Seagrass Ecosystem Energy Fluxes: Methods

v0.0.2

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Introduction

Seagrasses are essential coastal habitats that support diverse and productive food webs. However, identifying factors that structure seagrass food webs and drive the flow of energy within them remain a key frontier in a rapidly changing world. Here, we propose a collaborative survey coordinated by the Smithsonian Institution's MarineGEO program and leveraging standardized approaches to characterize the rich flora and fauna of seagrass beds around the world. We will use these data to construct simple food webs, apply a novel framework to estimate energy fluxes among trophic levels, and associate these with hypothesized abiotic and biotic drivers, especially biodiversity. The proposed work will lead to one or more peer-reviewed manuscripts (including all participants as co-authors, to be submitted within one year of completion of all fieldwork) that will strongly enhance and generalize our understanding of seagrass ecosystem dynamics.

Requirements*

*Estimated times will vary by site and conditions

Personnel: 3-4 people

Estimated Total Time Per Site:

Preparation: 1 person x 1 day
Fieldwork: 2-4 people x 2-3 days
Sample Post-processing: 1 person x 30 days
Data processing: 1 person x 1-2 days

Materials:

Fieldwork

General

- ☐ Hand-held GPS unit
- ☐ 1 50-m transect tape with 1-m markers
- ☐ 6 (or more) PVC marker poles (diameter and length as needed)
- ☐ Waterproof camera
- ☐ Waterproof paper (for fieldsheets, labels)
- ☐ Pencil
- ☐ Clipboard/Dive slate
- ☐ Ruler (mm)
- ☐ 1 cooler with ice

Water Quality

- ☐ Data sonde/temperature logger/thermometer (for temperature)
- ☐ Data sonde/refractometer (for salinity)

☐ Secchi disk (for Secchi depth)

Seagrass Quadrat Surveys
☐ 1 50 cm-x-50 cm (0.25 m^2) quadrat (PVC or other material) divided in 4 equal 25 cm-x-25 cm (0.0625 m^2) quadrants

Seagrass Cores (if quadrat surveys cannot be conducted)
☐ *IF NEEDED:* Sediment corer (round; 15 cm diameter-x-20 cm length)
☐ *IF NEEDED:* 9 draw-string mesh bags (~1 mm mesh size; for biomass cores)
☐ *IF NEEDED:* 9 plastic bags (with internal and external labels; large enough to hold mesh bags; for biomass cores)
☐ *IF NEEDED:* Large (2-lb) hammer or mallet (optional, recommended if diving)

Shoot Collections
☐ 18 small plastic bags (with internal and external labels; for shoot collection)

Macroalgae
☐ 18 mesh bags (with internal and external labels; for macroalgae)

Epifauna
☐ 18 draw-string mesh bags (500 µm mesh size, approximate dimensions: 75 cm x 20 cm, with 20 cm opening)

Fish
☐ 1 beach seine/fish trawl (record dimensions including height, width, opening and mesh size)

Post-processing

☐ Drying oven
☐ Sorting tray
☐ Petri dishes
☐ Forceps (fine-tip)
☐ **Nested sieve set with the following sizes: 8.0, 5.6, 4.0, 2.8, 2.0, 1.4, 1.0, 0.71 and 0.5 mm**
☐ 18+ scintillation vials (20-mL) with lids
☐ 70% ethanol (0.5-1.0 L)
☐ 80+ pre-weighed foil tins

Workflow

Preparation:
1. Review the proposal and expectations of participants here.
2. Review all of the hyperlinked protocols below (in blue). All materials (protocols, fieldsheets, and data entry spreadsheets) are provided for each method. Please make every effort to use these materials, as it is necessary for the timely submission and curation of your data. We are working on a simple streamlined data submission portal to be ready by Fall 2019.

Site Selection:

1. Identify ***at least 1 seagrass bed*** (more is fine) to sample. Beds should be:
    a. typical of your region;
    b. large enough to deploy three 50-m transects;
    c. reasonably accessible.
2. Lay out and mark the positions of three 50-m fixed transects using PVC poles or other markers, and record their positions using GPS. Place the transects parallel to shore and representing the shallow (inshore), middle (interior), and deep (offshore) parts of the bed (Fig. 1):
    a. If the bed is intertidal or relatively shallow, select transects that are increasingly far from shore and separated by the largest distance that is logistically feasible.
    b. If the bed extends into water too deep to work in, deploy the transects at the maximum distance from shore that is logistically feasible.
    c. Ensure that the transects are reasonably independent (separated by a minimum of 5-10 m). If it's not possible to arrange 3 transects within the bed so that they are not overlapping or they are too close, contact MarineGEO for further guidance.

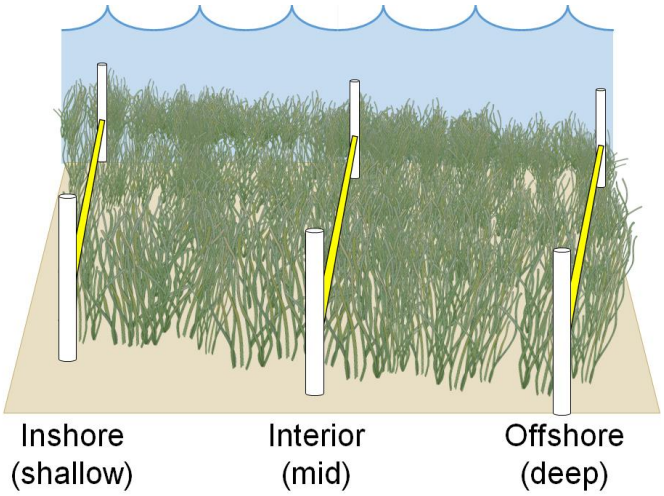

Figure 1. Position of three 50-m transects within a bed.

Fieldwork: Day 1

1. Measure environmental conditions (temperature, salinity, Secchi depth).
2. Before deploying predation assay, quantify fishes and large mobile invertebrates by conducting either a Beach seine, Trawl, or Diver visual census at or near the transects, either within or immediately adjacent to the seagrass bed.
3. *OPTIONAL:* Deploy Predation Assays (n =25) positioned roughly every 2 m along a *single* transect (Fig. 2). Choose one of the three transects that will ensure that the baits are submerged for the entire 24-hourt deployment. One hour after deployment, score bait loss from the predation assay.
4. Along each transect, take the following samples (Fig. 2):
    a. Use Seagrass density protocol to survey percent cover, composition, and shoot density (every 4 m, n = 12 per transect).
    b. Use Seagrass macroalgae protocol to collect macroalgae from within the quadrats used for the Seagrass density protocol (every 8 m, n = 6 per transect).
    c. Use Seagrass shoots protocol to collect shoots for later measurement of leaf characteristics and fouling load in the lab (every 8 m, n = 6 per transect).
    d. Use Seagrass epifauna protocol to sample epifaunal community structure for later processing in the lab (every 8 m, n = 6 per transect).

e. *OPTIONAL:* Use Sediment organic matter protocol to sample organic carbon in sediments for later processing in the lab (every 16 m, n = 3 per transect).
f. *IF NEEDED*: Use Seagrass biomass protocol to sample above- and belowground biomass of seagrass and shoot density (every 16 m, n = 3 per transect).

5. Take destructive samples (biomass cores, shoot collections, epifauna collections) at least 1-m from the permanent quadrats (Fig. 3).
6. Conduct a second replicate the mobile fish and invertebrate survey (Beach Seines, Visual Survey, Fish Trawls), or conduct on second day.
7. Return all samples to the lab for processing.

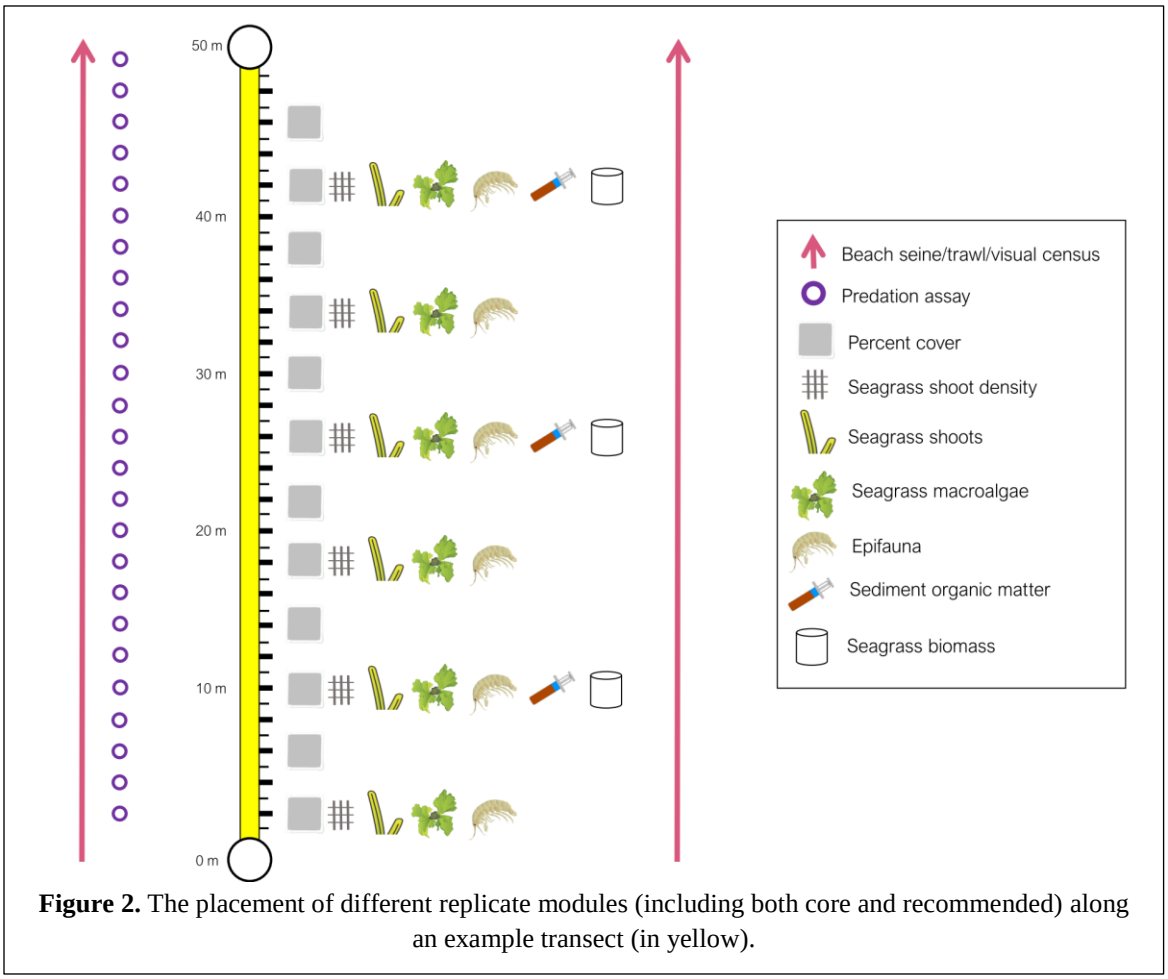

Figure 2. The placement of different replicate modules (including both core and recommended) along an example transect (in yellow).

Fieldwork: Day 2

1. *OPTIONAL*: Score 24-h bait loss from predation assay. Retrieve stakes and any associated markers.

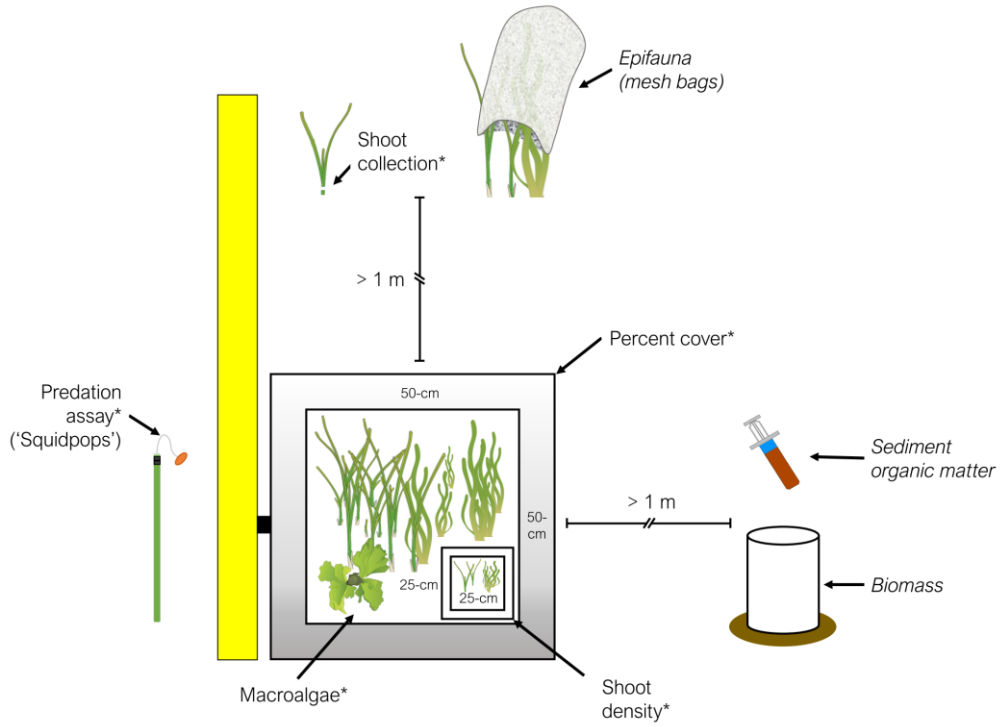

Figure 3. Example assays to be conducted along each transect (refer to Fig. 2 for more details).

Sample post-processing:

1. Samples should be processed within the following time frames:
    a. Seagrass shoot collections: within 24-h
    b. Seagrass macroalgae: within 24-48-h
    c. Sediment organic matter: within 1-3 days
    d. *IF TAKEN:* Seagrass biomass cores:
        i. Macrophytes: within 24-h;
        ii. Dry mass: within 1-3 days;
    e. Seagrass epifauna:
        i. Macrophytes: within 24-h;
        ii. Dry mass: within 1-3 days;
        iii. Epifauna (preserved): at leisure

Data Submission

1. For the individual modules, transfer data from all datasheets (field and lab) onto the appropriate data entry template(s) and submit to marinegeo-data@si.edu. Refer to the individual protocols for further guidelines regarding metadata and images. An online data submission portal is forthcoming.

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