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Yahara Lakes Water Quality Monitoring

Background

In 2013, Clean Lakes Alliance (CLA) launched a Citizen Water Quality Monitoring pilot. Objectives included evaluating and tracking near-shore water quality conditions on all five Yahara lakes: Lakes Mendota, Monona, Waubesa, Kegonsa and Wingra. The need for volunteer monitoring at near-shore areas was identified in a 2011 study by Richard Lathrop and Steve Carpenter. The near-shore areas are also where most people interact with the lakes, so near-shore conditions are especially relevant for public enjoyment of this shared resource. Over the course of the summer, CLA staff, interns and volunteers from CLA's affiliated *Friends of Clean Lakes* performed end-of-pier and public beach testing to provide more real-time information on near-shore lake water quality. Since 2014, this information has been made available to the public through a unique mobile-ready website called LakeForecast.org. Designed to be easy to use for the general public, LakeForecast.org aggregates information from volunteer monitors, weather stations, and the Lake Mendota Buoy to give users a complete picture of beach conditions. By using LakeForecast.org, lake visitors will be able to find the clearest, cleanest beach, and will also be empowered to advocate for cleaner lakes. The summer of 2015 saw the expansion of the program to 58 sites, and the full-scale launch of LakeForecast.org.

2016 Goals

2016 project goals are to:

1. Continue building a long-term dataset of turbidity, temperature, and beach quality conditions.
2. Collect sufficient data to help UW-Madison researchers model the formation and movement of potentially toxic blue-green algal blooms, and provide more accurate and timely beach condition information.
3. Initiate weekly off-shore water clarity measurement by Secchi disk on all five lakes, as well as depth profiles of dissolved oxygen and temperature, beginning with Lakes Monona and Waubesa.
4. Extend water quality monitoring to all public beaches with volunteer assistance and as part of a lifeguard-monitoring pilot in collaboration with City of Madison Parks.
5. Encourage increased near-shore water quality monitoring frequency following a positive blue-green algae identification, and display locations of recently observed blue-green algae sightings on LakeForecast.org.

6. Exceed last year's total number of sampling events of 1,258.
7. Exceed last year's number of visits to Lakeforecast.org of 9,309.
8. Inspire volunteers to become advocates for cleaner lakes.
9. Continue *Lake Forecasting Steward* opportunity to those wishing to financially support the continued expansion of the monitoring program.

In partnership with government agencies, University of Wisconsin researchers, and water quality advocacy groups, CLA will train and equip volunteers and coordinate monitoring of near-shore water turbidity, temperature, and various qualitative measurements. The intent of the monitoring is to better track changing beach conditions and the formation and movement of potentially toxic blue-green algal blooms. The off-shore monitoring initiated this year will allow CLA and partners to compare near-shore and off-shore lake conditions, and will follow a protocol consistent with the WI DNR's Citizen Lake Monitoring Network. Water clarity will be collected by use of a Secchi disk, while dissolved oxygen and temperature will be measured throughout the water column with a YSI 550A multi-probe.

The data collected by citizen monitors and CLA staff will supplement the sampling conducted by other entities, creating a more robust dataset for all parties to draw upon. This information will be used in research on blue-green algal blooms, and provide more timely and accurate beach assessments to inform area lake users. Additional benefits of citizen monitoring include increased engagement of Dane County residents with the lakes and an increased awareness of dynamic water quality issues.

CLA has found that citizen monitoring can be a powerful tool in raising awareness and increasing public interest in water quality. This project is an opportunity to do so in a way that will meaningfully contribute to cleaning up our lakes.

Implementation

End-of-Pier Program

Regular monitoring will build awareness and educate the public about our lake ecosystems, particularly the quality of our waters. This will be accomplished through the reporting of temperature, turbidity, and qualitative observations (e.g. wave intensity, waterfowl presence, algal surface bloom presence, etc.) through a mobile-ready website at LakeForecast.org.

In 2016, all volunteers will collect quantitative and visual observations at least once a week. In order to coordinate sampling times to get more accurate "snapshot" information, we are asking all volunteers, if possible, to sample on **Thursday mornings between 7 a.m. and 12 p.m.**



Blue-green algal blooms can form quickly and be pushed along the shoreline by wind on our lakes. In order to better track the movement of these blooms, we're encouraging volunteers to perform more frequent monitoring during periods when they're reported. CLA staff will inform volunteers via email when multiple volunteers and/or Public Health- Madison & Dane County reports a blue-green algal bloom presence. Blue-green algal bloom reportings will be incorporated into LakeForecast.org, displaying the observations similar to the example to the right.

In this program, sampling will occur at end-of-pier. Volunteers will perform the following activities at their chosen sites at least once per week and as frequently as seven times per week from the **Thursday before Memorial Day (5/26) through Labor Day (9/5)**.

Quantitative parameters to be measured include: water turbidity (an indicator of clarity), water temperature, and air temperature. Water and air temperature will be measured using a digital thermometer (Appendix 1). Water turbidity will be determined using a 120cm turbidity tube. Complete instructions for water turbidity sampling are provided in Appendix 2. Qualitative, visual observations will be collected for: wave intensity, waterfowl presence, surface bloom presence, algal bloom type, floating plant debris abundance, bather load (or the number of people in the water), and water clarity (Appendix 3). Volunteers will record their data on provided data sheets, and enter results into the web-based data entry system (Lakeforecast.org).

Adopt-A-Beach Program

In the Adopt-A-Beach Program, CLA staff and volunteers will sample public beaches. Volunteers will perform the monitoring activities at their chosen sites at least once per week and as frequently as seven times per week from the **Thursday before Memorial Day (5/26) through Labor Day (9/5)**. More frequent monitoring will be encouraged as detailed above, especially during periods when algal blooms are present.

The staff and volunteers participating in the Adopt-a-Beach program will collect the same qualitative and quantitative parameters as described in the End-of-pier program.

City of Madison Lifeguards

In 2016, City of Madison lifeguards will collect quantitative and visual observations daily at six public beaches. Lifeguards will perform the following activities at their site at least once per day and up to three times per day. More frequent monitoring will be encouraged, especially during periods when algal blooms are present.

City of Madison lifeguards participating in this program will collect the same qualitative and quantitative parameters as described in the End-of-pier program.

Off-Shore Monitoring Pilot

In 2016, in order to fully understand the interaction between the off-shore and near-shore environment, CLA volunteers will begin sampling the deepest point (deep hole) of all Yahara lakes.

The off-shore monitoring program will focus on two components: water clarity sampling and dissolved oxygen and temperature measurement. Data from the off-shore monitoring program will be compared to data from the near-shore program.

On Lakes Mendota, Monona, Waubesa, Kegonsa and Wingra, volunteers will use a Secchi disk to measure water clarity, and a digital hand-held thermometer to measure air and surface water temperatures **once per week on Thursday mornings**. Secchi depth monitoring will take place at the deepest point of each lake. CLA staff will train volunteers using a Secchi depth monitoring protocol (Appendix 5). Volunteers will record results on a standard data sheet and submit those results to CLA weekly via email or phone.

On Lakes Monona and Waubesa, concurrent with Secchi sampling, volunteers will use a YSI 550A multi-probe meter to measure dissolved oxygen and temperature at multiple depths. In lakes, temperature can affect the life cycles and survival of organisms (including algae) and the ability of the water to hold oxygen. By building a vertical profile of temperature, we will be able to make inferences about lake mixing patterns. Dissolved oxygen, or oxygen present in the water, can also impact the type of aquatic life a water body can support. Low levels of dissolved oxygen can kill sensitive organisms and are generally undesirable as they can indicate that organic matter is decomposing in the water column (i.e. after an algal bloom dies). In the bottom of Lake Mendota, the presence or absence of dissolved oxygen determines whether phosphorus will remain bound to iron or be released into the water column.

Volunteers operating the YSI multi-probes will be trained by CLA staff, and will carry out appropriate calibrations before each measurement as outlined in Appendix 5. Results will be recorded on a standard data sheet and submitted to CLA weekly via email or phone.

Crowdsourcing Program

The general public will also be invited to participate in qualitative monitoring through the LakeForecast.org mobile-ready website. This program, launching in 2016 or 2017, will allow the public to observe and report real-time water clarity information at local beaches. Research performed by the United States Geological Survey (USGS) indicates that this type of data collection, known as crowd hydrology or crowdsourcing, has a high level of accuracy.

Smartphone users will be able to both input data and observe current water conditions entered by citizen monitors. Anyone will be welcome to enter and view results, with the goal of providing more real-time water quality information to beachgoers and other recreational lake water users.

Volunteer Recruitment, Training and Support

CLA Watershed Coordinator, Katie Nicholas, and CLA Water Resources Specialist, Justin Chenevert, will carry out most project-management responsibilities. Nicholas and Chenevert will perform tasks required to recruit, train and assist volunteers with performing water quality monitoring, and will collaborate with Gina LaLiberte (WDNR Research Scientist) to teach volunteers monitoring protocols during spring trainings.

Volunteer training sessions will be held at the Verex Plaza (150 E. Gilman St. Level B Madison, WI 53703) during the month of May. These training sessions will combine classroom and hands-on field experience to familiarize volunteers with sampling equipment, testing/reporting protocols, and identification of blue-green algae. All volunteers will receive the necessary sampling equipment, data sheets and procedural guidance at each training session. Training videos will be created and placed on CLA's website to refresh volunteers of protocols during the sampling period.

Throughout the year, Nicholas and Chenevert will provide assistance and support to volunteers. This support includes obtaining and disseminating equipment and supplies (e.g. sample bottles and reporting forms), troubleshooting equipment issues, and performing periodic check-ins with volunteers.

Annual Project Reporting

At the end of 2016, CLA will compile and interpret both individual and aggregated sampling results from each monitoring program. These results will be presented to volunteers via mail and in an annual report format accessible through CLA's website. The information will also be shared with UW-Madison researchers in an effort to develop a predictive model for blue-green algal bloom formation. CLA will also inform other water resources organizations of the data collected, and facilitate its timely distribution.

Contact Information

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Appendix 1

Instructions for Performing Digital Air and Water Temperature Measurements

Equipment/Materials Needed

- Digital Arrow-Shaped Thermometer (either Thermoworks or Fisher Scientific brand)
- Near-shore Water Quality Monitoring Data Sheet

General Rules of Sampling

- Sample air temperature as close to lake sample collection site as possible
- Collect data by removing the probe from the chamber and allowing the temperature reading on the probe to stabilize before recording.
- Pressing the “hold” button freezes the current temperature on screen for easier recording
 - *Thermoworks thermometers do not have a “hold” button
- Remember to remove the plastic sheath that covers the temperature probe when sampling.
- You can switch between °C and °F by pressing the [°C/°F] button.
 - *this button is located on the back of Thermoworks thermometers

Sampling Methods

Step 1 – Air temperature Measurement

1. Remove the temperature probe from the probe chamber.
2. Hold the thermometer so that it is shaded by your body
3. Press the [ON/OFF] button.
4. Allow the temperature to stabilize.
5. Record stabilized temperature in °F on water quality monitoring data sheet.

Step 2 – Water Temperature Measurement

1. Sample at ~3 feet total depth
2. Carefully move to the sampling location, while wading slowly in the water. If collecting samples from your pier, sample as above (3 feet total depth) but disregard the wading.
3. Remove the temperature probe from the probe chamber.
4. Press the [ON/OFF] button.
5. Insert thermometer vertically into the water, submerging the silver probe.
6. Allow the temperature to stabilize.
7. Record stabilized temperature in °F on data sheet.

Step 3 – Enter Data

1. After recording your measurements on the paper form, please enter the data into the online submission form on [Lakeforecast.org](https://lakeforecast.org) (<https://lakeforecast.org/#/login>) using your username and password provided by CLA.



Appendix 2

Instructions for Performing Turbidity Measurements Using a 120cm Turbidity Tube

Turbidity is a measurement of how cloudy water appears. Turbidity is also a measure of how much light passes through water, and is caused by suspended solid particles that scatter light. These particles may be microscopic plankton, stirred up sediment or organic materials, eroded soil, clay, silt, sand, mud, industrial waste, chemical precipitates or urban runoff.

Equipment/Materials Needed

- 120cm turbidity tube
- Near-shore Water Quality Monitoring Data Sheet

General Rules of Sampling

- Do not wear sunglasses when sampling
- Record value when you can first see the white and black disk.

Sampling Methods

Step 1 – Sample Collection

1. Sample at ~3 feet total depth, 6 inches below the surface
2. Dip the tube into the water at your sampling site and fill to the top

Step 2 – Turbidity Measurement

1. Take your filled turbidity tube to a shaded spot. If there is no shade around, use your body to block the sun from shining on the tube
2. Look down through the tube toward the target disk on the bottom of the tube.
3. If the disk is visible, record the water level as 120 centimeters
4. If the disk is not visible, slowly release water from the release valve until the disk at the bottom of the tube becomes visible. Record the water level in centimeters (cm).
5. Record all values on water quality monitoring data sheet

Step 3 – Enter Data

1. After recording your measurements on the paper form, please enter the data into the online submission form on [Lakeforecast.org](https://lakeforecast.org) (<https://lakeforecast.org/#/login>) using your username and password provided by CLA.



Appendix 3

Instructions for Collecting Qualitative Data

Equipment/Materials Needed

- Near-shore Water Quality Monitoring Data Sheet
- Computer or smartphone

Qualitative, Visual Observations

Step 1 – Collect Observations

1. Record all data on the near-shore water quality monitoring data sheet.
 - a. Wave intensity on a scale of 1 - 3 (1 = calm to small ripples, 2 = small to moderate chop, 3 = rough water).
 - b. Waterfowl presence in the water or at the lake edge, paying particular attention to geese/ducks (1 = none, 2 = some, 3 = a lot).
 - i. "Some" signifies between 1 - 10 waterfowl are present.
 - ii. "A lot" signifies greater than 10 waterfowl are present.
 - c. Algal surface bloom presence (1 = none, 2 = some clear evidence, 3 = strong, extensive presence) within the general vicinity of the sampling area
 - d. Algal bloom type (G = green algae, B = blue-green algae or both blue-green and green algae)
 - e. Floating, uprooted plant debris abundance (1 = none, 2 = small coverage, 3 = heavy coverage)
 - f. Bather load, or the number of people in the water (1 = none, 2 = some, 3 = a lot/crowded).
 - i. "Some" signifies between 1 - 10 people are in the water
 - ii. "A lot" signifies greater than 10 people are in the water
 - g. Water clarity (Good= can see toes, fair= can barely see toes, murky= cannot see toes)

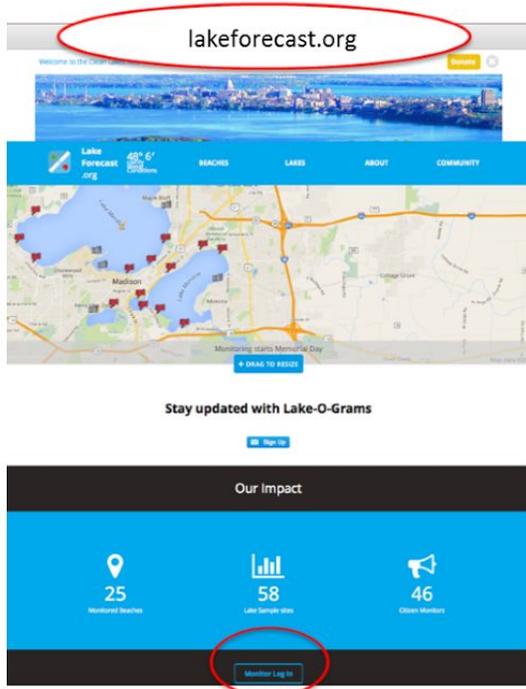
Step 2 – Enter Data

1. After recording your measurements on the paper form, please enter the data into the online submission form on [Lakeforecast.org](https://lakeforecast.org) (<https://lakeforecast.org/#/login>) using your username and password provided by CLA.

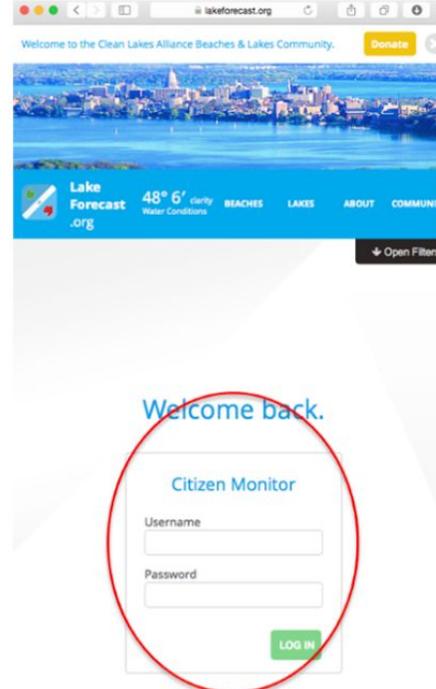
Appendix 4

Online Data Entry with LakeForecast.org

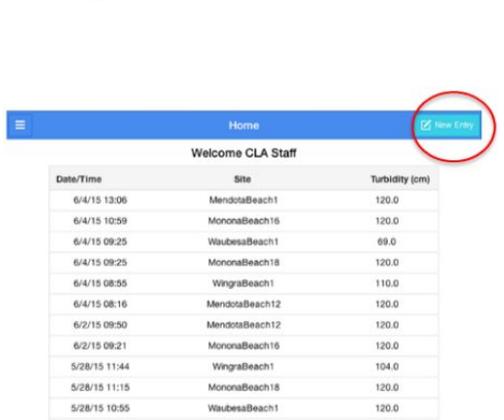
STEP 1



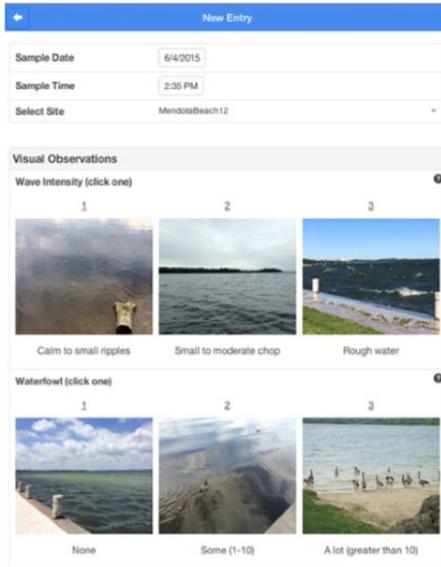
STEP 2



STEP 3



STEP 4



STEP 5

New Entry

Sample Date: 6/4/2015

Sample Time: 2:35 PM

Select Site:

Visual Observations

Wave Intensity (click one)

1 2 3



Calm to small ripples Small to moderate chop Rough water

Waterfowl (click one)

1 2 3



None Some (1-10) A lot (greater than 10)

STEP 6

New Entry

Sample Date: 6/4/2015

Sample Time: 2:35 PM

Select Site: MendotaBeach12

Visual Observations

Wave Intensity (click one)

1 2 3



Calm to small ripples Small to moderate chop Rough water

Waterfowl (click one)

1 2 3



None Some (1-10) A lot (greater than 10)

STEP 7

Surface Algal Bloom (click one)

1 2 3



None Some clear evidence Strong extensive evidence

Select bloom type:

Blue-Green Green



Bluish green tint, paint, oily-like appearance Green in color, filamentous, plant-like hair-like strands

STEP 8

Water Clarity (click one)

1 2 3



Good Fair Murky

Quantitative Measurements

Air Temp (°F) 72.1

Water Temp (°F) 68.1

Turbidity (cm) 120

Phosphorus sample?

Comments

Enter comments here

Appendix 5

Instructions for Sampling Secchi Depth (Water Clarity)

A Secchi disk is a black and white checkered disk that is lowered into the water column to measure water clarity. As one of the oldest formalized methods of measuring water clarity, taking secchi depth allows us to compare water clarity today to measurements taken decades ago. It is also an inexpensive and accurate way to track changing conditions in the open waters of lakes. This procedure has been adapted from the WI DNR Wisconsin Citizen Lake Monitoring Training Manual.

Equipment/Materials Needed

- Secchi disk
- Two clothespins
- Data recording sheet
- Pencil

General Rules of Sampling

- If waves are greater than about 5", **choose another day to monitor**. Large waves greatly reduce the accuracy of your Secchi reading.
- Similarly, readings are most accurate between 10 a.m. and 4 p.m., because of the angle of the sun. If at all possible, carry out your monitoring during those hours.
- Recording the initials of the sampler is critical, because of how eyesight varies among individuals.
- Always wear your PFD.
- Make sure to anchor your boat in the correct location.
- Take care when dropping the anchor to avoid disturbing sediment, which might then impact your Secchi depth reading.
- Remove your sunglasses before performing the monitoring.
- Sample on the shady side of the boat.
- Get as close to the surface of the water as you safely can.

Sampling Methods

1. Anchor your boat at the sampling location.
2. Fill in the "Sampler and Sample Information" portion of your data sheet.
3. Make the four visual observations found on your data sheet
 - a. Cloud cover (estimate the percentage of sky covered by clouds to the nearest 25%)
 - b. Wave intensity (1= calm to small ripples 2= small to moderate chop 3= rough water. If whitecaps are visible from from your boat, mark a "3")
 - c. Water appearance (Estimate whether the water is clearer or murkier than normal)
 - d. Water color (it is easiest to judge water color against the white pattern of the Secchi disk at about 1 foot depth)
 - e. Feel free to record other observations - such as presence of boaters, waterfowl, or algae blooms

4. Remove your sunglasses, lean over the shady side of the boat to get as close to the water as is safe, and slowly lower the secchi disk into the water until the black and white pattern disappears.
5. Mark the surface of the water with a clothespin.
6. Lower the disk several more feet, then slowly reel in the rope until the disk reappears.
7. Mark the surface of the water with another clothespin.
8. Find the spot on the rope exactly between the two clothespins - this is your first Secchi reading.
9. Repeat steps 3 - 7 and average your two readings - this is the final value you will report.
10. Record the Secchi depth to the nearest quarter foot.

Data Submission

Please communicate the results of your off-shore sampling to Clean Lakes Alliance on a weekly basis. You may call in your results to (608) 255-1000, email or send a picture or scan of your results to justin@cleanlakesalliance.com.

Satellite Monitoring

By taking readings at the same time as Landsat 8 is overhead, you can help improve the ability of this satellite to estimate water clarity on unmonitored lakes. The dates on which the satellite will be overhead of the Madison-area lakes are:

Friday, May 06, 2016
Saturday, May 14, 2016
Sunday, May 22, 2016
Monday, May 30, 2016
Tuesday, June 07, 2016
Wednesday, June 15, 2016
Thursday, June 23, 2016
Friday, July 01, 2016
Saturday, July 09, 2016
Sunday, July 17, 2016
Monday, July 25, 2016
Tuesday, August 02, 2016
Wednesday, August 10, 2016
Thursday, August 18, 2016
Friday, August 26, 2016
Saturday, September 03, 2016
Sunday, September 11, 2016
Monday, September 19, 2016
Tuesday, September 27, 2016

Appendix 6

Sampling Dissolved Oxygen and Temperature with a YSI Multi-probe

The YSI 550A is a handheld instrument that can continuously measure dissolved oxygen (DO) and temperature. We'll be using it to take measurements at various depths at the deepest point of the lake. This instrument requires careful calibration before each use, as well as proper care and maintenance, to measure accurately. The nature of the probe requires that the user specify the altitude and salinity of the water body before operation. The full manual may be found at https://www.ysi.com/File%20Library/Documents/Manuals/605348-YSI-550A-Operations-Manual-Rev B_001.pdf.

Equipment/Materials Needed

- YSI 550A case with probe
- Bottle of clean tap water
- Data recording sheet

Membrane Maintenance

The YSI 550A uses a thin semi-permeable membrane (found inside the probe housing) to isolate the electrodes while allowing gases to pass through. It is essential that this membrane is clean and properly installed. If the membrane seems dirty, clean it gently with a lint-free cloth and rubbing alcohol. Check that there are no bubbles under the membrane cap. If you see bubbles or tears in the membrane, please contact Clean Lakes Alliance staff immediately, as the membrane must be replaced.



Calibration

1. Remove the probe from the calibration chamber on the back of the YSI, and ensure that the sponge inside the instrument's calibration chamber is moist. Put the probe back into the calibration chamber.
2. Power the instrument on and allow the readings to stabilize (values do not change significantly over ~10 seconds). This may take 5 to 15 minutes, depending on the age of the instrument and condition of the probe.
3. Press and release both the UP arrow and DOWN arrow keys at the same time to enter the calibration menu.
4. Press the MODE key until "%" is displayed on the right side of the screen for oxygen units. Press ENTER.

5. The screen will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude. Our Yahara Lakes are between 840 - 850 ft above sea level, so select "8" and then press the ENTER key.
6. CAL will now display in the lower left corner of the screen, the calibration value in the lower right corner and the current DO reading (before calibration) will be the main display. Once the current DO reading is stable (it is normal for this to take several minutes), press the ENTER button.
7. The LCD will prompt you to enter the appropriate salinity of the water you are about to analyze. Since we are analyzing freshwater, select "0" and press ENTER.
8. Press the MODE key so that the unit displays the dissolved oxygen reading in mg/L.
9. Look up the expected dissolved oxygen value for your elevation and temperature using the table titled "Dissolved Oxygen Saturation (mg/L) Based on Elevation or Ambient Barometric Pressure" found in the back pocket of your monitoring binder.
10. If the reading on the YSI screen is not within 0.3 mg/L of the value found on the chart, re-calibrate the YSI.
11. **DO NOT turn the unit off** until you are done collecting data for that day.

Calibration Drift Test

After calibration, the dissolved oxygen reading displayed on the screen should not change significantly, as long as the air temperature remains stable. Switch the probe to display dissolved oxygen in % saturation, and leave the probe for about 5 minutes - if the reading changes by more than 5%, please contact Clean Lakes Alliance staff immediately, as the probe probably needs to be cleaned.

Monitoring Procedure

1. We will be taking dissolved oxygen measurements in milligrams per liter, so once the unit is calibrated, verify it is displaying dissolved oxygen in mg/L. If the unit displays % saturation, use the MODE button to switch to mg/L.
2. Place the probe in the lake.
3. Stir the probe so that it is moving at about 1/2 foot per second. This is important because the probe consumes dissolved oxygen while measuring, so if the probe is left in the same place, readings will be artificially low.
4. Allow temperature and dissolved oxygen readings to stabilize. Record.
5. Rinse the probe with clean water, shake off excess water and then store the probe in the calibration chamber. Power off the YSI.

Data Submission

Please communicate the results of your off-shore sampling to Clean Lakes Alliance on a weekly basis. You may call in your results to (608) 255-1000, email or send a picture or scan of your results to justin@cleanlakesalliance.com.

Notes

1. Pressing the down arrow and the MODE buttons at the same time will switch the temperature units between Fahrenheit and Celsius.
2. Pressing the button that looks a star will turn on the backlight.