# Monitoring Vertical Temperature and Dissolved Oxygen Profiles on Inland Lakes with Automatic Data Loggers

December 30, 2020

# Contents

## 1. Introduction

High-frequency temperature and dissolved oxygen data on inland lakes can enhance knowledge of a variety of lake processes, including stratification, internal nutrient loading, ecosystem metabolism, oxythermal habitat, and lake responses to a changing climate. Still, the use of automated data loggers requires more careful planning and a larger initial investment in time than typical discrete field measurements. This protocol describes the construction, deployment, and data management of vertical arrays of temperature and/or dissolved oxygen loggers located at the deepest point of a lake.

## 2. Project Outline

To deploy a temperature logger array just after ice-out, begin planning by the start of the new year at the latest. Ordering loggers, applying for permits and publishing the required public notices may take a month or more. Plan ahead for field visits to clean equipment, download and verify data, recalibrate dissolved oxygen loggers, and replace aging equipment.

General steps to starting data logger monitoring:

1. Select sites
2. Talk with potential stakeholders and local recreational safety warden; determine if array can remain in place during the winter
3. Apply for waterway marker permit and miscellaneous structure permit (may take several weeks)
4. Gather equipment and hardware, construct the array, taking careful note of data logger placement and serial numbers
5. Launch the data loggers
6. Deploy the array in the field
7. Schedule regular visits to clean the sensors, download the data, and remove the navigation buoy during the winter if necessary
8. Update the master tracking spreadsheet after every fieldwork event

## 3. Obtaining Permits

Two permits are required: a miscellaneous structure permit for the cinder block anchors that will be placed on the lakebed and a waterway marker permit for the floating buoy. The purpose of the navigation buoy is to prevent collisions between watercraft/fishing lines and submerged equipment. Before beginning the permit application process, consult your local Recreational Safety Warden about the project and what safety measures should be taken on that lake. The safety warden will also decide whether the data logger chain may remain submerged over the winter months. Contact local lake groups or other stakeholders before installing equipment and offer to share the data.

### *Waterway Marker Permit*

The total time from submittal to approval is typically 2 – 3 weeks. The application form serves as the final permit once signed by appropriate parties. Page two of the permit gives instructions and “A

Guideline for Creating Local Boating Ordinances and Placing Waterway Markers in Wisconsin Waters" gives size and color requirements for the waterway markers.

Instructions:

1. Fill out the Waterway Marker Application and Permit 8700-058 form (Appendix C).
    a. Section 1: list the project start and end dates (work with the permit reviewer to extend as long as possible if you plan to monitor for multiple years) and mark 1 informational buoy with "RESEARCH" as the message on the marker
    b. Section 2: write "DNR/public water body" after Property Owner Name and leave the rest blank
    c. Section 3: Local government authorization may not be needed because a state agency can make the approval, but always contact the local municipality before placing a buoy
2. Create a map showing the proposed location of the buoy. Include latitude and longitude coordinates and distances to riparian owners and nearby significant objects. Note the site map requirements for the miscellaneous structure permit below so you can use the same map for both permit applications.
3. Submit application materials to the DNR Recreation Safety Warden.
4. Renew this permit as needed.

### *Miscellaneous Structure Permit (Ch 30)*

Plan several months to obtain the Miscellaneous Structure Permit. Unlike the Waterway Marker Permit, this permit does not expire. Complete the application online through the DNR website by clicking "LICENSES" on the main page and the scrolling down to "Water Permits."

1. Fill out the Water Resources Application for Permit Projects form 3500-053 (Appendix D)
    a. Section 1: buoys are placed on public waterbodies, so fill in the address of the local DNR office.
    b. Section 2: check "Select if same as landowner" box
    c. Section 3: check "Select if same as landowner" box
    d. Section 4: include Project Name and detailed Public Land Survey System information or latitude and longitude
    e. Section 5: Wetlands
        i. If there is a wetland, include proof of wetland delineation or correspondence with a qualified DNR staff
        ii. If there is no wetland, you can also submit a map from the Surface Water Data Viewer with Wisconsin Wetland Inventory and Wisconsin Indicator layers turned on as proof.
    f. Section 6, Endangered / Threatened Resources: A preliminary assessment can be completed from the public NHI portal. If endangered or threatened resources are present, a full endangered resources review may be necessary.
    g. Section 7, Project Information: provide an anticipated start date (date of installation) for the project, a photo of the "before" condition (aerial photo is sufficient), and a narrative description of a few paragraphs including alterations that will be made to the lake bed.
2. Site map from Surface Water Data Viewer that includes:
    a. Location and perimeter of the project site, relationship to nearby water resources

    b. Major landmarks
    c. Wetland layers
3. Proof of ownership document: typed document saying it is a public water body.
4. Plans and specification: drawing showing the data logger array setup.
5. Narrative description including:
    a. Purpose
    b. Materials methods, equipment
    c. Proposed schedule and sequence of work
    d. Erosion control measures
    e. Minimize impacts to waterways, area impacted
6. List of Adjacent Riparian Owners: can be found from the Wisconsin Statewide Parcel Map. Consider any private property within 200 ft of the proposed location to be "adjacent" for the purposes of this permit. In most cases, there will be no properties this close to the deepest spot, and you may submit a document stating this fact and referring to your site map.

Once the permit application is pending, publish a Class-1 notice in a local paper stating your intent to place a "structure" (the cinder block anchor) on the lake bed (Appendix E). You may also be required to notify interested parties, usually a lake group. The text of the required notice will be provided in an email when the permit is conditionally approved. During the 30-day public comment period, members of the public may request a public hearing. Making local stakeholders aware of your plans before this stage of the permit process is highly recommended.

### *US Army Corps of Engineers Nationwide Permit*

Work with the DNR staff member who issued the Misc. Structure Permit to obtain the US Army Corps of Engineers (USACE) permit. Be sure that USACE staff are aware of your project before you install the monitoring equipment. This type of low-impact scientific monitoring fits Nationwide Permit 5, Scientific Measurement Devices (Nationwide Permit means that no specific application is necessary). The text of that permit emphasizes that it is up to the applicant to determine whether the work will fall under NWP 5, and to receive a 401water quality certification from DNR. Scientific measurement devices generally receive a water quality certification automatically because the DNR web site is set up to be a joint federal/state permit application.

## 4. Data Loggers

Although other brands of data loggers may be used, this protocol describes how to use the HOBO Water Temperature Pro v2 Data Logger and the HOBO Dissolved Oxygen Data Logger (U26-001). Both products can take hourly measurements for several years before the battery or memory is exhausted. Temperature loggers without remaining battery life can be replaced by HOBO at reduced cost if returned to the company. Dissolved oxygen loggers can be mailed back to Onset for battery replacement, but batteries cannot be replaced by users. The loggers are hermetically sealed and use an optical interface to communicate with the shuttle or base station, which makes it possible to download data from the loggers without drying them completely.

*Table 1. Properties of HOBO data loggers used in this protocol.*

| | **HOBO Pro v2 Temperature** | **HOBO Dissolved Oxygen Logger (also measures temperature)** |
|---|---|---|
| **Accuracy** | ± 0.21°C between 0° - 50°C | ± 0.2 mg/L up to 8 mg/L<br>± 0.5 mg/L from 8 to 20 mg/L<br>± 0.2°C |
| **Drift** | 0.1°C/year | Not specified |
| **Memory** | ~40,000 measurements | ~ 21,000 measurements (DO and temp) |
| **Battery Life** | 6 years of hourly measurements | 3 years at 5-minute logging intervals, probably ~5 years with 1-hour intervals |
| **Other features** | Buoyant, optical communications, drop resistant at 1.5 m | Buoyant, optical communications, includes calibration boot, sponge, and protective guard |
| **Maintenance** | Regular de-fouling, battery factory replaceable only | Replace DO cap every 6 months, regular de-fouling, Onset can replace battery |
| **Additional equipment** | HOBO Waterproof Shuttle or Optic USB Base Station | HOBO Waterproof Shuttle or Optic USB Base Station, antifouling guard, sodium sulfite DO calibration solution if anoxic conditions expected |
| **Software** | HOBOware Free, HOBOware Pro if using Waterproof Shuttle | |

These data loggers require the use of HOBOware or HOBOware Pro. This software is used to access information about the loggers such as memory and battery life, set the logging frequency and start time, and retrieve data either directly from the loggers or through the data shuttle. Both the free and Pro versions of the software can read data from the Optic USB Base Station and allow the user to plot the data and export it in table format. The Pro version of the software features a bulk export tool for quickly creating ".csv" files and is required to read data off the HOBO Waterproof Shuttle. Without the shuttle, one must either bring a laptop and USB Base Station into the field or bring the loggers into the office. Thus, purchasing the waterproof shuttle and HOBOware Pro is recommended. Details about offloading data are provided in Section 11.

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*Figure 1. USB Base Station (left) and Waterproof Shuttle (right) with the coupler for Pro v2 temperature loggers.*

### *Verifying Temperature Logger Accuracy*

Test the loggers for accuracy before deploying them. A single-point calibration either with an ice-bath or a well-mixed water bath at room temperature should provide a sufficient test for Onset temperature sensors. Launch the loggers for the test and compare their readings with a National Institute of Standards and Technology (NIST)-certified thermometer. For the two-point calibration, let the loggers and ice water come to room temperature, checking the certified thermometer for the initial ice water temperature and final room temperature.

A multi-point test, which tests loggers at a range of temperatures, is preferred for new loggers or loggers that have remained in storage. Place a heat-resistant vessel on a hot plate and fill with a mixture of ice and water. Stir and bring the water to just above freezing. Launch the loggers with a recording interval of 30 seconds and add to the container along with the NIST-certified thermometer. Allow the loggers and thermometer to equilibrate for 15 minutes. After, check and record the temperature of the thermometer every 30 seconds (at the same time that the loggers are scheduled to record). Then slowly bring up the temperature of the ice bath by turning the hot plate on while mixing constantly. Raise the temperature slowly enough that the loggers have a chance to equilibrate and record the correct temperature. Once the temperature has reached the upper range of what would be expected in the field, remove the loggers and download the data to see if the loggers recorded the same temperature as the certified thermometer. Any loggers that failed to reach the minimum or maximum temperature recorded by the thermometer or exhibited bias should be examined more closely and possibly returned for service. More detailed instructions for single- or multi-point checks can be found in the USEPA "Best Practices" report (USEPA 2014 - https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=280013). If loggers remain deployed year-round, check for temperature sensor issues by comparing with a multiparameter meter in the field (see Section 10. Regular Maintenance).

If using a DO logger, the thermistor should also be evaluated using the methods above. The DO sensor will also need to be calibrated before it is deployed (see Section 10. Regular Maintenance).

## 5. Supplies and Expenses

To assemble a complete array that will keep your data loggers secure, you will need hardware and basic supplies. Cable ties must be replaced yearly because even UV-resistant or cold weather ties eventually become brittle. Other states have had success using small lengths of paracord to attach loggers, which is more environmentally friendly. To use paracord you will need a tool to bring the paracord through the braid of the rope. Most supplies can be found at any hardware store. The surface navigational buoy can be purchased from Rolyan Buoys, a local Wisconsin vendor, and the fishing float can be found from many online retailers.

The recreational safety wardens generally require a surface navigational buoy to keep boaters away from the submerged equipment. On some remote lakes, equipment may be deployed using only the submerged fishing float. A single fishing float is sufficient to suspend an array of 14 temperature loggers on 20 meters of nylon rope. Additional floats may be required for larger arrays or ones that include the heavier dissolved oxygen loggers.

Braided polyester rope or potwarp can be substituted for nylon rope. Typically, nylon rope stretches more under tension than polyester, and this may become important on deep lakes. Braided rope is much preferred to twisted rope because the braid allows the loggers to be attached by threading zip ties through the braid. Buy an additional ten feet of rope per lake beyond the maximum lake depth to accommodate knots and make retrieval easier. If constructing several arrays, buy rope in bulk.

Cable ties must be replaced yearly because even UV-resistant or cold weather ties eventually become brittle. Other states have had success using small lengths of paracord to attach loggers, which is more environmentally friendly. To use paracord you will need a tool to bring the paracord through the braid of the rope.

*Table 2. Example budget for an array with two dissolved oxygen loggers and five temperature loggers on a 40-ft deep lake.*

| Items | Itemized Cost | Quantity | Total Cost | Notes |
|---|---|---|---|---|
| **Supplies** | | | | |
| Rolyan Informational Buoy | $ 125.00 | 1 | $ 125.00 | |
| Cold-weather cable ties, 8” or longer | $ 3.09 | 1 bag | $ 3.09 | secure loggers to braided rope |
| concrete block | $ 1.15 | 2 | $ 2.30 | one block may suffice for lakes under 10 m max depth without high winds |
| Braided polyester or nylon rope 3/8 – 1/2“ | $ 30.00 | 50 ft | $ 30.00 | plan for 10 ft extra |
| galvanized quick link 1/2" | $ 3.99 | 1 | $ 3.99 | fits over buoy’s mooring eye |
| galvanized wide jaw quick link 1/4" | $ 1.89 | 1 | $ 1.89 | fits through chain links |
| 3/16" stainless steel chain | $ 2.98 | 2.5 ft | $ 2.98 | |
| fishing / shrimp trap floats, 7 lb. buoyancy, 5” X 11.75” | $ 10.00 | 1 | $ 10.00 | from West Marine Pro or Amazon; any brightly colored closed-cell floats work |
| Onset Pro V2 temp loggers | $ 129.00 | 5 | $ 645.00 | |
| Onset DO data loggers | $ 1250.00 | 2 | $ 2,500.00 | |
| Onset DO anti-fouling guard | $ 95.00 | 2 | $ 190.00 | |

| | | | | |
|---|---|---|---|---|
| sodium sulfite calibration solution | $ 25.00 | 1 | $ 25.00 | calibrate DO loggers to 0 mg/L DO; important for monitoring anoxia |
| Onset Hobo Waterproof Shuttle U-DTW-1 | $ 249.00 | 1 | $ 249.00 | can also be used as a base station for offloading data in the office |
| sodium sulfite calibration solution | $ 25.00 | 1 | $ 25.00 | |
| **Software** | | | | |
| Onset HOBOware Pro | $ 75.00 | | $ 75.00 | Needed to use waterproof shuttle |
| **Permits** | | | | |
| Local newspaper | $ 90.00 | 1 | $ 90.00 | high estimate for class-1 public notice of misc. structure permit |
| DNR Permit | $ - | 1 | $ - | waived if applicant is state agency (otherwise ~$100) |
| TOTAL | | | **$ 3,953.25** | |
| **TOTAL without DO loggers** | | | **$ 1,238.25** | |

*Figure 2. Potential tools for retrieving submerged equipment. The device on the left is a long pole with a hook. The device on the right (invented by Mica Kromrey) cruises beneath the water and intercepts the submerged equipment with one of the 2 hooks at the corners of the triangle. A SCUBA weight is used to partially sink the device.*

To retrieve equipment left under the ice without a navigation buoy, you will also need a device to retrieve the array from under the water. A long pole with a hook at the end (Fig. 2), a boathook or macrophyte rake can be used if they are strong enough to support the full weight of the array and the array is still visible underwater. If impossible to pinpoint visually, dragging a wide rake or a device like that in Fig. 2 will aid successful retrieval.

An additional project cost is staff time. We estimate approximately 54 hours to initiate a buoy chain and monitor for the first year (Table 3). After the project is initiated, field trips in spring and fall in time with the ice-free season should suffice, resulting in approximately 24 hours of staff time annually.

*Table 3. Estimated staff time in first year.*

| Activity | Time |
|---|---|
| Purchase equipment / hardware and assemble array | 10 hrs |
| Apply for permits | 10 hrs |
| Deploy array in field | 8 hrs (2 staff x 4hrs) |
| Regular maintenance | 8 hrs |
| Download data, manual QA check, plot data | 8 hrs |
| TOTAL | 54 hrs |

## 6. Choosing the Logger Depths

The depths at which the data loggers will be deployed is an important consideration and will depend on your purpose, budget, and the maximum lake depth. Obtain maximum depth from old bathymetric maps or temperature profiles but be prepared to adjust your data logger array a few meters in either direction after you arrive in the field. If not limited by budget, place a logger at 1-m depth intervals from 1 m below the surface to the bottom of the typical thermocline and then at geometrically increasing intervals (i.e., 1, 2, 3, 4, etc.) to 1-m depth from the bottom. Do not place a logger floating on the surface as it will be affected by solar radiation and air temperature. Cheaper alternatives include loggers at 1-m depth from the surface, 1-m distance from the bottom, and possibly logger(s) near the typical thermocline.

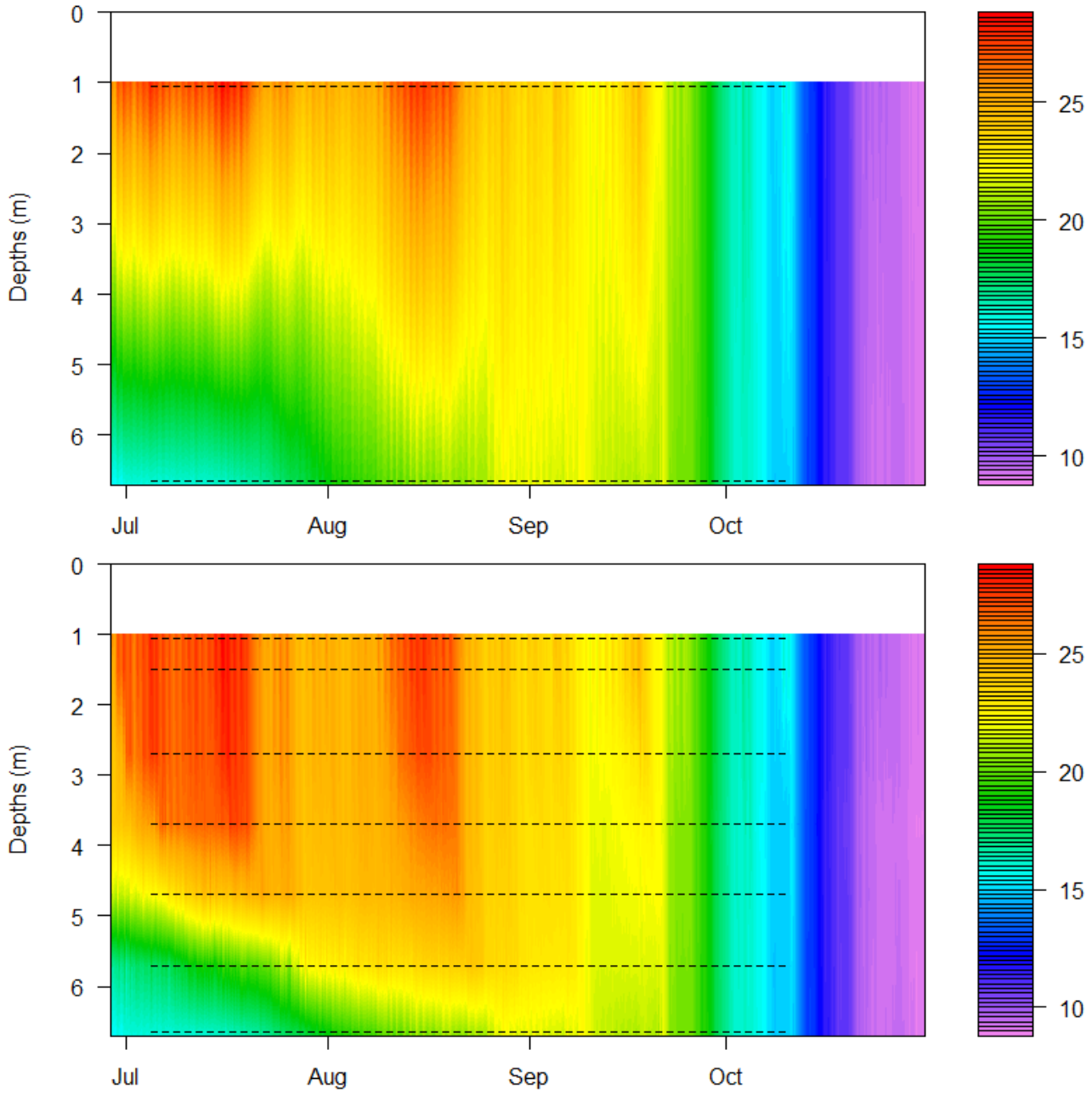


*Figure 3. Comparison of temperature data gathered from two (above) and seven loggers. The data is from the same data logger array on Pleasant Lake, Waushara county, except the top figure is generated with data only from the top and bottom loggers. Dotted lines represent the depths of the temperature loggers. With fewer loggers, the graphing function is forced to interpolate a greater distance, and the depth of the thermocline is unknown.*

Lake levels can vary dramatically and are important to account for when defining the depths of each logger. The submerged fishing float will ensure that the rope remains taut. Loggers placed below the fishing float will remain a constant distance from the lake *bottom*, whereas loggers suspended directly from the navigation buoy will remain a constant distance from the lake *surface*. Hang one "surface" logger from the navigation buoy at 1-m depth from the surface. The buoy sinks ~60 cm, so the logger must hang ~40 cm below the buoy.  Attach all remaining loggers below the fishing float; these will

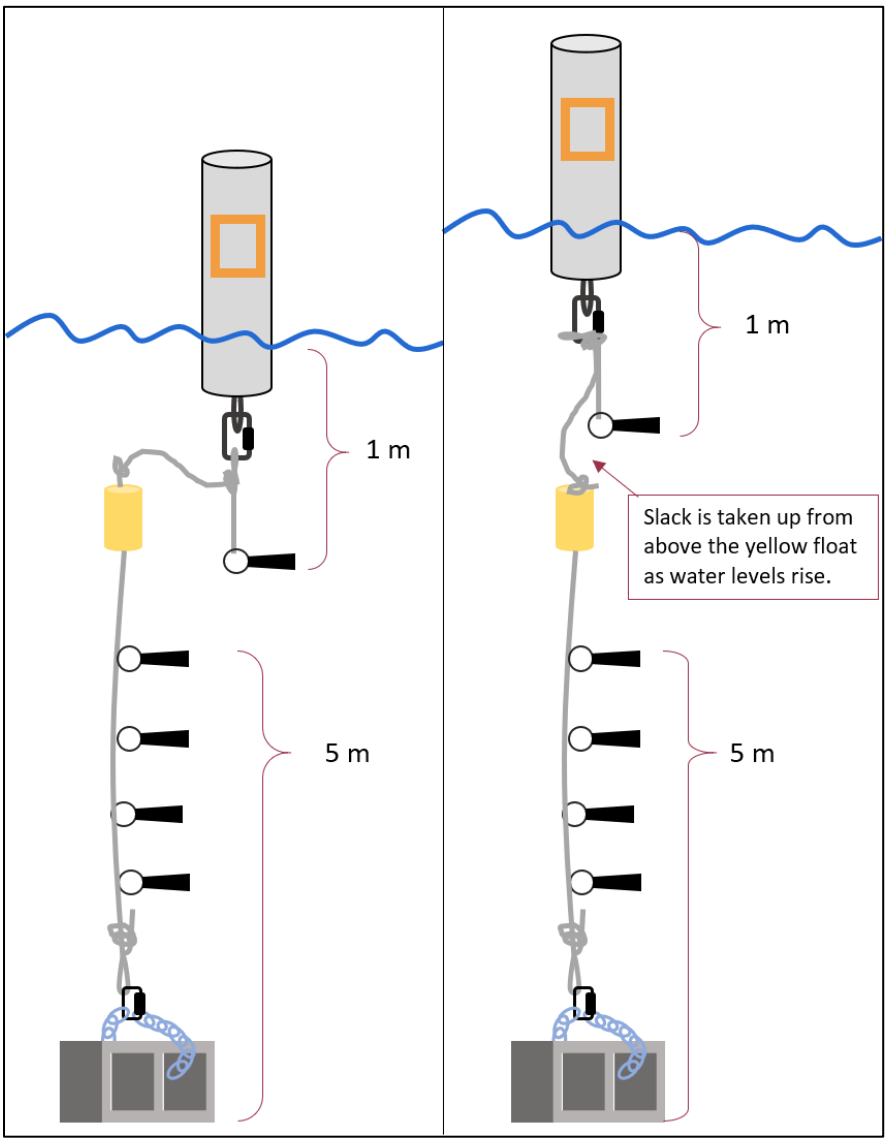


*Figure 4. Response of the data logger array to changing water levels.*

remain a constant distance from the bottom. When assigning logger names in HOBOware, include the meter distance and then either "dfs" or "dfb" to mean distance from top or bottom. This technique ensures that readings have reference points uninfluenced by water levels. Most readings are relative to the lake bottom, but the logger suspended from the navigation buoy allows for one reading near the

surface even when water levels rise. Note that in extreme drought, the fishing float may need to be moved down and some loggers may need to be removed.

The position of loggers relative to the surface will change with lake levels, making it difficult to compare to discrete profiles. One solution is to install an automatic water level logger to your array, which allows you to calculate each logger's depth from the surface at the same time as the temperature readings. A less expensive solution is to take manual water level readings at the deep hole or deployment location on regular field visits, and then interpolate water levels between the readings. In Section 9, we describe how to translate the logger positions established during assembly (as distance from bottom) to depths from surface on the date of deployment.

After choosing logger depths, record the setup and project details in the master spreadsheet according to the instructions in Section 12. Record-keeping and Quality Assurance/Quality Control.

## 7. Assembling the Array

Assembling the equipment and loggers for deployment can take an hour or more, depending on the number of data loggers. It is helpful to work in an open space where the rope can be stretched taut as it would be in the field, from the surface to the bottom of the lake. You will also need a meter tape, masking tape, and a permanent marker.

1. Begin by wrapping the 2.5 feet of chain through the cinder block and attaching the smaller quick-link to the ends.
2. Attach the rope to the ¼" quick-link with a bowline knot and secure the loose end of the rope with a clove hitch or similar knot. If using nylon rope, always burn the frayed end with a lighter or use electrical tape to stop it from unraveling.
3. Pull on the rope so that the chain is taut, as it would be in the field with the buoyancy of the fishing float pulling it up. Now set your meter tape alongside the setup, allowing a few inches for the block to sink into the lakebed if you suspect you will deploy on soft sediment.
4. Measure and mark the spot on the rope that would be 1 m from the bottom. Then measure and cut the appropriate length of rope, allowing 3 m extra beyond the measured depth of the lake to account for knots and changes in water level.
5. Measure and cut another length of rope for any loggers hanging directly off the buoy, again allowing enough extra rope for knots.
6. Thread the rope through the fishing float and tie a knot above it to hold it in place, usually 1 – 2 meters below the surface. You may need to adjust the depth of the float, so don't overtighten the knot.
7. Tie the top of the main line to the ½" quick-link along with the additional line that will hang directly off the buoy and arrange them alongside the meter tape. The ½" quick-link will attach to the bolt on the bottom of the buoy.
8. Working from the bottom, mark with sharpie or tape the desired locations of the loggers, measuring from the lake bottom for all loggers *below* the fishing float (start at the 1 m mark from

the bottom you made in step 4), and from the lake *surface* for the logger hanging directly off the navigation buoy at 1 m below the surface. To account for the length of the buoy when measuring rope from the surface, note that standard navigation buoys are weighted to sink about 60 cm (24 inches) below the water surface.

9. Double check your depths and then attach loggers with two zip ties (or paracord) by threading through the braid of the rope. Write the serial number and depth (include units and depth/distance from top or bottom, dfb/dfs) of each logger on a piece of paper. Use masking tape to label the depth of each logger (e.g., 8 m dfb). This will avoid confusion when launching and deploying the logger chain later, and this information should also be recorded in the master tracking Excel file (see Section 12). Note that the loggers are designed to be slightly buoyant and will float upward if not tightly secured. You will need to add a small weight (e.g., chain link) to the logger suspended from the navigation buoy. HOBO Dissolved oxygen loggers must be installed vertically with the sensor on top. Thread two zip ties through the hole of the DO logger and place another zip tie around the body of the logger toward the top to stabilize it against the rope (Figure 9).
10. Measure and record the distance from the top of the fishing float to the first logger below. This measurement will be used to determine logger depths from the surface on each field visit.
11. Write WI DNR and contact information of the permittees on the buoys with permanent marker.

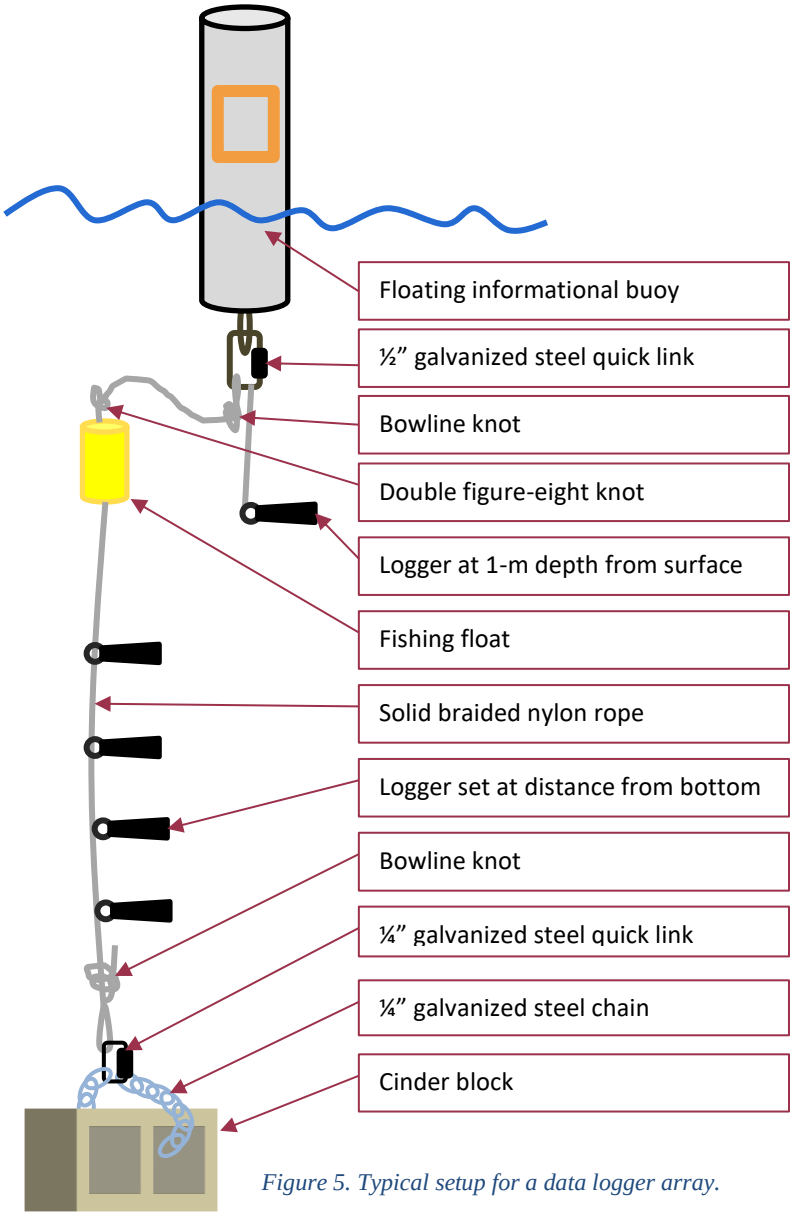


*Figure 5. Typical setup for a data logger array.*

*Figure 6. Dissolved oxygen logger installed vertically.*

## 8. Launching the Data Loggers

When launching many loggers at once, it is easy to lose track of which ones you have launched. Launch the loggers after they have been attached to the rope and labeled with masking tape bearing the deployment depth. Use a marker to indicate which loggers have been launched as you move up or down your rope.

1. Open HOBOware and connect the waterproof shuttle or the base station to a USB port on the computer.
2. Attach the appropriate plastic coupler to the shuttle or base station and attach the first data logger. If the connection is successful, the device and serial number will appear in the bottom left-hand corner of the window. If the connection is not successful, try unplugging and re-plugging the USB connection while keeping the data logger in the shuttle or base station.

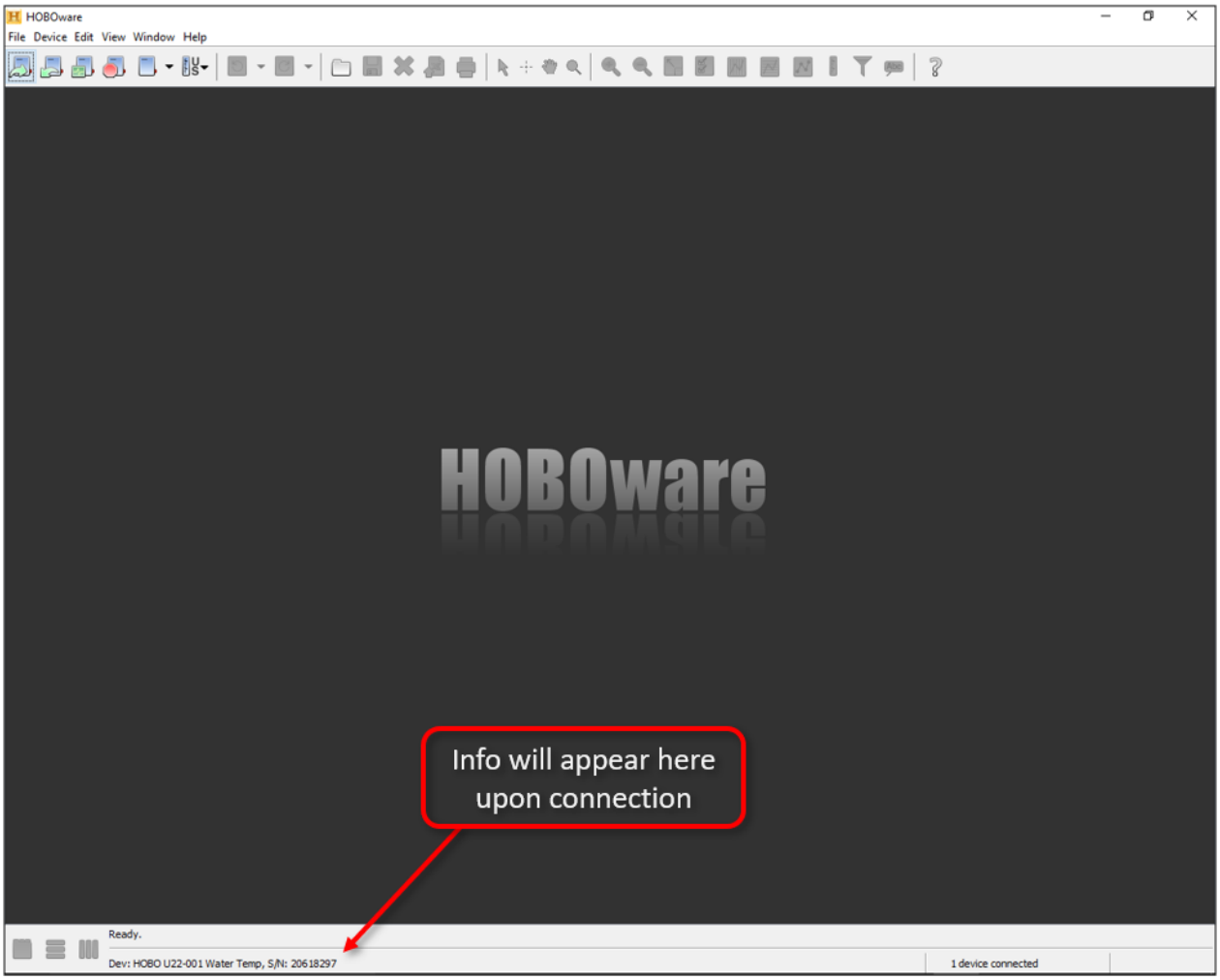


*Figure 7. Check that the logger is connected to HOBOware software.*

3. Check the status of the logger by clicking the third icon from the left. The status window displays important information about the logger. Check that the battery status is “good” and that there is enough memory. The window also indicates whether the logger is logging or stopped, the name (defaults to serial number), and the current temperature reading.

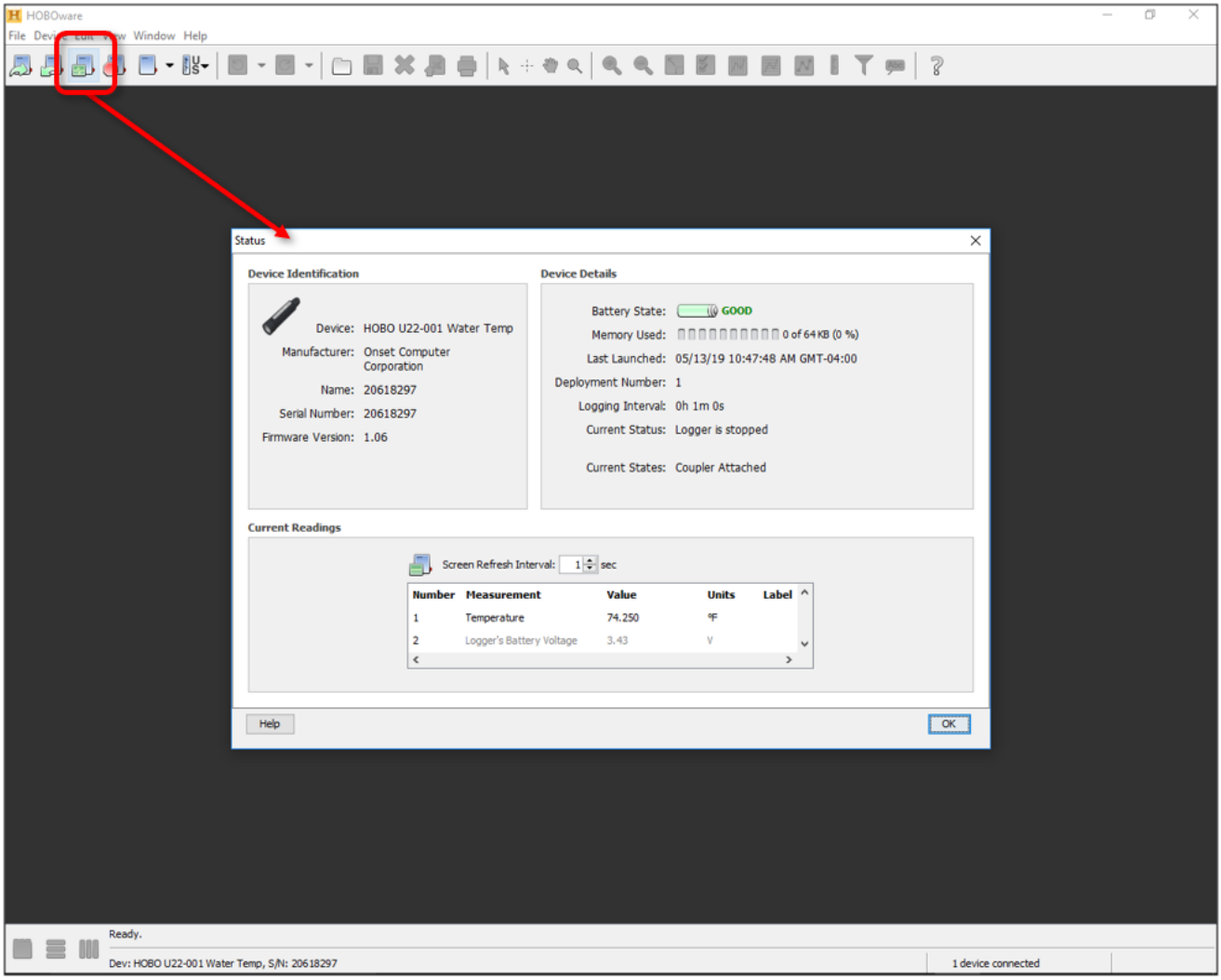


*Figure 8. Check logger status*

4. Once you are satisfied with the status of the logger, prepare to launch the logger by clicking the leftmost icon at the top of the window.
    a. Change the name of the data logger, following the format:
    LakeName_WBIC_depth_dfb/dfs
    Example: BigPortage_1629500_8m_dfb
    It is critical that each logger name contains these vital pieces of information! The lake name is for your convenience as you manage data. The WBIC is important for differentiating among lakes with the same name. The example logger is set at 8-m distance from the bottom.

b. Set the logging interval to 1 hour and make sure each logger records on the hour, so that all temperature readings are taken at the same time. This is very important as it will allow you to combine time series from loggers at different depths by matching the timestamps. Use military, local standard time (not daylight savings time).
c. Set the logger to start logging just after when you think it will be in the lake. If weather pushes your field work back, you can clip the irrelevant data after downloading it later.
d. Double check your settings and then click "Delayed Start".

5. If you are not sure if you launched a logger or not, connect it and check the status window.
6. Record information about your logger depths in the tracking spreadsheet as described in Section 12. Record-keeping and Quality Assurance/Quality Control.

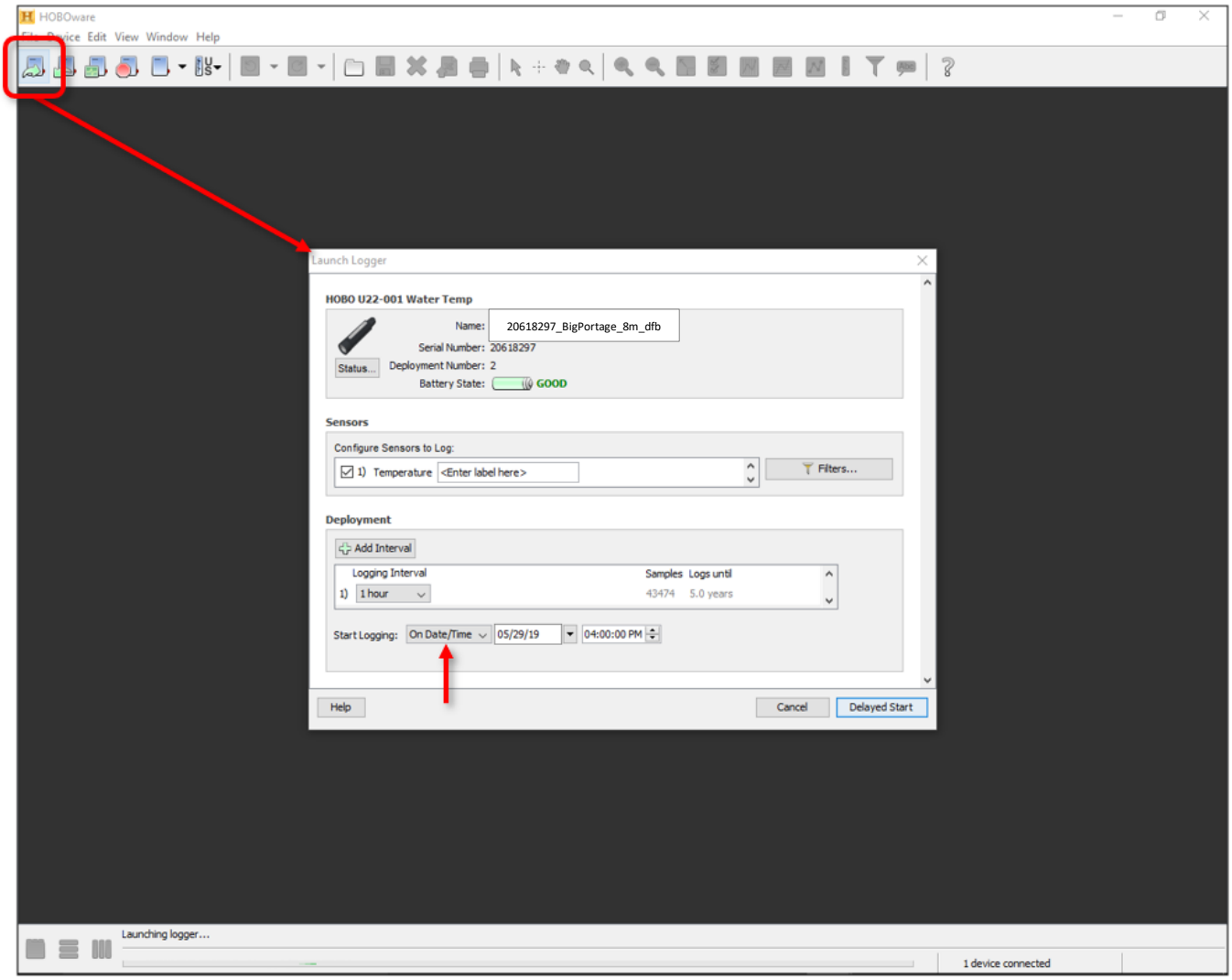


*Figure 9. Launch the logger.*

## 9. Field Deployment

Ensure that you have at least two people on the boat for safety the day that you deploy the logger chains.

1. Load the boat with buoy, logger array, and cinder block(s) and navigate to the deep hole station with a GPS unit.
2. Set an anchor and then take and record a depth reading (preferably with weighted, marked line).
3. If the maximum depth is different than expected, ensure that you are at the correct location. If you are at the deep hole station, adjust the fishing float location and logger depths accordingly (ensuring that the fishing float is at least 1 m below the surface).
4. Once the fishing float is in its final position, measure the distance from the top of the fishing float to the first logger beneath the fishing float and record on the data sheet.
5. On page 1 of the data sheet, draw the position of all loggers beneath the fishing float and write the distance from bottom of each (determined during assembly). On page two of the data sheet, record the logger information: distance from lake bottom determined during assembly, serial number, the logger type. If this is the first deployment, data will not be offloaded.
6. Mark the line in 0.25-m increments from the top of the fishing float up to the quick link that will attach to the navigation buoy. You will use these marks to help track the depth of the fishing float over time.
7. Connect the navigation buoy to the logger array. Use a wrench to tighten all quick links and ensure all knots and loggers are secure.
8. Double check the logger placement from bottom to top once more, ensuring correct depths.
9. Put on work gloves and place the fishing float and rope into the water. Then carefully drop the cinder block(s) over the side of the boat such that the rope will pull taut without tangling.
10. Position yourself directly over the fishing float, measure the distance from the top of the fishing float to the surface and record on the data sheet. Use a tape measure or the markings on the line.
11. Once you have observed that the fishing float is properly suspending the loggers, flip the navigation buoy and single logger into the lake.
12. Record the time (standard military) and the latitude/longitude of the buoy.
13. Using the diagram on page 1 of the data sheet, calculate the depth from surface for each data logger (e.g., Fig. 10). The depth of the first logger beneath the fishing float is the sum of the distance from the logger to the top of the fishing float and the distance from the top of the fishing float to the surface. Then use the depth from

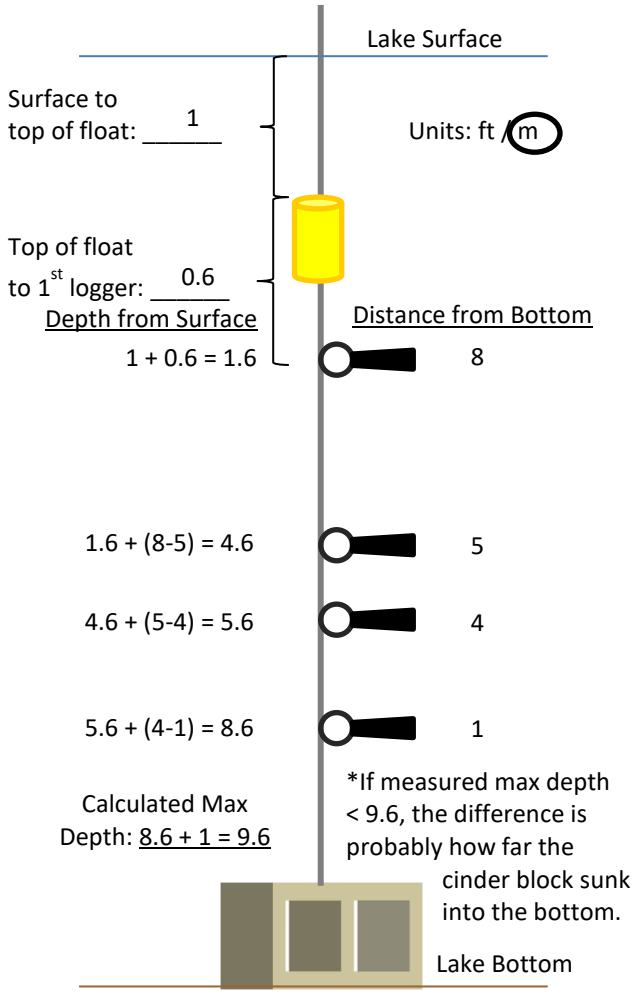


*Figure 10. Example calculations to determine depth from surface of each logger. Diagram from page 1 of field data sheet.*

bottom readings to determine the distance between subsequent loggers.

14. Calculated Max Depth is the sum of the last logger's depth from surface and the last logger's distance from bottom. Compare to the measured maximum depth at the buoy. If the Calculated Max Depth is larger, the cinder blocks probably sank into the sediment such that the distance of the loggers from the lake bottom is less than that measured during assembly. Record the difference on page 2 of the data sheet.
15. Copy the depth from surface calculations to page 2 of the data sheet.
16. Take a temperature and dissolved oxygen profile using a multiparameter meter. This data can be used later to confirm temperature logger readings and depths and test logger drift. Take readings at the exact same depths as the loggers using the depth from surface calculations. Otherwise, take readings at 0.5-m increments or less.
17. Take a Secchi depth reading.
18. Take a photograph of the deployed array to submit to the recreation safety warden.
19. Post an informational sign at the boat launch according to the permit instructions.

## 10. Regular Maintenance

One advantage of using automatic data loggers is that they require relatively little maintenance. Nevertheless, data loggers should be checked as often as allowed by fieldwork schedules, ideally monthly or in spring and fall at minimum. Dissolved oxygen loggers require more frequent cleaning than temperature loggers. Each of the following steps should be taken during a routine check on a data logger array. A suggested equipment list is provided in Appendix A.

Careful record keeping is essential for tracking loggers over time. You will fill out a data sheet and label "REMOVE" each time you haul the array out of the lake. This data sheet will record the configuration and condition of the array as you found it when you arrived. You will fill out a separate data sheet and label "DEPLOY" each time you set the array into the lake. This will record the configuration of the array as you leave it. You will fill out REMOVE and DEPLOY data sheets on days when you pull out the array, download the data with the waterproof shuttle, and then redeploy. This will avoid confusion.

1. Anchor off the bow and into the wind alongside the buoy so that the equipment can be returned as close to the original location as possible.
2. Fill out the top of the field sheet and circle "REMOVE".
3. Measure and record lake depth at the array location.
4. Measure and record the distance from the lake surface to the top of the fishing float. If the depth of the fishing float has changed since the previous visit, recalculate the depth from surface of each logger on page 1 of the data sheet.
5. Take a vertical profile with a multiparameter meter to compare with the measurements from the data loggers. Make sure to take readings at the depth from surface of each logger.
6. Take a Secchi depth reading.
7. Haul up the array and record the time (standard military). Check the equipment (buoy, chains, rope, quick links, knots, etc.) for damage and replace parts that are in danger of failing. Even galvanized steel can show significant oxidation from being submersed, yet this does not

necessarily mean it must be replaced. Note logger damage or other problems in the diagram on page 1.

8. Remove any biofouling from the loggers with a brush and vinegar if necessary.
9. Download the data from the loggers with the waterproof shuttle. The waterproof shuttle can be used to offload data from HOBO Temperature Loggers and HOBO Dissolved Oxygen Loggers in the field, using the plastic coupler (Coupler C – with the blue sticker). Once connected, press the lever on the shuttle to begin transferring data. Once the "transfer" light stops blinking and the "OK" light flashes green, you can move to the next logger. The shuttle can hold records from 63 loggers before some must be deleted to free up memory. You can manage which records are offloaded and deleted when the shuttle is connected to a computer via the USB cord. Record if the data was offloaded for each logger on page 2. If you are bringing the array back to the office, make note of that on the field sheet.

*Figure 11. Dissolved oxygen logger with significant fouling is cleaned with a plastic brush (left). Temperature data is downloaded using the waterproof shuttle (right).*

10. If you are redeploying the logger array, begin a new data sheet and circle "DEPLOY". Record the logger configuration before redeploying.
    a. If all loggers are working and the configuration remains the same, simply copy the drawing from previous visits, recording the distance from bottom of each logger and copying all logger information on to page 2. Measure a few distances between loggers

and between the top of the fishing float and first logger to make sure the rope has not stretched.

b. If the array changes (e.g., replace logger, add/remove loggers, change placement), then draw the new array and include the distance from the top of the fishing float to the first logger, the distance from bottom for each logger, the serial numbers, and logger types.

11. Carefully return the array to the lake. Put the fishing float and rope into the lake first, making sure that the rope is not tangled. After the anchor, loggers, and fishing float are in place, flip the navigation buoy into the lake. Record the time, latitude, and longitude.
12. Measure the depth of the fishing float.
13. Recalculate the depths from surface of all loggers and record on pages 1 and 2 (should remain the same if configuration is unchanged).
14. Take another vertical profile with the multiparameter meter, this time at the same depths from surface of the loggers in the new configuration.

Additional maintenance is necessary for the HOBO Dissolved Oxygen Logger because the sensor cap must be replaced and recalibrated every six months. Recalibration must be done in the office or on shore with a laptop and takes about one hour. Any loggers that need to accurately measure low dissolved oxygen levels, as might occur in the hypolimnion, should be calibrated to both 100% and 0% saturation. A sodium sulfite solution is used to calibrate to 0% saturation. Follow the manual for calibration instructions.

The dissolved oxygen loggers are also more prone to fouling than the temperature loggers. Biological fouling can be removed by gentle scrubbing with a toothbrush. Hypolimnetic loggers in some lakes may become fouled by calcium carbonate or other mineral formation, which can be removed with vinegar. The antifouling guards use copper and are effective at preventing biological fouling, but not mineralization on hypolimnetic loggers. Thus, check and clean dissolved oxygen loggers frequently to minimize fouling impacts on data quality.

### *Winter Monitoring*

Leaving the data logger array deployed over the winter is preferred for most applications. The navigation buoy may be left out to freeze into the ice, but you must remove the logger that hangs from the navigation buoy. Though we were concerned that the ice would damage the buoy, we have successfully left out a navigation buoy for three winters.

Alternatively, remove the navigation buoy before ice-on and replace soon after ice-off in the spring. This means there will likely be several weeks before and after winter when the monitoring equipment will be submerged without any navigation buoy to alert watercraft users. Consult the local recreational safety warden to ensure that this will not pose a significant hazard. The fishing float must be submerged deep enough (1 - 1.5 meters) to be below the draft of recreational watercraft. Measure the depth of the fishing float before you haul out the array in fall to ensure the proper depth.

Consider how you will locate and recover the equipment underwater in the spring if you plan to submerge the fishing float and remove the navigation buoy. Here are recommendations:

- Check historical spring Secchi depths to make sure the water will be clear enough to see the fishing float 1 - 1.5 m below the surface.
- Clearly label the yellow fishing float with “WI DNR” and contact information to avoid tampering.
- Add a large loop of rope on top of the fishing float to aid retrieval in spring.
- Deploy the array with a drag line. Connect a small anchor to the cinder block with a long piece of floating rope (1.5 X depth or up to 100 ft). In the spring, you can drag a grappling hook to intercept the floating rope and then retrieve the entire array.
- Take a GPS point as close to the equipment location as possible.

Otherwise, complete the array retrieval, data download and redeployment in fall as normal.

In spring, proceed to the navigation buoy and be prepared to reinstall the logger that hangs from it. If you removed the navigation buoy for winter, choose a calm, sunny day for retrieval. Motor to the GPS location you marked in the fall and slowly circle the location while the other crew member uses polarized sunglasses to look down into the water for the yellow fishing float. Once the float is located, snag the loop of rope with your boat hook. If you cannot see the fishing float, do not give up! This is when you may need to use a device like that in Fig. 2, a wide rake, or a grappling hook to blindly snag the line. If snagging the instrument line, take care not to damage the loggers. The zip ties could snap if too much pressure is applied. Connect the navigation buoy when you redeploy.

## 11. Offloading & Exporting Data

1. Offload data after every field visit.
2. Connect either the Waterproof Shuttle or the USB Base Station (with logger inserted) to a computer via USB.
3. If using the waterproof shuttle, click the status button third from the left to reach the Waterproof Shuttle Management window. When using the base station, you can immediately readout from the connected logger by clicking the second button from the left. Once all your .hobo files are saved, you can skip to step 9.

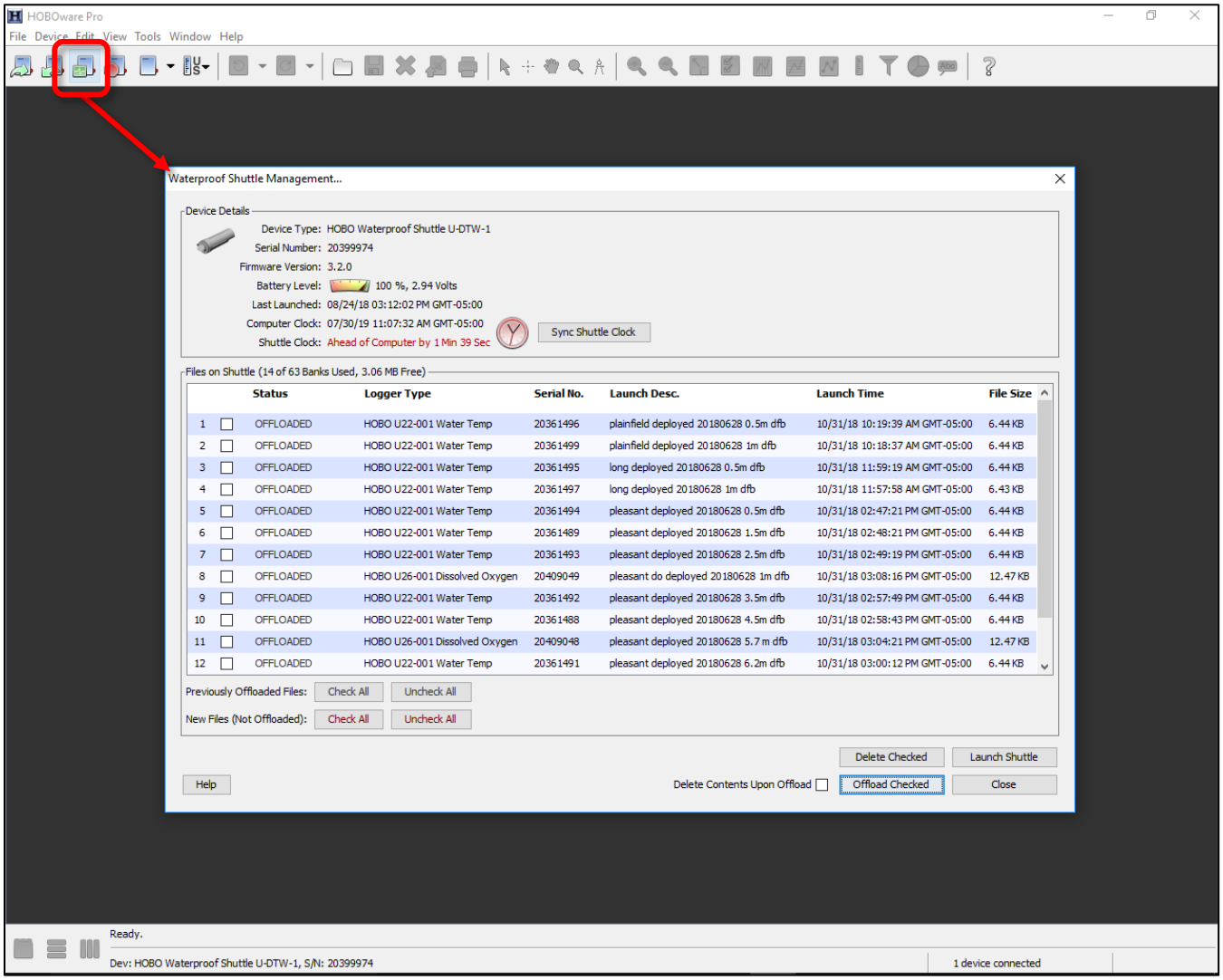


*Figure 12. Offloading data to your computer.*

4. From the Waterproof Shuttle Management window, select the files you will offload and click "Offload Checked".
5. You will be given an opportunity to rename the .hobo files and select the destination directory before offloading. The name of the .hobo files will also be the default name of any files you later export to .csv, so take the time to rename the files now. Add the date that data was downloaded

from the loggers in the field – otherwise you will have a file with an identical name the next time you transfer from the logger. This will also assist in merging files from the same logger together later. Your new filename should be LakeName_WBIC_mmddyyyy_meters_dfb/dfs (BigPortage_16299500_10152019_8m_dfb). Once you are done renaming, click the "Save Checked" button. You have now saved all checked .hobo files.

6. Sync the shuttle's internal clock with the computer's clock.

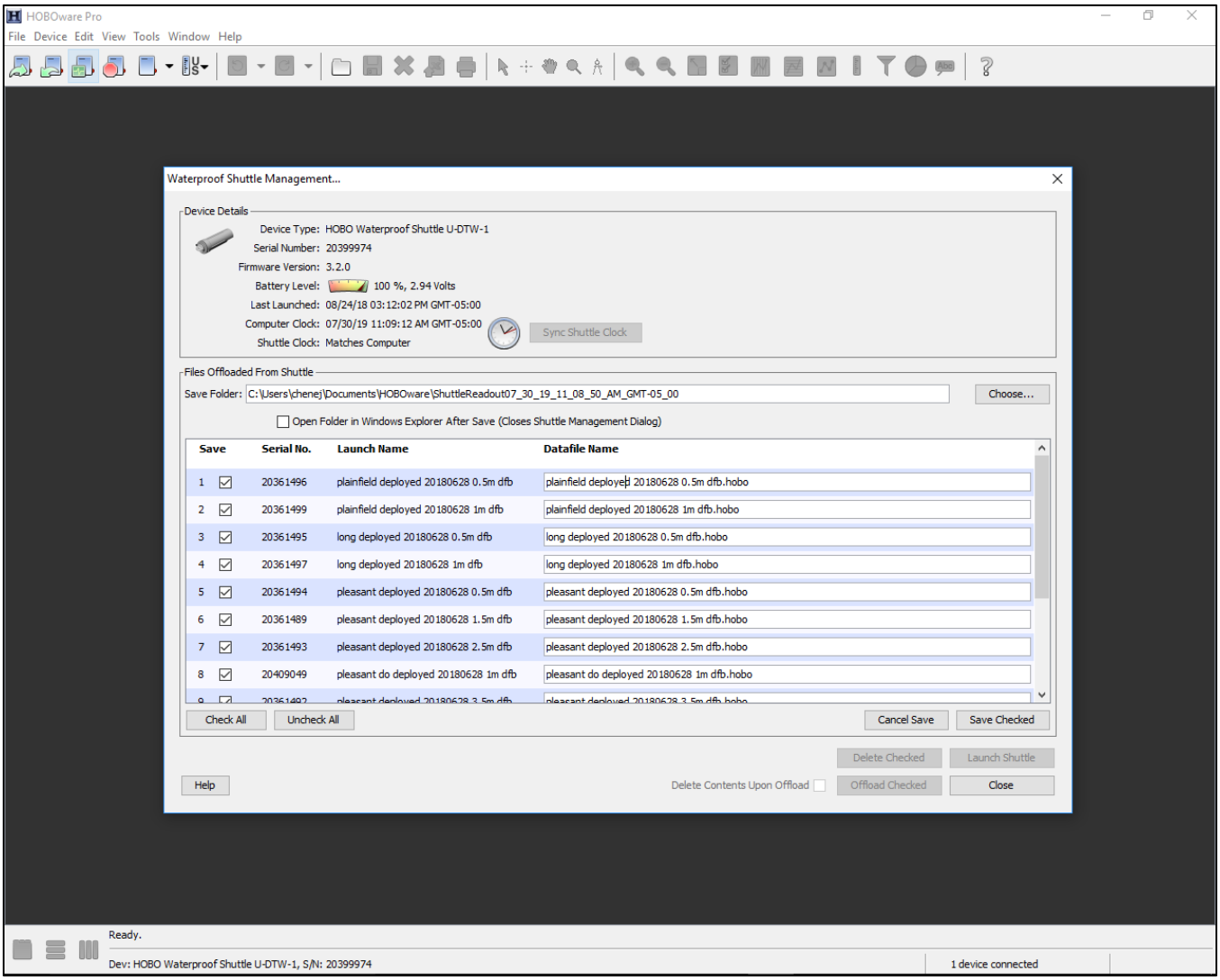


*Figure 13. Naming datafiles. Follow the naming convention in step 5, not that shown in the display of this figure.*

7. The shuttle can store data from 63 loggers. If space is low, delete files carefully. The "Launch Shuttle" button will delete all data files and sync the shuttle clock, so do not click this button until all new data is downloaded.
8. Open the .hobo files you just created (if they are not open already). You can choose to examine the plots in HOBOware or later in Excel or other software.

9. Before exporting any data, check the export settings under File > Preferences > General > Export Settings. The settings should match the picture below.

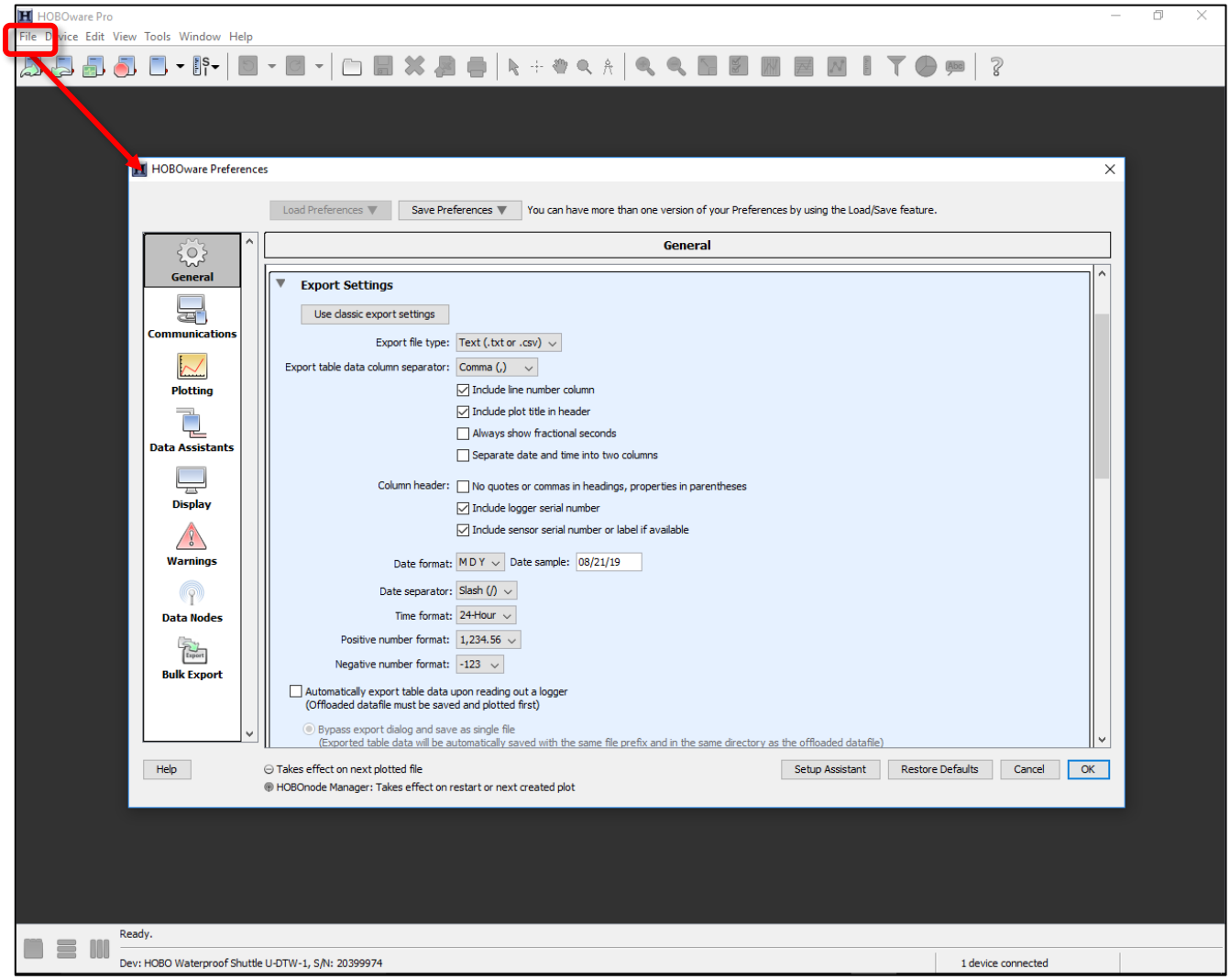


*Figure 14. Export settings.*

10. You can export by choosing File > Export Table Data. If you have HOBOware Pro, you can use the bulk export tool found under Tools > Bulk File Export to create many .csv files at once from the .hobo files you have just saved. Use Ctrl or Shift to select multiple files. You will be prompted to specify the directory where your new .csv files will be deposited.
11. Now your .csv files are ready to be opened by Excel or another spreadsheet program.

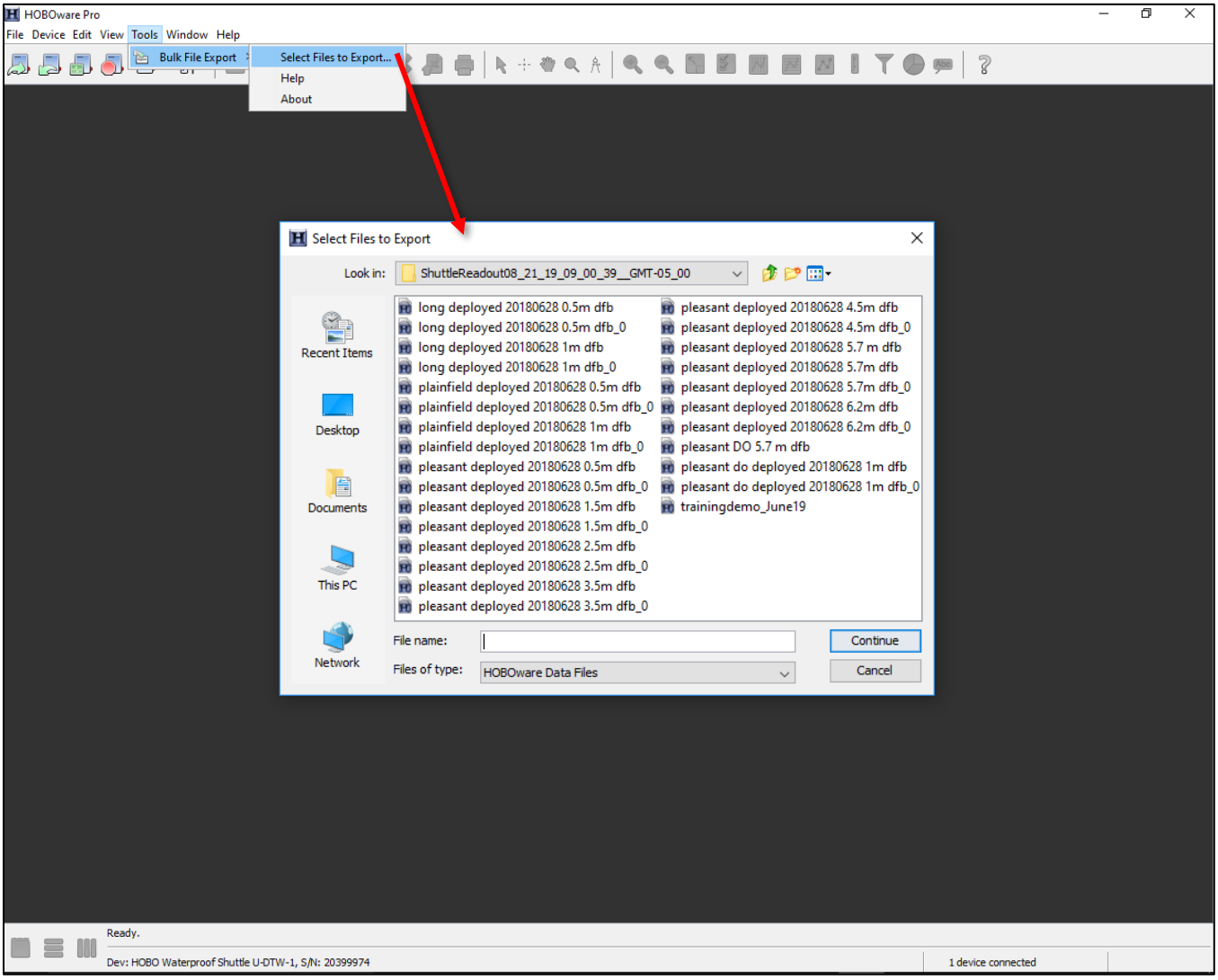


*Figure 15. Export data.*

## 12. Record-keeping and Quality Assurance/Quality Control

Currently, SWIMS is unable to accept data logger records from multiple depths at a single point. However, SWIMS can accept records from a single data logger (for example, temperature from a logger in a stream). The SWIMS team is aware of this and working to allow the upload of hourly data from multiple depths, at which point this document will be updated.

The sheer volume of data from automated data loggers poses special challenges to record-keeping. Over the course of six months, 10 data loggers will record about 43,000 hourly records, each of which must be associated with a project, lake, and depth. Additionally, multiple data files will be created for each logger because the information must be exported from HOBOware and modified (e.g., remove readings taken while the logger was out of the water) before being combined into a single file containing readings at multiple depths.

Crucial pieces of information that should be recorded for a given data logger project include:

- GPS location of the data logger array
- Lake depth at the location of the array on the dates of deployment and retrieval
- Distance from the lake surface to the top of the yellow fishing float on each visit.
- Time and date of field activities such as:
    - Deploying or removing the entire array from the lake
    - Removing or reattaching the navigation buoy
    - Downloading data from the loggers
    - Moving loggers up or down the rope
    - Replacing equipment
- Logger information such as:
    - Serial number
    - Depth from surface
    - Distance from bottom
    - Battery and memory status

Use a unique name to refer to each arrangement of loggers deployed on a lake. The first arrangement of loggers might be called Lake_2018, and this arrangement is recorded with logger names, depths, and serial numbers. If a new logger is added or loggers are moved up or down, the new arrangement might be called Lake_2019. Each fieldwork activity, whether it is a mid-season data download, the removal of the navigation buoy, or the removal or replacement of the entire array, is linked to an arrangement. Accurately recording field activities is important for checking the data later and filtering out readings taken while the loggers were out of the water.

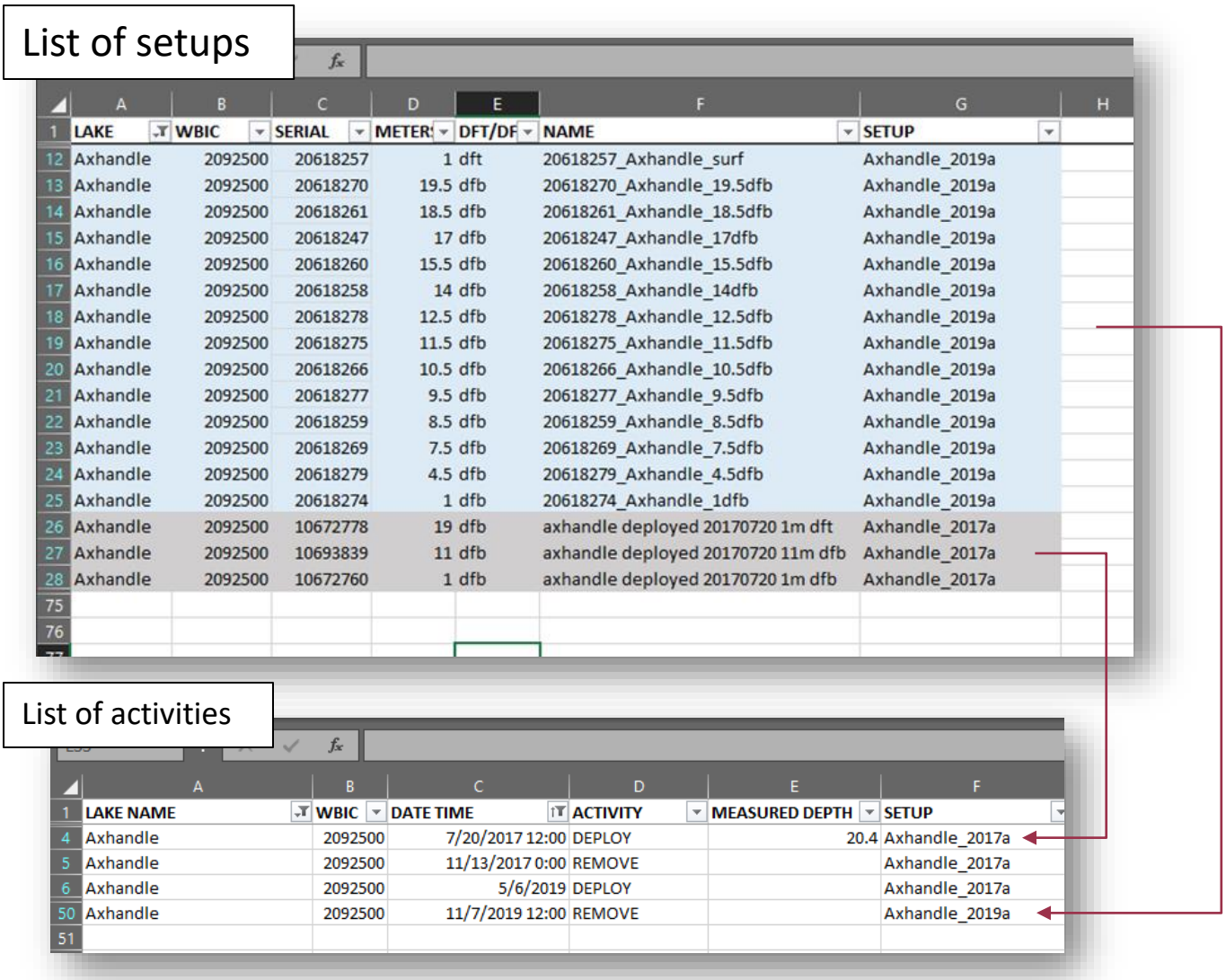


*Figure 16. The relationship between "activities" and "setups" in the master tracking Excel sheet. Each fieldwork activity must be associated with an arrangement of loggers so that for any given date and time the depth of each logger is known. Whenever a depth changes or loggers are added / removed, this must be tracked as a new setup. The log of activities is also helpful for removing data collected while the loggers were undergoing maintenance.*

Ensuring that the loggers take accurate readings is also critical for quality data. See instructions for checking the accuracy of temperature loggers in the laboratory and calibrating DO sensors (Sections 4 and 10). In addition, Sections 9 and 10 describe how to take a discrete vertical profile with a handheld multiparameter meter on each field visit so that it can be compared to logger readings afterward. The steps taken to derive the logger depths from the surface are critical for comparing the multiparameter meter profile with the logger readings. After downloading data from the loggers, select the reading time that most closely coincides with the time when the discrete profile was taken. Compare the temperature and DO readings from the loggers and the multiparameter meter on each field visit. Expect some differences between devices but retrieve loggers for further testing that are markedly different or appear to be drifting over time.

## 13. Additional Resources

- HOBO Dissolved Oxygen Logger (U26-001) Manual – pdf
- HOBO Water Temp Pro v2 (U22-001) Manual - pdf
- HOBO Waterproof Shuttle (U-DTW-1) Manual – pdf
- Waterway Marker Permit Application & Information
- Miscellaneous Structure Permit Application & Information
- General Instructions for Individual Waterway Permits
- Information on USACE Nationwide Permits (see section 5)
- A Guideline for Creating Local Boating Ordinances and Placing Waterway Markers in Wisconsin Waters

## Appendix A. Field Equipment List

**Logger chain:**

- ☐ Navigation buoy with DNR contact info
- ☐ Large stainless/galvanized quick link
- ☐ Small stainless/galvanized quick link
- ☐ Yellow fishing float
- ☐ Solid braided nylon rope
- ☐ Chain (2.5 ft)
- ☐ Cinder block
- ☐ Loggers (labeled and already launched from HOBOware)
- ☐ All-weather zip ties

**Other equipment:**

- ☐ Adjustable wrench
- ☐ Scissors or side-cutters
- ☐ Toothbrush (for defouling loggers)
- ☐ Vinegar (for defouling)
- ☐ Work gloves
- ☐ Field data sheet + pencil
- ☐ Permanent marker
- ☐ GPS w/ coordinates for deployment location
- ☐ Multiparameter meter
- ☐ Secchi disc
- ☐ Weighted marked line for measuring water depth at deployment site
- ☐ Measuring tape
- ☐ PFDs
- ☐ Sunglasses
- ☐ Sunscreen
- ☐ Lighter or electrical tape (for sealing rope)
- ☐ Replacement hardware for any parts in danger of failing (chain, quick-links, rope, etc.)

**Additional equip. for mid-season data collection:**

- ☐ Rag
- ☐ Brush
- ☐ Hobo data shuttle
- ☐ Appropriate plastic coupler for shuttle (Onset temp loggers and DO loggers use Coupler2-C with the blue label)

**Additional equip. for deployment over winter:**

- ☐ Second fishing float if desired
- ☐ Extra loop of rope for springtime retrieval
- ☐ Rag
- ☐ Brush
- ☐ Hobo data shuttle
- ☐ Appropriate plastic coupler for shuttle (Onset temp loggers and DO loggers use Coupler2-C with the blue label)

**Additional equip, for retrieval of submerged gear in spring:**

- ☐ GPS w/ coordinates of deployment location
- ☐ Pole with hook or other retrieval device
- ☐ Navigation buoy
- ☐ Polarized sunglasses
- ☐ Rag
- ☐ Brush
- ☐ Hobo data shuttle
- ☐ Appropriate plastic coupler for shuttle (Onset temp loggers and DO loggers use Coupler2-C with the blue label

## Appendix B. Inland Lake Continuous Monitoring Field Sheet

Lake Name: _____WBIC: _____ Date: _____ Time: _____

Crew members: _____ circle one: DEPLOY / REMOVE

Wind Speed: _____ mph from _____ % Cloud Cover / Precip:_____

Secchi Depth: _____ft / m Buoy Lat/Long: _____ Max Depth at Buoy:_____ft / m

Meter type: _____ *Take vertical profile measurements at same depth as loggers or at 0.5-m or 1-ft intervals. Use worksheet below right to determine exact depths of loggers from surface.*

| Depth ft / m | Temp °C | DO mg/L | Depth ft / m | Temp °C | DO mg/L |
|---|---|---|---|---|---|
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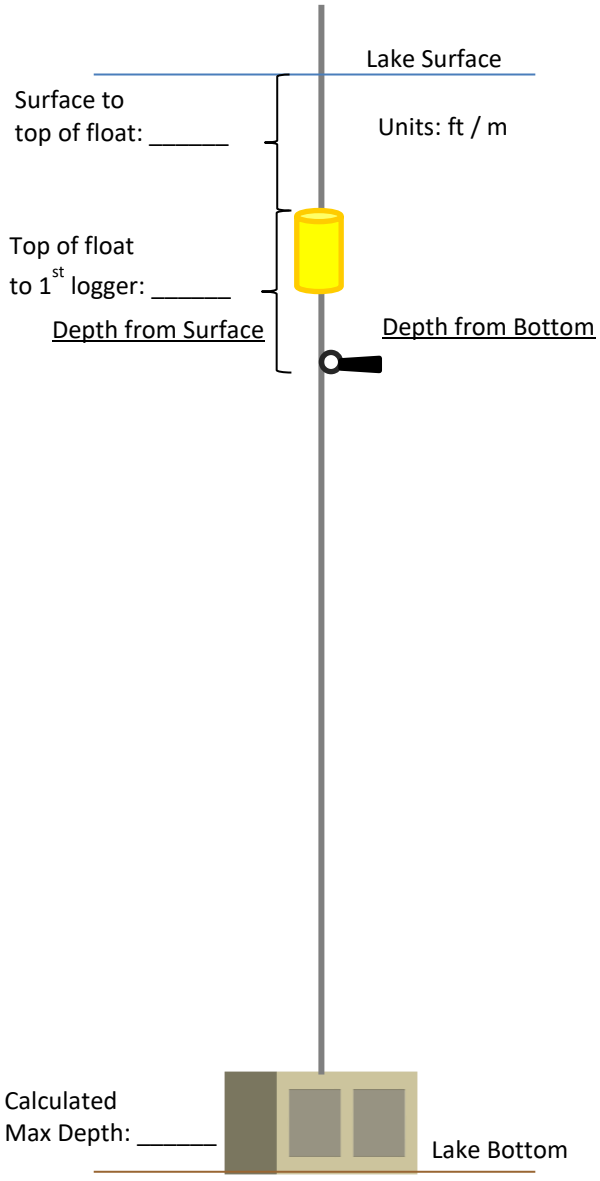
Draw logger array. Record depth from bottom & calculate depth from surface of each logger below float.



Lake Name: _____WBIC:_____ Date: _____ circle one: DEPLOY / REMOVE

Max Depth at Buoy:_____ft / m  Calculated Max Depth at Buoy:_____ft / m  Difference:_____ft /m

| Logger depth from lake bottom ft / m | Logger depth from lake surface ft / m | Serial no. | Logger type (DO / temp, model) | Data offloaded? yes / no |
|---|---|---|---|---|
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# Appendix C. Sample Waterway Marker Permit Application

Save... Print... Clear Data

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison, WI 53707-7921
dnr.wi.gov

**Waterway Marker Application and Permit**
Form 8700-058 (04/15)

**Notice:** Collection of this information is authorized under s. NR 5.09, Wis. Admin. Code. Failure to provide this information may result in removal of waterway markers. Personal information collected will be used to administer the Waterway Marker Permit program and may be provided to requesters as required by Wisconsin's Open Records law [ss. 19.31-19.39, Wis. Stats.].

**Instructions:** Refer to instructions and requirements on the back of this form. Complete this form and send to your local conservation county warden.

| ID No. | Region | (•) Placement ( ) Discontinue ( ) Change |
|---|---|---|

Jurisdiction: ( ) City (•) Town ( ) Village of Long Lake — County of Florence, Wisconsin.

**Section I: Applicant Information**

| Applicant Name | | | | |
|---|---|---|---|---|
| Justin Chenevert & Katie Hein | | | | |
| Street Address | | | | |
| 101 S Webster St | | | | |
| City | State | ZIP Code | | |
| Madison | WI | 53703 | | |
| Telephone Number (include area code) | | | | |
| (608) 264-9201 | | | | |
| Name of lake or body of water buoys will be placed | | | | |
| Lost Lake | | | | |

**Section 2: Property Owner**

| Property Owner Name | | |
|---|---|---|
| DNR/public water body | | |
| Street Address | | |
| | | |
| City | State | ZIP Code |
| | | |
| Telephone Number (include area code) | | |
| | | |

I consent to the placement of water marker(s) adjacent to the waters of my private property.

| Location of Marker(s) | ¼ ¼ | ¼ | Section | Township | Range | Signature of Applicant (authorizing representative) | Date Signed |
|---|---|---|---|---|---|---|---|
| deep hole | NW | NE | 12 | 39 N | 15 (•) E ( ) W | | |

For Construction Projects - Enter Information Below

| WDOT Project Number | Project Start Date | Project End Date |
|---|---|---|
| | | |

| Type of Marker(s) | Qty. | Type of Marker(s) | Qty. | Message on Marker | Remarks |
|---|---|---|---|---|---|
| Aid to Nav. Center | | Boat Excluded ◈ | | | Ordinance Required |
| Aid to Nav. Red | | Swim Area ◈ | | SWIM AREA | Name of Beach: |
| Aid to Nav. Green | | Controlled Area ○ | | | Ordinance Required |
| Mooring | | Hazard Warning ◇ | | | |
| Non-standard or signs | | Informational ▭ | 1 | RESEACH | |

Describe:

Attach diagrams and maps showing the proposed location of the marker(s). Identify the exact location of the water marker(s) in distance from one or more fixed objects, whose location is known or provide the GPS coordinates of the marker(s) placement.

The above information provided in support of the application for placement of water marker(s) is true and correct.

| Applicant Representative (print name) | Signature of Applicant (authorizing representative) | Date Signed |
|---|---|---|
| Justin Chenevert | | |

**Section 3: Local Government Authorization**

( ) **Approved** -- The above named applicant may place and maintain, subject to DNR approval, the above described marker(s).
( ) **Disapproved** -- The placement of the described marker(s) may not take place.

| Name of Local Government or State Agency | Restrictions |
|---|---|
| | |

| Approved by (print name) | Title | Approved by (signature) | Date Signed |
|---|---|---|---|
| | | | |

**Leave Blank - DNR Use Only**

| Warden's Recommendation ( ) Approved ( ) Disapproved | | Recreation Safety Warden ( ) Approved ( ) Disapproved | |
|---|---|---|---|
| Ordinance on File ( ) Yes ( ) No ( ) Not Required | | Signature | Date Signed |
| Warden's (Printed) Name | | Bureau of Law Enforcement ( ) Approved ( ) Disapproved | |
| Warden's Signature | Date Signed | Signature | Date Signed |

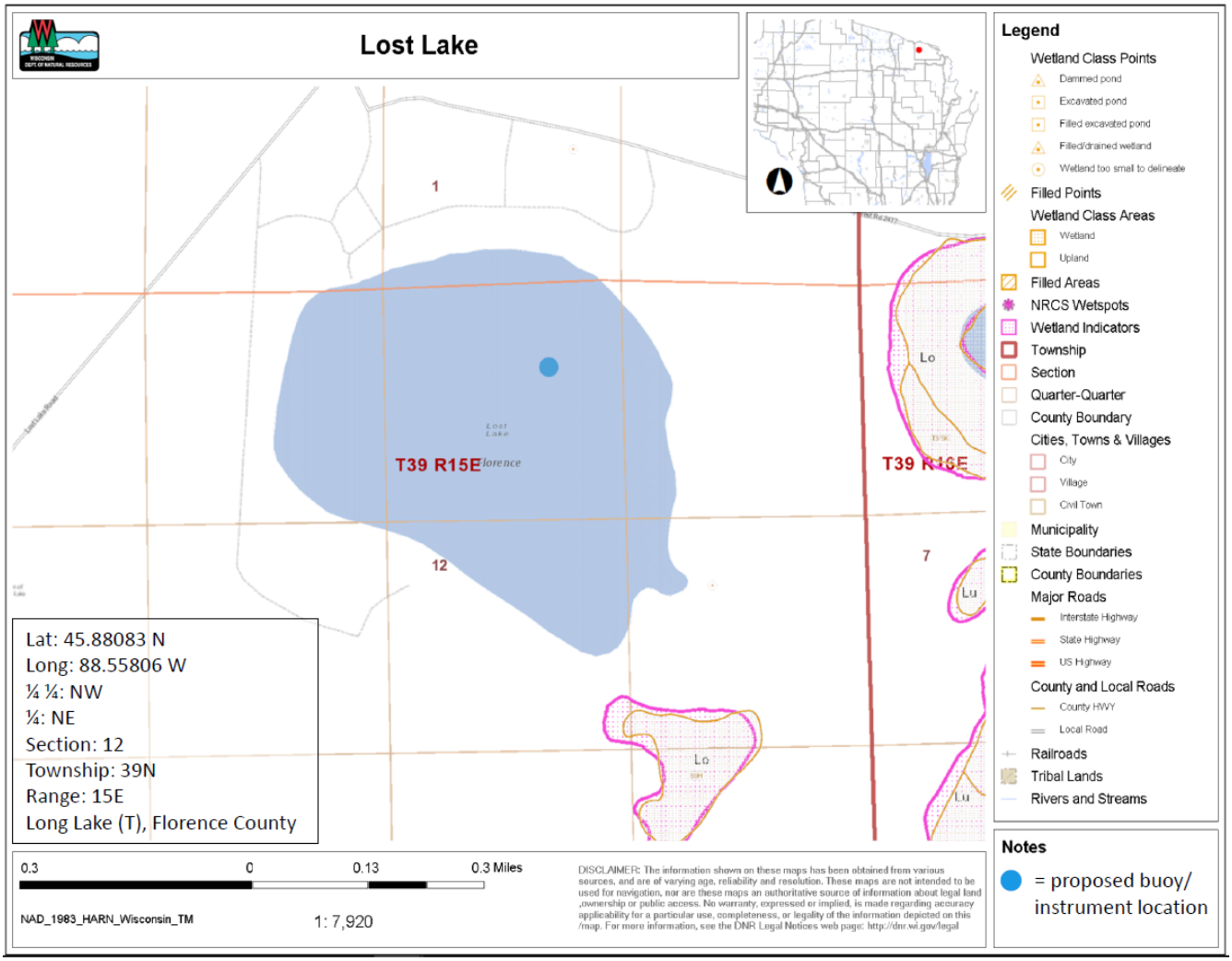



*Figure 17. Map accompanying the permit application. The map includes nearby wetlands, PLSS information, and latitude and longitude of the proposed buoy location.*

## Appendix D: Sample Miscellaneous Structure Permit Application

Water Resources Application for Project Permits (3500-053)

State of Wisconsin
Department of Natural Resources
dnr.wi.gov

**Water Resources Application for Project Permits**

Form 3500-053 (R 8/16) Page 1 of 2

**Notice**: Pursuant to chs. 30 and 31, Wis. Stats., ch. 281, Wis. Stats, and s. 283.33, Wis. Stats., this form is used to apply for coverage under the state construction site storm water runoff general permit, and to apply for a state or federal permit or certification for waterway and wetland projects or dam projects. This form and any required attachments constitute the permit application. Failure to complete and submit this application form may result in a fine and/or imprisonment or forfeiture under the provisions of applicable laws including s. 283.91, Wis. Stats. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Public Records Laws (ss. 19.31-19.39, Wis. Stats.). This form is required for U.S. Army Corps of Engineers (ACOE) regulatory purposes pursuant to 33 CF 325.

Read all instructions provided before completing

**Section 1: Landowner Information**

| Organization, Entity or Name * | Authorized Representative (Last Name, First Name) * , * | | |
|---|---|---|---|
| Mailing Address * | City * | State * ▼ | Zip Code * |
| Email * | Phone Number (xxx-xxx-xxxx format) * | Alternative Phone Number | |

**Section 2: Applicant/Information** ☐ Select if same as landowner

| Organization, Entity or Name * | Contact Person (Last Name, First Name) * , * | | |
|---|---|---|---|
| Mailing Address * | City * | State * ▼ | Zip Code * |
| Email * | Phone Number (xxx-xxx-xxxx format) * | Alternative Phone Number | |

**Section 3: Primary Project Contact** ☐ Select if same as landowner

○ Consultant or Plan Preparer ○ Contractor ○ Agent ○ Other - specify: _____

| Name (Organization or Entity) * | Contact Person (Last Name, First Name) * , * | | |
|---|---|---|---|
| Mailing Address * | City * | State * ▼ | Zip Code * |
| Email * | Phone Number (xxx-xxx-xxxx format) * | Alternative Phone Number | |

**Section 4: Project or Site Location:**

| Project Name: dummy project | County * ▼ | ○ City ○ Township ○ Village of * ▼ |
|---|---|---|

Location Address / Description *

**Public Land Survey System (PLSS)**– Provide the section, range, township information and latitude and longitude in decimal degrees, if available.

Select... ▼ ¼ of Select... ▼ ¼ of Section (xx) Township (xx) N Range (xx) ○ E ○ W Latitude (xx.xxxxx) Longitude (-xx.xxxxx)

If this site is not wholly contained in the quarter-quarter section, more description:

Contained on quarter-quarter section

Waterways: Provide the name(s) of closest water bodies: *

## Section 5: Wetlands

If a wetland is present at a project site and permit approvals are sought through the waterway and wetland program, storm water program, or concentrated animal feeding operations (CAFO) program, the department requires that a wetland delineation that accurately shows the location of a wetland is submitted with an application. A wetland delineation needs to be verified/concurred with before the application can be submitted or be considered a complete application. See the department "Wetland screening and delineation procedures" for more information.

Is a wetland present in the project area? ◯ Yes ◯ No

**If yes**, select all sources of information used and attach supporting report or documentation

- ◯ a. A copy of your wetland delineation and a Wetland Confirmation Service concurrence letter (wetland boundary verification service offered for a fee from the department)
- ◯ b. An assured delineator's wetland delineation report
- ◯ c. A copy of your wetland delineation and an Army Corps of Engineers concurrence letter
- ◯ d. A copy of your correspondence with a WDNR Water Management Specialist, WDNR Office of Energy Water Management Specialist or WDNR Transportation Liaison regarding your wetland review/ concurrence.

**If no**, please select one of the following items showing that a wetland is not present within the project boundaries:

- ◯ a. A copy of your wetland determination and a letter from the department's Wetland Identification Program stating wetlands are not present or the activity proposed in the wetland is exempt under NR 103.06(4)
- ◯ b. A letter from an assured delineator stating wetlands are not present
- ◯ c. Maps showing each resource(s) was reviewed for wetland absence (Surface Water Data Viewer):

  i. Surface Water Data Viewer- Wisconsin Wetland Inventory

  ii. Surface Water Data Viewer- Wisconsin Indicator layer

  iii. Surface Water Data Viewer- Digital Topographic map layer or aerial photo indicating if waterways, drainage ways, ditches, depressions, or standing water are within project boundary
- ◯ d. Show that the project limits are entirely in existing paved, graveled, or concrete areas
- ◯ e. A copy of your correspondence with a WDNR Water Management Specialist, WDNR Office of Energy Water Management Specialistor WDR Transportation Liaison regarding your wetland review/concurrence

(Please note that if the information provided is incorrect or incomplete, the overall permit application may be considered incomplete and may be returned to the applicant.)

## Section 6: Endangered or Threatened Resources

Has the presence of endangered or threatened resources been evaluated according to protocols developed by the DNR Bureau of National Heritage Conservation (BNHC) http://dnr.wi.gov/topic/ERReview ◯ Yes ◯ No

If Yes, select how the evaluation was completed and attach supporting report or documentation:

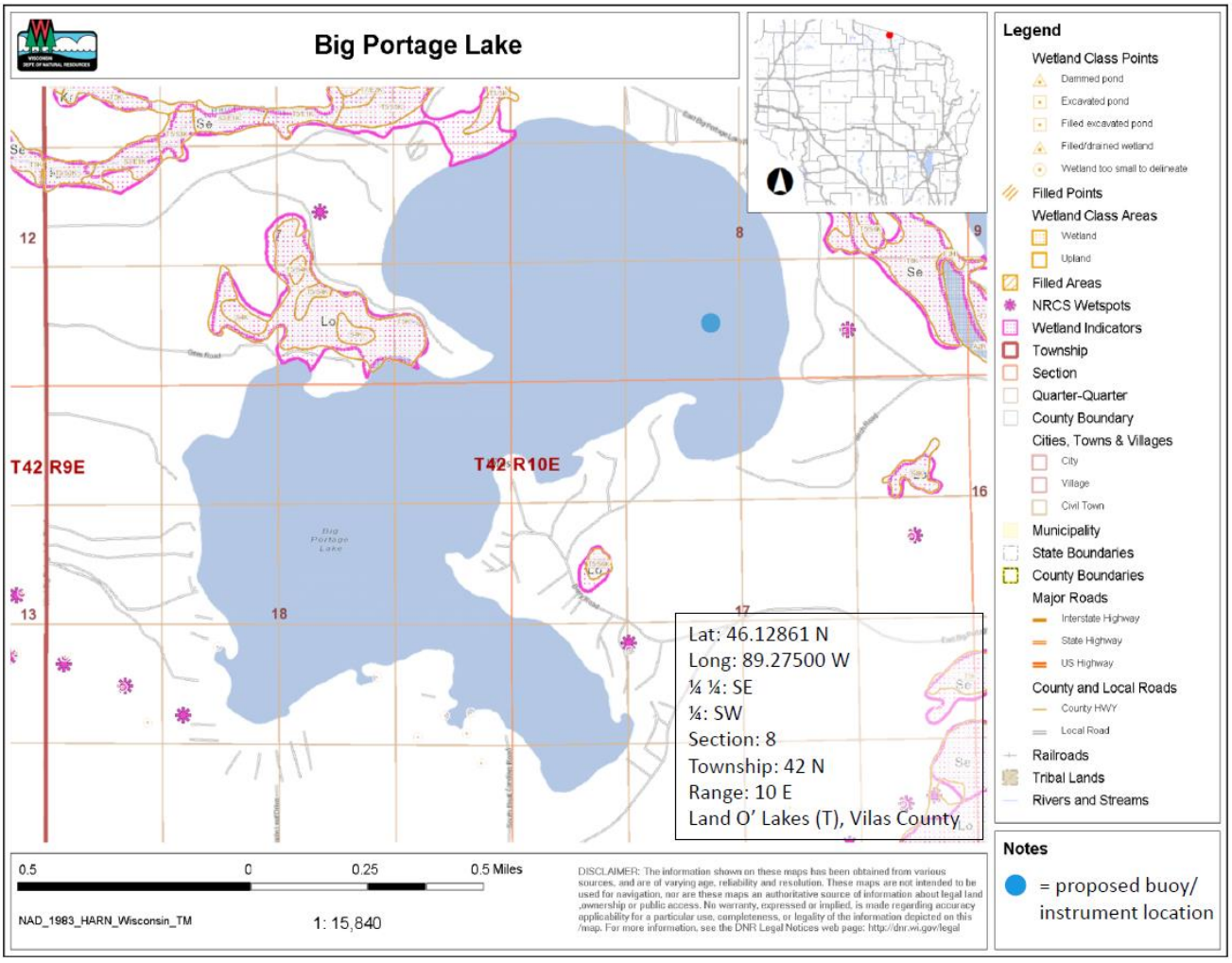
- ☐ a. Endangered Resources Preliminary Assessment from the Public Portal
- ☐ b. Certified ER Review Letter - specify: ERR-_____ (example ERR-15-123
- ☐ c. Broad Incidental Take Permit /Authorization -specify (e.g. No / Low Impact Activities, Grassland & Savanna Management, etc.):_____
- ☐ d. Other: _____

## Section 7: Project Information (Attach additional sheets as necessary)

| | |
|---|---|
| Anticipated Project Start Date: * | Projected Project End Date: |
| Photos: Provide photographs of the "before" condition. | Most Recent Date of Photograph: |

**Narrative of the Project:**
Provide a one to two paragraph description of the proposed project, including land and water alterations and intended use(s) of the project. Include this in the attachment section.

## Site Map


Big Portage Lake
T42 R9E
T42 R10E
12
8
9
13
18
17
16
Lat: 46.12861 N
Long: 89.27500 W
¼ ¼: SE
¼: SW
Section: 8
Township: 42 N
Range: 10 E
Land O' Lakes (T), Vilas County
Legend
Wetland Class Points
Dammed pond
Excavated pond
Filled excavated pond
Filled/drained wetland
Wetland too small to delineate
Filled Points
Wetland Class Areas
Wetland
Upland
Filled Areas
NRCS Wetspots
Wetland Indicators
Township
Section
Quarter-Quarter
County Boundary
Cities, Towns & Villages
City
Village
Civil Town
Municipality
State Boundaries
County Boundaries
Major Roads
Interstate Highway
State Highway
US Highway
County and Local Roads
County HWY
Local Road
Railroads
Tribal Lands
Rivers and Streams
Notes
= proposed buoy/ instrument location
0.5 0 0.25 0.5 Miles
NAD_1983_HARN_Wisconsin_TM
1: 15,840
DISCLAIMER: The information shown on these maps has been obtained from various sources, and are of varying age, reliability and resolution. These maps are not intended to be used for navigation, nor are these maps an authoritative source of information about legal land ,ownership or public access. No warranty, expressed or implied, is made regarding accuracy applicability for a particular use, completeness, or legality of the information depicted on this /map. For more information, see the DNR Legal Notices web page: http://dnr.wi.gov/legal

## Proof of Ownership

Public waters of the State of Wisconsin are owned in common by the citizens of Wisconsin and held in trust by the Department of Natural Resources. All structures in this permit will be placed on public waters.

Each miscellaneous structure will be situated at the deepest point of the lake. The minimum horizontal distance between the structure and the shoreline is ~ 200 ft.

## Project Narrative

# Project Description: Inland Lake Continuous Temperature Monitoring

May 22, 2017

We plan to install continuous temperature monitoring equipment on up to 11 inland lakes in order to better quantify how water temperature varies at the surface of the lake and at depth over a year or more. The continuous temperature monitors, or thermistors, record water temperature at a set interval and store the data for download later. The thermistors have the ability to function for a year or more, depending on the frequency of data collection.

Water temperature exerts a great deal of control on lake processes, including: the rate of chemical reactions, the ability of water to hold oxygen, and the metabolic rate of some aquatic organisms. By deploying two or more thermistors along a single vertical line at the deepest point of a lake, we can also investigate patterns of thermal stratification, or how water temperature changes with depth. The extent and duration of thermal stratification has diverse ecological implications and may ultimately affect the public's use and enjoyment of the resource.

The lakes selected for this continuous temperature monitoring program showcase a range of hydrologic regimes, depths, and degrees of clarity. All of these properties affect the thermal properties of the lake and how it will respond to seasonal changes in air temperature.

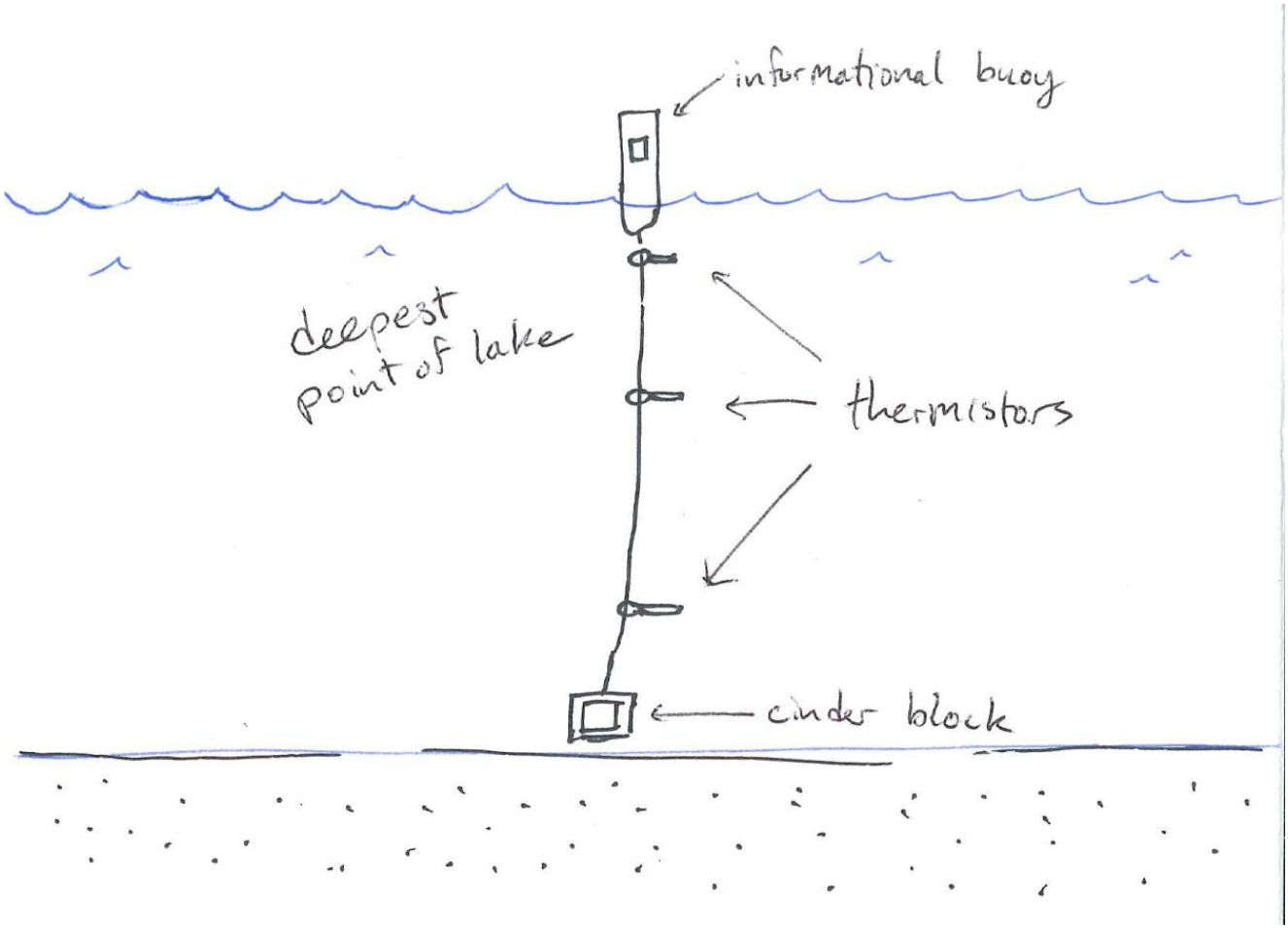
The research instrumentation will consist of an informational buoy attached to a cinder block with a length of rope. The thermistors will be secured along the rope with zip ties so as to remain at predetermined depths. The instrumentation will remain at the deep hole of each lake until ice-on.

Contacts:

Justin Chenevert
Water Resources Specialist
justin.chenevert@wisconsin.gov – (608) 264-9201

Katie Hein
Lake Monitoring Technical Lead
catherine.hein@wisconsin.gov – (608) 267-2376

Plans and Specifications



## Appendix E. Example Class-1 Notice in Local Paper of Intent to Place a Structure on the Lakebed

*Note that the specific text for the public notice will be emailed to the permit applicant.*

Notice of Pending Application for Proposed Miscellaneous structure
Chenevert Justin, 101 S Webster St, Madison, WI 53703 has applied to the Department of Natural Resources for a permit to place a structure on the bed of Axhandle Lake.
The project is located in the SE1/4 of the SE1/4 of Section 4, Township 32 North, Range 9 West, Town of Sampson, Chippewa County.
The project consists of anchoring a series of Thermometers at various depths in the deepest part of various lakes in this case Axhandle Lake. The anchor will be a cement block with and informational buoy.
The Department will review the proposal provided by the applicant and any information from public comments and a public informational hearing, if requested. The Department will determine whether the proposal complies with ss. 1.11 and 30.12(3m), Stats., and ch. NR 150, Wis. Adm. Code, and ensure that the required mitigation meets the standards in s. 281.36(3r), Stats. if the project impacts wetlands.
The Department has made a tentative determination that it will issue the permit or contract for the proposed activity.
If you would like to know more about this project or would like to see the application and plans, please visit the Department's permit tracking website at
https://permits.dnr.wi.gov/water/SitePages/Permit%20Search.aspx and search for WP-IP-N0-2017 -16-X05-23T15-59-23.
Reasonable accommodation, including the provision of informational material in an alternative format, will be provided for qualified individuals with disabilities upon request.
Any person may submit comments and/or request a public informational hearing by emailing Steven.LaValley@wisconsin.gov or writing to Steven LaValley, 1701 North Fourth Street, Superior, WI 54880 by U.S. mail. If you are submitting general comments on the proposal, they must be emailed or postmarked within 30 days after the date this notice is published on the Department's website. If you are requesting a public informational hearing, the request must be emailed or postmarked within 20 days after the date this notice is published on the Department's website. A request for hearing must include the docket number or applicant name and specify the issues that the party desires to be addressed at the informational hearing.
If no hearing is requested, the Department may issue its decision without a hearing. If a public informational hearing is held, comments must be postmarked no later than 10 days following the date on which the hearing is completed.
The final decision may be appealed as indicated in the decision document.
Docket Number IP-WC-2017-9-01765

**WISCONSIN DEPARTMENT OF NATURAL RESOURCES**
For the Secretary
Water Management Specialist
06/06/2017
Date