

Sediment Sample Collection and Rapid Classification

Standard Operating Procedure for the Great Lakes Benthic Mapping Project

Version: 1.4 (2025-1-10)

I. Purpose

This document describes general and specific procedures, methods, and considerations for collecting benthic sediment samples using a Ponar dredge and conducting a rapid in situ sediment sample classification. The sample classification data are intended to characterize fine unconsolidated sediment and provide data for predictive substrate distribution models derived from remotely sensed data (e.g., multibeam, LIDAR) and underwater imagery (Battista et al., 2019; Mabrouk et al., 2022).

II. Scope and applicability

This standard operating procedure (SOP) applies to collecting benthic sediment samples using a Ponar dredge (Standard or Petite) and for a rapid in situ sediment classification once the sample is retrieved. This SOP describes methods to sample and classify fine unconsolidated sediments (e.g., sand, silt, mud) and does not support methods to collect larger sediment sizes, such as cobbles or boulders. Nor does this SOP address sample processing for sediment grain size fraction, contaminant analysis, or biotic analysis.

Assumptions

For the purposes of this SOP, sediment is defined as the organic and inorganic material that has accumulated on the bottom of a lake. This SOP was developed to support the objectives of the Great Lakes Benthic Mapping (GLBM) project. It is intended to standardize data collection and ensure that derived data can be integrated with other sediment data collected from underwater video analysis using other platforms, such as an ROV or drop camera for the GLBM project.

Regulatory requirements

Depending on the study area, collecting a sediment sample may require a research or sample collection permit from local, State, or Federal agencies. In addition, NOAA Administrative Order (NAO) 216-6A, Environmental Review Procedures for implementing the National Environmental Policy Act (NEPA), requires all proposed federal projects to undergo a review concerning environmental consequences on the human environment. Sediment samples that meet the Categorical Exclusion criteria for the NCCOS Great Lakes Mapping Projects memorandum (Schulze-Haugen, 2021) qualify to be categorically excluded from further NEPA review. Samples collected within a National Park or National Marine Sanctuary may require permits and have

additional regulations or requirements. To identify and address these needs, contact the appropriate administrator. It is also a good practice to contact the relevant state agencies to determine if other state permits are needed.

Sampling Roles and Responsibilities

A team of 3 people is recommended to collect sediment samples so that the collection is safe and efficient.

- 1) Boat captain: Operates the vessel and oversees operations and safety, navigates to sample sites, and can operate the winch when necessary.
- 2) Data recorder: Plans and coordinates sample collection, classifies sediment, and collects and manages records.
- 3) Dredge handler: Stationed on the back deck, prepares and operates the Ponar, communicates with the winch operator to control pickup, ascent, and descent, opens the Ponar when retrieved, and takes pictures and videos of the sample.

Collection Inputs

The following information is needed to conduct and classify sediment sample grabs:

1. Site information, including coordinates, depths, and, if possible, expected substrate.
2. Sediment sample data requirements, including a classification schema/card if applicable
3. Sediment collection equipment (see requirement section III)

The Ponar dredge is often used on missions in conjunction with an imagery sensor, such as an ROV or drop camera system. There is the benefit to having observed the bottom with an imagery sensor prior to deciding to deploy a Ponar sediment dredge.

Collection Outputs

1. SQLite database from Survey 123 with the sampling site's information and the sediment sample classification/description.
2. Photos/videos for the sediment sample and the ID plaque at each site.
3. Excel files with Ponar navigation data (exported from [QAQC Smartsheet](#) as csv for web map development).

Any alternative procedure will be recorded with a description of the circumstances requiring its use if the field investigators decide that any of the methods described in this section are inappropriate, insufficient, or impractical and that another method must be used to obtain a sediment sample. There is no endorsement or recommendation made by mentioning brand names or commercial goods.

III. Methodology and procedures

Summary

The Ponar (Standard/Petite) dredge collects sediment samples with fine unconsolidated sediments at predetermined sites or when decisions are made after an ROV or drop camera survey. The spatial position of sediment samples is provided by an ultra-short baseline system (USBL). The collected samples are assessed in the field to classify and describe the substrate type.

Requirements

- 1) Research vessel: A small vessel (6-10m long) is preferred because it can collect data in shallow waters and is maneuverable. It also takes advantage of the drop camera's ability to collect data quickly and over many sites.
- 2) Vessel cabin and deck space: A dry cabin is needed to prevent sensitive electronics from getting wet. Adequate deck space is also required to operate and store the Ponar sampler securely and provide room for safe deployment. A minimum of 2 sq m (~25 sq feet) of open deck space is required.
- 3) The Ponar Sampler: There are two types of Ponar samplers, the standard Ponar and the Petite Ponar. Both have the same design and sampling mechanism, but they are different sizes. The sampler is made of stainless steel and designed for collecting sediment surface samples from unconsolidated substrates, including sand, gravel, mud, or clay. It consists of 2 arms attached to the two opposing semi-circular jaws that open and close to grab a sediment sample. The sampler has a trigger mechanism using a strong spring that keeps it open and is released on contact with the bottom, allowing the jaws to close on the sediment sample. It also has a safety pin that prevents the jaws from closing and safeguards users from unexpected closings. Weights may be added to ensure easy and enough penetration of the jaws to the substrate. A removable stainless steel mesh window with rubber protection at the top of each jaw allows the researcher to check the sample acceptance, take pictures, or other sample measurements (Figure 1).
 - The Standard Ponar: Used to collect sediment samples from deeper water. It is heavy and needs a winch to operate. The dry weight is 23 kg (50 lbs) and 34 kg (75 lbs) when full with the sample. The box size is 23X23 cm (9X9 inches), with a sample area of 0.05 m² (81 in²), and a scoop volume of 8.2 liters (500 in³).
 - The Petite Ponar: Used to collect sediment samples from shallow water. Lighter and smaller in size than the standard Ponar, which makes it easy to handle without a winch. The dry weight is 10.8 kg (24 lbs) and 12.7 kg (28 lbs) when full. The box size is 15.2X15.2 cm (6X6 Inches), with a sample area of 0.02 m² (36 in²) and a scoop volume of 2.4 liters (146.5 in³).



Figure 1. Standard Ponar Sample in the opened and closed positions, Photo modified from Aquatic BioTechnology, Inc.

- 4) Ultra-Short Baseline (USBL) System: A USBL system is a method of underwater acoustic positioning and is used for tracking underwater objects such as AUVs, ROVs, drop cameras and Ponar dredges. The system used in this SOP is a Sonardyne Micro-Ranger 2 USBL system, and it consists of;
 - A Micro-Ranger Transceiver (MRT) mounts on the USBL pole and submerges a few feet (2-3) below the boat hull to transmit an acoustic signal to the transponder attached to the Ponar.
 - A Nano transponder attaches to the Ponar to determine its location and depth.
- 5) A laptop or PC with Micro-Ranger 2 Software installed: This computer displays the results on a radar-style monitor and stores navigation files.
- 6) A second laptop or PC with Survey123 and ArcMap: This computer will be used to record event data and visualize site locations. A second computer has been required because operating Survey123 and Ranger simultaneously has been very challenging. If possible, the two computers should mirror each other to provide redundant systems.
- 7) Vessel Navigation system: A dedicated system for the boat captain to visualize the location of sites and map a course to sites

- 8) Davit/Winch: A Davit/winch on the deck is necessary especially for the standard Ponar's deployment and recovery. It can aid in more rapidly deploying and recovering the Ponar sampler, especially for deep (>30m) sites.
- 9) Sediment Sample Classification Sheet: A water resistance sheet used to collect information for the rapid assessment of the sediment sample to describe and classify the substrate using Wentworth (1922) Grain size classes. (Figure 2)
- 10) Camera: To collect photos/video of the sediment sample and the whiteboard with the site information.
- 11) Geotechnical Gauge Card: A waterproof plastic card guides the researcher to accurate and consistent observations of the sediment sample. It includes a measuring scale, roundness chart, soil colors, soil compaction tests for clay and sand, and a size classification chart with actual sand grains from coarse to silt permanently fused to the plastic card. (Figure 3)

PONAR SAMPLE LOG: For use with Ponar deployments					
CRUISE ID: _____		DEPLOYMENT ID: _____			
SITE ID: _____		DATE: _____			
SEDIMENT COLOR: <small>Can mark more than one.</small> <div style="display: flex; justify-content: space-between;"> <div> ___Black ___Gray ___Red </div> <div> ___Brown ___Green ___Other </div> </div>		GRAIN SIZES PRESENT: <small>Indicate presence with an X.</small> <div style="display: flex; justify-content: space-between;"> <div> ___Clay ___Sand ___Pebble ___Shell Hash </div> <div> ___Silt ___Granule ___Cobble ___Wood </div> </div>		DOMINANT GRAIN SIZE: <small>Indicate with an X.</small> <div style="display: flex; justify-content: space-between;"> <div> ___Clay ___Sand ___Pebble ___Shell Hash </div> <div> ___Silt ___Granule ___Cobble ___Wood </div> </div>	
GRAIN COMMENTS: <div style="height: 40px;"></div>					
BENTHOS PRESENT: <small>Indicate presence with an X.</small> <div style="display: flex; justify-content: space-between;"> <div> ___Mollusc ___Algae </div> <div> ___Live Veg ___Other </div> </div>		ANTHRO PRESENT: <small>Indicate presence with an X.</small> <div style="display: flex; justify-content: space-between;"> <div> ___Marine Debris ___Other </div> <div> ___Microplastics ___Other </div> </div>		BENTHOS/ANTHRO COMMENTS: <div style="height: 40px;"></div>	
SILT/CLAY DESCRIPTION: <small>Mark one.</small> <div style="display: flex; justify-content: space-between;"> <div> ___Very Soft ___Soft ___NA </div> <div> ___Stiff ___Very Stiff </div> </div>		SAND DESCRIPTION: <small>Mark one.</small> <div style="display: flex; justify-content: space-between;"> <div> ___Loose ___NA </div> <div> ___Dense </div> </div>		H2 SULPHIDE: <div style="display: flex; justify-content: space-between;"> <div>___Yes</div> <div>___No</div> </div>	
OXIDIZED: <div style="display: flex; justify-content: space-between;"> <div>___Yes</div> <div>___No</div> </div>		REQUIRED PHOTOS TAKEN: <div style="display: flex; justify-content: space-between;"> <div>___Yes</div> <div>___No</div> </div>			
ADDITIONAL COMMENTS: <div style="height: 40px;"></div>					

Figure 2. Sediment Sample Classification sheet for rapid assessment of the Ponar sample. Photo: NOAA/NCCOS

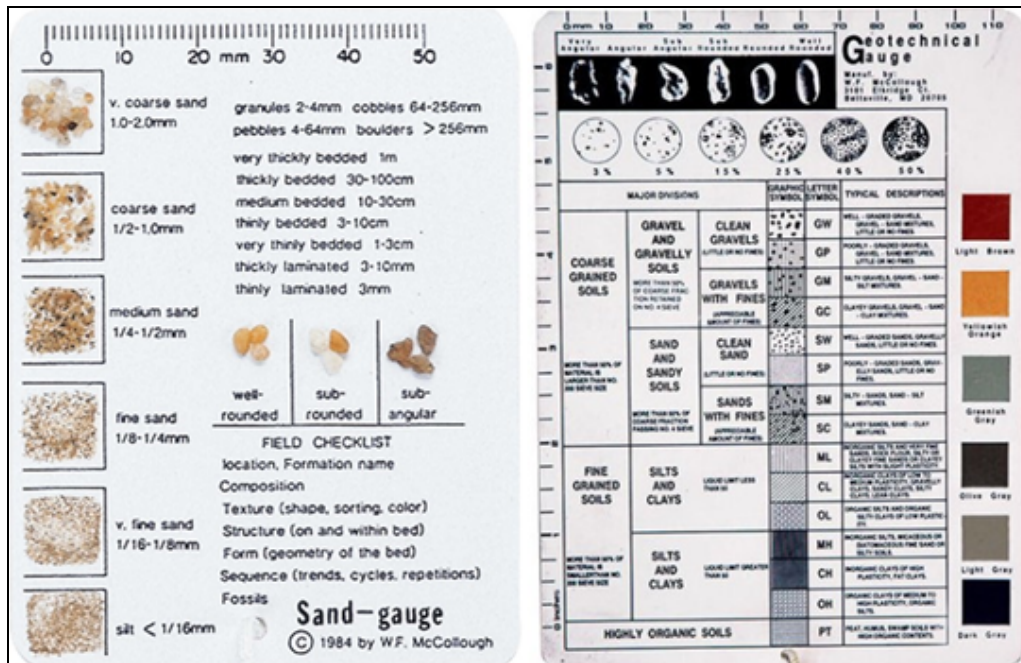


Figure 3. Geotechnical Gauge Card to guide the researchers in the sample rapid classification. Photo: W.F. McCullough, Inc.

Procedures

During daily field operations, the Science Party Chief plans which sample sites will be visited in coordination with the boat captain to ensure safety and efficiency. Additionally, he/she will set up the USBL navigation system (Micro-Ranger 2) that will track the Ponar location at the sampling site. The captain will then navigate to each site using the provided coordinates from the handheld GPS unit or the boat's navigation system. During transit to a site, the sampler operator should prepare the sediment sampler to deploy it at the target site. If an imagery sensor, such as ROV or drop camera, is also being used, it should be deployed first to aid in decision-making on Ponar site identification and expectations.

1) Pre-sampling preparation (approaching the target site)

- The team is wearing Personal Protective Equipment (PPE)
- The Ponar sampler should not be handled unless the safety pin is in place.
- Ensure all parts are in good working condition
- The sampler is securely fastened to the line on the davit/winch.
- Ensure the USBL is working properly, the Pole is dropped, and the transponder is mounted to the sampler and enabled
- Record the target site information on a whiteboard (cruise ID, date, site ID, dive ID)
- Sediment sample sheet/Survey 123 ready with site information
- Camera-ready to capture photos/video for the sample

2) Sediment Sampling Procedure at the target site (0-6 m, 0-20 ft)

- Replace the safety pin with the spring pin with the sampler open and keep tension on the line to avoid any slack that may release the triggered spring pin.
- Deploying the sampler using the winch needs extra caution and should be directed by the captain/winch operator and requires good communication between everyone on the vessel
- Logging on the Ponar transponder should begin prior to deploying the Ponar. This requires toggling the transponder on the Micro-Ranger 2 software so that the transponder is outlined in green.
- The grab sampler should be lowered slowly to within 2-5 m of the bottom, then allowed to free fall to the bottom.
- The jaws will close automatically as the grab sampler is raised from the sediment surface. If the Ponar grab sampler descends too quickly or too slowly a good sample will not be collected. It may take some trial and error to find the best speed given the equipment used. Stopping the sampler during the descent may cause the trigger to release.
- When the Ponar hits bottom (the line will go slack), the Ponar handler should communicate this event with the winch operator/captain and data manager. Then, the Ponar should be raised back to the boat. The ascent should be steady and at a moderate velocity to ensure the Ponar flaps remain closed. If the flaps are opened upon retrieval, try changing the ascent speed.
- Caution: One of the most dangerous parts of the sampling procedure is when the Ponar comes out of the water and comes on board. At this time, the ponar is very heavy and not yet secured.
- Bring the sampler on board with caution and lower it in the plastic bin.
- Stop logging the USBL transponder.
- Open the Ponar flaps and assess the sample to determine if it meets the requirements.
 - A successful grab is one having relatively level, intact sediment over the entire area of the grab and a lack of obvious disturbance or washout.
 - Grabs containing little to no sediment or grossly slumped surfaces are unacceptable.
 - If the sample is accepted, start taking photos or videos with whiteboard information in view (Figure 4).
 - In case of an unacceptable Ponar sample, empty the Ponar and deploy it again at the same site with a new deployment ID.
- Start collecting sample information (color and stratification) using the rapid classification sheet and stainless steel scoop and take a photo.
- Empty the sampler content in the bin, secure the Ponar with the safety pin, and then continue filling the rest of the sheet using the geotechnical gauge card for reference.
- Determine the presence and dominant geological substrate (cobble, pebble, granule, sand, silt, and clay), biological substrate, and anthropogenic substrate.
- Describe the silt/clay stiffness and sand looseness for more information; see section IV
- Submit the sample information to Survey 123 using the rapid classification sheet ensuring the Survey123 entries and the datasheet match.

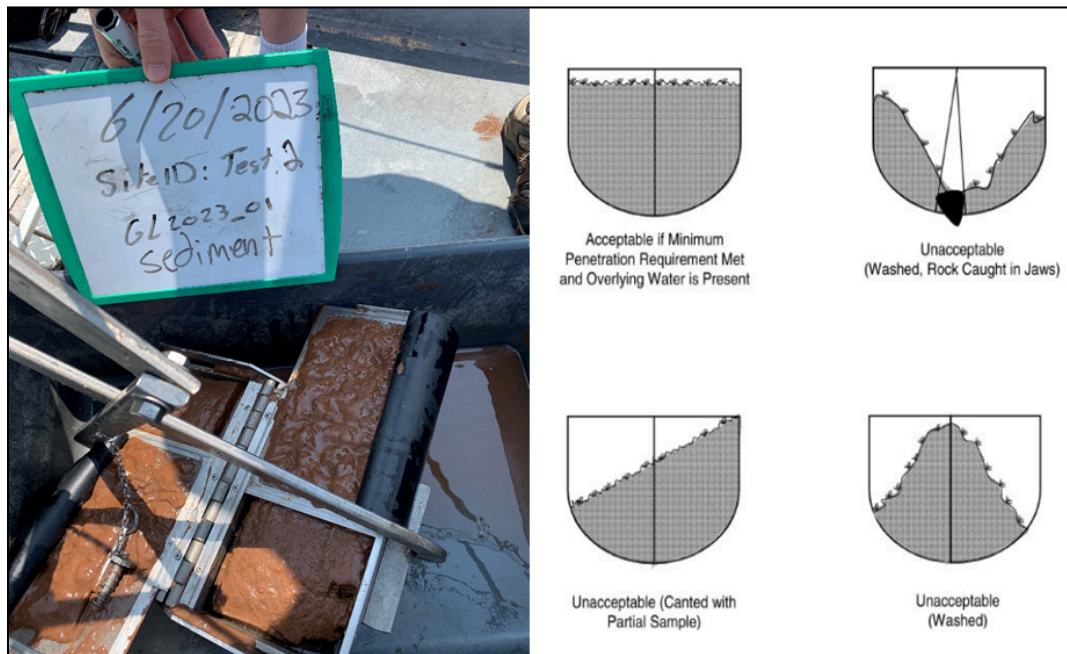


Figure 4. The captured photo of the standard Ponar with windows open and a whiteboard with the site information in view (left; NOAA/NCCOS). Illustrations show the acceptable and unacceptable sediment grab samples (right; EPA, 2001).

3) Benthos Assessment

Simple presence/absence is to be noted for any species of mussels, algae, live vegetation, or other fauna.

4) Post-Sampling Procedures

- Pull up the USBL pole with the attached MRT and secure it.
- Dump the sediment sample back in the water and rinse the bin and the sampler with fresh water
- Secure the sampler in the plastic pin for transit until the next sampling
- Update the ArcPro/ArcMap layer for completed Ponar sampling sites

5) End of Day.

- Confirm USBL/Survey 123 data are exported and saved on the hard drive/memory stick
- Confirm all photos/videos are saved on the SD drive
- Take SD drive, hard drive/memory stick for backups and copy data to 2 NCCOS hard drives
- Copy of the ArcPro/ArcMap project to the 2 NCCOS hard drives
- Fill out the Cruise End-of-Day Data Collection Sheet ([link](#))

IV. Clarification of terminology

EPA Description of Sediment Classes

Sand - Particles 0.06-2.0 mm in diameter, possessing a gritty texture when rubbed between fingers. Loose materials (not cohesive) that often cannot be molded into shapes (non-plastic).

Silt - Particles 0.004-0.06 mm in diameter, generally fine material possessing a greasy or smooth, talc-like feel when rubbed between fingers.

Non-plastic and not cohesive.

Clay - Particles less than 0.004 mm in diameter, which forms a dense, gummy surface that is difficult to penetrate with tools (hardpan). Clay is both plastic and cohesive.

Marl/Hash - Calcium carbonate, usually greyish-white, often containing fragments of mollusc shells.

Clay Stiffness

Very Soft: Easily penetrated several inches by thumb. Exudes between thumb and fingers when squeezed in hand.

Soft: Easily penetrated one inch by thumb. Molded by light finger pressure.

Medium Stiff: Can be penetrated over ¼" by thumb with moderate effort. Molded by strong finger pressure.

Stiff: Indented about ¼" by thumb but penetrated only with great effort.

Very Stiff: Readily indented by thumbnail.

Hard: Indented with difficulty by thumbnail.

Sand Description

Very Loose: Easily penetrated with ½" reinforcing rod pushed by hand.

Loose: Easily penetrated with ½" reinforcing rod pushed by hand.

Medium Dense: Penetrated a foot with 1/2 " reinforcing rod driven with a 5-lb hammer.

Dense: Penetrated a foot with 1/2 " reinforcing rod driven with a 5-lb hammer.

Very Dense: Penetrated only a few inches with 1/2 " reinforcing rod driven with a 5-lb hammer.

V. Equipment and supplies

The field team lead must develop a checklist of sampling equipment and materials prior to the start day of the field trip and ensure that proper sample containers and labeling materials are accounted for. The list must include field measurement equipment and materials listed below.

The field team must also ensure that all field equipment is in good working condition and have backups for critical equipment.

Planning and Data Recording Equipment

- 1) Navigational charts
- 2) Maps with preselected sample sites
- 3) List of sample sites with spatial coordinates and depths
- 4) Sampling rapid assessment sheets, printed on water resistance papers
- 5) Laptop/PC computer, Software ArcPro/ArcMap, Survey 123.
- 6) Waterproof Field Camera (to take a surface photo/video of the sample and the whiteboard)
- 7) Whiteboard slate
- 8) Dry erase markers

Sediment Sample Equipment

- 1) Ponar grab sampler (Petite Ponar 6.8kg or standard Ponar 34 kg when full)
- 2) Winch, in the case of the standard Ponar
- 3) Geotechnical Gauge Card
- 4) Ponar heavy release pin with spare spring and chain
- 5) Plastic bin
- 6) Stainless steel scoop
- 7) Paper towels

Navigation System (USBL)

- 1) USBL system (Topside controller unit, Transponder, Transceiver, Laptop/PC)

Extra/Duplicate equipment

- 1) Standard/Petite Ponar Grab sampler + spare spring and chain
- 2) Waterproof camera
- 3) 2 Geotechnical Gauge Card
- 4) Extra hardware: pins for grabber, shackles

VI. Data and Records Management

The Science Party Chief must check all required data and samples are recorded or stored before moving to the next site with particular attention that the Survey123 entries match the datasheet for best QAQC practices. At the end of each day, collected data (Survey 123 SQLite files, USBL navigational files, photos/videos, and ArcGIS projects) should be transferred to two mirrored external hard drives for backup, and files should be checked to ensure data for each site was stored. ViceVersa or other data management software can be used to safely transfer and update the data collection.

VII. Health and Safety

When operating the Ponar sampler, follow these safety precautions:

- Wear appropriate apparel and personal safety equipment, including a personal floatation device (PFD), safety boots, helmet, and gloves.
- Avoid sampling in rough seas, and keep the boat in proper balance at all times.
- Safety pin on when not in use and sampler out of the way in a plastic bin.
- Establish a communication protocol between the team.
- The sampler is very heavy, so always keep a safe operating distance and stay out of the way when it is being used.
- Be extra cautious when handling the Ponar with the spring pin on. Unexpected movement of the lever arms or scoops will release the trigger of the spring pin and can cause severe injury to fingers or hands, which is dangerous.
- Emergency procedures are prepared and explained to the team

VIII. References

Battista, T., W. Sautter, M. Poti, E. Ebert, L. Kracker, J. Kraus, A. Mabrouk, B. Williams, D.S. Dorfman, R. Husted, and C.J.Jenkins. 2019. Comprehensive Seafloor Substrate Mapping and Model Validation in the New York Bight. OCS Study BOEM 2019-069 and NOAA Technical Memorandum NOS NCCOS 255. 187 pp. <https://repository.library.noaa.gov/view/noaa/21989>

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SOP Version table

Version	Date	Notes (e.g. writer, major changes)
1.1	2023-09-07	Charles Menza
1.2	2024-04-11	Ayman Mabrouk
1.3	2024-05-07	Ayman Mabrouk
1.4	2025-02-20	Kimberly Edwards, Updated after GL2401 (WSCNMS)

