Seagrass Ecosystem Energy Fluxes: Methods

v 0.0.1

Last updated 12 April 2019

Smithsonian Institution

marinegeo@si.edu

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 fieldwork) that will strongly enhance and generalize our understanding of seagrass ecosystem dynamics.

Requirements*

*Estimated times will vary by site and conditions

Personnel: 2-4 people

Estimated Total Time Per Site:

Preparation: 1 person x 1 day
Fieldwork: 2-4 people x 1-2 days
Sample Post-processing: 1 person x 30-60 days
Data processing: 1 person x 1-2 days

Materials:

Fieldwork

- ☐ Hand-held GPS unit
- ☐ 1 50-m transect tape with 1-m markers
- ☐ 2 (or more) PVC marker poles (diameter and length as needed)
- ☐ Waterproof camera
- ☐ Waterproof paper (for fieldsheets, labels)
- ☐ Pencil

- ☐ Clipboard/Dive slate
- ☐ Ruler (mm)
- ☐ *IF NEEDED: 1* beach seine/fish trawl (record dimensions including height, width, opening and mesh size)

- ☐ Dried squid mantle (for predation assay)

- ☐ 13-mm diameter auger punch or cork borer
- ☐ Sewing needle
- ☐ Scissors
- ☐ Thin monofilament line (2-19 lb test)
- ☐ Electrical tape (1 roll)
- ☐ 25 fiberglass garden stakes (30-50 cm in length; for predation assay)

- ☐ 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

- ☐ *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)

- ☐ 18 plastic bags (with internal and external labels; for shoot collection)

- ☐ 9 5-mL plastic syringes with graduations (0.1-0.2 mL) with the applicator tip cut off (for sediment organic matter)
- ☐ 9 small plastic bags (with internal and external labels; for sediment organic matter)

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

- ☐ 1 cooler with ice

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. Contact coordinating scientist, Jon Lefcheck, by email to indicate participation and to discuss logistics: LefcheckJ@si.edu.

3. Review all of the linked 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 will greatly enhance the receipt and curation of your submitted data.

Site Selection:

1. Identify at least 1 seagrass beds (locations) to sample. Beds should be:
    a. typical of your region;
    b. large enough to deploy three 50-m transects;
    c. reasonably accessible.
2. Record GPS coordinates at each sampling location. Take photos of the surrounding landscape and some underwater photos of the seagrass habitat for each trip. Also record field notes on the general layout and condition of the habitat, conspicuous features or organisms, etc.
3. Lay out and mark the positions of three 50-m fixed transects using PVC poles or other markers. 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.

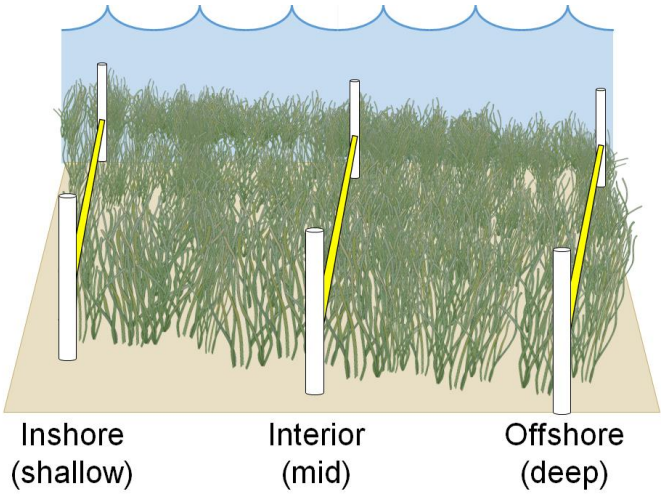

Figure 1. Position of three 50-m transects within a bed.

Fieldwork: Day 1

1. Measure environmental conditions (temperature, salinity, Secchi depth).
2. *Before* conducting any further sampling, quantify fishes and large mobile invertebrates. Shallow sites should consider Beach Seines. Deeper sites with good visibility should use the Visual Survey, and deeper sites with low visibility should consider Fish Trawls.
3. 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.
4. One hour after deployment, score bait loss from the predation assay.

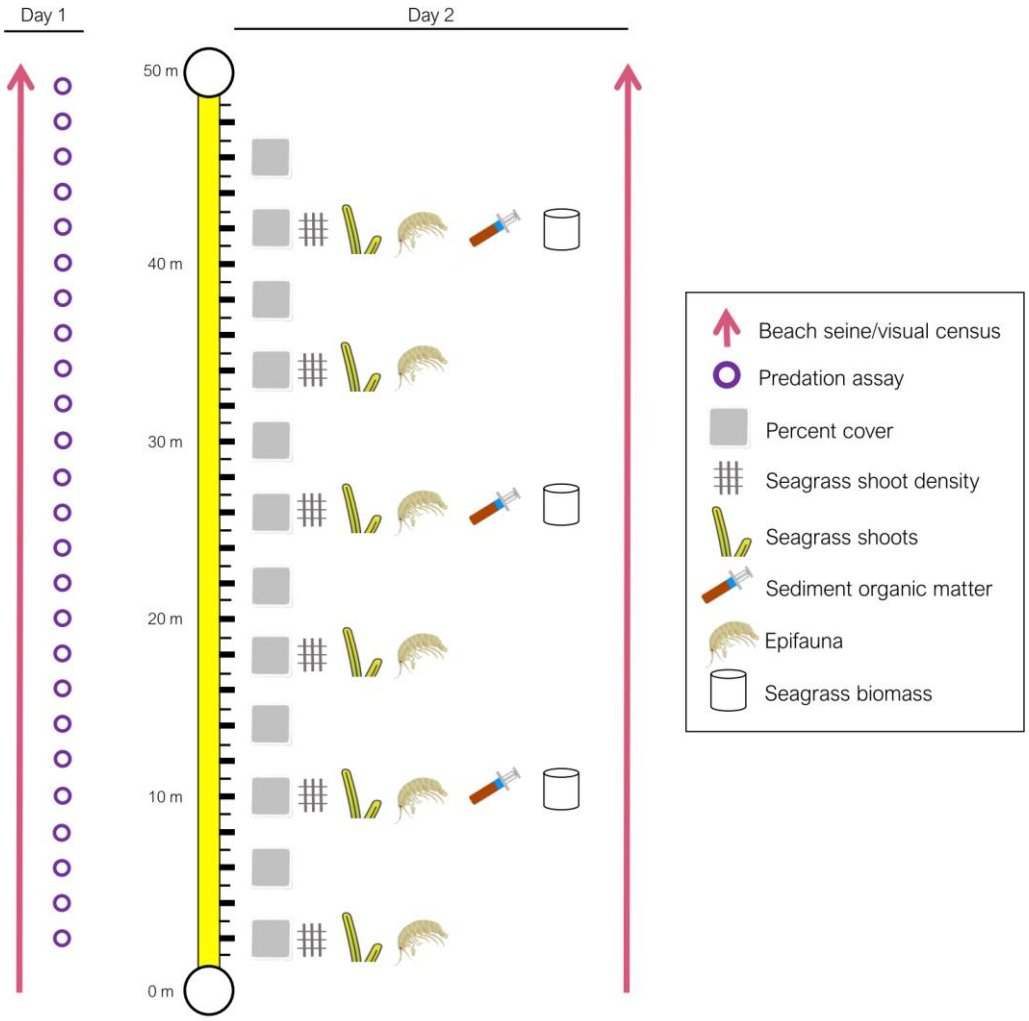

Figure 2. The placement of different replicate modules (including both core and recommended) along an example transect, and their timing of deployment.

Fieldwork: Day 2

1. Return to the site.
2. Conduct a second replicate the mobile fish and invertebrate survey (Beach Seines, Visual Survey, Fish Trawls.).
3. Score 24-h bait loss from predation assay. Retrieve stakes and any associated markers.
4. Along each transect, take the following samples (Fig. 2):
    a. Seagrass Density to survey percent cover, composition, and shoot density (every 4 m, *n* = 12 per transect). *If visibility is too poor to conduct surveys*, take Seagrass Biomass Cores to sample above- and belowground biomass of seagrass and shoot density (every 8 m, *n* = 3 per transect).
    b. Seagrass Shoots for later measurement of leaf characteristics, fouling load, and disease in the lab (every 4 m, *n* = 6 per transect).

   c. Sediment Organic Matter for later processing in the lab (every 8 m, *n* = 3 per transect).
   d. Seagrass Epifauna for later processing in the lab (every 4 m, *n* = 6 per transect).
5. Take destructive samples (biomass cores, shoot collections, epifauna collections) at least 1-m from the permanent quadrats (Fig. 3).
6. Return all samples to the lab for processing.

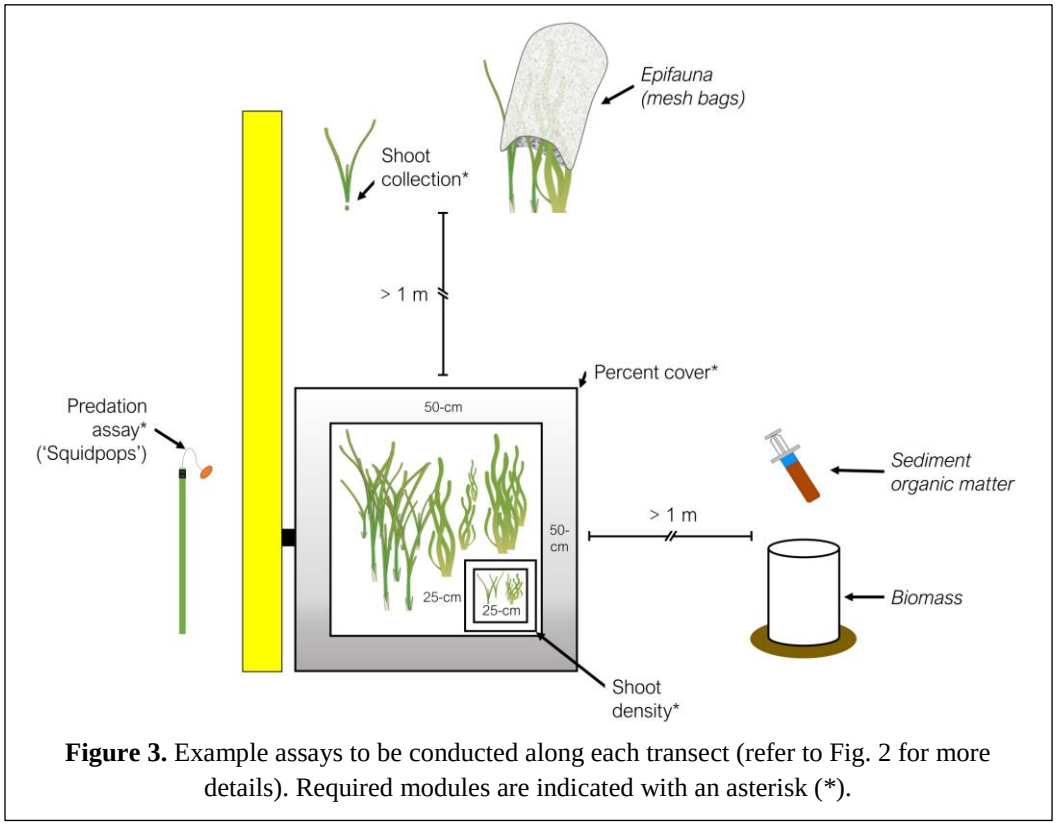

Figure 3. Example assays to be conducted along each transect (refer to Fig. 2 for more details). Required modules are indicated with an asterisk (*).

Sample post-processing:

1. Activities from Day 1 require no post-processing.
2. The samples on Day 2 should be processed within the following time frames:
   a. Seagrass shoot collections: within 24-h
   b. Sediment organic matter: within 1-3 days
   c. *IF TAKEN:* Seagrass biomass cores:
      i. Macrophytes: within 24-h;
      ii. Dry mass: within 1-3 days;
   d. Seagrass epifauna:
      i. Macrophytes: within 24-h;
      ii. Dry mass: within 1-3 days;
      iii. Epifauna (preserved): at leisure

Data Submission

1. Label the site observations and photographs, and share with marinegeo-data@si.edu.
2. 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.

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