Development of a Comprehensive State Monitoring and Assessment Program for Wetlands in Massachusetts: Salt Marsh Component

Appendix A

Standard Operating Procedures: Assessment of Salt Marsh Wetland Communities

Phase 2: 2009-2012

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Standard Operating Procedures: Salt Marsh Assessment

1. Scope and Application

This SOP establishes a standard set of procedures to be followed for data collection toward the development of a Site Level Assessment Method (SLAM) for Massachusetts salt marshes and to verify and calibrate the Conservation Assessment and Prioritization System (CAPS) as a mechanism for a landscape level analysis (Level 1) of ecological integrity. This project will focus on assessment of wetland biological community condition in salt marshes.

Described below are the procedures that will be followed in collecting data on macroinvertebrates, vascular plants, and habitat (e.g. tidal hydrology, marsh zonation, open water patch composition, etc.) to serve as a basis for development of a SLAM and Indices of Biological Integrity (IBIs) for salt marsh wetlands.

2. Summary

This SOP is applicable for salt marshes throughout Massachusetts. This wetland community is known as tidal fringe wetland in the hydrogeomorphic (HGM) classification and estuarine emergent (E2EM) in the Classification of Wetlands and Deepwater Habitats of the United States. Data collection for the pilot study (phase 2b) focused on salt marshes from the NH/MA border in Salisbury, MA, south to Hull, and Cape Cod. The watersheds included in the site selection process were Cape Cod, Charles (Boston Harbor), Ipswich, Merrimack, Mystic, Neponset, North Coastal, Parker, and Weymouth & Weir Watersheds. These watersheds provided an appropriate mix of urban, suburban, and relatively undeveloped coastal areas. They include salt marshes that are representative of those found throughout Massachusetts. By limiting field work to these select watersheds, we were able to sample a greater number of sites toward statistical validation of the CAPS model. Investigators had conducted previous assessments in these watersheds and were familiar with the landscape. This local knowledge aided logistical planning. Target sites for the operational study (phase 2c) are open to all watersheds containing DEP-mapped salt marsh. Additional watersheds include Buzzards Bay, Islands, Mount Hope Bay, Narragansett Bay, South Coastal, and Taunton Watersheds.

Sampling sites will again be selected using a stratified random process, as further described in Section 8. Field data collection will involve sampling of several biotic communities to determine if 1) there is a dose-dependent response in various attributes of the biological community to stressors within the landscape and 2) to verify and calibrate the ecological integrity metrics that are utilized in the CAPS model. Characterization of the wetland and assessment of its biological condition will be conducted in the field by assessing habitat, hydrology, macroinvertebrates, and vascular plants.

3. Safety Considerations

- Fieldwork will not be conducted during heavy rain events or unsafe conditions such as electrical storms or high wind events. Practice "safety first."
- Sampling will always be conducted by two or more persons, unless otherwise approved by the field manager.
- All persons must carry cell phones or other emergency communication devices while sampling. It is recommended they be waterproof or stored in a waterproof case.
- If there is no safe access to a plot point, the field sampling will either be moved to a location with safe access—following protocol as described in Section 8 of this SOP—or not be conducted for that site if such a location is unavailable.
- Flagging tape will be used to mark access point locations for safe exit, in instances where such locations could be difficult to find as deemed appropriate by field crew.
- Attempts to access a plot point where an onshore breeze of intensity that results in a "small craft warning" or above for two or more days, and that creates an atypical tide condition shall be assessed for safety prior to sampling. At any time during the sampling, should the incoming tide not recede as predicted (i.e. tide is still in flood stage when it should be in ebb stage), all monitoring shall stop and the site evacuated until such a time when the tide has receded to a point where sampling can safely resume.
- If a boat, canoe, or kayak is used to access a plot point, all persons must wear personal flotation devices while on the water.
- All watercraft used must comply with USCG required safety equipment per 46 U.S.C, Chapter 43. An online Vessel Safety Check interactive program is available from USCG at http:/www.uscgboating.org/safety/vsc.htm.
- Good judgment will be used in selecting clothes and personal protection items. Common items needed include: extra clothing, sunshade, sunscreen, hats, insect repellent, and waterproof knee boots—chest waders or hip waders for highest anticipated depths. Any staff not dressed appropriately for field work should not participate in the survey. Proper footwear is a must (e.g., no "flip-flops" for field work).
- Good judgment will be used in walking on marsh surfaces; mosquito ditches will be circumvented, or when deemed possible, crossed with caution.
- Private property will be respected using the following guidelines.
    - If property is in close proximity to buildings or other heavily used areas, landowner permission will be sought
    - Posted property will not be accessed without permission of the landowner
    - Otherwise, sampling will proceed without any special effort to gain landowner permission

4. Sample Collection, Preservation, and Handling

Macroinvertebrates will be collected and preserved in 90% ethyl alcohol solution and placed in a cooler with ice until ready to be transported to the laboratory for sorting and identification or to a storage facility for later processing. Samples will be checked periodically to ensure that they contain ample alcohol solution if they are not sorted within 2-3 days. Samples will not be held for more than two weeks before sorting to the family level. Each sample will be placed in a plastic collecting bag that is labeled with site number, site name, date of sampling, sample number, sampling method, and name of sampler. The Macroinvertebrate Samples Record Check form (Appendix C) will be used to catalog the collection and processing of samples.

The collection of vascular plants will be limited to species that cannot be identified in the field. For species that cannot be positively identified in the field samples will be collected for lab identification and photographed for digital preservation. Taxonomic identification at the species level (preferred) or genus level (if species identification is not possible) will be achieved in the laboratory through the use of field guides, technical keys, and reference to regional herbaria housed at research universities such as UMass. Samples will be labeled in the field with the plant ID (e.g., "unknown sedge #1") site location, date, and person who collected the sample, and assigned a code in the laboratory for use in digital preservation.

5. Equipment/Apparatus

Before leaving for the field the Field Manager will confirm the following equipment is available (m = macroinvertebrates, v = vegetation; habitat complexity and water chemistry sampling are included with vegetation and macroinvertebrate equipment, respectively, as they will be conducted alongside those sampling efforts).

Auger (2.5-inch diameter) [m]
Baster (pipette) [m]
Bayonet [v]
Binoculars [v]
Bleach solution (2%, for decontamination of gear) [m,v]
Bucket (2x, 5-gallon) [m]
Bucket (small) [m]
Clipboard [m,v]
Compass [m,v]
Cooler with ice [m]
Data forms [m,v]
Digital camera w/extra batteries [m,v]
D-Net (500 micron mesh size) [m]
Ethyl alcohol (90%) [m]
Field guides and technical keys [v]
Field notebook [m,v]
First aid kit [m,v]

Forceps [m]
GPS (Global Positioning System) [m,v]
Hard-bristle brush (for decontamination of gear) [m,v]
Labels for samples [m,v]
Lens cloth (for refractometer, soft cotton flannel) [m]
Location maps [m,v]
Magnifying lens [m]
Measuring tapes (2x, 100-meter) [m,v]
Pens and pencils [m,v]
Permanent marker [m,v]
Plastic collecting bags [m,v]
PVC stakes (3x) [m,v]
Protective gloves [m]
Quadrat frame (18"x18") [m]
Refractometer [m]
Scissors or jack knife [m,v]
Sieve (No. 8, 2,360 micron) [m]
Sieve bucket (500 micron) [m]
Spatula [m]
SOP [m,v]
Tap water [m,v]
Thermometer [m]
Tide chart [m,v]
Throw rope [m,v]
Trowel [m]

6. Reagents

Bleach solution (2%)
Ethyl alcohol solution (90%)
Tap water

7. Calibration & Training

Equipment calibration procedures for the GPS units and salinity refractometers will be done according to the manufacturers' recommendations. See section 2.6 of the QAPP for details.

Field crew members will have sufficient previous training and experience to reliably conduct field data collection or they will receive training from the CZM QA Manager, CZM Project Manager, and/or other project scientists with relevant expertise. The Macroinvertebrate Field/Lab Managers will ensure that all macroinvertebrate field crew members receive specific training on macroinvertebrate sample sorting.

All field crew members will receive training from the CZM QA Manager on appropriate QA/QC procedures.

8.0 Procedures

Sampling will occur between June 15 and September 30, to ensure adequate assessment of the targeted wetland biotic communities. Sample locations for open water/low marsh/high marsh (i.e., inner marsh) will be selected randomly within salt marshes (as depicted in MassDEP Wetlands mapping data; 1:12,000 based on photography from 1993-1999), stratified into 100 bins (deciles of the first principal component of CAPS metrics crossed with deciles of the second principal component; metrics include habitat loss, watershed habitat loss, wetland buffer insults, traffic intensity, sediment intensity, toxic pollution, edge predators, imperviousness, salt marsh ditch density, tidal restriction, connectedness, and similarity, among others). All points, including those sampled in previous years, will be separated by at least 500 meters. Approximately 500 points will be selected to allow for rejection based on the following criteria:

- The point is not within 200 meters of a salt marsh creek (each sampling point will be moved not more than 200 m to the nearest tidal creek suitable for sampling);
- The creek is not suitable for auger and D-Net macroinvertebrate sampling (e.g. channel width is less than 2 m; bank height is less than 1 m; bank height and/or condition could compromise safety);
- The point is not accessible due to physical barriers;
- The point is not accessible due to legal barriers (i.e. request to access private property is denied).
- Sites will be assessed on these criteria by CZM and DEP personnel using 2008 and 2009 orthophotos, 2008 oblique photos, various GIS layers, field reconnaissance, and local area knowledge.

Sample locations for marsh border will be placed at edges of salt marshes, stratified across quartiles of the habitat loss metric (≈ development intensity). One hundred fifty points will be selected, with a goal of visiting 50 points. All marsh border points will be separated by at least 500 meters.

A random identifier will be assigned to each point to obscure the CAPS metrics represented by each point. Field personnel will not have access to the original values until after the field season, thus sampling will be blind with respect to CAPS predictions.

Field personnel will visit points in (randomly assigned) numerical point order as consistent with field logistics. For example, the first acceptable (not rejected in aerial photo surveys, without access problems, and with appropriate habitat on the ground) open water/low marsh/high marsh points (i.e., inner marsh) will be visited.

GPS navigation will be used to locate each wetland plot. GPS precision must be 10 m or less and the navigator will stop and establish the plot once the distance to plot center is 0 m. In the case of GPS interference from tree-canopy or atmospheric effects wait 10 minutes for satellite reception to improve.

It will not be necessary to hit the plot exactly (since it's randomly selected) it just needs to be selected without bias. However, a reasonably precise GPS point is needed of where the

plot actually ends up. The strategy is to (1) do the best we can when locating the plot and (2) take a precise location (precision ≤ 10 m RMS) once the plot has been established. Field workers will keep trying until they get good GPS coverage.

8.1 Establishing Sampling Areas

Assessment Area A: For areas where vegetation (inner marsh only), macroinvertebrate, habitat complexity, and human disturbance sampling will occur:

A 50 x 100 m rectangular plot will be used to sample the wetland point (Figure 1)**.** A baseline transect, Transect A, will be created by extending a 100 m tape along the bank of the salt marsh creek, bay, or salt pond so that the wetland point occurs at 50 m. Stakes will be placed along Transect A at 0 m, 50 m, and 100 m. Three additional transects will be run perpendicular to Transect A, originating at Transect A and ending at 50 m or the salt marsh border community, whichever is closer. A consistent compass bearing will be used to run these transects (e.g., Transects 1, 2, and 3 will be laid on a bearing of 225 degrees from the bank (Transect A) to 50 m or the salt marsh border community, whichever is closer). The field crew leader based on observed vegetation characteristics, slope, and elevation will delineate the salt marsh border community. Geographic coordinates will be collected at the base of each perpendicular transect (i.e., Transects 1, 2, and 3) using a handheld GPS unit.

Transect A will be used to collect macroinvertebrate samples. Site conditions may require shortening the transect to no less than 70 m. The following locations of macroinvertbrate sampling stations along Transect A are based on a 100 m transect. They will be adjusted accordingly if Transect A is shortened. Macroinvertebrates will be sampled using the dip net method along Transect A at 15-21 m and 75-81 m.

The auger method will be used to sample macroinvertebrates at 15 m and 85 m. In substrate with a high concentration of organic material, determined by visual inspection, compositing and sub-sampling methods will be used to collect two additional samples—one from four auger samples collected equidistant from 20 m to 45 m, and the other from four auger samples collected equidistant from 55 m to 80 m (Figure 4). In sandy substrate, compositing will not occur due to the potential for damage to soft-bodied macroinvertebrates, however two single samples will be collected at 40 m and 60 m.

Quadrat sampling will occur on the marsh surface along Transect A at 25 m and 75 m. Transects 1, 2, and 3 will be used to collect plant and habitat complexity data using point- and line-intercept methods, respectively. Plant and macroinvertebrate transects will be marked with flagging to prevent trampling.

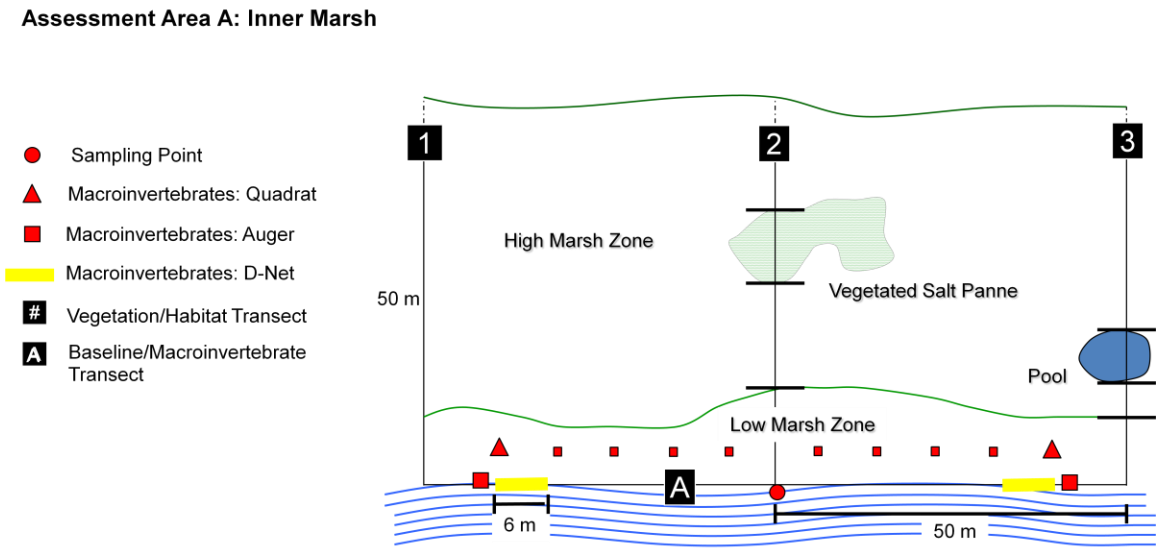

Figure 1. Example plot diagram for inner marsh sampling. Transect A is a baseline transect from which Transects 1, 2, and 3 are run to collect vegetation and habitat complexity data. Transect A is run along the bank of a prominent water feature such as a tidal creek, bay, or salt pond. It is also used to sample macro-invertebrates and surface water salinity. Transects 1, 2, and 3 are run perpendicular to Transect A at 0 m, 50 m, and 100 m. The location for all samples (vegetation, macroinvertebrates, water chemistry, etc.) will be noted on the plot diagram.

A sampling point will be moved if any of the following conditions are encountered.

- The length of any perpendicular transect (Transects 1, 2, and 3) is <30 m, as may occur in narrow wetlands (e.g. fingerlike projections, fringe marshes).
- The length of the baseline transect (Transect A) is <70 m, as may occur in narrow wetlands, particularly in urban landscapes.

The sampling point will be moved to the nearest location that does not violate the previously stated conditions, but no greater than 200 m away. If a suitable sampling point cannot be found within 200 m of the original point the site will be dropped and another sampling point from the same bin selected.

A site will not be sampled if the field manager determines that the wetland is neither a salt marsh nor is in transition to/from a salt marsh. This may occur with error in wetland mapping.

Assessment Area B: For areas where vegetation (marsh border only) sampling will occur:

A rectangular plot will be used to sample the wetland point. Transect A will be created by extending a 70 m tape along the upland/marsh border edge. Three additional transects will run perpendicular to Transect A at 0 m, 35 m, and 70 m originating at Transect A and ending at the high marsh/salt marsh border edge or 50 m, whichever is smaller. The minimum transect length will be 5 m. The salt marsh border community will be delineated by the field crew leader based on vegetation characteristics. Plants commonly

found in the salt marsh border communities of New England include *Iva frutescens*, *Myrica gale*, *Panicum virgatum*, and *Solidago sempirvirens*, among others.

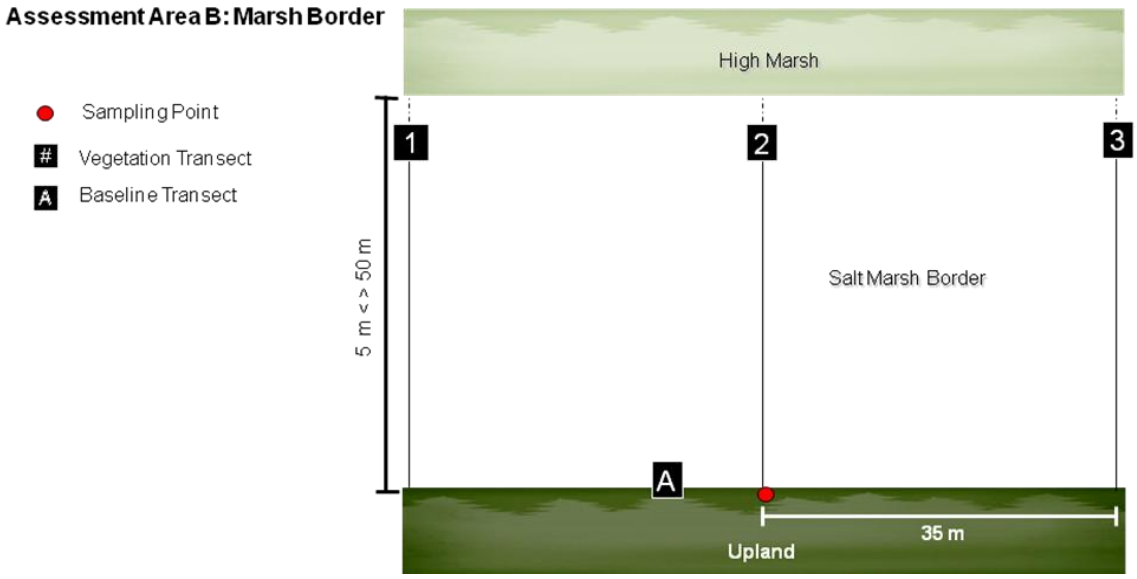

Figure 2. Example plot diagram for marsh border sampling. Transect A is a baseline transect from which Transects 1, 2, and 3 are run to collect vegetation data. Transect A is run along the edged shared by upland and salt marsh border communities. Transects 1, 2, and 3 are run perpendicular to Transect A at 0 m, 35 m, and 70 m. The location for all samples will be noted on the plot diagram.

8.2 Overview of Wetland Biotic Community and Habitat Assessment

Each point will be sampled for vascular plants and macroinvertebrates. Samples will be taken within a 50x100 m rectangular plot or a 50 m radius circle-plot. Samples will be analyzed to determine if the attributes of the biotic communities show a dose-dependent response to anthropogenic stressors in the landscape as measured by CAPS metrics. In addition a habitat assessment will be conducted to characterize the assessment area. A detailed description of the plot (includes hydrology, anthropogenic disturbance, etc.) will be recorded on field data forms.

8.2.1 Habitat Assessment

(a) Habitat complexity

Patch composition of open water features, plant communities, and marsh zones will be determined to assist in the characterization of the wetland. Transects 1, 2, and 3 will be walked to observe and record points of transition.

From Transect A, walk three 50 m transects and record the number and types of natural transitions using the line-intercept method. Habitats are defined as heterogeneous plant communities (e.g. *Spartina patens*/*Distchlis spicata* mix) and hydrogeomorphic features (e.g. panne, pool, and creek, plus ditch) in each of the

following marsh zones: low marsh, high marsh, salt marsh border, and brackish border (Figure 2). Both a plant community and hydrogeomorphic feature can be recorded at the same location (e.g. *Spartina alterniflora*-short and panne in the high marsh zone). Do not record transitions for habitats that measure less than one meter along the transect.

Record the tape measure reading for each habitat transition to the nearest tenth of a meter in the appropriate box(s) (e.g. 5.5 m). Separate recorded habitat transitions with a comma if that habitat occurs more than once on a transect. List no more than three plant species when describing a community. Record species in order of dominance, with the first species being the most dominant. For example, record a habitat patch that includes *S. patens (75%), J. gerardii (25%),* and *P. maritimum* (< 1%) as *S. patens* / *J. gerardii* mix. Record start and end distances (range) for all hydrogeomorphic features (e.g. Panne = 25-30 m). Include patches and features that are offset up to 1 m from the transect. Complete a Habitat Complexity Form for each transect.

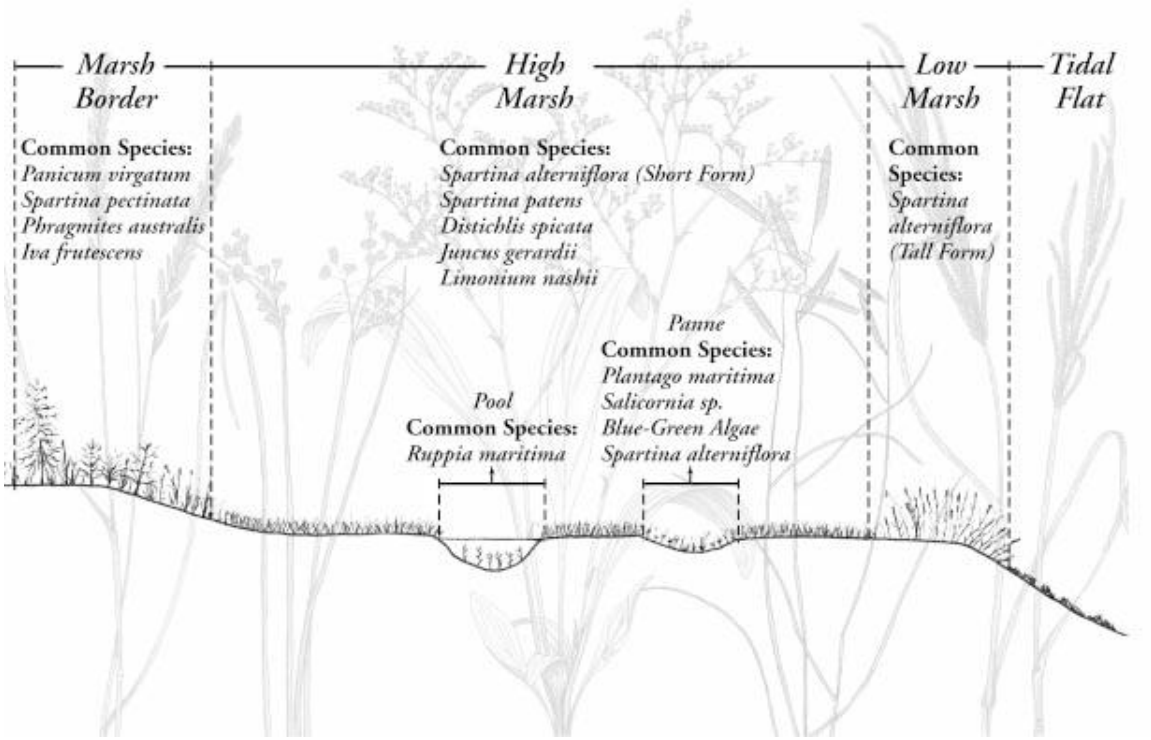

Figure 3. Plant zonation in northeastern salt marshes. This diagram shows the major plant zones and dominant species; see text for details and Tiner (1987), Mitsch and Gosselink (1993), or Bertness (1999) for a description of salt marsh vegetation patterns. (Adapted from Carlisle, et al, 2002).

(b) Tidal hydrology (Sampled in 2009 only)

Tidal flow will be sampled at a subset of known or potential tidal restrictions. The two main goals are: 1) determine the relative magnitude of tidal restriction at select sites, and 2) develop a magnitude of tidal restriction data set that will be used to train

a tidal restriction model developed from remotely sensed data interpretation (for information about the model see Tidal Restriction – Aerial Photo SOP – Appendix R of the main project QAPP (Forested Wetlands)). Locations will be identified using a combination of field observations, remotely sensed data, local knowledge, and best professional judgment. This effort is being managed under the Tidal Restriction Assessment Standard Operating Procedures (QAPP, Appendix B).

(c) Salinity

Salinity will be measured concurrently with macroinvertebrate sampling. Measurements of salinity can help to explain the diversity, distribution, and abundance of plants (as recognized in zonation patterns) and animals in salt marshes. Two measurements will be made at each plot using a hand-held refractometer (see the QAPP, Appendix F for the operation manual).

Take readings from surface water at the start of each D-Net sample collection (presumably 15 m and 75 m along Transect A, depending on direction of tidal flow). The minimum distance between readings must be 20 m. Note on the Plot Diagram form the location along Transect A from which readings were taken.

Remove prism cover, place one or two drops of liquid on the prism surface, and replace cover. Aim the front end of the refractometer to the direction of bright light, and adjust the adjusting ring of diopter 5 until the reticle can be seen clearly. The corresponding reading of the light/dark boundary will give the percent of salt content of liquid on left and parts per thousand on right.

Adjustment of null: open the cover plate, place one or two drops of distilled water on the surface of the prism. Close the cover plate, rotate and adjust the correcting screw to make the light/dark boundary coincide with the null line. Open the cover plate to clean the water off the prism surface with a soft cotton flannel cloth.

(d) Human disturbance

Visual observations of human disturbance to the wetland will be noted. Investigators will note the following activities on the Human Disturbance field data form, describing the type, extent, and severity of each disturbance.

Walk the perimeter of the sample plot and describe on the Human Disturbance Form the types, extents, and severity of disturbances within a 100 m buffer of the sample point (200 m diameter circle depicted on the site map). Disturbance types are listed below. Also record any of these indicators of disturbance when encountered while implementing other elements of the SOP.

Mark locations of disturbances on the site map according to the Human Disturbance Form (QAPP, Appendix C).

- Water control structures (culvert, tide gate, dam, weir, storm water input, fill (road/railroad), ditching, channelization, and other human activity affecting the hydrology of the site
- Soil disturbance (filling, sedimentation, haying)
- Obvious spills of pollutants
- Direct point or non-point source discharge from agricultural operations, septic or sewage treatment systems, or storm water affecting water quality of the site
- Walking trails, horse trails, and roads (excluding wildlife trails)
- Small-craft boating and boat storage
- Presence of trash/litter
- Presence of garbage dumping

8.2.2 Protocols for Sampling, Sorting, and Identifying Biotic Communities

8.2.2.1 Macroinvertebrates

Macroinvertebrates will be sampled as indicators of changes in tidal flow, vegetation cover, salinity regime, water quality and community composition, and ecosystem health. Macroinvertebrates will be sampled from August-September. Three types of samples will be collected at each assessment area: quadrat samples at the top of the salt marsh creek bank, and D-Net and auger samples in the creek.

(a) Quadrat sampling

Quadrats are used to sample invertebrates that exist on the upper edge of the estuarine stream bank or seaward marsh edge. We expect to find crabs, mussels, barnacles, amphipods, isopods, flies, spiders, grasshoppers, and mites in this habitat. Two samples will be collected along Transect A at 25 m and 75 m in each area (Figure 1). If these locations are not typical of the bank condition, sample collections will be located elsewhere along Transect A, while keeping a minimum distance of 30 m from each other. Protective gloves are used for this sampling technique.

At each sampling location, methodically work the hands backwards and forwards across the surface of the ground within the frame, and identify, count and record every living invertebrate (to family-level) that you encounter. Since barnacles are usually too numerous to count, record their abundance with the following notation: + = rare, ++ = common, and +++ = abundant. Place organisms that cannot be identified to family-level into a re-sealable plastic bag, and label (see instructions in Section 8.2.2.1 (d)). Results are recorded on the Quadrat Samples Record Form (QAPP, Appendix C). If samples are collected, record the information on the Invertebrate Sample Record Form (QAPP, Appendix C). Mark actual sample locations on the Plot Diagram. Thoroughly rinse the frame.

(b) D-Net sampling

D-Nets are used to collect invertebrates from shallow water environments (e.g., tidal creeks) at low tide. We expect to find mollusks, polychaete worms, amphipods, isopods, and other organisms requiring constant inundation with seawater. Two samples will be collected along Transect A from approximately 15-21 m and 75-81 m in each area (Figure 1). We will aim to collect samples from different habitat types, such as banks and vegetated margins, different substrate types, woody debris, and floating alga mats, where possible. Transect locations may be moved to incorporate these habitats, but a minimum distance of 30 m should be maintained between the D-Net samples, and a minimum distance of 10 m should be maintained between the D-Net samples and auger samples, as shown in Figure 1. Sample locations will be recorded.

At each sampling location, place the flat side of the D-Net on the surface substrate in approximately 0.3 m of water and hold the net perpendicular to the substrate. Walk against the direction of tidal flow for 6 meters along Transect A while pulling the net through and over different habitats. Bring the net containing the sample to the surface for retrieval. Gently swish the net back and forth in the stream to allow fine silt and sand to pass through the mesh, being careful not to lose organisms. Place the contents of the inverted net over a bucket half filled with water and wash all debris and invertebrates off the net and into the bucket. Use forceps to remove any organisms that remain on the net, and place these in the bucket. Pour the contents of the bucket through a standard US No. 30 brass sieve to remove the water. Place the contents of the sieve into a re-sealable plastic bag, and label (see instructions in Section 8.2.2.1 (d)). Make sure that no invertebrates are left on the sieve. Sample labels will include information such as sample number, field site ID, sample station, date, names of collectors, sampling method, and preservative used. Record the sample information on the Macroinvertebrate Samples Record Check Form (QAPP, Appendix C). If a large number of snails and crabs are collected in a sample, identify them in the field, record the numbers of each family (and if possible, species) on the datasheets, and then return them back to the water alive. Wash out the D-Net to remove all remaining debris.

(c) Auger sampling

A 2.5-inch diameter auger is used to collect a sediment or substrate sample from the creek. We expect to find a variety of worms, snails, clams, amphipods, isopods, and other organisms that live on or within the substrate. Where organic material is the dominant substrate, four samples will be collected along Transect A in the following manner:

Sample 1: Single sample collected at 15 m.

Sample 2: Composite sample from four samples collected 5-7 m from each other beginning at 20 m and ending at 45 m. Composite sample will be sub-sampled, as described below.

Sample 3: Composite sample from four samples collected 5-7 m from each other beginning at 55 m and ending at 80 m. Composite sample will be sub-sampled, as described below.

Sample 4: Single sample collected at 85 m.

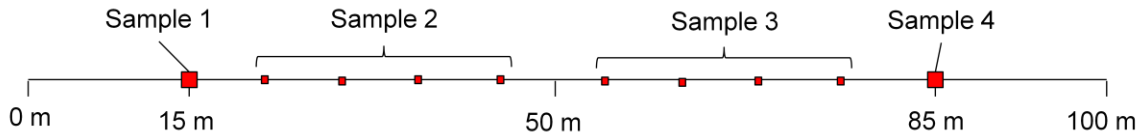

Figure 4. Schematic of auger sampling stations along Transect A.

Four samples will be collected along Transect A at 15 m, 40 m, 60 m, and 85 m when sand is the dominant substrate.

At each sampling location, fill two 5-gallon buckets with seawater to be used later. Place the No. 8 sieve on the bottom of the sieve bucket. Hold the auger perpendicular to the water surface above the point from which the sample will be taken. Push the auger downward into the sediment until the bucket of the auger is half embedded in the substrate. Turn the auger handle to help force the auger into the substrate. Carefully pull the auger out of the sediment and quickly place the sieve bucket beneath the auger so that none of the sample is lost. If the sample is lost, repeat no less than 5 m away in the direction opposite that which the tide is flowing (e.g., 5 m upstream if there is an ebb tide). Keep the sieve bucket under the auger and return to the bank, where the remaining auger contents will be emptied into the No. 8 sieve.

For composite samples, repeat the above method three times, adding the material from a total of four auger samples collected from 20-45 m or 55-80 m along Transect A (see Figure 4) to the No. 8 sieve.

Place the sieve bucket into one of the 5-gallon buckets filled with seawater. With the spatula, gently scrape large debris off the No. 8 sieve, then stir and mix to suspend materials and organisms within the sieve bucket. Slowly lift the No. 8 sieve out of the bucket while collecting and mixing the suspended material. Take the No. 8 sieve out of the sieve bucket and discard its contents.

Replace sediment-laden water with clean seawater if necessary, or switch to a second 5-gallon bucket filled with seawater. Dip the end of the sieve bucket into

the 5-gallon bucket of water and gently swirl once to redistribute the remaining material evenly across the sieve bucket while lifting. Drain water and divide the contents of the sieve in half using your spatula and the dividing line marked on the bucket. Gently scoop out ½ of the sample, as labeled on the bucket, and discard. Repeat mixing, sieving, and halving procedure once again for the material remaining in the sieve bucket. Again, gently scoop out ½ of the sample, as labeled on the bucket, and discard. Place the remaining half of the material in a sample bag with a label including the site ID and name, date, and sample ID (see instructions in Section 8.2.2.1 (d)) and record the sample information on the Invertebrate Sample Record Form (QAPP, Appendix C).

For single samples, rinse the material in the manner described above, but place the entire washed contents of the sieve bucket into a labeled sample bag—do not sub-sample.

Add alcohol as appropriate to preserve. Clean the auger by swishing it back and forth in the water. Repeat for all samples.

(d) Sample bagging and labeling

Use the following procedures to bag and label samples:

1. Using a permanent ink marker, label all sample bags with the following information: sample number (begin each sample number with "A" for auger samples, "D" for D-Net samples, and "Q" for any quadrat samples collected; e.g., A1, A2, D1, D2), plot identification, site name, and date. This can be done before going into the field. In addition, record this information on waterproof paper labels (e.g., Rite in the Rain® paper) and place in their respective sample bags as back-up labels.
2. Gently flood all bagged samples with 90% concentration ethyl alcohol and seal carefully.
3. Record the sample information from Step 1 on the Macroinvertebrate Samples Record Check Form (QAPP, Appendix C).
4. Place each bagged sample in a separate second bag—so that each sample is double-bagged—and place in a cooler with ice to prevent heating in hot weather.
5. Transport and store samples in an air-conditioned laboratory (or similar workspace) or a refrigerator for no longer than two weeks before sorting. Samples should be checked every 2-3 days if they are not sorted immediately to ensure they have ample ethyl alcohol preservative.

(e) Sample sorting

Use the following procedures for sorting samples:

1. Empty the contents of a sample into the standard US #30 sieve. You should place the sieve over a bucket so that sediment is not washed down the drain.
2. Gently rinse the sample under tap water to remove fine organic detritus, silt, and clay. Place the sieved sample into a white sorting tray (one small handful at a time, if necessary). You must be careful to remove any organisms that may be stuck on the sieve.
3. Place the sorting tray under a desk light or magnifying lamp, and using the magnifying lens and forceps, remove invertebrates from the sediment and place them into a large (40 mL) vial two-thirds filled with 70% or higher concentration of alcohol.
4. Immediately after you have finished sorting, have the macroinvertebrate lab manager scan the debris in the sorting tray to double check your work. Tightly seal and label each vial (two for each sampling station: one for D-Net and one for auger, and register the sample on the Macroinvertebrate Samples Record Check Form (QAPP, Appendix C).
5. Samples can be identified and counted any time after the sorting has been completed, but should not be left for more than six months because alcohol in the vial sometimes evaporates and ruins the sample. Sample degradation can be prevented by routine checks and preservative added if necessary.

(f) Sample Identification

Use the following procedures for identifying samples:

1. Pour the vial contents of the D-Net sample or auger sample into petri dish. Maintain separate D-Net and auger samples. Make sure that no organisms remain in the vials.
2. Place the petri dish under the dissecting scope set at 10X magnification, and in a deliberate, systematic manner, scan back and forth, identifying organisms as you go. You may need to increase the magnification to see finer details.
3. Using Weiss (1995), Pollock (1998), and other references, identify the invertebrates to family level.
4. Record and count each taxon on the Laboratory Bench Form (Appendix C).
5. Immediately after you identify and record a specimen, return it to a labeled vial two-thirds filled with 70% or higher concentration alcohol. There should be one vial per sample.
6. Label and safely pack the vials for return to your project coordinator so that someone can reexamine specimens or identify them to a lower level of taxonomy at some future date.
7. If you have doubts about an organism's identity, consult with a marine invertebrate specialist. Place the specimen in question in a separate vial with alcohol and a complete label. Send the specimens to a specialist for

verification, and add to your records later. Alternatively, arrange to have a taxonomist present during an identification session to provide assistance.

8. Record the completion of this process for each sample on the Macroinvertebrate Sampling Record Check Form (Appendix C), which traces the sample collection, sorting, and identification to this stage.
9. On the Laboratory Bench Form (Appendix C), add the data from the quadrat sample taken from the same sampling station. Enter the total number of organisms for each family or taxonomic group, the number of different types of taxa you identified, and the resulting total abundance for the completed composite sample.
10. Repeat this process for the remaining two sample stations, using a separate Laboratory Bench Form for each station.
11. Once collecting, sorting, and identifying samples for a site has been completed, there will be two completed copies of the Laboratory Bench Form (one for each sample station).
12. Samples and the Sample Record Check Form are to be returned to the project leader for archival action. Similarly, return all Quadrat Samples Record Forms and Laboratory Bench Forms to the project leader once they are completed.

8.2.2.2 Vegetation

Vegetation data will be collected as an indicator of community composition and species diversity (proportion of native to invasive), and provide useful information on potential threats to natural systems. Invasive plants named as such in this assessment are those currently regulated by the Commonwealth of Massachusetts (Somers et al 2006). Data collection will occur near average low tide from mid-July to mid-September. The protocol for sampling inner marsh and marsh border plots is the same.

a. Estimate species richness and relative abundance of all vascular plants in a 50x100m plot using a modified point-intercept method. A single bayonet (vertical projection) will be used to record species at fixed intervals along each transect. Walk along the transect opposite the side used to lie the transect to avoid trampling samples. Set the transect interval by dividing the transect length by 10; this will produce 11 point intercept locations along each transect. As stated in section 8.1, the minimum and maximum vegetation transect lengths will be 30 m and 50 m, respectively. Tally each plant species intercepted by the bayonet from marsh surface to canopy at each fixed interval along the transect. Record the transect length and interval along with species occurrence on the Vegetation Form (QAPP, Appendix C).

b. Following transect sampling conduct a 15-minute walk around (within) the entire plot and list species not encountered on transects on the Vegetation Form. Enter zero for intervals 1-11 for these species.

c. Collect unknown species for offsite identification by a second expert. Place each species in a separate collecting bag labeled with plant ID (e.g., “Unknown #1, etc.), plot ID and date. Take digital photographs on site as needed. List PhotoID # next to unknown plant ID for interval 1 on the Vegetation Form.

d. Refer to resources on regional flora if necessary (e.g., Tiner, 1987; Gleason & Cronquist, 1991).

8.3 Protocol for Decontamination of Field Equipment

Inspect all equipment for debris and remove before leaving a site. Dispose of debris in a trash bag or on dry, high ground. When possible, leave equipment to air dry and inspect to remove any remaining plant fragments. Scrub and rinse equipment to remove any additional debris with a hard-bristled brush and 2% bleach solution. Clean the salinity refractometer according to manufacturer's recommendations.

9. Quality Control

Compliance with procedures in this SOP will be maintained by following the items described below. See sections 2.5 and 2.6 of the QAPP for additional details about QA/QC measures.

- Computer aided use of stratified random sampling procedures for site selection (accuracy, representativeness)
- Use of standardized sampling procedures such as transect and time-constrained sampling (precision, accuracy, representativeness)
- Prompt review and documentation of any changes to the SOPs (precision, accuracy, comparability)
- Use of highly qualified field scientists (precision, accuracy, comparability)
- Rigorous training and mentoring of less experienced technicians in both structured and informal settings, the latter on an as needed basis (precision, accuracy, comparability)
- External validation of taxonomic identification for taxa with which the field crew has had limited prior experience (90% of samples); minimum of 10% of total samples (precision, accuracy)
- Daily checks to ensure that data forms are completely filled out (completeness)

The Quality Assurance Manager is responsible for periodically inspecting the methods used and inconsistencies will be documented and if possible, corrected. Any significant changes will be made in coordination with MassDEP and EPA.

10. Interferences

Inclement weather (heavy rain) may interfere with our ability to collect representative data on a variety of parameters. Severe weather may delay field data collection due to safety concerns. Access may be a challenging aspect of data collection in more developed areas of the study area. Posted property or sites that are too difficult to access or unsafe to sample will be replaced with alternative sites from the same stratified sampling bin.

11. Preventative Maintenance

Field equipment will be inspected by the CZM Field Manager each day before going out to collect field data. At the field site equipment will be tested prior to data collection to ensure that it is working properly. Equipment will be subject to regular maintenance as needed and as recommended by the manufacturer. GPS accuracy will be assessed once a month by a check of any units used in the field with a known location. See section 2.6 of the QAPP for more detail.

12. Corrective Actions

Data quality control ensures high quality data, however we are prepared to re-measure any plots within the same season or period of monitoring as needed (e.g., data are missing, samples are lost or compromised, etc.). Any plots that contain data that cannot be resolved will be removed from the data set.

13. Waste Minimization and Pollution Prevention

Care will be taken to avoid transport of vegetation and soil to other sites. This will be done by thorough inspection of all equipment and clothing prior to departure from a site. Invasive plant samples will be disposed of in a way to avoid accidental release into the environment.

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