4.6. Data Analysis

Data will be analyzed by MTRI staff. Methods used to assess data will be in keeping with those used in the report by Eaton and Boates previously referred to in this document, and will be submitted to qualified advisors before reports are finalized.

4.7. Data Reporting

In the fall after the last sampling session in October, the data for the year's field season will be presented to the volunteers at a volunteer appreciation event. After the

October sampling session, an opportunity will be arranged where volunteers can get together to talk about their experiences, review the program's goals, discuss common problems and make suggestions for improvements to the program.

The data will also be reported to other project funders and stakeholders, and be made available on the MTRI website for anyone who may wish to review it.

Acknowledgements
This protocol was prepared by staff at the Mersey Tobeatic Research Institute and incorporates the suggestions of experts and community members. While the sampling techniques in this protocol should remain consistent inter-annually, other sections of the document may be fine tuned to reflect changes in reporting, or to improve clarity. The following documents were used to develop this document:

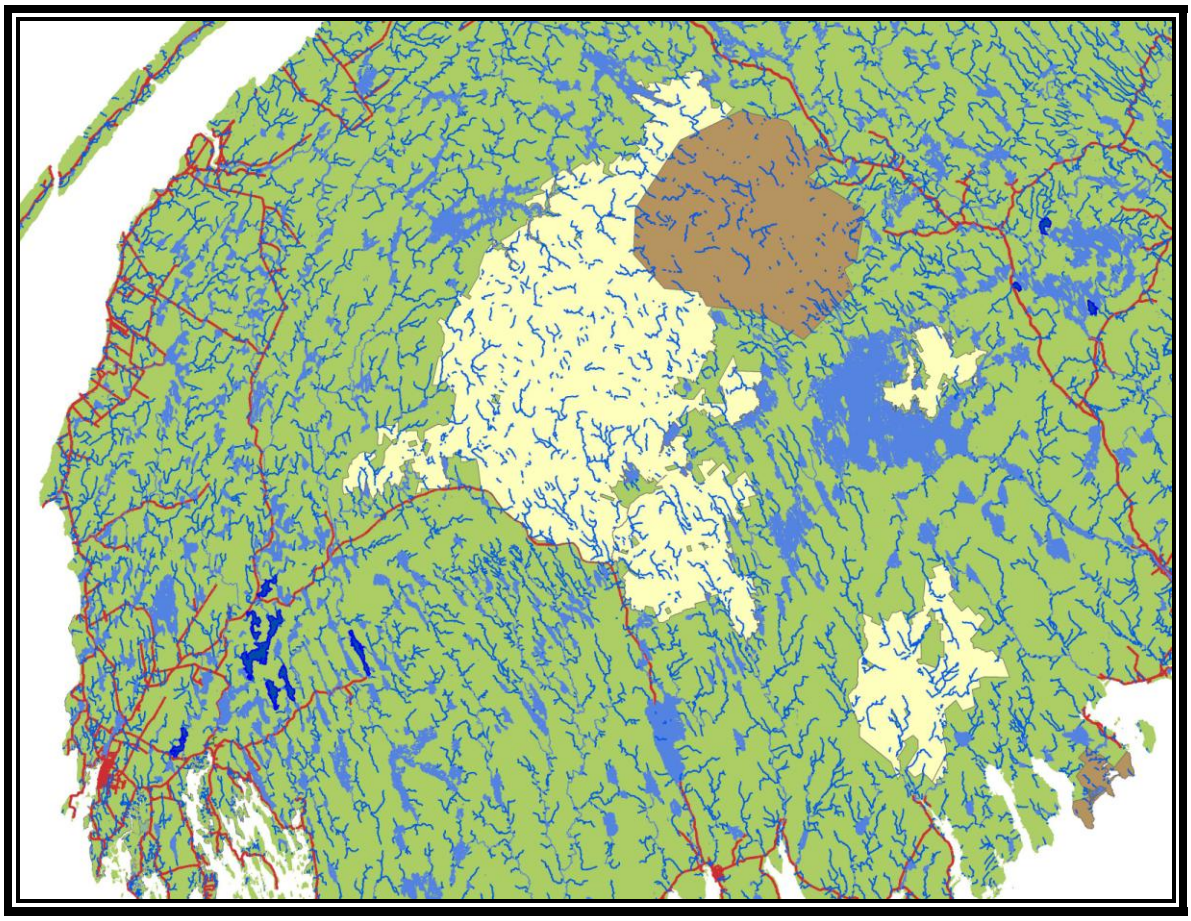
Kings County, Nova Scotia Volunteer Lake Water quality Monitoring Program Reference Manual. 60 pgs.

Water Quality Index Monitoring Protocol Quebec-Atlantic Bioregion. 2008. 34 pgs. Parks Canada.

Appendix 1- Lakes to be Sampled in Year one

Tusket Watershed:
Wilsons
Bennetts
Sloans
Fanning
Raynards
Kegeshook
Salmon

MedwayWatershed:
Hog
Little Ponhook
Cameron



Appendix 2- YSI Sonde Calibration and Care Instructions

The following YSI Sonde calibration and care instructions were provided to MTRI by Nova Scotia Power Incorporated in 2008. They serve as a reliable guide for how to prepare the Sonde for sampling and cleanup. Generally, the Sonde will be calibrated by the coordinator, but volunteers interested in being involved in this process are encouraged to participate and should let their local coordinator know they are interested.

Calibration Procedures

* Prior to taking the YSI Sonde out for field use it should be pre-calibrated in a controlled environment to ensure all systems are working properly. The 650 MDS display units should also be charged for up to six hours and no more than 48 hours before use in the field. The parameters should be calibrated in the following order: conductivity, turbidity, pH, and dissolved oxygen.

-Conductivity should be calibrated using specific conductance to the level that the standard is rated (presently 1413 us/cm at 25°C) and should be calibrated daily while in the field.

-A 3-point turbidity calibration (0, 10, and 100 NTU) should be performed once per month and a 1-point calibration (0 point) should be performed daily. The turbidity probe can be tested, and if off by >0.2 NTU, it should be recalibrated.

-A 2-point pH calibration (pH 7 and pH 4 buffers respectively) should be conducted at least once daily at field temperature. Allow at least 1 minute for temperature equilibration when calibrating in each solution.

-A dissolved oxygen (DO) calibration should be done every day in % saturation mode at field temperature. If calibrating in this mode, the Sonde should be left with a small amount of water in the loosened calibration cup for approximately 10 minutes to allow temperature and humidity equilibration to occur before entering the barometric pressure. If a new membrane is installed the probe needs to be in continual operation for 15 minutes to begin reading and calibrating correctly.

* More frequent calibrations should be done with regards to the above parameters if measurements and/or response times appear inaccurate or unstable. With regards to changes in barometric pressure throughout the day, there is no need to re-calibrate DO. When calibrating for a specific parameter, ensure that the corresponding probe is sufficiently covered by the calibration solution.

* With regards to the various calibration solutions, they can be re-used as long as cross-contamination is minimized. Between individual calibrations, the probes should be rinsed with distilled water and patted dry with lint-less tissue (Kimwipes). Do not allow the tissue to come in contact with the end of the 6036 turbidity probe as this may scratch the lens. When a standard continually reads lower as it is diluted, it is time to replenish it.

* Conductivity standard is purchased at the appropriate concentration. Turbidity standard is purchased in batches of 100 NTU concentration, and therefore, 10 NTU must be diluted from this using distilled water. 0 NTU is merely distilled water. Both pH buffer solutions are mixed using the powder pillows provided and distilled water in a ratio of 1:50ml respectively. The DO calibration does not involve any special solutions. pH buffers and calibration solutions will not harm other probes.

E2 Care and Maintenance of the YSI Model 6820 Sonde

* Used calibration solutions can be disposed of via the waste stream as long as they are diluted sufficiently, according to the Nova Scotia Department of the Environment1. For example, the pH buffer MSDS recommends dilution to at least 5 times the volume of original solution and running the tap for at least 5 minutes to ensure adequate flushing. This appears to be a reasonable protocol to follow for the remaining solutions.

E2.1 6265 DO Probes

YSI recommends that the KCL solution and the Teflon membrane at the tip of the 6252 probe be changed at least once every 30 days during the use of the Sonde in sampling studies. In addition, the KCL solution and membrane should be changed if a) bubbles are visible under the membrane; b) significant deposits of dried electrolyte are visible on the membrane or the O-ring; and c) the probe shows unstable readings or other probe related symptoms. See the Sonde Operations Manual for instructions on changing the DO membrane. If changing the membrane does not correct the problem, or if either of the silver electrodes are black in color, the probe should be resurfaced using the fine sanding disks provided in the Sonde maintenance kit. See the Sonde Operations Manual for instructions on resurfacing the DO probe. The response of the probe should be checked after completing either of the above procedures.

E2.2 6560 Salinity/ Conductivity/ Temperature (SCT) Probes

The openings that allow fluid access to the conductivity electrodes should be cleaned regularly. Small cleaning brushes are included in the Sonde maintenance kit. Dip the brush in clean water and insert it into the hole 15-20 times. If deposits have formed on the electrodes, it may be necessary to use a mild detergent. The response and accuracy of

the probe should be checked after performing the above procedure. There is no specific maintenance with regards to the temperature portion of the probe.

E2.3 6561 pH Probes

Cleaning is required whenever residue appears on the glass and/or platinum surfaces of the probe or when the response time of the probe becomes slow. There are various levels of cleaning depending on the results obtained from each procedure. If proper probe operation is not restored upon the completion of the cleaning procedures, then a "pH Electrode Slope Test" should be performed to determine if the slope of the pH probe has shifted beyond the specified operating range.

E2.4 6036 Turbidity Probes

Care must be taken not to scratch the end, or lens portion of the probe. If measurements seem unrealistic, check the end of the probe for debris or air bubbles which may be adhered to it and rinse them off. The lens should be rinsed with distilled water before and after each use.

E2.5 Depth Sensor

The depth sensor should be cleaned periodically when the Sonde is being submersed as part of a study. A syringe is supplied in the maintenance kit. Fill the syringe with clean water and insert it into one of the holes in the pressure port on the side of the Sonde bulkhead. Gently force the water through the port and flush until the water emerges clean.

E2.6 General recommendations for long term storage

Remove all probes but the SCT and DO probes. Store these probes according to instructions in the YSI Sonde Manual. Cover the empty ports with the plugs provided. Fill the calibration cup with enough distilled/deionized/tap water to cover the remaining sensors and tightened the cap to attain a good seal.

Appendix 3- Completed Data Sheet

Depth of lake at Sample Location (m) 4.24

ACPF Volunteer Water Quality Data Collection Sheet

Collectors: Jill and Lindsey

Site Information

Site ID	**CH2**	Date (dd/mm/yyyy)	**July 15, 2010**
Lake Name	**Cameron Lake**	Time	**10:45 am**
UTM Easting	**0344726**	UTM Northing	**4910073**

Weather Conditions

Precipitation				
Rain	None X	Drizzle	Moderate	Heavey
Sky and Air Conditions				
Wind	Calm X	Slight	Moderate	Heavy
Cloud Cover %	44%	Air Temperature c°	21°c	

Secchi Disk Depth

Disappears (m)	**1.52**
Reappears (m)	**1.46**
Average (m)	**1.49**

YSI Measured Water Quality Parameters Depth Profile

Depth (m)	Temp c°	pH	Conductivity	Turbidity	DO (%)	DO (mg/L)	Salinity
0.25m below surface	**24.09**	**5.68**	**23**	**0.015**	**88.6**	**7.44**	**0.01**
2 x Secchi Depth **2.98m**	**18.04**	**5.66**	**23**	**0.016**	**88.0**	**7.32**	**0.01**
1m from bottom	**12.4**	**5.66**	**23**	**0.015**	**86.9**	**7.23**	**0.01**

Water Quality Sample Collection Checklist

Chlorophyll *a*	**X**	Nitrate and Nitrite	**X**
Total Phosphorous	**X**		
On Selected Lakes and Dates Only			
Alkalinity			**X**
Colour			**X**

As Soon as you get BACK HOME…..

Samples to be Sent to the Lab

Samples	**Action Required**
Nitrate and Nitrite	Chill X
Total Phosphorous	Chill X
Chlorophyll *a* (process in conjunction with colour observations below)	Filter X Freeze X
Samples for Selected Lakes and Dates	
Alkalinity	Chill X
Colour	Chill X

Appendix 4- Contact Information

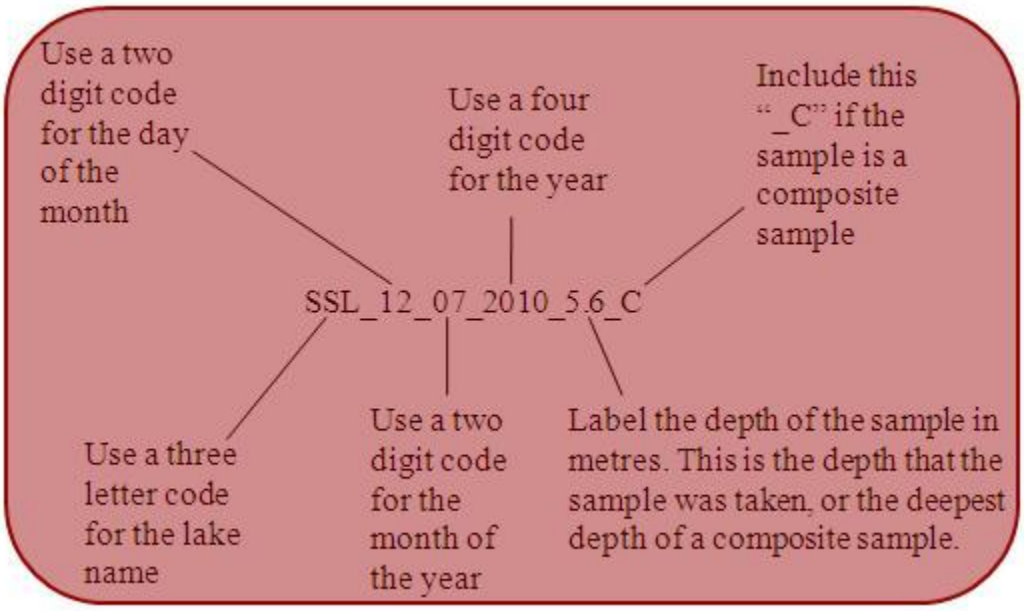
- Lindsey Beals, Aquatic Health Researcher; Medway Community Coordinator
  Mersey Tobeatic Research Institute (MTRI)
  902-682-2371
  lindsey.beals@mersesytobeatic.ca
  www.merseytobeatic.ca

- Brad Toms, Wildlife Researcher
  Mersey Tobeatic Research Institute (MTRI)
  902-682-2371
  brad.toms@merseytobeatic.ca
  www.merseytobeatic.ca

Appendix 5. UTM locations of water quality sampling sites.

Lake	Easting	Northing
Bennetts	0267198	4867286
Cameron	0344726	4910073
Fanning	0266185	4878119
Hog	0347187	49114957
Kegeshook	0276853	4869771
Little Ponhook	0352308	4914957
Raynards	0265670	4870773
Salmon	0239350	4861025
Sloans	0265068	4875127
Wilsons	026232	4867049

Appendix 6. Labeling samples for laboratory analysis.



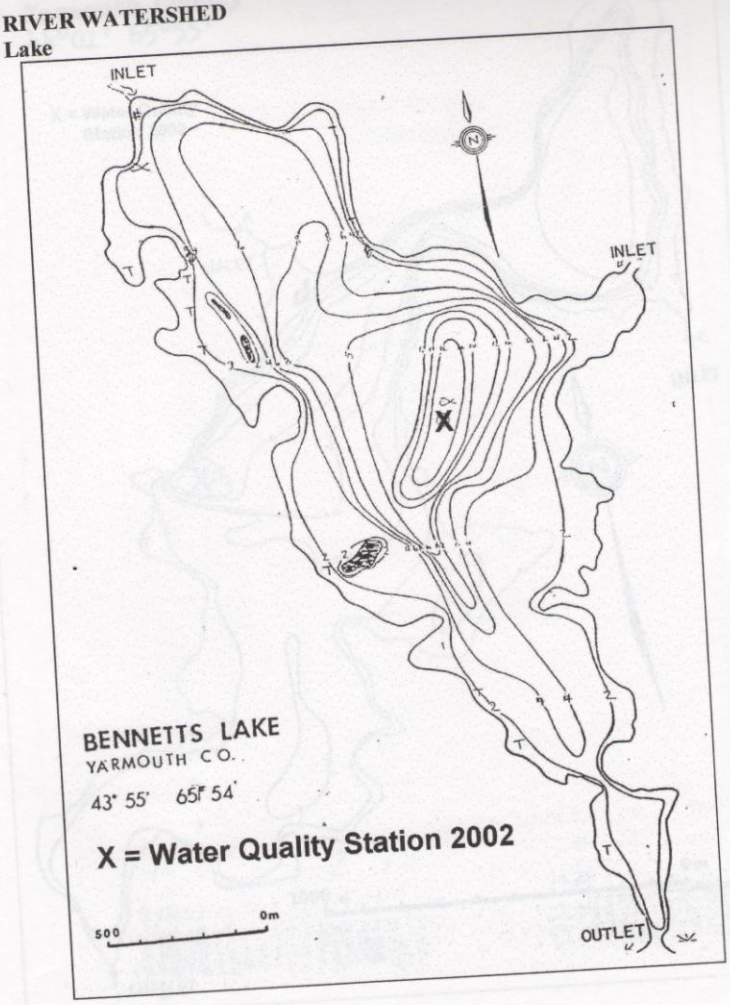
Appendix 7. Bathymetric (depth) lake maps for sampling lakes.

APPENDIX I-3. Bathometric Maps of Lakes Sampled

Bathometric maps existed for 16 of the 19 lakes sampled. Maps were not available for the Tusket River watershed's Third Lake and Lac de L'École as well as the Medway River watershed's Cameron Lake. Maps are organized in alphabetical order according to watershed.

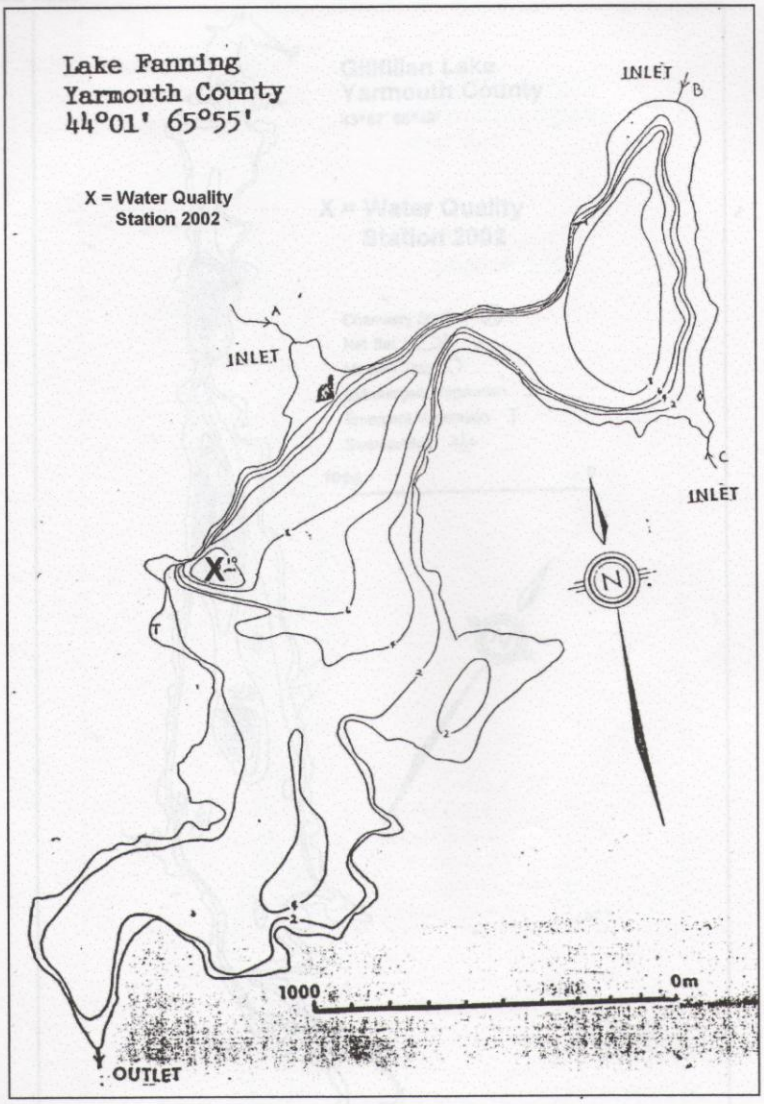
TUSKET RIVER WATERSHED

Bennett's Lake



69

Fanning Lake



70

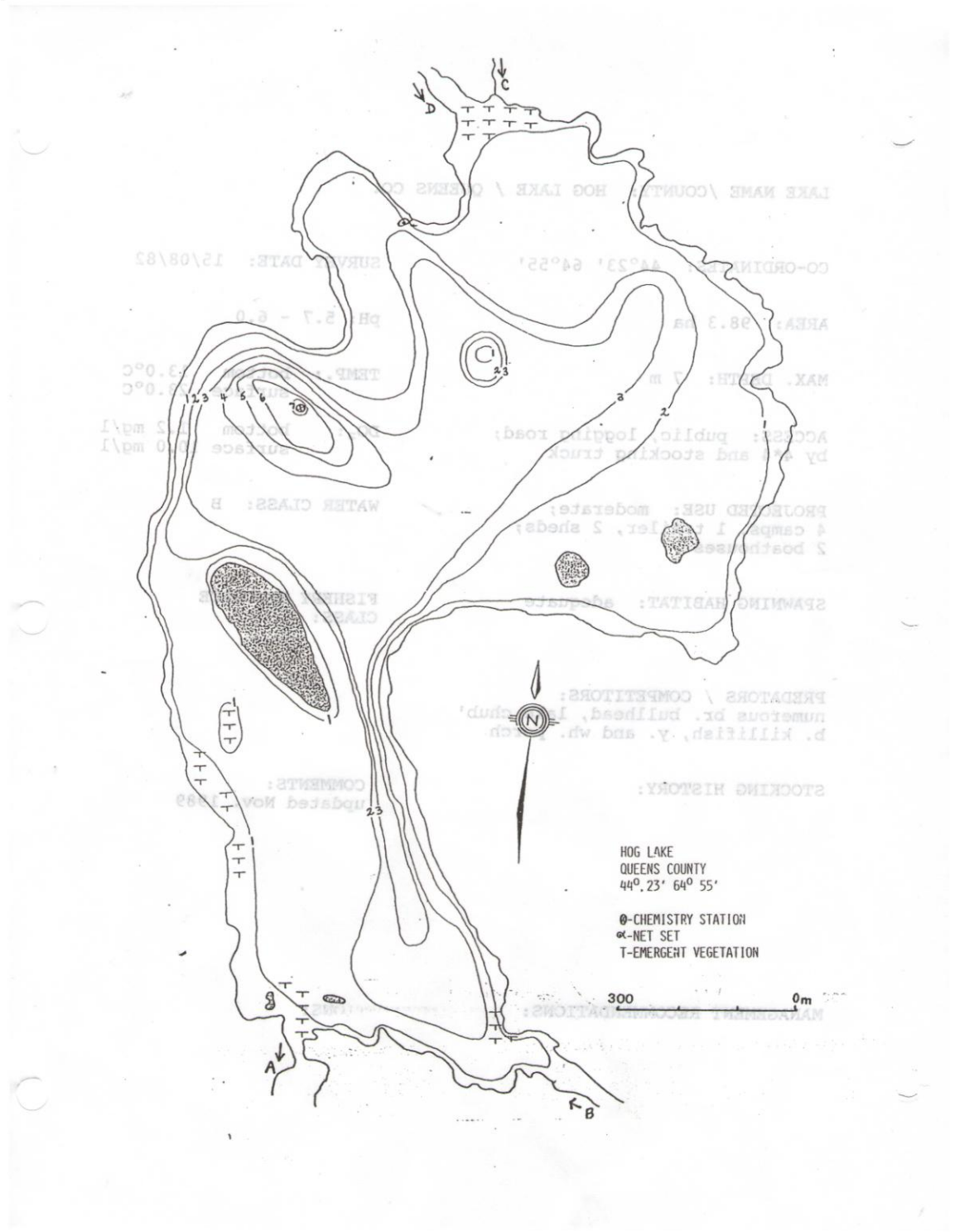
72
Kegeshook Lake
Kegeshook Lake
Yarmouth County
43°58' 65°48'
X = Water Quality
Station 2002
X1
X2
N
Chemistry Station
Net Set
Minnow Trap
Shore Seine
Submergent Vegetation
Emergent Vegetation
0m
1000

76
Sloan's Lake
Sloans Lake
Yarmouth County
43°59', 65°56'
X = Water Quality
Station 2002
X1
X2
N
0m
500
Chemistry Station
Net Set
Minnow Trap

77
Wilson's Lake
Wilson Lake
Yarmouth County
43°56' 65°53'
X = Water Quality
Station 2002
Emergent Vegetation
Bog/Swamp
500
0m
Cavanaghs Run
Abstorms Run
N

79
Salmon Lake
X = Water Quality
Station 2002
SALMON LAKE
YARMOUTH COUNTY
43°52', 66°01'
INLET
OUTLET
N
500
0m
chemistry station
net set

80
0
500
BIG PONHOOK
LAKE
INLET
N
X
2
4
6
8
10
12
14
X = Water Quality
Station 2002
44°18' 64°51'
QUEENS CO.
Little Ponhook L.
MEDWAY RIVER WATERSHED
Little Ponhook Lake


C
D
A
B
N
HOG LAKE
QUEENS COUNTY
44°.23' 64° 55'
Ø-CHEMISTRY STATION
∝-NET SET
T-EMERGENT VEGETATION
300
0m