Massachusetts Estuaries Project
Marine Benthic Monitoring
Field Standard Operating Procedures

Prepared for:
Watershed Planning Program
Division of Watershed Management, Bureau of Water Resources
Massachusetts Department of Environmental Protection

CN 510.6

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Photos by Normandeau Associates, Inc. Images of benthic habitat from Pleasant Bay 2020 survey, including eelgrass, a horseshoe crab, and quahog shell rubble. *Massachusetts Estuaries Project-Benthic Monitoring Report: Pleasant Bay 2021*. MassDEP. June 2021.

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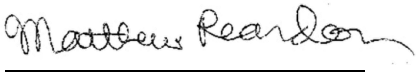

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I. General Information

1.0 Introduction

The Massachusetts Department of Environmental Protection (MassDEP) established the Massachusetts Estuaries Project (MEP) to monitor and protect estuarine ecosystems in southeastern Massachusetts embayments. MEP's goal is to assess the conditions of these embayments and to develop critical site-specific nitrogen thresholds that could be used as a management tool by communities to identify needed corrective and protective measures for both now and in the future.

Benthic infaunal communities are a good indicator of embayment conditions and are used to assess the level of habitat health from healthy (low organic matter, high dissolved oxygen) to highly stressed (high organic matter, low dissolved oxygen). Communities in benthic assemblages respond to a variety of stressors in different ways allowing the type of stress affecting the assemblage to be identified. As many macroinvertebrates have relatively long life cycles of a year or more and are relatively immobile, the structure of the assemblage is a response to past and/or present conditions (Howes et al. 2003, US EPA 2020). MEP uses the approach, which is accepted by the regulatory community, that the pollution tolerance of individual species allows their use as indicators in relation to pollution effects on estuarine and marine habitats.

The objectives of the MEP benthic monitoring are to assess embayment ecological health and to determine if long term changes are occurring in southeastern Massachusetts estuaries that may indicate stress from nutrients and other factors including invasive species and climate change.

This document constitutes the Standard Operating Procedures (SOP) manual for the field tasks of benthic monitoring for the Massachusetts Estuaries Project. The goals of this SOP are to (1) provide sufficiently detailed instructions to enable field technicians to follow consistent and technically valid protocols, and to (2) document the field procedures used in these surveys.

2.0 Technical Approach

MEP benthic monitoring will include sampling to support a sediment and benthic macroinvertebrate community characterization. The approaches to conducting sampling for this characterization are described below in Sections 2.1 (water quality), 2.2 (soft-bottom infaunal and sediment), 2.3 (under digital still images and/or video), 2.4 (hard-bottom/ riprap destructive), and 2.5 (soft-bottom sediment profile imagery). All MEP benthic monitoring will be conducted in August-October. Sampling in this period is consistent with previous MEP benthic monitoring procedures and the National Coastal Condition Assessment (NCCA). Benthic sample locations in previously assessed embayments will be determined by MassDEP using existing benthic sampling locations and the process

described in the MEP Benthic Monitoring QAPP (MassDEP 2025a). Benthic sample locations in unassessed embayments will be determined following a Generalized Random Tessellation Stratified (GRTS) sampling design as described in the MEP Benthic Monitoring QAPP. Sample locations for all monitoring approaches will be identified by latitude and longitude (decimal degrees) in the Embayment Specific Study Plan and approved by MassDEP prior to field activities.

All ecological sampling activities performed by the Town or town representatives (Town staff, seasonal employees, volunteers, and/or contractors) for MEP benthic monitoring will be conducted following the provisions of: (1) a Massachusetts Division of Marine Fisheries Scientific Collector's Permit, and (2) any local permits that are required.

The chief scientist must notify the project manager and MassDEP, Town or teaming partner before any unanticipated changes to the survey sampling occur. Examples of unanticipated changes include, but are not limited to, an unanticipated barrier, mooring field, or eelgrass is encountered, any changes to sample locations or transects, and/or length and proximity of video sites. This notification requirement will ensure that the survey will be conducted as stated in the Survey Plan and the selected procedures in this Field SOP unless there is a compelling reason for modification. The notification will also facilitate a brief discussion between the chief scientist, project manager, and MassDEP, the Town, or teaming partner, which will help ensure that possible consequences for data collection and data quality are considered.

2.1 Water Quality Measurements

Benthic macroinvertebrate community structure is influenced by water quality, including water temperature, dissolved oxygen (DO), pH and salinity. Water quality data will be used to understand the different communities that can be observed in an estuary and indicate areas that may have impairment. Water temperature, DO, pH, and salinity measurements will be taken at each station prior to soft-bottom infaunal, sediment, or hard-bottom destructive sampling with a calibrated multi-parameter water quality sonde. Measurements will be taken at specific depth intervals, consistent with the NCCA (See Section II), within 37 meters of the designated station location. Water quality data will be submitted via an electronic file.

2.2 Soft-Bottom Macroinfauna and Sediment Sampling

The benthic macroinvertebrate assemblage and the sediment (i.e., grain size and total organic carbon) present at stations selected throughout an embayment will serve as the basis for assessing embayment health. Sediment samples (for benthic macroinfauna and sediment characteristics) will be collected using a 0.04-m^2 Young-modified Van Veen grab. Benthic stations will be located and verified using marine navigation grade GPS with the coordinates provided in the Embayment Specific Study Plan. Along with the collection of the benthic samples, the field crew will also complete the field processing of those samples. Macrofauna samples will be gently washed through a 0.500 mm-mesh sieve and preserved

in 10% buffered formalin. Samples will be kept in the custody of the chief scientist and transferred with appropriate Chain-of-Custody forms to the laboratory for processing.

Additional grab samples will be collected for grain size analysis and total organic carbon at each of the sampling stations.

2.3 Digital Still Image and/or Video Monitoring

Underwater still images and video are used to document the current condition of an area and provide a landscape perspective on the benthic habitat with information including substrate characteristics, habitat relief, the occurrence of large identifiable taxa, species relationships, and human impacts (e.g., plastic trash, lost fishing gear, and fishing activities and effects). To achieve high quality underwater still or video images, the field crew will deploy the camera and record the still images or video prior to any bottom disturbing collection activity. A drop camera system will be deployed to record a minimum of 2 digital still image or 2 minutes of video of the bottom at each station prior to soft-bottom macroinfauna and sediment sample collection. For hard-bottom or riprap areas, a drop camera, towed camera, or SCUBA divers will be deployed to record digital still images or video of the bottom prior to all hard bottom/riprap destructive sample collection or as a stand-alone hard bottom survey. The Embayment Specific Study Plan will specify the underwater digital image approach or approaches to be used for embayment monitoring prior to field activities. Upon arrival to the station location, the depth will be verified using the onboard depth sounder and recorded on the appropriate datasheet.

Digital images (still or video) will be collected by a drop camera using a high definition (HD) digital camera. The drop camera will be attached to a frame that either captures a 1.0 m^2 quadrat in the view frame or has two attached scaling lasers with a range of 5 to 10 centimeters at 100 feet separation. Prior to deploying the drop camera, an image of a whiteboard with the date, time, and station number written on it will be taken. The camera will be lowered to an elevation 2 to 4 feet off the bottom. Turbidity can be a limiting factor; the final elevation will be determined on site at the time of the monitoring. The drop camera will be monitored in real time by a field biologist onboard the vessel to ensure quality is acceptable for a detailed review.

Digital still images can be collected by SCUBA divers using a HD digital camera with attached lights in conjunction with a 1.0 m^2 quadrat (e.g., aluminum, PVC). At each sampling location an image of a dive slate with the date, time, and station number written on it will be taken. The quadrat will be placed horizontally on the substrate and a minimum of two images will be collected at each sample location. Images will be taken perpendicular to the bottom, at a uniform distance from the surface across all samples. If turbidity causes poor visibility, a smaller quadrat (0.5 m^2) may be substituted with a minimum of 4 images collected at each location.

Digital video can be collected by SCUBA divers using a HD digital camera with two attached scaling lasers with a range of 5 to 10 centimeters at 100 feet separation. The

beginning of each video will include a shot of a whiteboard or dive slate with the date, time, and station number written on it. Digital video will be conducted along 100-foot transects. If a specific feature is being recorded, the transect will be centered on the feature and be parallel to its longest dimension. The camera will be maintained at a constant elevation off the bottom of 2 to 4 feet if possible. Turbidity can be a limiting factor; the final elevation will be determined on by the divers at the time of the monitoring.

All original field datasheets and associated digital image files will be generated by and remain in the custody of the Chief Scientist. Appropriate Chain-of-Custody forms will accompany the samples when transferred from the field to the laboratory for analysis.

Stand-alone Video Survey (Optional) – A stand-alone video survey will be conducted if proposed in the Embayment Specific Study Plan. Digital video will be collected by a towed camera unit, remotely operated underwater vehicle (ROV), or two SCUBA divers. The digital camera will have two attached scaling lasers with a range of 5 to 10 centimeters at 100 feet separation. The beginning of each video will include a shot of a whiteboard with the date, time, and station number written on it. At least 20 minutes of HD video footage will be obtained from each station or area. If transects are established and conducted using a camera system towed from a vessel, the vessel will move at approximately ¼ knot speed during video recording in order to maintain position along the transect. The slow vessel speed will enable clear, detailed, and reviewable video images to be obtained. If divers or a remotely operated underwater vehicle (ROV) are used to conduct the survey, the survey vessel will be anchored near the station to maintain position. Specific stations, areas, or transect locations and length will be determined in the Embayment Specific Study Plan prior to field activities. For transects, the transect length may extend beyond the area or feature of interest (e.g., hard-bottom or riprap boundaries); as doing so will enhance the overall understanding of the embayment. The tow camera unit will maintain a constant elevation off the bottom of 2 to 4 feet if possible. Turbidity can be a limiting factor; the final elevation will be determined on site at the time of the monitoring. The video will be monitored in real time by a field biologist onboard the vessel (except for surveys conducted by divers) to ensure quality is acceptable for a detailed review.

All original field datasheets and associated digital image files will be generated by and remain in the custody of the chief scientist. Appropriate Chain-of-Custody forms will accompany the samples when transferred from the field to the laboratory for analysis.

2.4 Hard-Bottom/ Riprap Destructive Sampling (Optional)

Hard-bottom or riprap destructive sampling will be conducted if proposed in the Embayment Specific Study Plan to quantitatively characterize the macrofauna and macroflora found on hard surfaces in the embayment. Hard-bottom or riprap destructive sample locations will be determined by GRTS sampling design as described in the MEP Benthic Monitoring QAPP (MassDEP 2025a) and identified in the Embayment Specific Study Plan prior to field activities.

Destructive samples will be collected by divers using a 1/16 m^2 frame placed horizontally on the hard substrate and an airlift dredge. The diver will take a digital photograph with an underwater camera (e.g., GoPro, Sony), and note total percent cover of macroalgae found within the frame and any finfish observed in the area before sample collection. Total percent cover of macroalgae will be characterized using the modifiers defined in the Coastal and Marine Ecological Classification Standard (CMECS) presented in Table 1. The sample will then be collected into a 0.79 mm mesh bag. The square is to be vacuumed at a high suction rate to capture the highly motile organisms, then large organisms such as echinoderms and algae will be picked by hand and placed into the bag. The area within the frame will then be cleaned of all organisms. The bag will be removed, tied, returned to the surface, and the sample preserved in 10% buffered Formalin. Samples will be kept in the custody of the chief scientist and transferred with appropriate Chain-of-Custody forms to laboratory staff for processing.

Table 1. Percent Cover Modifiers (FGDC 2012).

Coarse Percent Cover Values	**Fine Percent Cover Values**
Trace	< 1%
Sparse (1 to < 30%)	1 to < 10%
	10 to < 20%
	20 to < 30 %
Moderate (30 to < 70%)	30 to < 40 %
	40 to < 50 %
	50 to < 60 %
	60 to < 70 %
Dense (70 to < 90%)	70 to < 80 %
	80 to < 90%
Complete	90 to 100%

2.5 Soft-Bottom Sediment Profile Image (Optional)

Soft-bottom Sediment Profile Imagery (SPI) will be conducted if proposed in the Embayment Specific Study Plan. SPI sample locations in previously assessed embayments will consist of all of the existing benthic locations sampled during the initial assessment found in the embayment technical report and re-identified in the Embayment Specific Study Plan. SPI sample locations for unassessed embayments will be determined by GRTS sampling design as described in the MEP Benthic Monitoring QAPP and identified in the Embayment Specific Study Plan.

A sediment profile camera system will collect at least three photographic images for analysis from each station generally within the first 12 seconds after bottom contact. The sediment profile images will be reviewed and the following parameters evaluated: sediment grain size; sediment layering, thickness, and type; surface and subsurface fauna and

structures; approximate prism penetration depth; approximate surface relief; approximate apparent redox potential discontinuity (aRPD; the transition from oxidized to reduced sediment conditions) depth, and other major, readily discernable patterns. The aRPD depth will be categorized using the CMECS depth modifiers (Table 2). All original SPI field datasheets and associated video and digital image files will be generated by and remain in the custody of the chief scientist. Appropriate Chain-of-Custody forms will accompany the samples when transferred from the field to the laboratory for analysis.

Table 2. aRPD Depth Modifier (FGDC 2012).

aRPD Depth Values	**aRPD Depth (centimeters)**
Zero	0.0
Diffusional	> 0.0 to 1.0
Shallow	> 1.0 to 2.0
Moderate	> 2.0 to 3.5
Deep	> 3.5 to 5.0
Very Deep	> 5

3.0 Sampling Schedule and Logistics

Benthic sampling will be conducted during August-October of a sampling year. Embayment specific surveys and sampling locations will be determined and described in the survey plan section of the Embayment Specific Study Plan following the MEP Benthic Monitoring QAPP (MassDEP 2025a) prior to field activities. The embayment specific survey plan will detail the schedule of operations, field team, vessel, benthic monitoring surveys to be conducted, sequence of tasks and events, sampling location and coordinates of each station, and sample handling and custody.

4.0 Sample Site Selection

Benthic sample locations in previously assessed embayments will be determined by MassDEP using existing benthic sampling locations and the process described in the MEP Benthic Monitoring QAPP (MassDEP 2025a). In unassessed embayments, benthic sample locations will be determined following a GRTS sampling design as described in the MEP Benthic Monitoring QAPP. The number of sampling locations will depend on the approach and tier selected for each embayment. Sample locations will be identified in the survey plan section of the Embayment Specific Study Plan prior to field activities. Preceding each survey, the field team will receive a listing of sampling locations that includes the Site ID, Sample ID, Latitude and Longitude for each location, along with a map of sampling locations. The list of sampling locations will include Alternate locations that will be used if sampling cannot be conducted at the Primary locations.

A review of access to sample locations in previously assessed embayments or a site evaluation for unassessed embayments will be performed prior to the start of field work to identify issues with boat access to small or narrow sub-embayments. An access review will provide an opportunity to identify any problems with access before sampling and allows for a discussion with MassDEP, the Town, or teaming partner to finalize the stations in the area and possible alternative locations. The site evaluation will ensure sampling locations and alternative locations meet the target population identified in the selected GRTS survey design. The evaluation will also provide initial verification of site suitability and further align the MEP benthic monitoring protocols with the National Coastal Condition Assessment and Massachusetts Coastal Condition Assessment programs. A desk study is recommended for both the access review and the site evaluation to help minimize costs.

Sampling sites will be located by the field team using shipboard differential Global Positioning Systems (GPS).

In general, water quality, benthic, and sediment samples will be collected within a 37 m radius of the predetermined sample locations (point X). However, if grab samples cannot be collected at point X, they can be collected at another location within the 37 m radius of point X.

If acceptable grab samples cannot be collected within the 37 m radius, they may be taken in the >37 m to 100 m radius area of point X without the need to resample the water quality. If sediment samples still cannot be obtained after 3 attempts within the 100 m radius of point X, that site location will be designated as "completed, no sample", and noted as such on the field data sheet.

5.0 Quality Assurance

The MEP has developed a Quality Assurance Project Plan (QAPP; MassDEP 2025a) that presents the organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities associated with the Benthic Monitoring. The QAPP describes the specific protocols that will be followed for sampling, sample handling and storage, chain of custody, laboratory and field analyses, data review and validation, document management, data management, and data usability assessment. Aspects of QC and QA procedures from the QAPP are summarized below.

5.1. Quality Control

The function of QC is to continually monitor the reliability and validity (accuracy, precision, and completeness) of data produced on a daily basis. The QAPP has been approved by MassDEP and any changes to the procedures must be coordinated with MassDEP through the current Massachusetts Estuaries Project Manager. For the Benthic Monitoring, chief scientists will act as quality control supervisors who will:

- Monitor performance and results of quality control procedures;
- Monitor instrument maintenance, calibration, and reliability;

- Monitor sample control procedures and documentation; and
- Monitor training of technicians.

Specific sample control procedures including packaging, preservation and Chain-of-Custody (COC) for each task are documented in Sections II through VI of this SOP. In general, each sample is given a unique sample number. Each sample is then tracked by its sample number from field collection and throughout the laboratory and data processing functions. Daily collection of samples is tracked from the field site to the laboratory for final analysis by means of a COC form. At the laboratory each sample is tracked through each storage and analysis step by means of sample control logs. The function of this process is to provide a paper trail of who performed each step in the analysis of a sample from collection to storage, when each step occurred, what condition the samples were in and where each step took place.

Data Control Procedures

Specific data control procedures for completing datasheets and COC forms are documented in Section VII Data Handling of this SOP. In general, all completed datasheets are maintained by the Project Manager. The project field files contain the following documentation:

- Embayment Specific Study Plan,
- Field Standard Operating Procedures,
- Copies of all datasheets,
- Sample and data logs.

Training of Technicians

To assure the standardization of field procedures, a two-level system for training field team members will be used. The first level is documented standard operating procedures, and the second level is a training program for all new project personnel. At a minimum, this training program consists of:

- A complete reading and explanation of the project QAPP and field SOP.
- The Field Manager will observe the first two or more times a new procedure is performed.
- Personnel assigned to unfamiliar tasks are accompanied by an experienced team member for at least their first two attempts.

5. 2 Quality Assurance

The function of QA is to verify the achievement of quality through all phases of a project. This is accomplished primarily by audits, tests, and surveys that provide objective evidence that quality control programs are being implemented. Field tasks are subject to at least one audit per sampling year. The audit is conducted by a QA Manager, who reviews the operations, plans, and survey objectives and examines the acquisition and transfer of data from the field to the laboratory.

Audit results are presented to the appropriate project management by the QA Manager after the audit has been completed. At this time, specific findings are presented, and recommended courses of corrective action developed. The audit results are documented in a written report and reviewed by the Project Manager and chief scientist that have responsibility in the area audited. These reports include a summary of audit results, observations made with a listing of non-conformities, recommendations and corrective action taken.

The QA Manager and Project Manager maintain files of all project audits. This file includes copies of the audit checklists, audit reports, written replies, the record of completion of corrective action and follow-up action.

5.3 Non-Conforming Items and Corrective Action

Documentation of problems or unusual events occurring during a survey is accomplished using Extraordinary Event/Nonconformity (EE/NC) Report. The EE/NC Report is designed to dispense information to the Project Manager and the QA Manager and to obtain necessary action on items that are critical to technical operations. The EE/NC Report is used to describe results from observations such as:

- Losing a sample
- Noting samples that are grossly different from expected (content, preservation, labels)

The EE/NC Report is designed for use by any person who identifies a problem. The originator's supervisor is responsible for delivery of the completed form to the Project Manager. The Project Manager must respond within ten working days. The contracted QA Manager is informed of each report and maintains an awareness of the status of follow-up.

Samples or data not in conformity with specifications or which do not meet preconditions for the next step in processing or use, are set aside until the problem is resolved and documented via the EE/NC procedure detailed in the MEP Benthic Monitoring QAPP.

EXTRAORDINARY EVENT/NONCONFORMITY REPORT

EE/NC Report Number:

Project Name: _____

Date: _____

Originator: Name: _____

Problem: _____

Recommendation: _____

_____

Signature: _____ Date: _____

Project Manager: Name: _____

Recommendation: _____

_____

_____

Signature: _____ Date: _____

Quality Assurance: Name: _____

Response: _____

_____

Signature: _____ Date: _____

Project Manager: Name: _____

Report Filed: _____

Signature: _____ Date: _____

Distribution List of Copies: _____

_____

Figure 1. Extraordinary Event/Nonconformity Report.

6.0 References

FGDC (Federal Geographic Data Committee). 2012. Coastal and Marine Ecological Classification Standard. June 2012. Marine and Coastal Spatial Data Subcommittee, Federal Geographic Data Committee. June 2012. FGDC-STD-018-2012. 343 pp.

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II. Field Standard Operating Procedures for Water Quality Measurements

Measurements for water temperature, dissolved oxygen (DO), pH, and salinity will be taken at each station prior to soft-bottom infaunal, sediment, or hard-bottom destructive sampling using a calibrated multi-parameter water quality sonde. At the start and end of each sampling day the multi-parameter sonde will be calibrated following the manufacturers' recommended procedures for each probe. The calibrations will be recorded on a Calibration Log (Figure 2). If the water quality sonde manufacturer provides a calibration worksheet, use the manufacturer's worksheet to document the calibration. Water quality will be submitted by the Chief Scientist by an electronic file.

1.0 Equipment List

Water quality measurements will be taken with a calibrated multi-parameter sonde. The following is the supply list for collecting measurements:

- Multi-parameter water quality meter with a data recorder and temperature, DO, pH, and salinity/conductivity probes
- Extra batteries

Following is the supply list for calibrating the multi-parameter sonde:

- De-ionized water
- Calibration cups
- Calibration standards, solutions, and/or buffers
- Thermometer
- Barometer to use for calibration

2.0 Gear Deployment

The following describes the sampling procedure to obtain water temperature, DO, pH, and salinity consistent the NCCA Field Operations Manual (US EPA 2020).

1. Use the vessel instrumentation to measure the total water depth at the station to the nearest 0.1 m and record on the Sample Collection form (See Section III, Figure 4). The hydrographic profile data will be electronically recorded and submitted by an electronic file.
2. Lower the sonde into the water and record single water temperature, DO, pH, and salinity measurements at each depth after all readings have stabilized. Measurements will be collected at the following depths: 0.1 m below the surface, 0.5 m below the surface, every 1 m from depths of 1.0 to 10.0 m, and if the site is deeper than 10 m, every 5 m thereafter. Take the last set of measurements at 0.5 m from the bottom, making sure to not let the sonde touch the bottom. If the sonde touches the bottom wait for the sediment disturbance to settle for a minimum of 5 minutes.

3. The field crew will note any questionable measurements and retake the water quality measurements at the same depth interval as the probe is retrieved (upcast). The second measurements will be used to verify the initial readings.
4. The field crew will note any measurements that need further comment or when a measurement cannot be made. The explanation of these notes will be placed on the Sample Collection form.

3.0 Form

Calibration Log

Date	**Time**	**Equipment**	**Initials**
	Present	**Should Be**	**Adjusted To**
Battery level			
Temperature °C	(Instrument =I)	(Certified therm. = T)	**ΔT=I - T**
Barometric Pressure			
Dissolved Oxygen	present reading mg/L %	 100%	 mg/L %
Conductivity		50.00	
pH		7.00	
		10.00	

Figure 2. Example of a Calibration Log.

III. Field Standard Operating Procedures for Soft-Bottom Infaunal and Sediment Sampling

Soft-bottom benthic sample collection will be conducted in the following order:

1) Collect water quality measurements (See Section II);
2) Deploy drop camera and take digital images of the bottom (See Section IV);
3) Collect macrofauna sample;
4) Collect sediment sample for grain size and total organic carbon (TOC)

1.0 Equipment List

A 0.04-m^2 Ted Young-modified Van Veen grab sampler will be used to collect soft-bottom sediment samples for benthic macrofauna and sediment characteristics (grain size and TOC) analyses. Following is the supply list for collecting samples:

- Young-modified Van Veen grab with grab stand or frame if needed
- Weights and pads for grab
- Nitrile gloves
- Plastic tub or bucket
- 0.500 mm screening bucket or stainless steel sieve
- Sieve box or bucket
- Electrical tape
- Forceps (fine-tipped)
- Funnel (wide-mouth)
- Formalin[1,2] (37% formaldehyde)
- Borax[3]
- Ruler (cm)
- Squirt bottle (ambient water)
- Stainless steel mixing pot or bowl with lid
- Stainless steel or Teflon spoons (15”), scoops, or spatula
- Glass, Nalgene or other sturdy plastic, wide-mouth sample jars (500 ml) with lids
- Glass, Nalgene or other sturdy plastic, wide-mouth sample jars (125 ml) with lids
- Plastic bags (e.g., Whirl Pak, for grain size samples)

[1] Follow safe chemical handling procedures including: the use of personal protective equipment (e.g. gloves and safety glasses), the manufacture’s Safety Data Sheet recommendations, and the OSHA Formaldehyde Standard (29 CFR 1910, 1048) when using this chemical.
[2] A prepared 10% buffered formalin solution can be used for samples and purchased through laboratory chemical suppliers.
[3]Borax is necessary as buffer only if you are preparing your own 10% buffered formalin solution.

- Scrub brush
- Cooler with wet ice.

The following items will also be needed for recording measurements:

- Survey Log form (Figure 4)
- Sample Collection form (Figure 5)
- #2 Pencils
- Waterproof paper for internal sample jar labels
- Fine-tipped indelible markers
- Write-on yellow tape or pre-printed write on labels
- Clear tape strips

2.0 Gear Deployment

The Van Veen grab sampler will be used to collect sediment samples for benthic macrofauna and sediment characteristics. Three grab samples (2 to be sorted and 1 archived) for macrofauna and one grab sample for sediment characteristics will be collected from each benthic station.

Once the survey vessel is on station and coordinates have been verified, the water quality and underwater video surveys will be performed (see Sections II and IV). Once these surveys have been completed, the sediment grab will be deployed. When slack in the winch wire indicates that the grab is on the bottom, the grab and captured sample will be brought back to the surface. Upon retrieval of the grab, the sample will be inspected for acceptability (sufficient quantity, undisturbed surface layer, not washed out; Figure 3). If the sample is unacceptable, the grab will be emptied, rinsed, and redeployed.
Precautions will be taken during the deployment and retrieval of the grab sampler to prevent contamination of samples between stations. Sampling for infauna, TOC, and grain size all require that the grab and associated sampling equipment be washed and thoroughly rinsed between sampling stations.

The following describes the sampling procedure to obtain sediment samples as outlined in National Coastal Condition Assessment (NCCA) Field Operations Manual (US EPA 2020).

Note: *The sampler, spoons and mixing bowl or bucket must be thoroughly rinsed with ambient water after sampling at each site to ensure no sediments remain. This practice reduces the risk of the equipment carrying residues from site to site.*

1. Attach the sampler to the end of the winch cable with a shackle and tighten the pin (or secure the pin with a cable tie).

2. Set the grab according to the manufacturer's instructions and disengage any safety device designed to lock the sampler open.
3. Lower the grab sampler through the water column such that travel through the last 5 meters is no faster than about 1 m/sec. This minimizes the effects of bow wave disturbance to surficial sediments.
4. Allow a moment for the sampler to settle into the substrate and then allow slack on the cable (letting the cable go slack serves to release the jaws of the sampler so they will close as the sampler is retrieved).
5. Retrieve the sampler and lower it into its cradle or a plastic tub on-board. Open the top and determine whether the sampling is successful or not (see Figure 3).
    - A successful grab is one having relatively level, intact sediment over the entire area of the grab, and a sediment depth at the center of at least 7 centimeters.
    - Grabs containing no sediment, partially filled grabs, or grabs with shelly/rocky substrates or grossly slumped surfaces are unacceptable.
    - Grabs completely filled to the top, where the sediment is in direct contact with the hinged top, are also unacceptable.
    - It may take several attempts using different amounts of weight to obtain the first acceptable sample. More weight will result in a deeper bite of the grab. In very soft mud, pads may be needed to prevent the sampler from sinking into the mud. If pads are used, the rate of descent near the bottom should be slowed even further to reduce the bow wave.
6. If, after several attempts, only grabs less than 7 centimeters deep can be obtained, use the next successful grab regardless of the depth of sediment at the center of the grab.
    - Use the comments section on the Sample Collection form (Figure 5) to describe your efforts and be sure to accurately record the depth of the sediment captured by the grab.
7. Carefully drain overlying water from the grab. If the grab is used for benthic community analysis, the water must be drained into the container that will receive the sediment to ensure no organisms are lost.
8. Enter notes on the condition of the sample (smell, substrate, presence of organisms on the surface, etc.) in the Sediment Characteristics section of the Sample Collection form.
9. Process the grab sample for either benthic community analysis or sediment testing as described below.
10. Repeat steps 3-9 until all samples are successfully collected. To minimize the chance of sampling the exact same location twice, the boat engines can be turned periodically to change the drift of the boat, or additional anchor line can be let out.

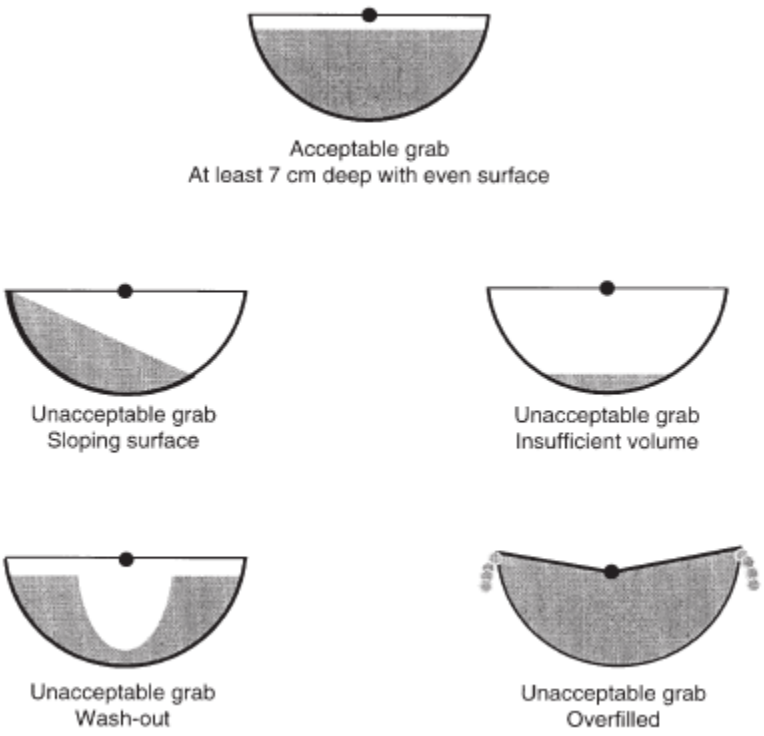

Figure 3. Illustration of acceptable and unacceptable grabs for benthic community analysis using a 0.04m² Van Veen grab sampler (from US EPA 2015).

3.0 Collection Procedure

3.1 Field Processing of Benthic Macrofauna Samples

Prior to sample collection (before the sample jar gets wet), an external label (including station location, replicate number, and date) will be taped to the outside of the jar. The external label may be pre-printed and taped on using clear tape or written directly on write-on yellow tape or a pre-printed adhesive label. Sample jars will be pre-filled with concentrated preservative solution by placing 1 teaspoon of Borax and 125 mL of formalin into a 500 mL sample jar[4], following safe chemical handling procedures. The concentrated preservative solution will produce a 10% buffered formalin-seawater solution when the sample jar is filled with seawater.

If the macrofauna grab sample is acceptable, the sample will be processed. A field description of sediment is recorded following measurement of penetration depth. The sediment should be characterized as being coarse sand, fine sand, silt, clay, gravel, mud, or of a mixed type. The presence of shell hash should also be recorded. Obvious odors, such as

[4] If a prepared 10% buffered formalin solution is used, sample jars to do not need to be pre-filled.

hydrogen sulfide (the odor of rotten eggs), petroleum, other odors, or a lack of noticeable odors should be recorded. General sediment colors (i.e., black, green, brown, red, or gray) should also be recorded. Photographs of the grab may be taken before and after the sample has been sieved; Sample labels (station location, replicate number, and date) will be included in each photograph to identify the sample. The penetration depth of the sample will then be measured using a plastic ruler (marked in millimeters) pushed into the sediment. Any sediment adhering to the surface of the ruler will be rinsed back into the grab for processing with the remainder of the sample. The grab will then be placed over a 0.500 mm screening bucket or sieve, the jaws opened, and the sample emptied into the bucket or sieve. Clean seawater will be used to gently rinse the sample. Large macrofauna or epifauna will be removed and not counted in the sample total (e.g., sand dollars, anemones, shrimp, sea cucumbers, snails, clams, mussels, and hermit crabs). The portion retained on the screen will then be transferred into labeled jars and fixed in 10% buffered formalin in seawater. The sieve will be carefully inspected to ensure that all organisms were removed. A rinse bottle will be used to rinse the outside of the sample bottle onto the screen to capture any organisms that did not make it into the mouth and stuck to the side of the sample jar. Fine forceps can be used if necessary to transfer infauna to the sample jar. Sample jars will be glass, Nalgene or other sturdy plastic jars with screw-capped lids. Using a #2 pencil, fill out an internal label on waterproof paper including station location, replicate number, and date and place in the jar with the sample. Each sample jar will be filled no more than half full of sample material. The sample bottles should then be filled with seawater to the top to achieve the correct preservation dilution and to prevent sloshing during transport, which can result in organisms getting stuck to the cap. If a pre-prepared 10% buffered formalin solution is used, the sample jar should be filled to the top with the prepared solution to prevent sloshing. The jar will be gently turned around on its side to distribute the buffered formalin evenly throughout the sample. The screening bucket or sieve will be washed between samples using copious amounts of forceful water and a stiff brush.

All benthic macrofaunal samples must be handled gently during the sieving process, fixed in 10% buffered formalin as quickly as possible to prevent deterioration of the fauna, and all sample jars must be labeled accurately.

Following each benthic survey, the macrofaunal samples (stored in sturdy coolers) will be driven to the contracted laboratory. The samples to be processed, while still preserved in 10% buffered formalin, can be shipped by FedEx ground or 2-day express delivery (if courier delivery is not feasible). The lids on the plastic sample jars will be taped and the jars inserted individually into large zip-locked or tied plastic bags lined with absorbent padding.

3.2 Field Processing of Sediment Samples

If the grab sample to be used for sediment characteristics (grain size analysis and TOC) meets the acceptability criteria, the water overlying the sample will be siphoned or gently decanted from the grab. The surface sediment (0 to 2 cm) will then be collected with a scoop and transferred to appropriate storage containers provided by the laboratory. Laboratory

instructions regarding fill levels and sample handling will be followed. If it is necessary to collect more than one grab to obtain sufficient material for analysis, the grabs will be homogenized before subsampling. The sediment samples must be kept cold or frozen. All samples will be kept on ice in coolers during transport. Sample labels will be checked to ensure that all station information is complete and matches the field datasheet and COC.

Grain Size Analysis
Use a scoop to collect the upper 0–2 cm from the grab, homogenize, and collect approximately 50 ml subsample for grain size analysis. Place sediment into a clean, labeled, 125 ml wide-mouth jar (4 oz) or plastic bag. Samples once transferred to the laboratory can be refrigerated for up to 28 days.

TOC
Use a scoop to collect the upper 0–2 cm from the grab, homogenize, and collect approximately 50 ml for TOC. Place sediment into a clean, labeled, 125 ml wide-mouth jar (4 oz). Samples once transferred to the laboratory can be frozen for up to 28 days.

4.0 Sample Form

The chief scientist may retake a sample if he/she/they feels any problems have prevented a valid sample.

For grab samples, a waypoint will be entered into the shipboard GPS when a sample is collected. The marker set for each waypoint will be named as the station name, with the replicate number appended. Waypoints will be stored separately for the grab survey. A QC check of waypoints against the recorded coordinates will be done after each sample is collected. Waypoints will be stored on the shipboard GPS until data checking confirms that all samples were collected within 37 meters of the target station location. Any sample coordinates found through data checking to be outside of the 37-meter station radius will be compared against the sample coordinates for the stored waypoint. Thus, if an incorrect waypoint is identified through data checking, the hand-entered data will be compared to the electronic waypoint on the GPS, and any error discovered in the navigational data will be corrected as necessary.

At the beginning of each station, the date, arrival time, weather, and names of all field crew members present will be entered (see Survey Data Sheet; Figure 4). Measurements made and samples collected will be recorded on pre-printed Sample Collection Forms (Figure 5).

Information specific to sample collection will include:

- Station name
- Sample identification number
- Time and date of sample collection
- Sample description (color, texture, etc.)
- Samplers' initials

- Requested analyses
- Location (the latitude and longitude coordinates where a sample is collected).

MASSACHUSETTS ESTUARIES PROJECT: BENTHIC SURVEY DATA SHEET

Embayment Name:		**Time (Arrive/Depart)** /
Date:	**Weather:**	**Sea State:**
Station ID:	**Crew:**	**Chief Scientist:** **QA/QC confirm** ☐

Water Quality: Water Temp, DO, pH, Salinity

Time: _____ **Calibration Completed** ☐ **Surface to** _____ **(bottom depth m)**

Profile Taken ☐ **Number of Measurements** _____

Survey Type:

Digital Video ☐

Digital Still ☐

Soft-bottom Benthic Grab ☐ **Number of Samples Taken** _____

Samples taken within 37 m of station location? Y/N (If no, provide information below)

If GRTS survey, include information on "oversample" locations below.

Other ☐

Notes

Figure 4. Example of a Benthic Survey Data Sheet.

Sample Collection Form: Soft-Bottom Infaunal and Sediment Grab Samples

MEP Project Name:

STATION: ________________ TIME ON STATION:________________ STATION DEPTH (M):________________DATE:________________	Weather:________________________ Recorded By:________________________
Sample data	**Field Measurements**
Sample ID:	Grab Size: 0.04-m²
Latitude:	Grab Penetration (cm):
Longitude:	Sediment Texture:
Replicate:	Other:
Time:	Analyses: (circle all applicable) GR TOC FA
Sieved By:	Organisms observed:
Comments:	
Sample ID:	Grab Size: 0.04-m²
Latitude:	Grab Penetration (cm):
Longitude:	Sediment Texture:
Replicate:	Other:
Time:	Analyses: (circle all applicable) GR TOC FA
Sieved By:	Organisms observed :
Comments:	
Sample ID:	Grab Size: 0.04-m²
Latitude:	Grab Penetration (cm):
Longitude:	Sediment Texture:
Replicate:	Other:
Time:	Analyses: (circle all applicable) GR TOC FA
Sieved By:	Organisms observed :
Comments:	
Sample ID:	Grab Size: 0.04-m²
Latitude:	Grab Penetration (cm):
Longitude:	Sediment Texture:
Replicate:	Other:
Time:	Analyses: (circle all applicable) GR TOC FA
Sieved By:	Organisms observed :
Comments:	
GR = grain size, TOC= total organic carbon, FA = Infauna	

Figure 5. Example of a Sample Collection Form.

IV. Field Standard Operating Procedures for Underwater Still Images and/or Video

Digital images will be taken before benthic grab sampling is conducted. Digital still or video images for a single sampling location will be accomplished by using a drop camera or two SCUBA divers. SCUBA divers (optional) are recommended in more turbid waters and areas with riprap due to their maneuverability compared to a towed system. A high definition (HD) digital camera in an underwater housing with either scaling lasers or lights with a 5 to 10 cm (2 to 4 inches) separation or a visible quadrat will be used. Sampling locations will be determined in the Embayment Specific Study Plan prior to field activities. If SCUBA divers are used to obtain digital still images the HD digital camera will be used in conjunction with a 1.0 m^2 quadrat placed horizontally on the substrate. SCUBA divers will follow safe diving practices during field activities.

A stand-alone digital video survey (optional) will be accomplished by the use of a towed underwater camera, a ROV, and/or two SCUBA divers using a HD digital camera in an underwater housing with scaling lasers or lights with a 5 to 10 cm (2 to 4 inches) separation. Digital video will be conducted along 100-foot transect centered on the hard-bottom feature and parallel to its longest dimension. Transect length will be determined in the Embayment Specific Study Plan prior to field activities. At each station, simultaneous high-definition video (1080 p) and still images will be captured with the digital camera (e.g., GoPro Hero 4).

To achieve high quality underwater still images or video the field crew will deploy the camera and record the video or still images before collecting soft-bottom infaunal, sediment, or hard-bottom/riprap destructive samples. Avoid heavy disturbance of the bottom with anchors prior to capturing the video and still images. Camera lenses will be checked for debris and water droplets and carefully cleaned using a soft absorbent cloth after each time the waterproof case is opened to replace batteries or download images. In addition, in-field video or still image review will occur in a shaded or darkened area to help improve screen visibility and reduce glare from sunlight. A computer monitor or large screen is recommended.

1.0 Equipment List

- GPS unit, either vessel navigation system or handheld
- Survey boat
- Camera frame or sled (for a drop or towed camera system)
- SCUBA equipment (for diver survey; includes 2 of each - compasses, depth gauges or dive computers, scuba tanks, buoyancy compensators with correct weights, regulators, masks and snorkels, fins, dive knives, and wetsuits)
- 2 small all-purpose buoys (for diver survey)
- Weighted lines (for diver survey)
- White board

- Dry erase markers
- Laptop computer
- Computer monitor (for a drop or towed camera towed system)
- Camera cable (100 feet; for a drop or towed camera system)
- 2 external hard drives (500 GB or larger in size)
- Video: High definition (HD) digital camera with underwater housing and strobes in video mode (use a low light camera if possible)
- Video: Two scaling lasers or lights
- Still Images: HD digital camera with an underwater housing (use a low light camera if possible)
- Still Images: 1.0 m^2 quadrat

2.0 Gear Deployment:

2.1 Drop or Towed Camera Systems

Video recordings are made using a HD digital camera in an underwater housing and strobes in video mode attached to a frame or sled with on-board computer monitor.

1) Obtain transect or station locations from the Embayment Specific Study Plan prior to video or still image survey.
2) Program geographic position system (GPS) points for each transect or station into GPS unit prior to the field effort and correct by Wide Area Augmentation System (WAAS) to an accuracy of ±3.0 – 3.5 meters.
3) Locate and verify each station location or the start and end points for each transect in the field with the GPS.
4) Attach the camera, lights, and scaling lasers to frame or sled and check the connection to the on-board computer monitor. Check all equipment for proper functioning. Check the camera battery life to ensure enough power is available to record the entire transect or station.
5) While the camera is still out of the water, start recording.
6) Image the white board with the date, time, and station at the start of video or still image recording at each transect or station.
7) Lift the frame or sled, gently place it over the side of the vessel, and slowly lower the system to the bottom. Confirm good image quality and distance from the bottom using the on-board computer monitor.
8) The camera system is held approximately one meter off the bottom to attain a field of view of one square meter. Turbidity can be a limiting factor; in areas of poor visibility the frame or sled can be lowered to maintain image clarity.
9) For video recording, the camera system will be towed at a speed of approximately 0.25 knot or the lowest speed possible to maintain course and direction and clear imagery.

10) For still images, the drop camera will be lowered and a minimum of 2 images of the bottom will be collected at each station. Images will be taken perpendicular to the bottom.
11) Upon completion of video or still image collection, slowly bring the camera system to the surface and lift the frame or sled back on board the vessel.
12) Review the video or images on the camera to ensure the data was saved correctly on the data card. Check the camera battery life and data card storage capacity.
13) Exchange batteries or data card as required between stations. Download data card immediately upon its removal from the camera to two external hard drives. One external hard drive will serve as the primary drive and be used to review the video or still images. The other drive will serve as a backup drive in case the primary drive becomes corrupted. Confirm files were properly saved to the external hard drives.

2.2 Divers Camera Use

1) Obtain transect or station locations from the Embayment Specific Study Plan prior to video or still image survey.
2) Program geographic position system (GPS) points for each transect into GPS unit prior to the field effort and correct by Wide Area Augmentation System (WAAS) to an accuracy of ±3.0 – 3.5 meters.
3) Locate and verify each station location or the start and end points for each transect in the field with the GPS.
4) Deploy weighted lines with buoys attached at each end from the survey boat between the points for each transect. The lines are weighted at each end and at varying intervals to minimize movement of the lines from the designated alignment between the beginning and end points and to prevent drift due to tides or currents. The lines are marked in 10-meter intervals.
5) Attach the lights to the camera and check all equipment for proper functioning. Check the camera battery life to ensure enough power is available to record the entire transect or station.
6) While the camera is still out of the water, image the white board with the date, time, and station or transect.
7) For video recording, two divers will swim each transect line maintaining a constant elevation off the bottom of 2 feet -4 feet at each transect. Turbidity can be a limiting factor; in areas of poor visibility the divers can lower their elevation to maintain image clarity. The camera is held approximately one meter off bottom to attain a field of view of one square meter.
8) Still images are collected using 1.0 m^2 quadrat placed horizontally on the substrate at pre-determined locations along each transect. A minimum of 2 images will be collected at each sample location. Images will be taken perpendicular to the bottom, at a uniform distance from the surface across all

samples. Biological data and observations on sediment type and other flora and fauna are recorded on a dive slate or with a similar method and then entered onto field datasheets.

9) After the divers have returned to the vessel, review the video or images on the camera to ensure the data was saved correctly on the data card. Check the camera battery life and data card storage capacity.
10) Retrieve the buoys and weighted lines once sampling is completed at the transect.
11) Exchange batteries or data card as required between stations. Download data card immediately upon its removal from the camera to two external hard drives. One external hard drive will serve as the primary drive and be used to review the video images. The other drive will serve as a backup drive in case the primary drive becomes corrupted.

Note: Special certifications are required for the SCUBA work contained in this SOP. All SCUBA diving conducted under this SOP is expected to occur under a Scientific Diving Program. SCUBA divers conducting digital image surveys are required to have a valid and current SCUBA certification from a recognized SCUBA certification organization (e.g., PADI, NAUI, or SSI) along with first aid, CPR/AED, and Emergency Oxygen for Scuba Diving Injuries (Divers Alert Network) certifications.

Disclaimer: The Massachusetts Department of Environmental Protection and the Commonwealth of Massachusetts accept no responsibility and no liability for loss of any kind, including personal injury or property damage due to the work and/or activities described in this Field Standard Operating Procedures.

3.0 Collection Procedure

The date and time will be recorded on the video image. Vessel start and finish positions at each survey location will be captured electronically using a navigational software program or handheld GPS unit. Transect and/or station ID, along with the date, vessel location coordinates, time, and water depth will also be recorded on the Station Log (Figure 6) at the start of each video recording or still image survey. At the end of each video recording or still image survey, the vessel location coordinates, along with the date, time, and water depth will be recorded on the Station Log.

4.0 Sample Form

At the beginning of each survey, the date, start time, weather, and names of all field team members present will be entered (see Survey Log Form, Figure 4). Measurements made and samples collected will be recorded electronically. Information specific to sample collection will include:

- Station name
- Sample identification number

- Time and date of sample collection
- Location (the latitude and longitude coordinates where a survey is conducted)
- Description of benthic habitat observed

Underwater Digital Image Survey **Station Log**		
MEP Project Name:		
Station:	**Date:**	**Survey (circle): Video / Still / Both**
Start Time:	**Start Depth:**	**Start Lat:**
		Start Long:
End Time:	**End Depth:**	**End Lat:**
		End Long:
Bottom Description:		
Notes:		
Video Minutes:		

Figure 6. Example of a Station Log for underwater still image and/or video monitoring.

V. Field Standard Operating Procedures for Hard-bottom/ Riprap Destructive (Infauna and Inflora) Sampling (Optional)

1.0 Equipment List

- 2 yellow mesh bags
- Field datasheets with coordinates
- Pencils
- 2 airlifts with 45º attachments
- (3) < 1.0 mm mesh bags per station and extras
- (2) 1/16 m^2 frames
- 2 small + 2 large sharp scrapers
- Clipboards
- Plastic bags
- Labels
- Survey Forms
- Cooler
- SCUBA equipment (includes 2 of each - compasses, depth gauges or dive computers, scuba tanks, buoyancy compensators with correct weights, regulators, masks and snorkels, fins, dive knives, wetsuits, and Shoe Goo)

Prior to use, all < 1.0 mm mesh bags should be checked for rips, all scrapers should be sharpened, and airlifts and hoses inspected for fitness. Bags with holes in the mesh should be mended or not used. Water quality measurements will be conducted at hard-bottom/ riprap destructive sampling locations before divers enter the water (See Section II above).

2.0 Gear Deployment

At benthic destructive stations, divers will proceed down the line to the bottom taking with them the following:

1. Airlift with 45-degree attachment and SCUBA tank.
2. 0.79 mm mesh bags with elastic cord for attachment to the airlift and appropriate labels and plastic bags for the mesh bag samples to be placed in.
3. Two sharp scrapers, 1 large, 1 small.
4. One clipboard with a Field Datasheet (Figure 7) which has directions (compass azimuth) and distances (number of swim kicks) from the starting location to each replicate. Directions use azimuths rounded to the nearest 5 degrees and number of kicks (1-12) are chosen using a random number table but are selected such that all but two of the five samples will be in different quadrants.
5. 1/16 m^2 frame.
6. Yellow mesh bags.

3.0 Collection Procedure

At the station the following procedures are followed:

1. The first replicate is located by going from the starting location along a specified compass azimuth for the specified kick strokes. A kick stroke is defined as a kick of the right foot in a normal kicking cycle and is closely equivalent to a distance of 1 meter. Care should be taken to avoid kelp and mussel beds.

2. The 1/16 m^2 frame is placed at the first replicate location utilizing the following guidelines:
   - The samples are to be as horizontal as possible.
   - Substrate heterogeneity is to be minimized as much as possible by selecting a flat, crevice free area covered with foliose algae within a 1/2 meter of the original random point.
   - If the original random point falls within an area scraped clear or a dense kelp bed or mussel bed, move back or forward along the specified compass azimuth to the edge of the bed to take the sample. Note the changed location on the field datasheet. Special care should be taken to avoid kelps.

3. Sampling is conducted in the following sequences:
   - The diver will take a digital photograph with an underwater camera and notes on total percent cover of macroalgae (except for the crustose algae) found within the frame, note any finfish observed in the area of sampling, and make appropriate comments on the condition of the sample. Percent coverage will be described using the modifiers provided in Table 2 of this document. The datasheet will be filled out. This is to be done without disturbing the sample area.
   - The sample is then collected into a < 1.0 mm mesh bag using the airlift dredge and a scraper. The square is first vacuumed at a high suction rate to capture highly motile organisms. Large organisms such as mussels, echinoderms and algae should be picked out by hand and placed in the bag. Large rocks should be discarded after all organisms are scraped from them. The area within the frame, including all crevices and rock sides to a depth of 4 in. should be cleaned of all organisms. The crustose algae should be chipped to expose pockets where animals, especially polychaetes, may reside. When sampling is completed, the bag is removed, tied, and placed in a plastic bag. The diver will squeeze as much water as possible from the plastic bag before tying it off. The bag will then be placed in a yellow mesh bag and secured to the airlift or the mooring block.
   - The scraped surface type is recorded on the Field Datasheet after the sample is collected.
   - The diver must match the mesh bag with the proper internal tag that identifies the azimuth of the sample.

4. The remaining replicates are sampled following Steps 1, 2 and 3.
5. A general algae collection for voucher specimens of all macroalgae species at the station, especially those observed within the samples is to be made.
6. Samples will be placed in 500 ml sample jars, fixed with 10% buffered Formalin, and labeled.
7. Destructive and general algae samples are sent along with the completed external labels and appropriate Chain of Custody form to the contracted laboratory.

Note: Special certifications are required for the SCUBA work contained in this SOP. All SCUBA diving conducted under this SOP is expected to occur under a Scientific Diving Program. SCUBA divers conducting hard-bottom/ riprap destructive sampling are required to have a valid and current SCUBA certification from a recognized SCUBA certification organization (e.g., PADI, NAUI, or SSI) along with first aid, CPR/AED, and Emergency Oxygen for Scuba Diving Injuries (Divers Alert Network) certifications.

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4.0 Sample Form

BENTHIC DESTRUCTIVE

Project: _____ Station: _____ Sample: _____

Replicate	A	B	C	D	E
Sample #					
Date					
Time					
Collectors					
Azimuth					
Kicks					
Macroalgae Total % Cover					
Scraped Surface Type					
Smooth					
Irregular					
Creviced					
Finfish	0 = 0	+ = 1-10	++ = 11-100	+++ = 101+	
Gunner					
Pollock					
Other					

Comments: _____

_____

_____

_____

Figure 7. Example of benthic destructive field datasheet.

VI. Field Standard Operating Procedures for Soft-Bottom Sediment Profile Imaging (SPI; Optional)

1.0 Equipment List

The sediment profile camera system consists of a digital camera (e.g., Canon 7D, 18-megapixel sensor) enclosed in a pressure-resistant housing, a 45° prism, and a mirror that reflects an image of the sediment through the camera lens. A strobe mounted inside the prism is used to illuminate the sediment. The prism is also equipped with a video camera with a feed to the surface via cable so that prism penetration can be monitored in real time. The camera/prism system is mounted in a cradle that is secured to a larger frame, which ensures that the prism penetrates the sediment at a 90° angle. In addition, the camera frame supports a plan-view video camera mounted to view the surface of the seabed in front of the prism. Prior to every field deployment, all essential items are gathered and tested for proper operation.

2.0 Gear Deployment

A winch is used to lower the entire assembly at a steady rate to the seafloor. Images from the video-plan camera are relayed to the surface via the video cable and permit the camera operator to see the seafloor and know exactly when the camera has reached the bottom. The camera operator then can view the prism penetration and choose exactly when to record sediment profile images. Each time the camera is on the bottom, a series of 2–4 photographs is taken, generally within the first 12 seconds after bottom contact.

This sampling protocol helps to ensure that at least one usable photograph is produced during each deployment of the camera. After the required number of replicates, the camera assembly is returned to the ship. The date, time, station, replicate, water depth, and comments will be recorded in a field log. Vessel location coordinates will also be recorded with each touchdown of the camera. The digital camera saves images to compact flash solid-state memory cards. The video signal (from the plan-view video camera) is recorded on mini-DVD digital videotape for later review. The combination of video and digital images will ensure accurate and reliable collection of SPI data. The video contributes the real-time assessment component, whereas the still images provide high-resolution detail for full image analysis in the laboratory.

3.0 Collection Procedure

SPI sample collection consists of the following steps:

1) Record beginning and ending location and time of station visit
2) Record prism penetration (±1 cm), and
3) Collect 3 images at each station.

4.0 Sample Form

Coordinates at the location of each sediment profile image (SPI) sample will be entered into the field station log in Excel. A waypoint will be entered into the shipboard GPS when a sample is collected. The marker set for each waypoint will be named as the station name, with the replicate number appended. Waypoints will be stored separately for the SPI survey. A QC check of waypoints against the recorded coordinates will be done after each sample is collected by the chief scientist. Waypoints will be stored on the shipboard GPS until data checking confirms that all samples were collected within 37 meters of the target station location. Any sample coordinates found through data checking to be outside of the 37-meter station radius will be compared against the sample coordinates for the stored waypoint. Thus, if an incorrect waypoint is identified through data checking, the hand-entered data will be compared to the electronic waypoint on the GPS, and any error discovered in the navigational data will be corrected as necessary.

At the beginning of each survey, the date, start time, weather, and names of all sampling team members present will be entered (see Survey Log Form, Figure 4). Measurements made and samples collected will be recorded electronically. Information specific to sample collection will include:

- Station name
- Sample identification number
- Time and date of sample collection
- Sample description (color, texture, etc.)
- Samplers' initials
- Requested analyses
- Location (the latitude and longitude coordinates where a sample is collected)

VII. DATA HANDLING

1.0 Data Handling Field Datasheets

Data from sample processing that occurs in the field for all field tasks will be recorded on field datasheets. The field datasheets will be printed on an 8-1/2" x 11" sheet of weatherproof paper.

All completed datasheets will be reviewed for completeness and legibility by the originator and Chief Scientist. Field data manually recorded on field datasheets will be the responsibility of the Chief Scientist during the field activity. Datasheets will then be transferred to the Project Manager for quality control checks within 1 week of collection.

2.0 Data Handling Electronic Files

Hand-entered coordinates for sample locations will be checked against electronic waypoints on the shipboard GPS after each sample is collected. Waypoints will then be stored on the shipboard GPS until data checking confirms that all samples were collected within 37 meters of the target sampling location.

Field data recorded electronically will be the responsibility of the Chief Scientist during the field activity. Electronic water quality data and digital images files will be provided to the Project Manager within 1 week of collection.