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SeagrassNet Monitoring Program 2019 - 2023

Quality Assurance Project Plan

April 2019

Prepared by

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Project QA Officer: Kalle Matso, PREP

Field Operations Manager/Laboratory Manager: Dante Torio, UNH

Lead Scientist: Fred Short, UNH

USEPA Project Officer: Erik Beck, US EPA

USEPA QA Officer: Anthony Pepe, US EPA
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A3 – Distribution List

Table 1 presents a list of people who will receive the approved Quality Assurance Project Plan (QAPP), any QAPP revisions, and any amendments.

<table>
<thead>
<tr>
<th>QAPP Recipient Name</th>
<th>Project Role</th>
<th>Organization</th>
<th>Telephone Number and E-mail Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>David Burdick</td>
<td>Project Manager</td>
<td>UNH</td>
<td>603-862-5129 <a href="mailto:david.burdick@unh.edu">david.burdick@unh.edu</a></td>
</tr>
<tr>
<td>Kalle Matso</td>
<td>Project QA Officer</td>
<td>PREP</td>
<td>603-781-6591 <a href="mailto:kalle.matso@unh.edu">kalle.matso@unh.edu</a></td>
</tr>
<tr>
<td>Fred Short</td>
<td>Lead Scientist</td>
<td>UNH</td>
<td>603-659-3313 <a href="mailto:fred.short@unh.edu">fred.short@unh.edu</a></td>
</tr>
<tr>
<td>Dante Torio</td>
<td>Field Operations Manager/Laboratory Manager</td>
<td>UNH</td>
<td>603-534-8563 <a href="mailto:dantorio@gmail.com">dantorio@gmail.com</a></td>
</tr>
<tr>
<td>Ted Diers</td>
<td>Data User</td>
<td>NH DES</td>
<td>603-271-3289 <a href="mailto:ted.diers@des.nh.gov">ted.diers@des.nh.gov</a></td>
</tr>
<tr>
<td>Erik Beck</td>
<td>EPA Project Officer</td>
<td>USEPA</td>
<td>617-918-1606 <a href="mailto:beck.erik@epa.gov">beck.erik@epa.gov</a></td>
</tr>
<tr>
<td>Anthony Pepe</td>
<td>EPA QA Officer</td>
<td>USEPA</td>
<td>617-918-8379 <a href="mailto:pepe.anthony@epa.gov">pepe.anthony@epa.gov</a></td>
</tr>
</tbody>
</table>

A4 – Project/Task Organization

The project will be conducted and managed by scientists and technicians from the University of New Hampshire (UNH) Jackson Estuarine Laboratory (JEL), in partnership with the Piscataqua Region Estuaries Partnership (PREP). PREP is part of the U.S. Environmental Protection Agency’s (EPA) National Estuary Program, which is a joint local/state/federal program established under the Clean Water Act with the goal of protecting and enhancing nationally significant estuarine resources. The PREP receives its funding from the EPA and is administered by UNH.

The Project Manager (David Burdick) will be responsible for coordinating all program activities. The Lead Scientist (Fred Short) will be responsible for selection of the monitoring site in Portsmouth Harbor, directing the set-up of the site, and field monitoring and laboratory activities, including “stop/go” decisions for monitoring activities during extreme events. The Field Operations Manager (Dante Torio) will manage all field staff for monitoring activities. Dante Torio will also serve as the Laboratory Manager, supervising any laboratory operations at JEL and conducting analyses according to the procedures in this QAPP, identifying any non-conformities or analytical problems, and reporting any problems to the Project QA Officer and Project Manager.

At the end of the project, the Project QA Officer (Kalle Matso) will review the results of QA/QC checks and verify that the procedures of this QAPP were completed. The Project QA Officer will be responsible for a memorandum summarizing any deviations from the procedures in the QAPP, the results of the QA/QC tests, and whether the reported data meets the data quality objectives of the project.
Funding for PREP is provided by the EPA. Therefore, the Project QA Officer will be accountable to the EPA Project Manager (Erik Beck) and the EPA Project QA Officer (Anthony Pepe). The EPA Project Manager and EPA Project QA Officer will be responsible for approving the QAPP.

The principal user of the data from this project will be PREP for State of Our Estuaries Reports. Additional users include EPA, NH Dept. of Environmental Services, and the municipalities that impact the ecosystem health of the Great Bay Estuary. The Project Manager and the Project QA Officer will work together to prepare a report at the end of the project with all the data and results of QA/QC efforts.

Figure 1 shows an organizational chart for this project.

**Figure 1: Project Organization**

![Organizational Chart]

A5 – Problem Definition/Background

The long leaves of eelgrass (*Zostera marina*) slow the flow of water, encouraging suspended materials to settle, thereby promoting water clarity. Eelgrass roots stabilize sediments and both the roots and leaves take up nutrients from sediments and the water. Eelgrass provides habitat for fish and shellfish, and it produces significant amounts of organic matter for the larger food web. Because of eelgrass’ importance, monitoring of this resource is critical. For many years, the distribution of eelgrass throughout the Great Bay Estuary has been monitored. It is well recognized, however, that distribution only tells part of the story of eelgrass health; it is also important to describe in greater detail how particular eelgrass meadows are changing with regard to more specific parameters, such as density, shoot length, and above and belowground biomass. SeagrassNet is an internationally accepted protocol for achieving this objective.
The data generated through SeagrassNet monitoring will be used by PREP and its partners to evaluate trends in seagrass health over time. This QAPP will apply to the years 2019 through 2023.

**A6 – Project/Task Description**

**Great Bay Site**

The goal of the Great Bay work is to continue monitoring an established SeagrassNet site in Great Bay, NH. (This site was established in 2007 with funds from a private philanthropy and the Great Bay National Estuarine Research Reserve.) The site is located in Great Bay with its three cross-transects distributed between Lubberland Creek to the central bay, each running in a north-south direction (see Figure 2). The site has been monitored three to four times per year from 2007 to the present. The monitoring has provided scientific evidence of the eelgrass decline in the Great Bay (Short et al. 2017). This site will be monitored three times: in April, July and October of 2019. More detail on procedures and specific parameters can be found in Section B1: Sampling Process Design.

**Portsmouth Harbor Site**

Although a previous Portsmouth Harbor site was established in 2001 at Fishing Island flat, there has not been eelgrass at the location since 2009. Therefore, a new site must be established. The new SeagrassNet site will be offshore of Gerrish Island near Fort Foster (see Figure 3). The tasks required to establish a new site include: lay out and permanently mark three 50 m cross-transects at appropriate locations, taking into account eelgrass coverage and the objective of having the three transects at high, medium and low-depth locations.

When the new site in Portsmouth Harbor is established, it will be monitored by the same protocol as the Great Bay site, but sampled using SCUBA because it is sub-tidal; that is, along 3 cross-transects. The current plan is for the Portsmouth site to be monitored two times per year (July and October). More detail on procedures and specific parameters can be found in Section B1: Sampling Process Design.

![Figure 2: Great Bay SeagrassNet monitoring site with Transects A, B and C.](image-url)
Figure 3: General location for the Portsmouth Harbor SeagrassNet site indicated with green arrow. The specific site is TBD. Previous SeagrassNet site indicated with red arrow.

Table 2: Project Schedule Timeline

<table>
<thead>
<tr>
<th>Activity</th>
<th>Dates</th>
<th>Product</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>QAPP Updates (as necessary)</td>
<td>1/9 of each, 2/15 of each</td>
<td>Revised QAPP Document</td>
<td>3/1 of each</td>
</tr>
<tr>
<td>Activity</td>
<td>Anticipated Date(s) of Initiation</td>
<td>Anticipated Date(s) of Completion</td>
<td>Product</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>-----------------------------------</td>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Training</td>
<td>4/1 of each year</td>
<td>4/30 of each year</td>
<td>Field crews trained on SOPs</td>
</tr>
<tr>
<td>Portsmouth Harbor Site Establishment</td>
<td>6/1/19</td>
<td>6/15/19</td>
<td>Permanent transects established in Portsmouth Harbor</td>
</tr>
<tr>
<td>April monitoring event at Great Bay site.</td>
<td>4/15 of each year</td>
<td>4/30 of each year</td>
<td>SeagrassNet monitoring protocol implemented and completed at the Great Bay site.</td>
</tr>
<tr>
<td>Sample analysis – April</td>
<td>4/30 of each year</td>
<td>5/30 of each year</td>
<td>Data for various parameters obtained and recorded.</td>
</tr>
<tr>
<td>July monitoring events at Great Bay and Portsmouth Harbor sites.</td>
<td>7/15 of each year</td>
<td>7/30 of each year</td>
<td>SeagrassNet monitoring protocol implemented and completed at both sites.</td>
</tr>
<tr>
<td>Sample analysis – July</td>
<td>7/30 of each year</td>
<td>8/30 of each year</td>
<td>Data for various parameters obtained and recorded.</td>
</tr>
<tr>
<td>October monitoring events at Great Bay and Portsmouth Harbor sites.</td>
<td>10/15 of each year</td>
<td>10/30 of each year</td>
<td>SeagrassNet monitoring protocol implemented and completed at both sites.</td>
</tr>
<tr>
<td>Sample analysis – October</td>
<td>10/30 of each year</td>
<td>11/30 of each year</td>
<td>Data for various parameters obtained and recorded.</td>
</tr>
<tr>
<td>Data Quality Audit</td>
<td>5/1 of each year</td>
<td>1/30 of year following field season</td>
<td>Memo (see Section C2) summarizing any QAPP nonconformance</td>
</tr>
<tr>
<td>Annual Report</td>
<td>1/1 of year following field season</td>
<td>3/31 of year following field season</td>
<td>Final project report</td>
</tr>
</tbody>
</table>

### A7 – Quality Objectives and Criteria

Data quality objectives for the SeagrassNet monitoring program are summarized in Table 3.

**Table 3: Data quality objectives, criteria, and quality control protocols for the SeagrassNet monitoring program.**

<table>
<thead>
<tr>
<th>Data Quality Objective</th>
<th>Criteria</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision</td>
<td>Biomass measurements should be maintained to 1/100 of a gram.</td>
<td>Laboratory analysis will measure biomass with a Sartorius Balance (Type = E2000D).</td>
</tr>
<tr>
<td>Bias</td>
<td>Percent cover, shoot density, canopy height, and grazing estimates should be comparable across members of the field assessment team within ±10%.</td>
<td>Field assessment team members will “calibrate” their assessments of percent cover, shoot density, canopy height, and grazing estimates prior to field work by reviewing published examples of visual representations of different percent covers (Short 2017). Field estimates will then be made by consensus of the field team. The field assessment team will also review photographs and associated percent cover.</td>
</tr>
</tbody>
</table>
Spatial Accuracy
GPS units should have a reported accuracy less than or equal to 2 meters. New transects will be established using a highly accurate, real-time kinematic (RTK) GPS. Transect locations will then be staked in the field using screw anchors. The minimum accuracy tolerance of the unit will be set to reject saving of waypoints with spatial accuracy less than 0.03m, thereby assuring spatial accuracy requirements are met or exceeded.

Comparability
Field and laboratory data should be collected using standardized methods. Check that protocols from the QAPP were used for field observations. The QA Manager should use filtering functions to check the field assessment team’s spreadsheets for data entry errors. All percent cover values should fall into one of the categories specified in the sampling methods. All biomass values should be between 0 and 500 grams. A minimum of 10% of field observations should be checked against electronic spreadsheets.

Completeness
Field observations should be made for percent cover, shoot density, canopy height, grazing, and wasting disease estimates. In addition, environmental data collection should include light levels, temperature, and salinity. Check field observations for completeness. Document reasons for any deviations from sampling protocol.

A8 – Special Training/Certification

The Field Operations Manager (under the supervision of the Lead Scientist) will organize and implement a training session for field staff. The training session will cover SOPs for transect establishment and monitoring, including the parameters noted in Table 3. The training will be based on this QAPP document. Field staff will sign an attendance sheet for the training, which will be retained by the Field Operations Manager. The training will be completed before sampling begins.

Table 4: Special Personnel Training Requirements

<table>
<thead>
<tr>
<th>Project Function</th>
<th>Description of Training</th>
<th>Training Provided by</th>
<th>Training Provided to</th>
<th>Location of Training Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Data Collection</td>
<td>Collection of light level, temperature, salinity, and biomass data.</td>
<td>Field Operations Manager</td>
<td>All field team staff</td>
<td>With Field Operations Manager</td>
</tr>
<tr>
<td>SeagrassNet Observational Data</td>
<td>Determination of percent cover, shoot density, canopy height, wasting disease, and grazing estimates.</td>
<td>Field Operations Manager</td>
<td>All field team staff</td>
<td>With Field Operations Manager</td>
</tr>
</tbody>
</table>
A9 – Documents and Records

QA Project Plan
The Project Manager will be responsible for maintaining the approved QAPP and for distributing the latest version to all parties on the distribution list in section A3. A copy of the approved plan will be posted to the PREP website (scholars.unh.edu/prep).

Field Data Sheets
The field data sheets for this project are attached as Appendix A and should be printed on waterproof paper for work in the field. Field crews fill in these forms during the day and return them to the Field Operations Manager upon completion. The original forms, or scanned copies of the original forms will be retained on file by the Field Operations Manager.

Laboratory Data Sheets
Laboratory results from the Laboratory Manager/Field Operations Manager will be retained in form of electronic laboratory data sheets at JEL. The Project QA Officer will confirm the results of the required QC tests performed.

Reports to Management
The Project QA Officer will collaborate with the Project Manager and the Field Operations Manager to produce an annual report for PREP. The report will describe any deviations from the protocols established in the QAPP, as well as summarize the results. The annual report will be posted to the PREP website (scholars.unh.edu/prep).

Archiving
The QAPP and final report will be kept on file at PREP for a minimum of 10 years after the publication date of the final report. The original field data sheets, or scanned copies of the original field data sheets will be retained by the Field Operations Manager and laboratory data sheets will be retained by the Laboratory Manager for a minimum of 20 years.

B1 – Sampling Process Design

The Great Bay and Portsmouth Harbor sites—each consisting of three 50 m cross-transects—will be sampled in April, July, and October (Great Bay) and in July and October (Portsmouth Harbor).

Establishing new site at Portsmouth Harbor: JEL will provide a sketch map of the seagrass meadows and GPS reference waypoints, for future reference. Approximately 9 waypoints should be used to clearly delineate (along with the sketch) the location of the seagrass bed. These waypoints will also be recorded and provided in the final report.

<table>
<thead>
<tr>
<th>Table 5: Sample Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>Light level</td>
</tr>
</tbody>
</table>
Parameter | No. of Cross-Transects | Samples per Event per Site | Number of Sampling Events
--- | --- | --- | ---
Salinity | 6 | 3 | 5
Tidal stage | 6 | 1 | 5
Species ID, % cover, canopy height, grazing, wasting disease, flowers/fruits, biomass, density count | 6 | (per site) X 2 sites | 5
Voucher specimen | 6 | 3 | 5

A “sampling event” refers to the number of times per year that a site is visited. (See Section B2, below.)
In 2019, the Great Bay Site will be visited 3 times and Portsmouth Harbor site 2 times. This may change from year to year, pending available resources.

Table 6: Transect Center Point Locations

<table>
<thead>
<tr>
<th>Station ID</th>
<th>Town, State</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Bay Site, Trans. 1 (A)</td>
<td>Newmarket, NH</td>
<td>-70.8996</td>
<td>43.069</td>
</tr>
<tr>
<td>Great Bay Site, Trans. 2 (B)</td>
<td>Newmarket, NH</td>
<td>-70.88488</td>
<td>43.0724</td>
</tr>
<tr>
<td>Great Bay Site, Trans. 3 (C)</td>
<td>Newmarket, NH</td>
<td>-70.8760</td>
<td>43.0744</td>
</tr>
<tr>
<td>Portsmouth Harbor, Trans. 1 - 3</td>
<td>Kittery, ME</td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>

**B2 – Sampling Methods**

**Sampling at Each Transect:** A “sampling event” refers to the number of times per year that a site is visited. (For the Great Bay site, this will be three per year. For the Portsmouth Harbor site, there will be two per year, and this may be increased to three per year, depending on available resources.) For each of the sampling events, the following parameters will be taken at each of the six transects: light levels and temperature (loggers are retrieved and brought back to the lab); salinity is ascertained with a refractometer; and tidal stage is noted on the field data sheet. In addition, for each transect, an eelgrass voucher specimen will be collected at each transect. Voucher specimens are preserved and contributed to herbarium collections as a permanent record. In addition to methods described below, additional information/resources can be found at the [Global Seagrass Monitoring Network website](https://www.seagrassnetwork.org/). The randomly chosen quadrat locations shown below are consistent at all SeagrassNet monitoring sites worldwide and will be used in both Great Bay and Portsmouth Harbor. These quadrat locations are also shown in Appendix B.
Transect C: Quadrat positions

Transect B: Quadrat positions

Transect A: Quadrat positions

Table 7: Sampling Schedule.

<table>
<thead>
<tr>
<th>Great Bay</th>
<th>Portsmouth Harbor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td># Days Required</td>
</tr>
<tr>
<td>April</td>
<td>5</td>
</tr>
<tr>
<td>July</td>
<td>5</td>
</tr>
<tr>
<td>October</td>
<td>5</td>
</tr>
</tbody>
</table>
Sampling Protocol

Parameters to monitor and monitoring methods:

Photographic record (one photo of each 0.25 m$^2$ quadrat)

Seagrass cover (visual estimate of 0.25 m$^2$ quadrat)

Seagrass cover (total cover and then cover by each species) estimated on a percent cover scale (0-100%) in each of the predetermined quadrats along the cross transects, using the Seagrass Percentage Cover Photo Guide (Appendix C).

Macroalgae cover (visual estimate of 0.25 m$^2$ quadrat)

Macroalgae cover (total cover) estimated on a percent cover scale (0-100%) in each of the predetermined quadrats along the cross transects.

Canopy height

Canopy height will be measured, ignoring the tallest 20% of leaves and identifying any grazing evidence.

Biomass

An individual shoot will be collected, including 7 cm rhizome approximately 0.5m, landward of each quadrat, including lateral branches if present, and placed into a mesh bag. Sediments are washed from the plant and separated into leaves, stems, and root-plus-rhizome. Epiphytes are scraped from the leaves with a razor blade and discarded. Plant parts are rinsed in fresh water and dried to constant wt (60° C for 24hr) and weighed. Dry shoot weight will be determined and multiplied by density to obtain biomass (g dry wt m$^{-2}$), which is entered on biomass data form (Appendix D).

Shoot density by species

A 25 cm x 25 cm quadrat will be placed inside the larger quadrat in a location representative of the quadrat’s overall shoot density. All the shoots within the 25 cm x 25 cm quadrat are counted and entered on the Field Sampling Form (Appendix A) under the last Species (% Cover/Density) row.

Sexual reproduction

The number of flowering stems in the 25 cm x 25 cm quadrat are counted and expressed as flowering stems per area.

Distance to the seagrass edge and distance to the last shoot

The deep edge of the seagrass bed will be defined as the deepest edge of the continuous meadow and the last shoot is the deepest occurring seagrass shoot. This is measured as the distance from the two ends and the center of the offshore cross transect (C) to the deepest edge and the last shoot.

The shallow edge of the seagrass bed is defined as the shallowest (most onshore) edge of the continuous meadow and the last shoot is the shallowest occurring seagrass shoot. This is measured as the distance from the two ends and the center of the onshore cross transect (A) to the shallowest edge and the last shoot.
Depth

Water depth will be measured at nine places (when the entire site is submerged) and the time will be recorded. Using a depth measure (e.g., depth sounder, weight on a rope marked with depth, etc.), the depth will be measured from the top of the substrate to the water surface at each of the nine cross-transect sites (left, center, and right on the three cross-transects).

Tidal information

The type of tides (diurnal, semi-diurnal) found in the area and the tidal range (spring high to spring low) for the site (obtained from tide charts) will be recorded. The team will also record whether the minimum depth of seagrass distribution is in the intertidal (between the spring high and spring low tidal levels) or subtidal zone (below the spring low tide level).

Environmental data

1. Water temperature (continuously measure temperature, °C) will be obtained with a Hobo® Pendant Light-temperature logger.
2. Salinity will be obtained using water samples collected in small screw-top water bottles (measured at every visit). A refractometer will be used to determine the salinity range (psu).
3. Light level (% surface light at deep and shallow depths vs. land) will be obtained using the Hobo® Pendant Light-temperature logger.
4. Surface sediment samples will be collected for future analysis. (The analysis is not covered under the scope of this project.) Samples (3) are obtained at the center of the three cross-transects using a syringe corer. Sediment characteristics to be analysed include:
   a. grain size (% gravel/sand/silt+clay)
   b. organic content (% loss on ignition)
   c. bulk density (wet weight minus dry weight of a known volume)

Necessary equipment and materials (for each SeagrassNet site)

- SeagrassNet monitoring manual
- percent cover standard sheet
- underwater digital camera
- GPS unit
- compass
- quadrat ID labeler
- 0.25 m² quadrat (50 x 50 cm) (2)
- 0.0625 m² quadrat (25 x 25 cm)
- waterproof data sheets (3 per site)
- plastic clip board
- 30 cm rulers (2)
- 50 m measuring tapes (2)
- permanent station markers (9 screw anchors)
- syringe sediment core samplers w/ rubber stopper (2)
- salinity refractometer
- plastic containers for salinity water samples (3)
- recording temperature and light logger (7 Onset HOBO Pendants)
- HOBO launch and download software and cables
- light sensor storage box
- mesh bags for biomass (12)
- large plastic resealable bags (36 for biomass)
- small plastic resealable bags (3 for sediment)
- paper bags (for drying biomass samples)
- zip ties (20)
- rubber bands (25)
- Large plastic storage box for SeagrassNet kit
- Also needed: use of a drying oven and a computer with internet access

Establishing Permanent Sampling Transects (Relevant for the Portsmouth Harbor site)

One transect per location will be installed perpendicular to shore at the center of a seagrass meadow at least 50 m wide, running from near shore to the deep edge, and serving as the center point for three cross-transects, which are independent.

In addition, three cross-transects per transect are installed, each 50m long with center points at:

- Deep station: (1 m into the bed from the offshore edge of the continuous meadow), marked with a permanent marker and recorded GPS location
- Shallow station: (1 m into the bed from the onshore edge of the continuous meadow), marked with a permanent marker and recorded GPS location
- Mid depth station: (between deep and shallow), marked with a permanent marker and recorded GPS location

Sampling (Three times/year for Great Bay site; Two times/year for Portsmouth Harbor site)

1. At the sampling site, the permanent markers along the transect are located.
2. The light and temperature loggers are retrieved, salinity sample obtained, and the tidal stage is noted on the field data sheet.
3. At one of the central permanent markers, the cross-transect will be set up using the 50m measuring tape to prepare for the sampling procedure along that cross-transect. The team
will take care to avoid walking on the shoreward side of the measuring tape, as this is the area to be sampled.

4. Information will be recorded in the header of the datasheet, including any interesting observations (weather, animals, etc.).

5. Sampling procedure for SeagrassNet quadrat measures:
   - The sampling quadrat will be placed (using the predetermined random distances provided on the datasheet) on the cross-transect on the shoreward side. The quadrat will be positioned so that the lower right corner of the quadrat is on the random distance mark when the person placing the quadrat is facing the shore (or the position of the quadrat may be already marked in red on the tape).
   - A photograph of the quadrat will be taken.
   - The seagrass species present in the quadrat will be identified and entered on the data sheet.
   - Percent cover in the quadrat will be estimated using the Seagrass Percentage Cover Photo Guide (see Appendix C).
   - Percent cover of macroalgae in the quadrat will be estimated using the Seagrass Percentage Cover Photo Guide (see Appendix C).
   - Canopy height will be measured, ignoring the tallest 20% of leaves, and entered on the data sheet (along with evidence of grazing, if present).
   - Flowering shoots, if present, will be counted and entered on the data sheet.
   - A biomass core (individual shoot samples for biomass outside the quadrat) will be collected more than 0.5m shoreward of the quadrat in an area of the same seagrass cover as the quadrat (to the collector’s best judgement).
   - A seagrass density count will be obtained using a 0.25 x 0.25m quadrat in a representative part of the large quadrat.
   - This sampling procedure will be repeated for each quadrat on the cross-transect.

6. SeagrassNet cross-transect measures
   - The water depth at the 0m, 25m, and 50m points on the cross-transect will be measured and, from these points, the distance to the edge of the seagrass bed obtained. The water depths, the time, and the distances will be recorded on the field data sheet.
   - A sediment core sample will be collected for future analysis (not covered within the scope of this project) at the permanent marker at the middle of the cross-transect (20 cm from the marker) and noted on the field data sheet.

7. Steps 3 - 6 will be repeated for each cross-transect until all three cross-transects have been fully sampled.
Post-sampling Procedures

1. Leaf, stem and sheath, and root-plus-rhizome biomass are measured for each core.
2. Wasting disease (total amount of leaf tissue infected) is estimated on a percent infected scale (0-100%) for all aboveground tissue collected.
3. Sediment samples are dried and stored for future analysis (not covered within the scope of this project).
4. HOBO Pendant light and temperature data will be downloaded into a csv file.

Table 8: Sample Requirements

<table>
<thead>
<tr>
<th>Analytical Parameter</th>
<th>Collection Method</th>
<th>Sampling SOP</th>
<th>Container Size and Type</th>
<th>Preservation Requirements</th>
<th>Max. Holding Time (Preparation and Analysis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voucher Specimen</td>
<td>Grab</td>
<td>Section B2</td>
<td>1-gallon resealable plastic bag</td>
<td>Cooler</td>
<td>2 days</td>
</tr>
<tr>
<td>Biomass Sample</td>
<td>Grab</td>
<td>Section B2</td>
<td>1-gallon resealable plastic bag</td>
<td>Cooler</td>
<td>2 days</td>
</tr>
</tbody>
</table>

B3 – Sample Handling and Custody

Biomass and any voucher specimens collected will be held in the custody of UNH JEL. Biomass samples will be held at UNH JEL at least until the Project Manager has received and reviewed the electronic data for the current year. After voucher specimens of eelgrass or seaweed are brought to UNH JEL, they may be given to the marine/estuarine collections of the UNH Hodgdon Herbarium or the herbarium of another institution at the discretion of UNH JEL.

B4 – Analytical Methods

Biomass Collection: The number of leaf meristems for each species of seagrass will be recorded on the Biomass Form (Appendix D) under “Shoot Count.” The percentage cover of wasting disease on each of the youngest three leaves will be noted and recorded on the Biomass Form as well. Plant matter will be separated from sediment and dried in oven for 24 to 48 hours or until the material is completely dry. When cool, the material will be weighed on electronic scale to an accuracy of 10 mg and recorded on the datasheet.

B5 – Quality Control

The Project QA Officer will check that the data quality objectives are met using the criteria and methods from Table 3 in Section A7.

The Field Operations Manager will verify that the field crews are following the protocols correctly during the field sampling audit (see Section C1).
Databases of results will be checked for transcription errors and bad data using two methods. First, the entire data set will be printed and checked against the entries in each field or laboratory data sheet. Second, the Project QA Officer will discuss outlier occurrences with the Project Manager to determine if there are outliers in the data set. The Project QA Officer and the Project Manager will examine the outliers to determine whether these data should remain in the dataset.

**B6/B7 – Instrument/Equipment Testing, Inspection, Maintenance, Calibration, and Frequency**

The Field Operations Manager will be responsible for checking the batteries in the GPS and digital camera before traveling to sampling sites each day that the equipment is in use. The GPS, camera, and a spare set of batteries will be taken into the field in a resealable plastic sampling bag or other watertight container. The field assessment team will also transfer photographs from the camera to a computer at the end of each sampling day to ensure that the camera has sufficient memory available to store new pictures on the next sampling day.

**B8 – Inspection/Acceptance Requirements for Supplies and Consumables**

The Field Operations Manager will prepare field equipment for daily use, insuring proper calibration is completed, software is updated, and/or power sources are optimized for peak performance (i.e., charged/cycled).

**B9 – Non-Direct Measurements**

Information on tides will be used to determine the dates and times at which site establishment and sampling will occur. NOAA Tide Predictions at Fort Point, Dover Point, and the Squamscott River span the study area:
- Fort Point (Portsmouth Harbor)
  http://tidesandcurrents.noaa.gov/noaatidepredictions/NOAATidesFacade.jsp?Stationid=8423898
- Squamscott River
  http://tidesandcurrents.noaa.gov/noaatidepredictions/NOAATidesFacade.jsp?Stationid=8422687

**B10 – Data Management**

Field data will be recorded in the field on waterproof SeagrassNet data sheets and transferred to the matching SeagrassNet data form online (SeagrassNet.org). Laboratory data will be transferred from SeagrassNet biomass data sheets to the matching SeagrassNet data form online (SeagrassNet.org). All field and laboratory data will be downloaded from the SeagrassNet website into csv format and transferred to the Project QA Officer as part of the laboratory report.

The field assessment team will assign filenames to photographs using the sample labeling scheme: site name, transect, and date. The field assessment team will provide the Project QA Officer with copies of all electronic files via an electronic data transfer system, such as Dropbox, or on a flash drive within 10
business days of the completion of laboratory work for the current field season. Files will be stored in a dedicated project directory on the JEL computers. The Project QA Officer will be responsible for uploading the data to PREP publications website at scholars.unh.edu/prep/. Management of hardcopy data and documents is described in Section A9.

C1 – Assessments and Response Actions

In order to confirm that field sampling, field analysis and laboratory activities are occurring as planned, the Project QA Officer, Field Operations Manager, and Project Manager shall confer after the first sampling event each year to discuss the methods being employed and to review the quality assurance samples. The audit will involve a visit to the lab and going through Sections B1 through B4 with the Field Operations Manager and confirming that all steps have been taken. At this time, all concerns regarding the sampling protocols and analysis techniques shall be addressed and any changes deemed necessary shall be made to ensure consistency and quality of subsequent sampling. The Project Manager will have the authority to resolve any problems encountered. Assessment frequencies and responsible personnel are shown in the following table.

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Frequency (Annual Basis)</th>
<th>Person Responsible for Performing Assessment</th>
<th>Person Responsible for Responding to Assessment Findings</th>
<th>Person Responsible for Monitoring Effectiveness of Corrective Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field sampling audit</td>
<td>Once after first sampling day</td>
<td>Field Operations Manager</td>
<td>Field Operations Manager</td>
<td>Field Operations Manager</td>
</tr>
<tr>
<td>Field analytical audit</td>
<td>Once after first sampling day</td>
<td>Field Operations Manager</td>
<td>Field Operations Manager</td>
<td>Field Operations Manager</td>
</tr>
<tr>
<td>Data Quality Audit</td>
<td>Annually</td>
<td>Project QA Officer</td>
<td>Project QA Officer</td>
<td>Project QA Officer</td>
</tr>
</tbody>
</table>

C2 – Reports to Management

The Project QA Officer will produce a QA/QC memo that will be an attachment to the final report. The final work product will be a report containing quality assured results for all parameters and a memo describing any deviations from the protocols established in the QAPP. Data from the final reports will be published in PREP’s State of Our Estuaries Reports.

D1 – Data Review, Verification, and Validation

The Project QA Officer will be responsible for a memorandum summarizing any deviations from the procedures in the QAPP and the results of the QA/QC tests. The Project QA Officer will review all field data sheets and/or final computer data files for completeness and quality based on the criteria described in Section A7. The Project QA Officer will also affirmatively verify that the methods used for the study followed the procedures outlined in this QAPP. If questionable entries or data are encountered during the
review process (see methods in Section B5), the Project QA Officer will contact the appropriate personnel to determine their validity.

**D2 – Verification and Validation Procedures**

The Project Manager will compare the QA memorandum against the QAPP. Any decisions made regarding the usability of the data will be left to the Project Manager; however, the Project Manager may consult with project personnel or with personnel from EPA, if necessary.

**D3 – Reconciliation with User Requirements**

The Project Manager will be responsible for reconciling the results from this study with the ultimate use of the data. Results that are qualified through the QA process may still be used if the limitations of the data are clearly reported to decision-makers. Data for this project are being collected as part of a long-term monitoring program. It is not possible to repeat sampling events without disrupting the time series. Therefore, the Project Manager will:

1. Review data with respect to sampling design.
2. Compare the QA memorandum with the QAPP.
3. If the data quality objectives from Section A7 are met, the user requirements have been met. If the data quality objectives have not been met, corrective action will be established by the Project Manager.

**References**


<table>
<thead>
<tr>
<th>Parameters</th>
<th>Example</th>
<th>Cross-transect 0-25 m</th>
<th>Cross-transect 20-50 m</th>
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<tbody>
<tr>
<td>Quadrat Measures</td>
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<tr>
<td>Photograph (1 per quadrat)</td>
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<tr>
<td>Voucher Specimen (1 of each</td>
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<td>Species = % Cover</td>
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</tr>
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<td></td>
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<tr>
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<td>A. Neashore</td>
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<td>E. Middle</td>
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<td>C. Offshore</td>
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<td>Water Depth (m) at time (hrs)</td>
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<td>Surface sediment observation/s</td>
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<td>Station Measures</td>
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<td>Light - Hobo (day in - day out)</td>
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<td>Zm - Zostera marina</td>
<td>Un - Unknown</td>
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<td>Water temp. logger (day out)</td>
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<td>Zm - Zostera nolii</td>
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<td>Salinity (ppt)</td>
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<td>Hw - Halodule wrightii</td>
<td></td>
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<tr>
<td>Tidal Stage (high or low / spring or neap)</td>
<td>low spring</td>
<td>Rm - Ruppia maritima</td>
<td></td>
</tr>
</tbody>
</table>
Appendix B: Quadrat Positions

For each of the three cross-transects, you will measure 12 quadrats. The position of the quadrats will be on the shoreward side of the measuring tape at selected locations (Figs. 2 & 6). The locations are shown below; they were predetermined using random numbers.

Figure 6. Location (distance) of quadrats along each cross-transect.
Appendix C
Seagrass Percentage Cover (% cover) Photo Guide
<table>
<thead>
<tr>
<th>Location:</th>
<th>Transect code &amp; no.:</th>
<th>Researchers:</th>
<th>Sampling date and time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>State/Country:</td>
<td>Station (circle one):</td>
<td>A. Nearshore, B. Middle, C. Offshore</td>
<td>Comments:</td>
</tr>
</tbody>
</table>

### PARAMETERS

| Species # 1 | Shoot count | Leaf weight (g) | Stem/Sheath weight (g) | Root/Rhizome weight (g) | Cross-transect 0-25 m | | | | | | Cross-transect 26-50 m |
|-------------|-------------|-----------------|------------------------|-------------------------|------------------------|---|---|---|---|---|
| Species # 2 | Shoot count | Leaf weight (g) | Stem/Sheath weight (g) | Root/Rhizome weight (g) | | | | | | | |
| Species # 3 | Shoot count | Leaf weight (g) | Stem/Sheath weight (g) | Root/Rhizome weight (g) | | | | | | | |
| Species # 4 | Shoot count | Leaf weight (g) | Stem/Sheath weight (g) | Root/Rhizome weight (g) | | | | | | | |
| Species # 5 | Shoot count | Leaf weight (g) | Stem/Sheath weight (g) | Root/Rhizome weight (g) | | | | | | | |
| Species # 6 | Shoot count | Leaf weight (g) | Stem/Sheath weight (g) | Root/Rhizome weight (g) | | | | | | | |