

ROV Sampling SOP

Standard Operating Procedure for the Great Lakes Benthic Mapping Project

Version: 1.4 (2025-02-20)

Purpose

This document standardizes the collection of underwater videos and photos using a remotely operated vehicle (ROV) to satisfy data requirements of the Great Lakes Benthic Mapping project. The corresponding videos and photos are intended to characterize benthic substrates, enumerate benthic species, identify anthropogenic impacts to habitats, and ground-truth remotely sensed lakebed data, such as multibeam bathymetry.

The outputs of ROV sampling and methods detailed in this document are:

1. Metadata describing deployment/dive events
2. ROV tracklines
3. Downward-looking video
4. Forward-looking video

These data will be associated with high-resolution remote-sensing data as well as other data streams, and therefore special attention must be paid to maximize spatial and temporal accuracy.

Scope and applicability

This SOP is meant to support ROV operators, scientists and data managers who will collect imagery data using an ROV, as well as boat captains who will support ROV operations. Minimum requirements and specifications for ROV data collection have been identified [here](#), including the requirement to collect data that satisfies the Coastal and Marine Ecological Classification Standard (CMECS, NOAA 2012), and the requirement of lakebed annotations.

Much of the material in this SOP is taken from 2023 Nancy Foster ROV Launch and Recovery procedures and 2023 ROV transect plans for the NRDA Mesophotic and Deep Benthic Community project in the northern Gulf of Mexico.

This SOP is intended to support ROV dives between 3 m and 80 m water depth, the depth range of the Great Lakes Benthic Mapping Project, on a small vessel. Since these data will be used to ground-truth remotely sensed data, these data should not be collected more than 2 years before or after remote sensing data acquisition to minimize the extent of changes to the lakebed. In dynamic areas, the time between remote sensing and ground-truthing should be less.

This SOP does not refer to biological collections or ground disturbance and, therefore, does not meet the regulatory requirements for ground disturbance permits. However, collections within the NPS or ONMS boundaries will require consultation with permit providers.

Methodology and procedures

The ROV will be deployed along predetermined transects typically between 50m and 150m. Any transects greater than 150m will be subset into segments with a maximum length of 150m, and each subset will be collected separately. Transects will be positioned using bathymetry and backscatter to locate features of interest or using procedurally generated algorithms to cover geographic and feature space. Since local environmental conditions can affect the direction of ROV transects, it is a best practice to place two perpendicular transects which cover the same feature or similar features nearby.

The ROV will traverse a transect along the lakebed at a set speed of 0.25 - 0.5 knots and an altitude of 1 - 1.5 meters. While underway the ROV will collect videos and photos which will later be annotated. A data manager will collect deployment information as well as important event encountered on the lakebed. The transect may be temporarily stopped to inspect or take videos of specific features in more detail when needed.

ROV imagery collection will generally be accomplished by a four-person team, consisting of a boat captain, ROV operator, ROV deck hand, and data manager. In cases where station planning has been accomplished beforehand and data management can be deferred until operations are completed, a three-person team is possible.

Each team member has specific responsibilities. The boat captain is in charge of the vessel and crew safety, operating the vessel, requesting assistance when needed, supporting site planning and granting deployment and recovery permission. The ROV operator is responsible for safely operating the ROV underway and assessing ROV data collection in real-time. The ROV deckhand is responsible for deck operations including, deployment, recovery and umbilical management. A data manager is responsible for selecting stations, assessing imagery in real-time, dive data acquisition, and data management off the boat. The Party Chief will be selected prior to the mission from this team and is in charge of coordinating activities, and ensuring imagery meets project specifications.

Procedures

1. Prior to cruise
 - a. ROV transects are chosen which meet data requirements and located within ROV limits
 - b. All known ROV sites are provided to cruise participants and uploaded to the vessel chartplotter (e.g. console Hummingbird) and USBL system
 - Different units have different waypoint capacities and the Sonardyne software can only accommodate a certain number of waypoints without crashing, so a stratification scheme is likely needed

- c. All staff have read and understand the cruise/mission plan
- d. All required ArcGIS licenses required for sampling are taken offline
- 2. Daily briefings and planning
 - a. Daily brief should address the following:
 - Complexity of the operation
 - Weather and sea condition limits
 - Equipment limitations
 - Personnel requirements (manning, training, location on deck)
 - Communications plan
 - Coordination between the deck, bridge, and scientists
 - Interaction of the equipment and the ship's gear (weight, lifting points, space)
 - Operational Risk Assessment or GAR
 - Contingency plans in case of snag or other "hang" situations
 - b. Site plan
 - Sites planned and identified with input from Party Chief, ROV operators and boat captain.
 - Boat captain plans site transit
 - Weather and sea state will play an important role in site planning. Deeper sites will be easiest and safest then the weather is calm and these should be prioritized during days / times of calm weather.
 - c. Time synchronization
 - All computers and equipment with clocks are checked to ensure they are using UTC and time is synchronized to be less than 1 second apart.
 - d. Equipment operation checks
 - All equipment is turned on and checked for proper functioning.
 - GNSS
 - ROV
 - Power
 - System boot
 - Thrusters
 - Lights/Lasers
 - Camera
 - Downward (HD)/Lasers
 - Forward/Rotating (SD)
 - Data Storage/DVR
 - Sediment Perturbation Device (SPD)
 - Field computer
 - USBL transceiver and transducer
 - Computer and wireless connection
 - MRT
 - GNSS
 - Logging
 - e. Sample record data management systems

- ArcGIS open to cruise planning GIS
 - Sample site recording shapefile prepared for data entry
 - Cruise database prepared for data entry
 - Waypoints in ship's navigation system
 - Waypoints in USBL software
- f. Vessel preparation
 - Equipment secured for travel
 - USBL pole secured out of the water
- g. Once all equipment, data management systems, and vessel passes operational checks, the vessel is cleared for transit
- 3. Vessel transit
 - a. Whiteboard or tablet prepared with record site information
 - b. Cruise database prepped
 - c. Look for hazards and communicate any to the captain
 - d. Boat captain gives notice to vessel occupants 10 minutes prior to arriving on site
- 4. On Site Safety checks
 - a. All appropriate personnel are in position and ready to proceed.
 - b. All personnel on deck are wearing PFDs, and close-toed shoes (hard hats if needed)
 - c. The appropriate safety chains are removed/down
 - d. The ROV tether is clear of obstructions
 - e. The ROV is NOT powered on
 - f. Ensure deployment area is clear of fishing gear or other hazards
- 5. Site Arrival
 - a. Visual assessment of wind, waves, vessels
 - b. Drift test (3-5 minutes), if needed
 - c. Vessel positioning
 - Boat positions itself upwind of site with the objective of positioning the vessel approximately 5m upwind of the transect line.
 - For sites where an anchor will be used, the precise site where the anchor is dropped will be dependent on depth, currents and vessel drift. The vessel can be backed into the proper position by allowing anchor line out and drifting to station.
 - Live boating may be used, but will depend on the comfort level of all involved and will typically only be used in situations where there is little to no drift or currents.
- 6. Once the vessel is situated, the Micro Ranger USBL Transceiver (MRT) is deployed, and the slant range is estimated via: [Slant Range Calculator](#) .
 - a. ROV operations suspended if USBL MRT roll exceeds 5 deg (poor positional accuracy).
 - b. If needed, the maximum slant range and other USBL properties in the USBL software are updated. Working range of USBL set to at minimum slant range plus 20 percent, as much as 50 percent may be required depending on geometry/depth.

- c. On site equipment checks
 - Time synchronized within 1 second
 - Boat engine on, neutral gear
 - ROV (Power, System boot, Motor, Thrusters, Cameras, Lasers)
 - Navigation and positioning
 - Vessel coordinates are coming in, and presented on map
- 7. On Site Surface Operations
 - a. CTD cast
 - Prior to deployment, request is made to captain
 - Captain grants deployment
 - Cast deployed to bottom and retrieved
 - CTD data downloaded and the profile average sound speed entered into USBL software
 - b. Video metadata
 - ROV operators **verify 'continuous recording' on Arctic Rays Thresher interface is enabled prior to every dive**
 - A dive board or tablet with cruise ID, date, deployment ID, target site ID (if more than one, the first) is prepared
 - The dive board and a clock set to UTC or a tablet showing both is shown to all cameras recording videos on the ROV
- 8. ROV Deployment
 - a. Back deck ready and requests ROV deployment to captain
 - b. Boat captain grants deployment. (Deployment and recovery at the discretion of the boat captain.)
 - c. ROV deployed into water and driven away from the vessel on surface to clear and pull umbilical taught
- 9. ROV Underwater Operations
 - a. ROV descends to lakebed
 - b. ROV video and navigation data are checked
 - c. ROV begins transect across waypoints at a speed of 0.25 - 0.5 knots and an altitude of 1 to 1.5 meters.
 - d. ROV transits from waypoint to waypoint until the ROV traverses across the final transect waypoint
 - e. ROV pauses at each waypoint to perform a 180° sweep and depending on visibility and conditions, may descend lower than transit elevation for image enhancement
 - f. As needed, flotation added to umbilical to keep umbilical neutrally buoyant in a catenary loop
 - g. If needed, down looking digital stills will be taken every 30-60 seconds throughout the dive
- 10. ROV Dive Annotations
 - a. All records are referenced to UTC and are collected in real time within the cruise database
 - b. The following records are collected:

- On transect effort and off transect effort periods. Anytime the ROV moves away from the transect the event is recorded
- Depth (depth of transect start and any changes to depth greater than 10m)
- Sites/Waypoints traversed
- Changes in substrate class
- Changes in water clarity
- Unique geological or biological features
- Fish
- Benthic invertebrate
- Maritime heritage
- Debris
- Highlights for outreach

11. ROV Recovery

- a. Inform boat captain ROV dive is complete and ROV will ascend
- b. ROV ascends to surface and driven away from the vessel to keep umbilical taut
- c. Recovery team communicates sightings, direction and depth of ROV with boat captain
- d. Deck team requests ROV recovery to captain
- e. Boat captain grants permission to recover ROV
- f. ROV driven towards ship with umbilical taut
- g. ROV hooked, and hoisted aboard
- h. ROV and umbilical are secured on deck
- i. MRT rotated/recovered to horizontal and secured
- j. Back deck communicates recovery is complete
- k. Staff moves to safe position for transit
- l. Vessel begins transit to recover anchor or next site

12. Data

- a. ROV data transfer
 - Downward video (camera must remain submerged in tote on deck for cooling during prolonged data download or transit).
- b. At the end of the day all data are downloaded onto hard drives and provided to the data manager.
- c. Confirmation the following data were collected and recorded
 - Downward video
 - Forward video
 - USBL navigation and position. Including positions for transponder and vessel GNSS records
 - ROV dive annotations in cruise database
- d. End-of-day data checklist is filled out

Clarification of terminology

AIS - Automatic Identification System
GPS - geographic positioning system
GNSS – Global navigation satellite system
MDBC - mesophotic and deep benthic communities
MRT - Micro Ranger Transceiver
Nav - navigation
ROV - remotely operated vehicle
USBL - ultrashort baseline system
UTC - Coordinated Universal Time

Equipment and supplies

- ROV (BlueROV2)
- Goal Zero 1500Wh Electric Generator (Qty 2, provided by MTU)
- Navigation systems
 - GPS
 - USBL
- Cameras
 - Downward facing (at least HD)
 - Forward facing
- Other sensors
 - Scaling Lasers (qty 4, positioned for vertical and horizontal scaling, e.g. green laser pointer dive lights)
 - Lights
 - Depth / pressure transducer

Cautions and interferences

Potential serious to catastrophic risks include:

- Vessel collision with another vessel
- Personal injury from entanglement with ROV umbilical
- Personal injury from ROV during deployment and recovery
- ROV Entanglement with submerged hazards including rocks and shipwrecks and scientific equipment
- Umbilical capture in the propeller
- ROV impact with the bottom
- ROV impact with the vessel

The air-sea interface presents the greatest risk of damage to the ROV, and potentially the vessel.

Rough weather will exacerbate all risks.

There are many other marginal risks which may delay or cancel a mission but do not cause serious injury or major property loss. These include water intrusion, electrical failure, ROV or navigation equipment malfunction, sickness, and communication failures, as well as failure of vessel systems unrelated to the ROV.

The ArcticRay camera must remain submerged in tote on deck for cooling during prolonged data download or transit.

Data and Records Management

All video and nav data will be recorded and stored on hard drives attached to field computers. A cruise data folder will be used to organize all data. The folder separates raw data from any processed data and divides data streams according to each sensor. All deployment event data will be recorded in the cruise database. All data will be backed up onto at least one other hard drive at the end of the day and the end-of-day data checklist will be completed.

Health and safety warnings

If there is an EMERGENCY, or question at any time as to the location of the ROV or ROV tether during launch or recovery, or there is slack in the tether, IMMEDIATELY:

- Get to a safe position
- Inform the boat captain
- Stop all propulsion
- Boat captain coordinates boat movement with ROV operator to facilitate recovery
- ROV operator coordinates ROV movement with boat captain

Note:

- Abrupt changes in wire angle, speed out, or tension may indicate a problem
- Real time monitored scientific equipment may show changes in data which may indicate a problem

Specifications

Video data - Underwater video will be used to ground-truth remotely-sensed information. All videos which will be annotated must be downward looking, and collected to at least full 1080 HD quality (1920 x 1080 pixels). Video may be collected in the .mp4, .mov., .wmv, .avi, or .mpg formats, but video data will be distributed and archived in .mp4 format. Minimum video requirements: Resolution: 1920 x 1080 pixels (full HD), Frame rate: 30fps, Compressor: H.264, Aspect ratio: 4:3, Bitrate: 4,000 - 8,000 kbps [video] / 192 kbps [audio].

Photo/Still data - underwater photographs or stills will be used to ground-truth remotely-sensed information. All stills will be collected to at least full 300DPI. Whenever possible stills will be collected in RAW format to provide the greatest processing flexibility.

Time convention - Coordinated Universal Time (UTC) will be used for all time records.

Horizontal datum - All horizontal positions of processed data and related data products (e.g., grids and mosaics) shall be referenced to the North American Datum of 1983 (NAD83) 2011 realization 2010 (NAD83(2011) 2010.0), or later. The ellipsoid will be cited at time of acquisition. Any transformation or datum adjustments should be referenced.

Vertical datum - All sounding data shall be referenced to the International Great Lakes Datum 1985 (IGLD85), and depths will be referenced to the [low water datum per lake](#) in which operations are being conducted.

Horizontal positional uncertainty / accuracy - the Total Horizontal Uncertainty in position records shall not exceed 5 m + 5% of the depth, with a confidence level of 95%. This uncertainty will support minimum mapping units of at 100 square meters down to 80 m the maximum depth of this project. ROV operations suspended if USBL MRT roll exceeds 5 deg.

Recorded horizontal position precision - Recorded horizontal positions shall retain a precision of at least centimeters; i.e., for positions recorded in decimal degrees: 6 decimal places and for projected coordinates (meters): 2 decimal places.

SOP Version table

Version	Date	Notes (e.g. writer, major changes)
1.0	2023-06-01	Charles Menza, prepared using 2023 Nancy Foster ROV Launch and Recovery procedures and 2023 ROV transect plans for the NRDA Mesophotic and Deep Benthic Community project in the northern Gulf of Mexico. Draft used for GL2301_L1
1.1	2023-06-28	Updates made using knowledge from GL2301_L1 tests
1.2	2023-07-07	Updates made with input from MTU, and incremental improvements from additional team reviews. Most changes to ROV and data management.
1.3	2023-08-14	Updated after GL2301 (Madeline Island)
1.4	2025-02-20	Updated after GL2401 (WSCNMS)