# Standard Operating Procedure for:

# Statewide Lake Assessment Program Field Data and Sample Collection

## University of Missouri Limnology Laboratory


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## 1 Equipment

1.1 Field Gear

1.1.1 Truck, keys, truck log (Annex 1), lake list, maps, GPS with lake locations loaded, canoe, paddles, PFDs, anchor, depth finder, emergency boat kit, field log with sheets (Annex 2) printed on Rite-In-The-Rain paper, pencils, Secchi Disk, Li-Cor Quantum light meter (handheld, sensors and cable), YSI EXO3 sonde (handheld, sonde, and cable), coolers, 4 L high density polyethylene (HDPE) bottles (1 per lake), 2 L HDPE bottles (1 per lake), 500 mL Polyethylene Terephthalate Glycol (PETG) bottle, cyanotoxin sampler, peristaltic pump with hose and batteries, garbage bag or light-tight container to keep samples in dark, 8 mL toxin vials in protective case (2 vials without preservative and 2 vials with preservative per lake), pipette and tips (4.5 mL capacity), 125 ml amber glass bottles with Lugols solution, and 100 mL graduated cylinder.

1.2 Processing Gear

1.2.1 Electronic vacuum pump, extension cord, 3-prong adapter, two side arm receiving flasks, hose to connect pump and flasks, magnetic filter funnel, two 250 ml graduated cylinders, two 500 mL graduated cylinders, three plastic beakers, chlorophyll filters (4 per lake, Whatman GFF, 0.7 µm, pre-combusted), total suspended solids filters (2 per lake, Whatman 934-AH, 1.5 µm, pre-washed, pre-combusted and pre-weighed), forceps, stapler, staples, filter log book (Annex 3), 10 ml pipette with tips, cooler for processed samples, total phosphorus tubes (labeled as TP, 6 per lake), total nitrogen tubes (labeled TN, 6 per lake), total dissolved nitrogen tubes (labeled TDN, 3 per lake), total nutrient bottles ( 60mL HDPE, 2 per lake), dissolved nutrient bottles (60 mL, 1 per lake), dissolved organic carbon bottles (60 mL HDPE, 1 per lake), ammonium bottles (30 mL HDPE, 1 per lake), nitrate bottles (30 mL HDPE, 1 per lake), alkalinity bottles (125 mL HDPE, 1 per lake), light-tight container with silica desiccant, and four 2 L bottles for use as ice packs.

## 2 Site Location

2.1 Sampling sites will be located near the dam at each reservoir in an area of deep water. The field crew is instructed to locate, to the best of their ability, the former stream/river channel where depth is at its maximum. Bathymetric maps, when available, will be used to identify the location of the deepest water. When maps are not available, the crew will identify the old channel by looking over the dam at the tree-line and identifying the "dip" or lack of trees that often occurs where the former stream/river channel is located. Maximum depths are provided to the field crew for each reservoir, based on historic profile data. A portable depth finder is used by the field crew to check depth prior to anchoring. The crew is also instructed to avoid being too close to the dam in order to avoid influence from the dam itself. On a small reservoir (<4 ha), this means being about 25 meters from the dam, while on a large reservoir (>800 ha) it might translate to 200 meters from the dam. In this way, we will sample each reservoir at the point of its greatest volume.

## 3 Data Collection

3.1 Upon arrival at the site, set the anchor and begin to fill in relevant information on the field log sheet (reservoir name, ID#, date, etc., Annex 3).

3.2 Collect a continuous multi-parameter profile with the YSI sonde from surface to bottom, identifying the depth of the mixed layer. The mixed layer, also known as the epilimnion, is the upper layer of water that, due to homothermic conditions, can mix easily via wind/wave action. The bottom of this layer is referred to as the thermocline and is identified by a 0.5 degree Celsius change in water temperature within a 0.5 meter depth.

3.2.1 The YSI will need to have the depth calibrated at each reservoir to account for difference in atmospheric pressure associated with changes in elevation and fluctuations in barometric conditions.

3.2.2 The sonde should be lowered through the water column at a rate of 45 – 60 seconds per meter.

3.2.3 The field technician conducting the YSI profile will note the depth at which changes in temperature and dissolved oxygen start occurring (usually a decrease in both parameters, though sometimes dissolved oxygen may increase, especially in clear water bodies) in order to identify how deep the mixed zone/epilimnion is. A temperature decline >0.5 °C within a half meter should be used to identify the thermocline/bottom of the epilimnion. Upon completion of the profile, the data can be reviewed to make certain the correct depth is documented as the mixed zone/epilimnetic depth.

3.2.4 The profile should be saved to the YSI hand-held using the reservoir's MU identification number and the date in which the profile was recorded.

3.3 Take a Secchi transparency reading, recording both the lowering and raising values. Remember, take reading on the shaded side of the boat and do not wear sunglasses while taking the reading.

3.4 Collect light profile data using the Li-Cor Quantum Sensor.

3.4.1 Measurement intervals will be determined by the Secchi transparency. Use of different intervals ensures the collection of sufficient data to calculate light attenuation rates on turbid reservoirs, while limiting readings collected on clear waterbodies to a reasonable number.

3.4.1.1. Secchi $\leq$ 1.0 meters = ¼ meter intervals

3.4.1.2. Secchi > 1.0 to 2.0 meters = ½ meter intervals

3.4.1.3. Secchi > 2.0 meters = 1 meter intervals

3.4.2 Light profile should be saved to hand-held using MU reservoir identification number and date of collection.

3.4.3 Unlike Secchi, the light profile should be collected on the sunny-side of the boat, and efforts should be made to keep both light sensors from falling into shadow.

3.4.4 The first reading should be taken with the water-sensor just below water's surface.

3.4.5 Make sure to record the intervals used for profile on the field sheet, as the Li-Cor does not have depth-measuring capabilities. Also record the PAR values from the water-sensor for surface, 1m and the final depth (also record the final depth). These recorded values will allow for verification of measurement intervals.

## 4 Sample Collection

4.1 Triple rinse one 4 L HDPE sample bottle, one 2 L HDPE sample bottle, and one 500 mL PETG bottle with surface reservoir water. The 4 and 2 L bottles should have unique identification numbers.

4.2 Collect four surface water samples (~0.25 m below surface) from around the boat using the 500 mL PETG bottle and composite them into the 2 L bottle. Record the 2 L sample bottle number on the field sheet as the surface sample and place in a trash bag or other light-proof container to protect it from direct sunlight.

4.3 Collect the 4 L mixed-layer composite sample using a peristaltic pump and tubing following the process below:

4.3.1 After connecting the pump to the battery, and placing tubing into the pump manifold, lower the weighted inflow end of the tube into the water below the surface.

4.3.2 Turn pump on and rinse tubing with surface water (outflow end of tubing should be hung over the opposite side of the boat). Once tubing is filled with water, lift inflow end up out of water and continue to operate pump until all water is evacuated from tubing.

4.3.3 Place outflow end of tubing into 4 L bottle. Turn pump on and start lowering inflow end of tubing through water column at a steady rate. The actual rate is not as important as making sure to maintain a consistent rate.

4.3.4 Lower tubing to a depth that is 1 m above the thermocline. The thermocline will be determined during the collection of the YSI profile and is defined as a change in temperature >0.5°C in a ½ meter. The sampling tube is marked in 0.2 meter increments to allow for proper sample collection. If the water column is not stratified, sample to 1 meter from bottom.

4.3.5 Raise the inflow end of tubing back up to the surface, again maintaining a constant rate. The goal is to fill the 4 L bottle with water, leaving some head-space to accommodate mixing when the sample is processed. If the first lowering-raising cycle does not fill the bottle (it usually doesn't), repeat the process of lowering/raising the tube. The rate in which the tube is lowered/raised can be different for each cycle, so adjust the speed from one cycle to the next to account for the amount of water you need to complete the sampling.

4.3.6 Sample collection needs to end with the inflow end of the sampling tube being lifted out of the water and all of the water within the tube being added to the sample bottle. This ensures that the water column is equally represented within the sample bottle. This means that on the last raising of the sample tube, there should be enough space within the sample bottle to hold all of the water within the tube.

4.3.7 Once the sample is collected, write the bottle ID number on the field sheet under epilimnion sample, and place in the light-tight trash bag/container.

4.3.8 Once off the water, sample bottles will be placed in a cooler with ice to limit biological activity within the sample until processed.

4.4 Collect Algal Toxin samples from the upper 0.5 meter:

4.4.1 Triple rinse the tube sampler with reservoir water (the 500 mL PETG has already been rinsed).

4.4.2 Lower the tube sampler into the reservoir until the top is just above the water surface, raise sampler, and pour water into the 500 mL PETG bottle.

4.4.3 Repeat three more times from various locations around the boat, placing all aliquots into the PETG bottle.

4.4.4 Once you are off the water, pipette 4.5 mL of the mixed composite sample into each toxin vial. For each reservoir there will be two vials identified as RM (short for Rover Microcystin, Rover being a term used by the lab to describe the SLAP project and Microcystin being one of the two toxins analyzed from this vial) that do not contain any preservative and will be used for microcystin and cylindrospermopsin analyses. There will also be two vials labeled RA (short for Rover Anatoxin) containing 0.5 mL of preservative and will be used for anatoxin-a and saxitoxin analyses. Each set of vials ($n$=4) is identified with a unique number that should be recorded on the field sheet. The field technicians will ensure that all vials used for a given reservoir have the same ID number. Toxin vials are stored on ice while in the field and placed in freezer upon returning to lab.

4.5 Preserve phytoplankton sample from the 4 L mixed layer composite sample. Upon returning to shore, field crew will measure out 100 mL of well-mixed water from the 4 L mixed layer/epilimnetic sample bottle. A graduated cylinder will be packed for this purpose. The 100 mL of sample water will be poured into an amber glass bottle (125 mL size), which will already be dosed with Lugols solution. Each 125 mL phytoplankton bottle will have an individual number that will be recorded on the field sheet.

## 5 Sample processing

5.1 Surface Sample

5.1.1 All plasticware such as beakers, graduated cylinders, etc. will be rinsed with water from the surface sample prior to processing.

5.1.2 Total Nutrients – Each sample will be processed to produce three total Phosphorus (TP) tubes, three Total Nitrogen (TN) tubes, and one 60 mL bottle. Place 10 mL aliquots of well mixed reservoir water into three pre-numbered tubes for TP analysis and three pre-numbered tubes for TN (TP and TN tube numbers for a given sample should match). Triple rinse and fill (to shoulder) a uniquely numbered 60 mL HDPE bottle with reservoir water for each sample (60 mL bottles will be acid washed with 5% HCl prior to use). The tube and bottle numbers are recorded in the filter log as samples are processed. Tubes and bottles are stored in a cooler with ice packs until crew returns to lab. Once in lab, the tubes are stored in the large silver refrigerator while bottles are stored frozen.

5.1.3 Alkalinity – A 125 mL HDPE bottle will be triple rinsed and then filled to the shoulder with well mixed lake water. Each bottle will have a unique number, which is recorded in the filter log as the sample is processed. These bottles are stored in a cooler with ice packs until crew returns to lab. Once in the lab, these bottles are stored in large silver refrigerator.

5.1.4 Chlorophyll - Process four filters per sample for analysis by passing 100 - 400 mL reservoir water through a 0.7 µm glass fiber filter (Whatman GFF). Volumes will depend on the amount of suspended material in the water, which can be gauged by Secchi transparency. Each processed filter is folded and placed into a uniquely numbered paper storage house. Filter house numbers and volumes filtered are recorded in the filter log as samples are processed. Chlorophyll filters are placed into a light-tight container with desiccant, which is kept on ice until field crew returns to lab and places container in freezer.

5.2 Epilimnetic/Mixed Layer Sample

5.2.1 All plasticware such as beakers, graduated cylinders, etc. will be rinsed with water from the surface sample prior to processing.

5.2.2 Total Nutrients – Same processing as with surface sample (above). Tubes and bottle numbers for this sample will be different than used for surface sample.

5.2.3 Total Suspended Solids (TSS) – Process two filters from each mixed layer/epilimnetic sample by passing between 50 – 1250 mL of reservoir water through a 1.5 µm glass fiber filter (Whatman 934 AH). TSS filters are folded in half and placed into uniquely numbered paper storage houses. The sides and top of each filter house should be folded and stapled closed to protect filter from contamination. Filters are stored in a light-tight container with silica desiccant, which is kept in a cooler with ice packs while in the field and then stored in the freezer once the field crew returns to the lab. Filter numbers and volumes filtered are recorded in the filter log as samples are processed.

5.2.4 Chlorophyll – Same processing as with surface sample (above). Note, the filtrate leftover from the processing of the chlorophyll filters from the epilimnion will be needed for the next step.

5.2.5 Total Dissolved Nitrogen (TDN), Ammonium-Nitrogen (NH4), Nitrate/Nitrite-Nitrogen (NO3), and Dissolved Organic Carbon (DOC) - Uniquely numbered 30 mL (labeled as NH4 and NO3) and 60 mL (labeled as TDN and DOC) HDPE bottles are rinsed and filled with filtrate from chlorophyll filtration. The Whatman GFF filters used for chlorophyll processing are pre-combusted to eliminate organic carbon contamination associated with filtration. The filtrate from these filters will be used for DOC analysis. Bottle numbers will be recorded in the filter log as samples are processed. Three tubes will also be processed for TDN. Each tube will receive a 10 mL aliquot of the filtrate. The tubes will be uniquely numbered, and these numbers will be recorded in the filter log. Bottles are stored on ice until returned to the lab, where they are then frozen to preserve until analysis. Tubes are stored on ice, and then refrigerated once back in the lab.

## 6 Clean-up

6.1 After all samples have been processed, the lake water remaining in the bottles should be dumped out and the bottles triple rinsed with tap water. Plasticware should also be triple rinsed with tap water. If space is available, leave plasticware out to air dry before packing it up. All processed samples will need to go into a refrigerator, if available, or placed in the cooler with the four 2 L bottles filled with ice.

## 7 Annex 1 - Truck Log

<table>
<tr><td>Date</td><td>Driver</td><td colspan="2">Destination</td></tr>
<tr><td colspan="2">Begin Odom</td><td>End Odom</td><td rowspan="2">Comments/Parked</td></tr>
<tr><td colspan="3">Fuel (Odom, $, Gallons)</td></tr>
</table>

## 8 Annex 2 - Field Log

Statewide Lake Assessment

Lake#_____ Lake Name_____

Date_____ Time_____ Surface Bottle # (2L)_____

Profile
Max Depth_____ Surf Temp_____ DO_____
Epi/Mixed Depth_____ _____
Epi Bottle# (4L)_____ _____
Depth of Epi Sample_____ _____

Light
Secchi_____/_____ H2O Sensor Reading
Surf _____
__1/4 meter (Secchi <1.0 m) 1 meter _____
__1/2 meter (Secchi <2.0 m) *_____ _____
__1 meter (Secchi >2.0 m) * = depth of last reading

Back at the truck
2 vials for Algal Toxin RM #_____
2 vials for Algal Toxin RA #_____ Phyto #_____

Comments_____
_____

## 9 Annex 3 - Filter Log

Statewide Lake Assessment Filter Log

| | | Total Nut Tubes & Bottle #s | Alk Bottle # | TSS Filters & Vol | CHL Filters & Vol | Dis Nut Tubes & Bottle #s | DOC, NO, & NH Bottle #s |
|---|---|---|---|---|---|---|---|
| Lake# | Surf Bttl # | | | | | | |
| Date | Epi Bttl # | | | | | | |