Dissolved Oxygen and Temperature

Monitoring Procedures (YSI Model 95D)

Dissolved oxygen and temperature are two of the fundamental variables in lake ecology. Measuring these parameters together provides valuable information for assessing the condition of a lake. The amount of dissolved oxygen in the water is an important indicator of overall lake health.

Water temperature serves as a driving force for many important lake processes. The temperature controls the length of the growing season in lakes, which influences the type and amount of biological activity. During the summer growing season, most lakes with significant depth (greater than 30 feet) are thermally stratified forming distinct layers of differing temperature and density. These layers are referred to as the epilimnion (warm surface layer) and hypolimnion (cold bottom layer), separated by a metalimnion (middle layer with decreasing temperature). The greatest changes in temperature occur at the thermocline in the metalimnion. Physical and chemical changes within these layers influence the cycling of nutrients and other elements within the lake system. Temperature also affects the level of dissolved oxygen in the water.

As temperature increases, the amount of atmospheric oxygen that can be dissolved in water decreases. Dissolved oxygen levels are also influenced by the time of day and by oxygen requirements of bacteria and other aquatic organisms. Photosynthesis during the daylight hours increases dissolved oxygen levels in the lake while dissolved oxygen is consumed by respiration at night. The bottom waters of many stratified lakes are susceptible to oxygen depletion, since atmospheric replenishment and photosynthetic production of oxygen are decreased at greater water depth and decomposition of organic matter in the bottom waters and sediment utilizes available oxygen. Low dissolved oxygen levels can result in the loss of susceptible organisms, such as trout and other coldwater fish, and the plant nutrient phosphorus can be released from the sediments when dissolved oxygen is depleted in the bottom waters of a lake.

Temperature and dissolved oxygen are typically measured as surface-to-bottom profiles, with measurements of both parameters collected at regular intervals. Temperature is easily measured with a thermometer or thermistor. Dissolved oxygen is either measured with an electronic meter or via a chemical test. Although most expensive, electronic dissolved oxygen/temperature meters provide the safest and most accurate means for volunteers to collect these data.

A. Equipment Checklist

□ boating safety equipment* and anchor*
□ YSI 95D meter and cable/probe
□ probe cable weight
□ safety lanyard
□ quick-reference DO calibration card
□ equipment storage box and supplies
□ DO/temperature monitoring procedures
□ DO/temperature data form(s)
□ pencil* or indelible ink pen*
□ weighted measured line*
□ Secchi disk*

*(provided by volunteer)

B. Dissolved Oxygen and Temperature Measurements

Dissolved oxygen (DO) and temperature are measured from the surface to within 3 feet of the bottom, as a profile, in the deepest basin of the lake (primary sampling station). Measurements of DO and temperature should be made every two weeks from mid-May to mid-September at the same time and location that you measure Secchi disk transparency in your lake. Dissolved oxygen/temperature profiles are used to track temperature stratification and oxygen depletion in the bottom waters of the lake (hypolimnion) during the entire summer growing season. An electronic DO meter that incorporates a thermistor is used to obtain the DO/temperature profiles. The meter displays the DO readout based on the rate of diffusion of molecular oxygen across a membrane. The thermistor component of the instrument provides the temperature readout.

1. Organize monitoring equipment. Before proceeding to the monitoring location use the equipment list above to organize all of the materials needed for the DO and temperature measurements, as well as your Secchi disk transparency measurements. You have been provided with a YSI Model 95D Dissolved Oxygen and Temperature system for measuring DO/temperature profiles in the lake. The YSI 95D system consists of a handheld micro-processor (the meter) and a detachable 100 foot cable with a microelectrode array (MEA) dissolved oxygen sensor (the probe). (**Note**: this equipment is very expensive. Please read and follow these instructions and handle and use the equipment with care to avoid damage.)

2. Preparing the meter and probe. The YSI 95D system was checked for "trouble-free" operation prior to distribution. New batteries were installed and the probe was fitted with a new membrane cap and fresh electrolyte solution. The probe is stored in a plastic bottle sleeve with a wetted sponge when not in use, which keeps the probe membrane from drying out. With proper storage and careful use, the membrane cap should last the entire monitoring season. However, if the membrane is damaged or gas bubbles appear in the electrolyte solution under the membrane and the meter will not calibrate the membrane cap may have to be replaced. You have been provided with a spare membrane cap and MEA probe solution in the case that the probe membrane needs to be replaced (Refer to Section G. Installing a New Membrane Cap). Refer to the attached Membrane Cap Installation instructions for replacing the membrane cap. If you have any concerns or questions about damage to the probe or replacing the membrane cap, call the technical support staff listed at the end of these monitoring procedures. (**Note**: the batteries in the meter should last for the entire monitoring season. However, if a "LO-BAT" message is displayed on the readout (upper left) after turning the meter on, the batteries are low or damaged and they need to be replaced. The YSI 95D meter uses six AA-sized alkaline batteries. The

batteries are installed in the battery-chamber at the bottom of the handheld portion of the meter. Markings inside each of the two battery-chamber sleeves illustrate the correct way to install the batteries. It is very important that the batteries are installed only as illustrated for proper meter operation and to guard against damage.)

For calibration and probe storage during operation and transport, the YSI 95D meter has a convenient chamber built into the instrument's side. If you look into the chamber, you should notice a small round sponge in the bottom. Carefully put about 10 drops of clean tap water into the chamber to wet the sponge. Turn the instrument over and allow any excess water to drain out of the chamber. The wet sponge creates a 100% water saturated air environment for probe calibration. Insert the probe into the calibration chamber.

Before turning the meter on, attach the probe cable to the handheld meter cable at the bayonet connectors. The connectors have a built-in "key" to ensure proper contact alignment. Align the key, and then connect the cables by rotating the locking ring on the probe connector until it fully engages with the bayonets on the meter's connector. Check for a secure connection. (**Note**: the connectors should be connected by hand only! No tools should be used. The connector contacts must be kept clean and dry.)

3. Calibrating the DO meter. Turn on the meter by pressing the ON/OFF button. With the probe in the calibration chamber, allow about 15 to 20 minutes for the DO and temperature readings to stabilize. (**Note**: turning on the meter will activate all segments of the display for a few seconds, which will be followed by a self-test procedure that will last for several more seconds. During this power on self-test sequence, the meter's microprocessor is verifying that the system is working properly. If the meter were to detect a problem, a continuous error message would be displayed. Should a continuous error message remain on the display, contact the technical support staff listed at the end of these monitoring procedures.) With the meter on and stabilized, press and release the MODE button until the DO reading (main display) is displayed in % (percent of air saturation).

To enter the calibration menu, use two fingers to press and release both the DOWN ARROW (▼) and UP ARROW (▲) buttons at the same time (or DOWN ARROW slightly ahead of UP ARROW). The display will indicate a small CAL box (lower left), the temperature (lower right) and an altitude value (main display). The altitude value is in hundreds of feet. For example, a number 9 here indicates 900 feet (9 x 100 feet). Use the arrow keys to increase or decrease the altitude value to approximate the local altitude of your lake. When the proper altitude value appears on the display, press the ENTER button once. (**Note**: the local altitude, or elevation, for your lake can be found on USGS topographical maps. Topographical maps can be viewed over the Internet at www.topozone.com to find lake elevations, or contact the technical support staff listed at the end of these monitoring procedures for this information.)

The display should now indicate a salinity value of 0 ppt (zero parts per thousand). If a different number is displayed here, use the DOWN ARROW key to decrease the salinity setting to 0 (for fresh water). When 0 is displayed press the ENTER button.
The meter should now indicate the current DO reading in % air saturation (main display) and the DO calibration value (lower right display). These values may not be the same. Make sure that the current DO reading (main display) is stable (not drifting up or down), then press the ENTER button. The display should read SAVE then should return to the normal operation mode with the

current calibrated DO (% air saturation) and temperature (^{o}C) readings. (**Note**: the DO calibration values should be in the range of 98 to 95% air saturation for the altitude range of 550 to 1400 feet.)

Turn the meter off by pressing the ON/OFF button. Leave the probe in the calibration chamber and the cables connected. Carefully pack up the equipment and prepare to head out on the lake. (**Note**: you will check the calibration of the meter out on the lake before taking measurements. A waterproof quick-calibration card is attached to the meter for reference out on the lake.)

4. Proceed to your sampling location. With all of your boating safety and monitoring equipment, boat out to the deepest basin of the lake (primary sampling station) for the DO and temperature measurements. (**Note**: As with all CLMP sampling, the DO/temperature measurements should be collected when the weather is good. BE SAFE! Bad weather may make sampling dangerous. Calm and dry weather conditions are best for monitoring the DO/temperature profile in the lake.)

5. Orient boat for sampling. Approach the sampling location from the upwind direction. Turn off boat motor, lower the anchor, and allow the boat to drift over the sampling station (deepest point) before securing the anchor line. This allows you to take your DO and temperature measurements over a relatively non-disturbed area. When in position, take out the DO/temperature data form (provided with these monitoring instructions) and record your lake's name, county, township, and Lake Sampling Site (Field ID) Number on the data form.

Note: *Use the Master List of Lake Sampling Site (Field ID) Numbers provided to find the correct number for your site. The Lake Sampling Site (Field ID) Number ensures that your data are entered correctly into the MiCorps online Data Exchange system and the CLMP Annual Report. Field ID's can be also found here:*

http://www.micorps.net/documents/2010_SiteID_List.pdf

If known, record the Latitude and Longitude of the sampling site and circle how it was obtained (GPS or Map). Record your name(s) and the date, time, weather conditions and any unusual lake conditions. Circle the Meter Model type and record the CLMP Meter ID# (e.g., IL-1, IL-12, MLSA-4, etc.) which is marked on the meter and storage box. Also, on the bottom of the first page of the data form draw an outline of your lake and mark the approximate sampling location.

6. Verify sampling station depth. With a weighted line that is marked off in feet (or your Secchi disk and line) determine the actual depth of the sampling location. Lower the weighted line until it gently contacts the bottom sediments. Note the depth and record the depth on the DO/temperature data form. (**Note**: do not use the DO cable/probe assembly for this measurement since contact with the sediments may cause probe/membrane damage.)

7. Check DO meter calibration. Turn on the DO meter and follow the calibration instructions in Step B.3 above to check the calibration of the meter prior to use. Leave the meter turned on. **Record the DO calibration (% air saturation) reading (main display), after you have saved the DO calibration value; calibration temperature (^{o}C); and the lake altitude value on the DO/temperature data form.** (**Note**: while you wait for the DO and temperature readings to

stabilize you may want to take your Secchi disk transparency measurement at this time. Make sure you record your results on the transparency monitoring data form.)

8. DO/temperature profile measurements. Press and release the UP ARROW (▲) button to change the DO reading (main display) to mg/l (milligrams per liter). You are now ready to take the DO/temperature profile measurements. You will be measuring DO/temperature at 5-foot intervals in the upper (epilimnion) and lower (hypolimnion) part of the water column and at 2½-foot intervals through the thermocline in the metalimnion of the lake. Generally the thermocline sets up between 15-40 feet depths during the summer. The cable has been marked at 10-foot (white tape and depth indicated) and 5-foot (orange tape) intervals. The 2½-foot point is simply the mid-point between the 10-foot and 5-foot markings.

A small weight has been attached to the cable near the probe so the cable/probe will sink straight down (i.e. perpendicular) from the surface of the lake into the water column. (**Note**: if it is too windy the cable/probe may not remain perpendicular to the surface of the lake while taking the measurements. It is best to take the DO/temperature measurements on a calm day.) Before taking the first measurement, adjust the hand strap on the meter to fit snugly around your hand. Also, attach the safety lanyard, which is attached to the meter, to your belt, belt loop, or your wrist. These precautions will help to minimize the possibility of dropping and damaging the meter while taking the DO/temperature measurements in the lake.

For the first measurement, place the cable/probe into the lake approximately 1 foot below the surface. Once the DO and temperature readings stabilize record the measurements (with pencil or indelible ink pen) on the back page of the data form. (**Note**: make sure the DO reading is in mg/l (main display). If the DO reading is not displayed as mg/l, press and release the MODE button until the mg/l reading is displayed.) Lower the cable/probe and continue the DO/temperature measurements at each 5-foot (or 2½-foot) interval as indicated on the data form with the last measurement taken 2½-3 feet above the bottom sediments of the lake. To avoid damage to the probe/membrane, do not contact the bottom sediments. Make sure you record the DO and temperature readings for each depth interval on the data form. (**Note**: For lakes with low DO below the thermocline, a small amount of agitation (i.e. jigging the cable/probe a few inches) may improve the YSI 95D system's DO and temperature response times. Allow sufficient time at each depth for the DO and temperature readings to stabilize before recording the results and proceeding to the next depth interval.)

9. Prepare to return to shore. After measuring DO/temperature at each depth interval and recording the data, turn off the meter, place the probe into the calibration chamber for transport, and carefully wind up the cable onto the cable carrier. Congratulations, you have completed the DO/temperature profile measurements for this sampling date. You will graph the data after returning to shore. If you have not taken your Secchi disk transparency measurement, do it now and record the results on the transparency monitoring data form. Organize and pack up the sampling equipment, pull up the anchor, and return to shore.

Cooperative Lakes Monitoring Program

Dissolved Oxygen and Temperature

Michigan Clean Water Corps

Data Form

Lake Name: Dead Spider County: Lake Township: Inland

Lake Sampling Site (Field ID) Number: 380137
(mark location on map below)

Latitude: 44.67°N Longitude: 85.49°W Circle GPS / (Map)

Volunteer Monitor Name(s): Barry Turbid + Tami Phosphor

Date Sampled: 9-15-07 Time: 12:30 pm

Weather Conditions (sunny, cloudy, windy, etc.): Calm, Sunny

Unusual Conditions (heavy rain, boating, etc.): none

Sampling Station Depth (measured): 65 feet

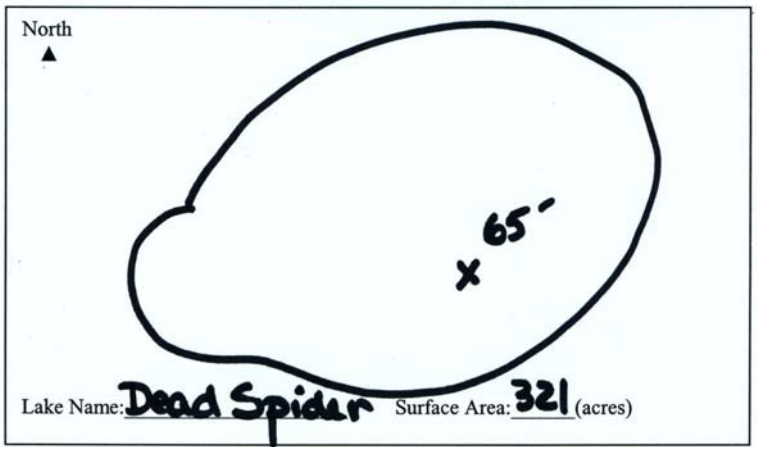
DO/Temp. Meter (circle one): YSI Model 95D (YSI Model 550A)

CLMP Meter ID# (e.g., IL-1, IL-12, MLSA-4, etc.): MLSA-2

Calibration DO: 96.3 % air saturation (after calibration value saved – main display)

Calibration Temperature: 20.1 °C Lake Altitude Value: 8 (x100 ft.)

In the box below draw an outline of your lake (or attach copy of lake map). Mark your DO/temperature sampling location (this should be the deepest basin in the lake) and write the total lake depth at this location.

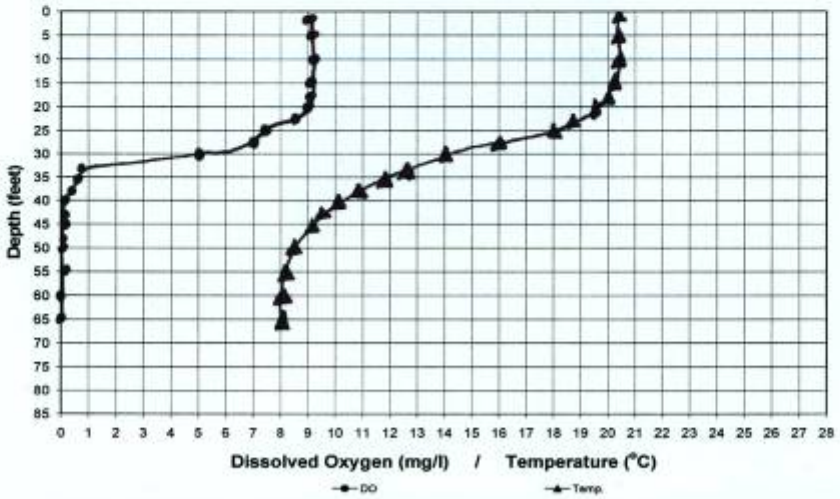


Depth (ft.)	Temp (°C)	DO (mg/l)	Depth (ft.)	Temp (°C)	DO (mg/l)
1	20.4	9.2	37½	10.9	0.4
5	20.4	9.2	40	10.1	0.2
10	20.4	9.2	42½	9.5	0.2
15	20.3	9.1	45	9.2	0.2
17½	20.0	9.1	50	8.5	0.1
20	19.3	9.0	55	8.3	0.1
22½	18.6	8.5	60	8.2	0.0
25	18.0	7.4	~~65~~ 62.½	8.1	0.0
27½	16.0	7.0	~~70~~		
30	14.0	5.0	~~75~~		
32½	12.8	0.8	~~80~~		
35	11.9	0.7	**Note**: Take last measurement 2½-3 ft. above bottom sediments of the lake.		

On the graph below plot your temperature and DO data as separate depth profiles. The y-axis is the lake depth (feet) from surface to bottom. Use the x-axis for both the DO (mg/l) and temperature (°C) scales. Use dots with a solid line for the DO data points and triangles with a dashed line for the temperature data points.

Dissolved Oxygen and Temperature Profiles

Lake Name Dead Spider Date 9-15-08



- Mail completed forms **no later than October 15** to: **Mr. Ralph Bednarz, MDEQ, Water Division, P.O. Box 30273, Lansing, Michigan 48909-7773.**
- If you entered these data into the MiCorps online Data Exchange, please provide your name & date entered:

Name: Barry Turbid Date: 9-15-2008

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C. Equipment Transfer and Data Analysis

1. Equipment storage. After returning from the lake, disconnect the handheld meter cable from the probe cable at the bayonet connector. Rotate the locking ring until the bayonets disengage and carefully separate the connectors. Find the plastic bottle storage sleeve and add a few drops of clean tap water to the sponge inside the sleeve. Remove the probe from the calibration chamber and slide the probe into the plastic bottle sleeve. It is important to store the probe in the plastic bottle sleeve with a wetted sponge when not in use to keep the probe membrane from drying out. Wrap the loose cable around the cable carrier and secure the cable/probe. Place the meter into the storage box with the extra membrane cap and MEA probe solution.

2. Equipment transfer. The YSI Model 95D system will be used on 2 or 3 additional lakes in your area during the summer. Check the equipment schedule and contact the volunteer monitor for the next lake on the schedule. Make arrangements with the volunteer for equipment pick up or delivery. You are equally responsible for following the monitoring schedule and for the careful transport and use of the equipment.

3. Data analysis. A good way to look at your data is to graph it. Plot the DO/temperature data you just collected on the graph provided on the bottom of the back page of the DO/temperature data form. You may also use the expanded graph page provided to plot the DO/temperature data. Graph the temperature and DO data as separate depth profiles. On the graph, the y-axis is the depth (feet) from surface to bottom (inverted scale). The x-axis is used for both the DO (mg/l) and temperature (^{o}C) scales. Use dots (•) with a solid line for the DO/depth data points and triangles (▲) with a dashed line for the temperature/depth data points. Make sure you also record the lake name and the date the data was collected at the top of the graph.

Submitting Data to the MiCorps Data Exchange Network

The MiCorps Data Exchange Network is an internet-based database designed to store data collected by volunteer monitors. This network allows you to enter data as well as to view data already entered into the database. As a new component to the CLMP program, we are asking volunteers to enter their own data directly into the MiCorps Data Exchange Network. The data entry web address is http://www.micorps.net/data/enter.

To enter data you will need your own username and password. To receive your username and password, email MiData@glc.org or call Anne Sturm at 734-971-9135 . As soon as you have your username and password, you can begin entering your data into the MiCorps Data Exchange Network at the following website: http://www.micorps.net/data/enter. After logging in, the website provides you with easy-to-follow steps for entering your data. If at any time you have questions or run into problems please email MiData@glc.org or call Anne Sturm at 734-971-9135.

In order to be included in the MiCorps data files or presented in the CLMP Annual Report, **all data must be entered into the database no later than October 30th**. You may enter your data after each sampling event or at the end of the sampling season.

If you do not have access to a computer with internet access, please plan to use the public computers available at your local library. If due to access issues or your personal comfort level with computers, you are unable to enter your own data into the MiCorps Data Exchange

Network, please email MiData@glc.org or call Anne Sturm at 734-971-9135 to make alternate arrangements for entering your data into the database.

D. Returning Monitoring Equipment and Data Forms

The DO/temperature monitoring equipment has been loaned to each monitoring group on a temporary basis. At the end of the season, the monitoring group leader, or the last volunteer using the equipment, will return the equipment to the CLMP Coordinator or with advanced approval from the CLMP Coordinator to a DNRE, Water Division District Supervisor. Send all Dissolved Oxygen/Temperature data forms to Mr. Ralph Bednarz (address appears below). Be sure to make a copy of the data forms for your files before mailing the originals to Mr. Bednarz.

E. Training

Onsite training is required to participate in this parameter project of the Cooperative Lakes Monitoring Program. A training session will be held at the Michigan Lake and Stream Association, Inc.'s annual spring conference in late April. Training may also be held at other sites in the weeks immediately following the annual conference. Contact one of the individuals in the technical support section below to learn more about the required training and training site locations. It is required that each of the participating lake associations send at least one volunteer sampler to take part in one of the training sessions. Some of the benefits of this training program include increased contact with resource people and other volunteers.

F. Quality Assurance/Quality Control

As part of the quality assurance/quality control (QA/QC) process for the Cooperative Lakes Monitoring Program, DNRE staff will conduct side-by-side measurements for the DO/temperature monitoring program this year. If your lake is selected for the QA/QC process, you will be contacted prior to the scheduled monitoring dates to arrange coordination of the side-by-side measurements. The DNRE will conduct DO/temperature measurements using both electronic meters and chemical methods.

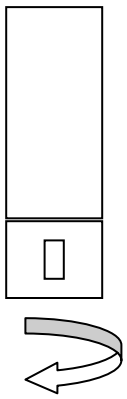
G. Installing a New Membrane Cap

WARNINGS

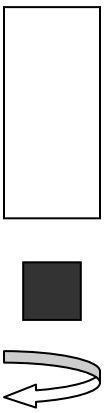
- **Use only YSI MEA probe solution in the membrane cap. Any other solution will damage the MEA sensor.**

To install a new membrane cap on your YSI Model 95 dissolved oxygen probe:

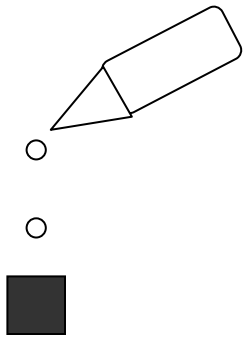
1. Unscrew and remove the probe sensor guard.
2. Unscrew and remove the old membrane cap.
3. Thoroughly rinse the sensor tip with distilled water.
4. Hold the new membrane cap and add 8 to 9 drops of MEA probe solution (about half full).
5. Tap the bottom of the cap with your finger a few times to remove any trapped air bubbles.
6. Screw the new membrane cap onto the probe tightly by hand (to prevent leakage of electrolyte). A small amount of probe solution should overflow.
7. Shake off any probe solution and rinse the stainless steel thoroughly with distilled water to prevent corrosion.
8. Screw the sensor guard onto the probe tightly by hand.



Unscrew guard (Step 1)

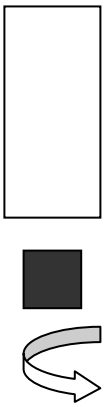


Unscrew old membrane cap (Step2)

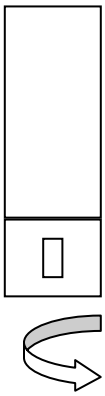


Fill new membrane cap with 8-9 drops of MEA probe solution. (Step 4)

Tap cap with finger to remove bubbles. (Step 5)



Screw on new membrane cap tightly by hand. (Step 6)



Screw guard on tightly by hand. (Step 8)

H. Saf

As with all CLMP sampling, the phosphorus samples should be collected when the weather conditions are safe. Be sure to sample with all of your safety equipment onboard (life jackets, back-up oars etc.) Collect your samples on the first available day that the weather is good. Sample with a partner, remain low in the boat when collecting samples, and do not lean over the side.

I. Technical Support

Should have any questions or comments about the DO/temperature monitoring procedures or problems with the equipment please contact:

Ralph Bednarz, CLMP Coordinator
Dept. of Natural Resources & Environment
Water Bureau
Constitution Hall – 2nd Floor South
525 West Allegan Street
Lansing, Michigan 48933
Phone: 517-335-4211 (desk)
517-241-1300 (office)
FAX: 517-335-4381
Email: bednarzr@michigan.gov

or

Jo Latimore, Outreach Specialist
Department of Fisheries and Wildlife
332 Natural Resources Building
Michigan State University
East Lansing, MI 48824-1222
Phone: 517-432-1491
FAX: 517-432-1699
Email: latimor1@msu.edu

Should you have questions or comments regarding entering or retrieving your data from the MiCorps Data Exchange Network please contact:

Anne Sturm
Great Lakes Commission
2805 South Industrial Hwy., Suite 100
Ann Arbor, MI 48104

Phone: 734-971-9135
FAX: 734-971-9150
Email: MiData@glc.org