



MassDEP

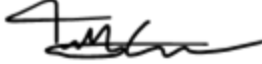


**Massachusetts Department of Environmental Protection
Bureau of Water Resources
Division of Watershed Management
Watershed Planning Program**

STANDARD OPERATING PROCEDURE

Statewide Bathymetry Project

CN 619.0

June 1, 2025 – June 1, 2027

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List of Revisions

Revision Date	Revision	Pages #s	CN/ (Old CN if applicable)	Initials
August 12, 2025	Original		619.0	DD / TG



1. SCOPE AND APPLICATION

This SOP is designed as a guide for MassDEP Watershed Planning Program (WPP) staff field leads for how to safely and effectively conduct a bathymetric survey. It may also be used for conducting biovolume/hardness surveys by using the same protocols but during the summer months. Post-processing of data files and basic quality control processes are also covered.

2. SUMMARY OF METHOD

Quantitative measurements of lake depth and (secondarily) both submerged aquatic macrophyte biovolume and bottom hardness are collected along a series transects in the lake using both down scanning and side scanning transducers (sonar unit). The data collected by the sonar unit is uploaded to Biobase, a cloud-based platform that automates the processing of sonar data to produce maps and reports regarding bathymetry, submerged aquatic biovolume and bottom hardness. Biovolume data should be collected and viewed with an understanding of when the data were collected within the year and the water level at the time of the survey. Raw data files are also sent to the Massachusetts Division of Fish and Wildlife's (FWE) Watershed Project Leader for in-house development of bathymetry maps for public use and distribution.

3. SAFETY CONSIDERATIONS

The unique characteristics of sampling sites in rivers and streams, navigation of unmapped waters, and weather-related issues provide many hazardous opportunities to a field monitor. The following points cover general safety considerations for the collection of water samples.

- **SAFETY FIRST!**
- Crew lead must have completed a Boater Safety Training course, and first aid, CPR and AED certification.
- Always sample in teams of two or more, unless otherwise approved by the WQ Monitoring Section Chief.
- Use good judgement in clothing and personal protection items. Dress based on anticipated conditions but be prepared for the "worst case" scenarios. Items to consider include extra clothing, sunshade, sunscreen, hats, insect repellent, insulated boots and gloves, waterproof boots for highest anticipated depths (chest waders or hip waders).
- For sampling from boats, each occupant is required to wear a personal flotation device (PFD).
- Equipment must be checked for defects prior to use to prevent accidents.
- Be sure to inspect all protective gear (boots, gloves, PFDs, etc.) for holes and defects. Do not assume the gear is free from defects or normal wear and tear.
- Field and First Aid kits must be taken on all sampling trips; inspect and re-stock as needed before going on-site.
- At a minimum, one person on any given sampling crew should be trained in Adult CPR/first aid.
- All personnel should remain cognizant of current and upcoming inclement weather and move to safety/cancel the survey if unsafe conditions exist.



4. PERSONNEL QUALIFICATION/RESPONSIBILITIES

Role	Requirement
Crew Lead <ul style="list-style-type: none"> Daniel Davis Peter Mitchell Steven Bittner James Meek Therese Beaudoin 	<ul style="list-style-type: none"> Completion of Boater Safety Training Course Internal training on trailering boats, boat deployment, and boat transport.
Support Crew <ul style="list-style-type: none"> WPP or CERO Staff Seasonal Staff or Interns 	<ul style="list-style-type: none"> Basic training on PFD use

5. EQUIPMENT

An equipment checkoff list for bathymetry surveys is provided in Table 1 as follows:

Table 1: Equipment and supplies – Bathymetric Survey

Type	Item	Quantity
Field Sheet	Bathymetry Survey Field Log including any contact information for arranging site access, access location, or other pertinent data – One lake and 1+ backup lake	1/lake
Data Collection: Bathymetry-Specific Equipment	Sonar unit (Lowrance) BOTH memory cards in sonar unit 12V Batteries (small) Bungies to hold unit in place (shock boat mounting) Battery connector to boat battery (if not using small battery) Quick guide for correct Lowrance bathymetry unit Macrophyte key Field GPS unit	1 1 2 3 1 1 1 1
Data Collection: Boat-Specific Equipment	Vehicle and Vehicle Book First aid kit Collapsible cone Garmin for Vehicle Flag for Jon boat if carrying in the bed Bungee cord for holding oars together Site keys and contact info for on site contact or permissions Decon sprayers (adjust volume by need) PPE - Waders, wading shoes, sun block, sunglasses, hat Boat and motor, with correct fuel tank or battery PFDs Seat cushion and/or throwable Oars Extra ratchet straps	1 1 1 1 1 1 1 1 Variable 1 2-3 2 2 2



Storage and Preservation (invasive species)	Medium zip lock plastic bags Large zip lock plastic bags Small cooler Wet ice	As needed As needed 1 As needed
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6. CALIBRATION

The sonar unit does not require user calibration.

7. DETAILED PROCEDURES

These are the step-by-step procedures for measuring depth, biovolume and percent cover within the lake using a sonar unit. Some of the setup has already been completed (assembling the sonar unit and mounting the transducers). They are included below for completeness.

- 1) Initial System Setup -Depth, Biovolume and Percent Cover Measurement Procedure
 - a) Follow the Biobase Portable Kit setup instructions for backpack system including the portable mount for the sonar transducer(s) (down scanning and side scanning). Those instructions are available here: https://s3-bb-cmn-sc-use1.s3.amazonaws.com/BIOBASE-PORTABLE-KIT-BOG_EN_988-13156-001.pdf. Backpack style kits may have a single transducer whereas other units may have two transducers.
 - b) Avoid mounting transducer(s) within 3 inches of the propeller.
 - c) For multi-transducer systems ensure transducer and side scan sonar are 12 inches apart (bracket ensures this spacing).
 - d) Ensure transducer(s) is level and at least 1/8 inch below hull but no more than 2-3 inches below the hull to reduce potential damage and limit snags on plants or debris.
 - e) If there is interference, adjusting the transducer angle may help. Transducer angle should always be perpendicular to the lake/river bottom.
 - f) The BioBase support page, including manuals, links to videos, and other support information is available here: <https://www.biobasemaps.com/SupportResources>
 - g) As of Spring 2025, MassDEP WPP has two Lowrance sonar units used to collect bathymetry data. They are models HDS7. and Elite FS9. The most recent manuals for those units are available on the Lowrance support website here: <https://www.lowrance.com/downloads/>
- 2) Survey Preparation - Transects and Files
 - a) In some scenarios, pre-designed transects are created in GIS and pre-loaded from a gpx file onto the sonar from the SD card in the sonar. These are not required but can be helpful for large lakes where navigation aids can help with transect spacing.
 - b) Files are not available in the field so they should be pre-loaded using the microSD cards in the sonar unit for data transfer.
 - c) On sonar viewer go to Files - Load desired transect (.gpx) file. The lake site ID and transect type will be indicated in the file name. Multiple lake transects can exist in a single file.
 - d) Designed transect spacing for each lake will vary due to resource constraints. Transect space should be set so that mapping can be completed in 1 day for most lakes with the largest lakes taking multiple days depending on staff availability.
 - e) Pre-loaded transects have a minimum spacing of 40 m. Transect spacing may be increased on larger lakes to achieve the resource usage goals. Two types of transects will be preloaded: straight line transects parallel to the longest shoreline and concentric circle transect following the shoreline. Selection of the type of transects to use will be based on lake characteristic and at the discretion of the crew lead. Generally, concentric circles are more appropriate for smaller ponds and coves in larger lakes.



- f) Pre-loaded transects are for general guidance and set at a minimum spacing. If time allows, reduce the transect spacing or consider adding additional transects based on field conditions or in directions perpendicular to their original transects.

3) Survey Day

- a) Prior to departure
 - i) Inspect bathymetry unit to ensure all equipment is present and there is no damage to cables, batteries, cooler, etc. and that the quick guide is included.
 - ii) Gather equipment listed above in Table 1 using the provided equipment checklist.
 - iii) Select lake to be surveyed and ensure that there are nearby backup lakes that could be completed if access is not available at the first chosen lake.
 - iv) Ensure that you have the **Bathymetry Survey Notes** field sheet for any lake to be surveyed (See Appendix A).
 - v) Ensure that you have both micro-SD cards for the sonar unit.
 - vi) Bring Bathymetry Project Handout for distribution to residents/managers etc. (See Appendix B).
 - vii) Contact any lake managers or other individuals who may be providing access to the site to confirm access (can be done the day/week before survey) as appropriate.
 - viii) Ensure that you have any entry instructions for the site including key/code information for gates.
- b) Upon Arrival
 - i) Add any new information to the Bathymetry Survey Notes field sheet including:
 - (1) Lake name (alternate name)
 - (2) Survey date
 - (3) Survey personnel
 - (4) Access location
 - (5) Access type
 - (6) **IMPORTANT** – Note any indication of general water level at lake (inches above or below “normal” bank full water level. This is critical to effective map generation. Optimally use rocks/docks/structures/gages to determine water level. Pictures are helpful. This information can be updated/completed as you conduct your initial survey since your first transect is around the laker perimeter where you can get the most accurate assessment of water level.
- c) Start logging sonar measurements.
 - i) Attach the transducer to the appropriate place on the starboard side of the motor. Ensure that the cable is not loose enough to get caught in the propellor. Note that you will want to put the transducer in place once you are away from shore to prevent damage from the transducer hitting the bottom or rocks/objects.
 - ii) Ensure that the transducer is oriented perpendicular to the bottom once the boat is fully loaded.
 - iii) Connect the sonar (and GPS if appropriate) to the first battery and turn on the unit.
 - iv) On sonar viewer ☐ Go to Advance Menu ☐ Select “Sonar” and then “Log Sonar” dialog
 - v) Name the sonar logging file using the following convention:
 - (1) Lake name (with spaces) plus a letter A for the first file. Shorten lake name as needed if the name is too long for the data field.
 - vi) Choose the “Right” memory card for saving the file.
 - vii) Make sure you select sl3 file type to capture both transducer and sidescan sonar.
 - viii) Select “create StructureMap”.
 - ix) Select “Start Logging”.
 - x) Check that logging has started by going back to the map screen and looking for both a red dot is blinking and that there is a file name/logging popup appearing every few seconds at the bottom of the screen.



- d) During the survey
 - i) Check alignment of transducers to ensure they are oriented perpendicular to the bottom. This should be rechecked any time the boat passes through a shallow area and strikes bottom, after passing through highly dense macrophytes, or when travelling backward through plants.
 - ii) The initial transect should be as close to the shoreline as possible while maintaining safety and ensuring that the unit is still able to collect data – deep enough and not in areas with macrophytes that are too dense. Maintain safe distance from any spillway or impediment to navigation.
 - iii) Subsequent transects should follow the pre-logged transects or be conducted in concentric circles around the lake.
 - iv) Adjust the designed transect spacing as necessary based on field conditions. Considerable individual judgment may be required to successfully complete the mapping.
 - v) Travel the designed transect with the boat while logging measurements with the sonar unit.
 - vi) A speed between 3-5 mph will minimize the disturbance from the motor and increase the transducer's ability to obtain an adequate signal. Slower speeds for very shallow areas are recommended and speeds above 5mph can be used in open/deep water – particularly for larger lakes.
 - vii) In the case of low battery, stop sonar logging prior to changing the battery and restart sonar logging with a different file name (increment the letter at the end of the file name A, B, C etc.) when battery change is complete.
 - viii) File size is limited to approximately 2.2gb (~2-2.5 hours of logging) after which it will automatically close the file. When recording the Loran screen will have a file name and size window that appears every few seconds. When you get close to the file limit start a new file using the protocol below. If you miss the warning message and it closes the file, try to start the new file at the last known location where logging was successful to prevent data gaps.
- e) Avoiding Data Loss
 - i) Data collection can be temporarily interrupted if the transducer depth is less than approximately 0.7m or if biovolume is too high the depth will show as a double dash (- -).
 - ii) Strategies for reestablishing sonar contact:
 - (1) Move to deeper water.
 - (2) Hold position with the transducer over a gap in the plants and/or over hard bottom.
 - (3) Check transducer angle and for possible blocking vegetation snagged on transducer.
 - (4) After reestablishing bottom contact return as near as possible to the point where data loss started but avoiding the conditions that caused the loss. Stay in slightly deeper water or less dense plant cover if necessary for transducer to maintain bottom contact.
 - iii) **Important** - Review boat track prior to stopping logging. Return to any area where the gaps in transects are too wide and survey between the prior transect lines. Gaps commonly occur when the boat turns too early or if there are extended areas where the transducer loses contact with the bottom.
 - iv) Note – The buffer width can be adjusted during post-processing to fill any gaps. However, a wider buffer results in a slight loss in detail so ensuring a consistent transect spacing will help produce the highest detail maps possible.
- f) Stop logging sonar measurements.
 - (1) To end a survey log for any reason, on sonar viewer, Go to Advance Menu, Select “Sonar” and then “Stop Logging” dialog
 - (2) The red dot indicator and file name popup will stop once logging has stopped.
 - ii) Complete the bathymetric Survey Notes field sheet PRIOR to departing the lake.
 - iii) **Important** – Note any areas of the lake you were not able to reach with the boat and describe them briefly. These will be used to potentially expand the map to those areas by manual logging. Examples:
 - (1) Could not reach northeastern extent of pond. Too shallow (~1ft deep) and plant biovolume 100%.



- (2) Lost signal in northeastern part of pond. Plants too dense.
- (3) Had to avoid area near dam due to flows/buoys.
- (4) Depth data may be suspect in X area – plants too dense.

g) Post Survey Actions

- i) Detach transducers from boat PRIOR to returning to shore to avoid damage.
- ii) Pack up sonar unit and avoid crimping/damaging cables and unit during travel.
- iii) Decontaminate boat and other equipment on site (check and clean) and back at MassDEP as described in other guidance documents.
- iv) Sonar unit cleaning - Transducers and cables should be washed in the sink while still connected to the unit (to prevent water damage in the connectors). Remove any plant material from the bracket and transducers and wash in hot water.
- v) Remove the correct micro-SD card from the sonar unit.
- vi) Email the Statewide Bathymetry Project Lead and place the memory card on his desk along with the completed Bathymetry Survey Notes Field Sheet.

4) Upload for Post-processing of Data Files

- a) Transfer raw data (.SL3) files to the appropriate folder on MassDEP Sharepoint Site.
- b) Rename files to the complete waterbody name and town(s).
- c) Sign in to the Biobase website (<https://www.biobasemaps.com/>).
- d) Select Web Upload.
- e) Select Add Sonar Logs.
- f) Navigate to Sharepoint folder and select all files for the surveyed lake.
 - i) Note: You may select multiple files and from multiple lakes at once.
- g) Select Start Upload.
- h) Uploading is complete once the status shows 100%. Do not close window until all files have reached 100% uploaded.
- i) Files will begin to process automatically once they are uploaded.
- j) **Important: Processed files will appear within an hour but they will not have been checked by Biobase staff. Wait 24 hours before considering the file processing complete.**

Biobase File Processing – They will do the following after upload to their system:

- i) Check and name the waterbody.
- ii) Process the files to create the various maps, data files, and coverages.
- iii) Conduct a QC review of the file(s). The QC review can catch spurious data – typically extreme depths or inaccuracies such as false bottom readings caused by high biovolumes are identified during this review. If any issues are found, Biobase staff will email the registered user about the QC issue.

5) WPP Bathymetry File Post-process Review on Biobase Website

- a) Review lake name against WPP records.
- b) Open each file and inspect for data gaps, obvious bad depth data (small very deep areas inconsistent with the surrounding bathymetry).
- c) If gaps are found:
 - i) Reprocess all impacted files (see Biobase website guidance for reprocessing instructions) with the smallest possible buffer that fills the data gaps (5m increments).
 - ii) Note that changes in buffer width must be made to each file prior to merging.
 - iii) Wait until the reprocessing has been completed and recheck until there are no gaps in any of the files.
 - iv) For waterbodies with more than one data file, merge all the appropriate files.

6) Quality Control

- a) Maintaining proper quality control of bathymetry data consists of three components;
 - i) Accurate assessment of water level during the survey.
 - ii) Ensuring complete and even survey coverage of the waterbody;
 - iii) Review of the uploaded data to determine any survey impacts due to data loss, excessive biovolume impacting accuracy, or spurious data (e.g., extreme depth records).



7) Data & records Management (Forms used and locations of storage)

- a) Files from the Lowrance sonar are stored in Monitoring section folders on MassDEP's secure network.
- b) These files are then uploaded to BioBase's cloud servers for processing
- c) Files are then downloaded back to Monitoring section folders on an as needed basis



Appendix A Bathymetry Survey Notes

Things to think about when doing bathymetry surveys at potential TAM lakes. Please note these for each lake surveyed:

Lake Name: Other Lake Name	Lake AU
Boat Access Lat/Long Beach Access Lat/Long	Access Type (Ramp Cartop Road) Shock boat possible (Yes No)
Town:	
Watershed:	
Date Surveyed:	Staff Surveying:
Contact notes including people or agencies who need to be contacted for permissions or gate access:	
Is there a gate? If so, hours of operation or contacting authority:	
Are there posted Motor Restrictions (and if so, by whose authority):	
What was the water level at the time of the survey? Choices here are "bank full", down approximately X inches, X inches above/below spillway, X gage reading. Any information that lets us better know the conditions during the survey would be helpful.	
Note any confirmed invasives:	
Current relative biovolume – Extreme, high, Light, Limited/No plants?	
Other Notes:	