Temperature, Dissolved Oxygen, Conductivity, and pH Depth Profile Monitoring Procedure on Lakes

State of Wisconsin Department of Natural Resources

STANDARD OPERATING PROCEDURES

June 2021

Sayner Lake, Wisconsin. Photo by Lisa Kosmond Helmuth.

Wisconsin DNR, Water Quality
Bureau Monitoring Program
EGAD #3200-2021-10

Contents

EGAD #3200-2021-10

Wisconsin Department of Natural Resources
101 S. Webster Street • PO Box 7921 • Madison, Wisconsin 53707-7921 608-266-2621
https://dnr.wisconsin.gov/topic/surfacewater/monitoring.html

Scope

Use a calibrated multi-parameter sonde to take depth profiles for temperature, dissolved oxygen (DO), conductivity, and pH at the deepest spot of the lake. This information determines the extent of stratification and the oxythermal habitat available for aquatic life.

Safety Protocols

WDNR field method safety protocols must be used when sampling. Use a stable boat for sampling and wear a personal flotation device (PFD). A two-person crew is recommended. Ensure that the anchor rope does not become fouled in the propeller. Collecting samples in cold weather carries the risk of hypothermia and collecting samples in hot weather carries the risk of dehydration and heat stroke. Prepare with appropriate clothing, blankets, sun protection, and drinking water. Carry a fire extinguisher, cellular phone or portable radio, and a first aid kit that includes materials for cleaning wounds (antibacterial soap and clean water or ethyl alcohol).

DNR Monitoring Safety Protocols

Equipment

- Boat
- Anchor
- PFD's for all boat passengers
- Lake bathymetric map
- GPS unit with latitude and longitude of deep hole or other sampling station
- Depth finder, metered sounding rod, or metered rope
- Field Data Sheet
- Multi-parameter Sonde Calibration Log
- Pencil
- Multi-parameter sonde (with temperature, conductivity, pH, and DO probes)
- Squirt bottle (1 L Nalgene) – tap water
- Calibration cups and standards
- Nearby barometer readings and elevation to use for calibration

Multi-parameter Sonde and Calibration

The multi-parameter sonde must be heavy enough to minimize sway and wobbling as it is lowered and raised in the water column. The instrument must be stabilized prior to taking a reading. Experiment with the sonde prior to sampling and add weight to the cable if needed. Ensure that the multi-parameter sonde's cable is marked every meter to track the depths of your profile measurements. All probes should be calibrated as directed below. These calibrations should be recorded in the Multi-parameter Sonde Calibration Log.

Create a Calibration Record

Keep a Calibration Record with the following items.

- Serial number
- Your name
- Date/Time
- Warmup time (minutes)
- Temperature from sonde
- Temperature from thermometer
- True barometric pressure (optional)
- D.O. pre-cal
- D.O. post-cal
- D.O. 10 min later
- Conductivity pre-cal
- Conductivity post-cal
- Conductivity cal solution
- pH pre-cal
- pH post-cal
- pH cal solution
- pH mV value
- pH slope
- pH offset
- pH stability

Temperature Meter Check

Check the accuracy of the sensor against a NIST-certified thermometer (a non-mercury type is recommended) at least once per sampling season. During this check, test three different water temperatures to reflect the temperatures sampled from winter through summer. One water bath should be left out to come to ambient room temperature. A second water bath should have ice added, and a final water bath should come from warm tap water near 30°C. Record the temperatures of both the NIST-certified thermometer and the multi-parameter sonde. On each sampling date, record a single temperature reading from both the sonde and an independent thermometer (often provided with the sonde). This can be done using the first set of calibration solutions.

Dissolved Oxygen Sensor Calibration

Calibrate the DO sensor preferably at the lake prior to each sampling event (Note: some newer instruments and probes may not require calibration as frequently). The most common calibration procedure places the sensor in a chamber with water-saturated air and calibrates to 100% saturation. The calibration procedure requires barometric pressure; some meters measure true barometric pressure directly, others ask for elevation, and others ask for the uncorrected barometric pressure. Weather stations report barometric pressure corrected for altitude, but the uncorrected barometric pressure must be used for DO calibration. Refer to “Calibration DO Saturation Charts.xlsx” and the formula below for guidance on deriving uncorrected or true barometric pressure.

True BP = Corrected BP – 2.5*(altitude/100)

where BP is barometric pressure in mmHg and altitude is in feet above sea level.

In addition, manufacturers typically recommend periodic comparisons with a DO chemical analysis procedure (e.g., Winkler titration) to check accuracy and linearity. Small “mini-Winkler” titration kits are suitable for this check and can be taken into the field. While general water-saturated air calibration steps are outlined below, be sure to calibrate the DO sensor according to the manufacturer’s specification.

General DO% Water-Saturated Air Calibration Procedure

1. Turn on meter
2. Visually inspect sensor
3. Ensure temperature readings are accurate
4. Correct for barometric pressure (or ensure sonde does this automatically)
5. Ensure settings are for freshwater
6. Place sensor in calibration chamber with small amount of water or damp sponge and wait for ~10 minutes for air to saturate with water and for sensor to warm up
7. Calibrate to 100% saturation
8. Accept calibration when stable
9. Check for drift – meter should read ± 1% (optical) or 2% (polarographic) of calibration value ~ 10 minutes later

Conductivity Probe Calibration

The conductivity meter must be calibrated prior to each sampling event or per manufacturer's guidance. Calibrate the meter in accordance with the manufacturer's instructions. For fresh waters, calibration standards are typically 1,000 or 10,000 µS/cm. Immerse the sensor in the calibration cup making sure that the solution is above the vent holes of the conductivity sensor. Rotate and move the sensor to remove air bubbles and wait for temperature to stabilize. Enter the concentration of the calibration standard. Proceed with and accept the calibration once the conductivity values stabilize. Ensure that the conductivity meter is temperature corrected to 25°C.

pH Probe Calibration

Calibrate the pH electrode prior to each sampling event in accordance with the manufacturer's instructions. A 2-point calibration should be sufficient for most lakes. Choose buffer solutions that bracket the likely pH values in the lake that will be sampled. Buffers 7 and 10 will work well for basic lakes common to southern Wisconsin lakes, and buffers 4 and 7 will work well for acidic lakes common to northern Wisconsin. If you will be sampling a wide range of pH's in the same day, conduct a 3-point calibration. Rinse the sensor and calibration cup with the buffer solution before beginning each calibration. Immerse the sensor in the first buffer solution, enter the buffer solution standard used, and accept the calibration after values stabilize. Repeat the process for each additional buffer solution.

Multi-parameter Sonde Field Procedure

1. Calibrate sensors before launching the boat. Enter calibration information into the calibration log.
2. Navigate to the sampling site on the lake and record site, weather and surface water conditions.
3. Determine the site depth using a depth finder, metered sounding line, or metered sounding rod.
4. Determine profile depth. You will be measuring at 1 m (or 3 feet) intervals from the surface (0 m) to the nearest whole meter off the bottom of the lake. Ensure that all sensors are completely submerged for the surface sample. Be careful not to hit the bottom sediments with the sonde.
5. Measure and record temperature, DO, conductivity, and pH for the full profile at 1-m intervals.

Documentation

In addition to routine information necessary for the project objectives, record the following data on the Lake Water Quality Field Sheet:

- Person observing profile
- Lake name
- WBIC
- Date
- Time
- Sample Location/Description
- WAMS ID
- Project ID
- Station ID
- Weather conditions
- Water surface conditions
- Site depth
- Water conditions affecting observations (i.e., algae, turbidity, etc.)
- User perception of water quality
- Visual estimate of water level
- Multi-parameter meter information
- multi-parameter meter calibrations done that day

Multi-parameter Sonde Care and Storage

Rinse the sensors with tap water after use and store probe in tap water or pH buffer solution (follow manufacturer's instructions). Do not store in deionized water as this will damage the pH probes. Keep the sensors clean, but never use solvents. Use a moist lens cleaning tissue to clean optical sensors. Maintain clean and dry sensor ports and clean and greased O-rings. For long-term storage, remove batteries and follow manufacturer's instructions for care of individual sensors. Generally, DO and conductivity sensors can remain on the bulkhead and can be stored in a small amount of any type of water. pH sensors are usually removed from the bulkhead and stored in pH 4 buffer solution. Replace optical DO sensors every 1-2 years in accordance with manufacturer's instructions. Polarographic DO sensors can last for ~5 years if properly cared for. Replace polarographic DO membranes and solution every 1-2 months or sooner if air bubbles or deposits of dried electrolytes are visible. Gently sand tarnished metal when replacing the membranes and solution.

Disinfection and Decontamination

Clean all equipment between lakes and at the end of the day to prevent the spread of invasive species. The boat and other equipment that goes in the lake (e.g., anchor), should be cleaned according to the

most recent disinfection procedures: http://dnr.wi.gov/topic/invasives/disinfection.html. Because multi-meter probes are very sensitive pieces of equipment, do not expose to hot water, chlorine, or other strong chemicals. Instead, perform a close visual inspection of your probe to ensure no AIS has attached to the probe. You may also be able to avoid transporting your boat between lakes by sampling from the boat of a resident on the lake.

- Boat, Gear and Equipment Decontamination and Disinfection Manual Code 9183.1 (https://dnr.wisconsin.gov/topic/Invasives/disinfection.html)

References

Updates and Tracking

Version No.	Date	Title	Section	Author	Approval
1.0	9/21	Temperature, DO, Cond., & pH	All	Lakes Team	Catherine Hein