SHOALS MARINE LABORATORY
INTERTIDAL TRANSECT MONITORING PROGRAM

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NOTICE TO DATA USERS: Appendix A of this document and the 'Data Quality Documentation.doc' file should be read carefully. These documents outline the history of data collection and known idiosyncrasies with the data set that may influence your data use decisions. Further, we ask you to contact us to tell us how you are using this data so that we can track use. Please send an email describing use to shoals.lab@unh.edu. We thank you for your time in reaching out to us. Our website: shoalsmarinelaboratory.org.

There are 29 TRANSECT SITES around the periphery of Appledore Island. Student research interns, overseen by Ph.D.-level mentors will sample 5 to 6 transects each year (sites 5, 7, 15, 20, 26; do 22 as time permits). Their locations are marked by steel pins cemented into the bedrock precisely 13.5 feet (4.1 meters) in vertical height above MLLW (mean lower low water). Most pins are circled and numbered with bright paint. We will work as a group on each transect; one buddy pair does odd levels and the other pair does even levels (see below regarding levels). See Appendix A for a brief history of the Shoals Marine Laboratory (SML) Intertidal Transect Monitoring Program. See https://www.shoalsmarinelaboratory.org/natural-history for information on the general geology and biology of the island.

1. MATERIALS:

field book	sighting stick	20 X 20 cm quadrat
field checklist	sighting scope	plastic bags
putty knife	yard stick	compass
bucket	hand lens	pencils
flagging tape	first aid kit	ruler/calipers

2. SITES: Locate the transect pin. The axis of the transect (see map) is a compass bearing from the pin, chosen to cross the shore along a line approximately perpendicular to the water line.

3. VERTICAL MEASUREMENTS: Measure vertical distances in feet below (or above) the pin. Feet are the traditional units of measure for the height of tides, so we use this for our vertical measurements. We will demonstrate use of the sighting scope and the tall sighting stick for surveying elevation (Figure 2).

The pin is level 0. For efficiency, place a temporary marker (e.g., a rock) at Level 5 and Level 10; this will alleviate having to go back to the pin each time you place a new quadrat.

Where intertidal organisms extend above the pin, measure upward until bare rock is found and number the levels as follows:

> Level -1 = top of frame placed one foot vertically above the pin (14.5 ft. above MLLW)
> Level -2 = top of frame placed two feet vertically above the pin (15.5 ft. above MLLW); and so on.

For reports, posters, and other communications, convert "levels" to "feet above MLLW" by subtracting the level from 13.5. Thus, level 11 is 13.5 - 11 = 2.5 feet above MLLW. Then convert to metric as appropriate.

Figure 2. Making vertical measurements. One intern uses a sighting scope (left) to find the appropriate location to place a quadrat. This done by 'sighting' to the correct level on the sighting stick (right). Interns must account for the height of the yardstick when determining their tide height level.

4. QUADRAT SAMPLES: Take samples at one foot vertical increments with the wire quadrat (Figure 3). Once the proper vertical position is determined, place the quadrat with the upper edge perpendicular to the transect axis, on a rock surface that is as representative as possible of the average slope and exposure of the transect. Avoid large cracks, pools, or other unusual microhabitats.

You will sample 3 quadrats per level. Put one near the transect line itself, and then one on either side (within 10m of transect). Choose your quadrat locations by physical features: try to be "organism blind", to avoid bias. Upper edges of each quadrat frame should be surveyed so that all are exactly at the proper vertical level.

Your safety is paramount! You should take samples ONLY as far down as permitted by tides and sea conditions during the study. Take advantage of extremely low tides to assess the lowest quadrats; this requires some planning ahead. Keep in mind that you need not do the quadrats in order.

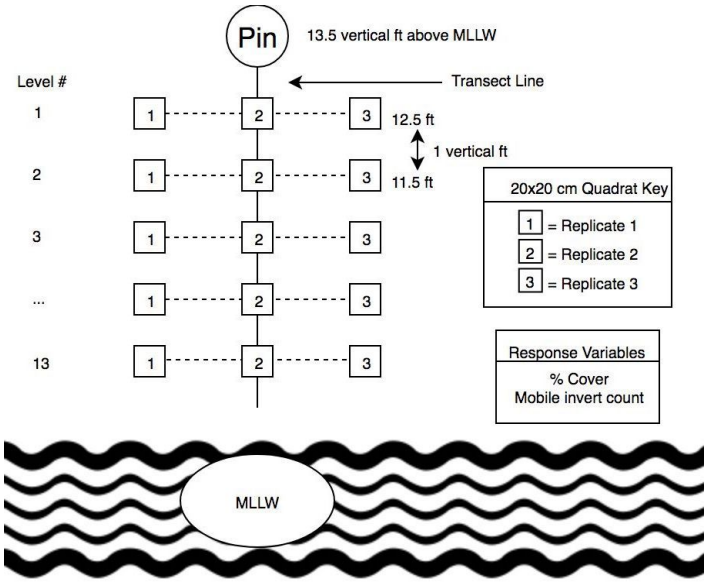

Figure 3. Schematic of SML Transect Protocol sampling structure. The pin is set at level 0, or 13.5 feet above mean low low water (MLLW). Students survey three replicate quadrats at 1-foot vertical intervals. Typically students are able to survey down to level 13 but may be able to continue further depending on weather conditions.

5. WHAT TO QUANTIFY: You must identify and quantify the abundances of all LIVE organisms that are visible to the naked eye and fall within the quadrat frame. You will need to take samples of some tiny or unknown organisms to the laboratory for keying or microscopic examination. Use the plastic bags.

Identify seaweeds and most animals to species, with the exception of the taxonomically difficult groups. It is not always possible to give a species name to young *Fucus* plants, in which case it should be reported as "*Fucus* sp."

You should not quantify dead organisms, although you may make note of them (e.g., 'many dead barnacles').

> PERCENT COVER

Estimate canopy and primary percent cover (Figure 4) of the following if they account for ≥ 3% of a quadrat:

- Seaweeds that form a canopy (e.g., rockweeds, *Chondrus, Mastocarpus*)
- Epiphytes (e.g., *Vertebrata, Elachista*)
- Epizoonts (e.g., *Dynamena*)
- Seaweed holdfasts covering the primary surface (e.g., rockweeds)
- Sessile invertebrates occupying primary rock surface (e.g., bryozoans, anenomes)
- Shell hash (coarse “sand” composed of ground-up shells) that covers primary surface

Canopy cover: Many quadrats will have different layers of organisms that must be quantified separately. For each layer above the primary surface, measure anything you see in the quadrat frame, regardless of where it is attached. Organisms comprising canopies may add up to more than 100%; for instance, you may have 20% cover of *Vertebrata*, 100% canopy cover of *Ascophyllum*, and then when you move it aside you find you have 15% cover of *Fucus*, 30% cover of *Mastocarpus*, and 3% cover of *Chondrus* (for a total of 168% canopy cover). No one species can have greater than 100% canopy cover, even though total canopy can exceed 100%.

Primary cover: The organisms taking up space on the rock (primary cover) should NOT add up to more than 100%; percent covers of barnacles, mussels, encrusting algae, holdfasts of erect algae, bryozoans, bare space, etc. should add up to ~100%. Organisms that account for <3% primary cover will be quantified as Category Species (see below).

Percent cover is estimated visually; use the 16 small squares within the quadrat to facilitate estimates. Each small square is approximately 6%.

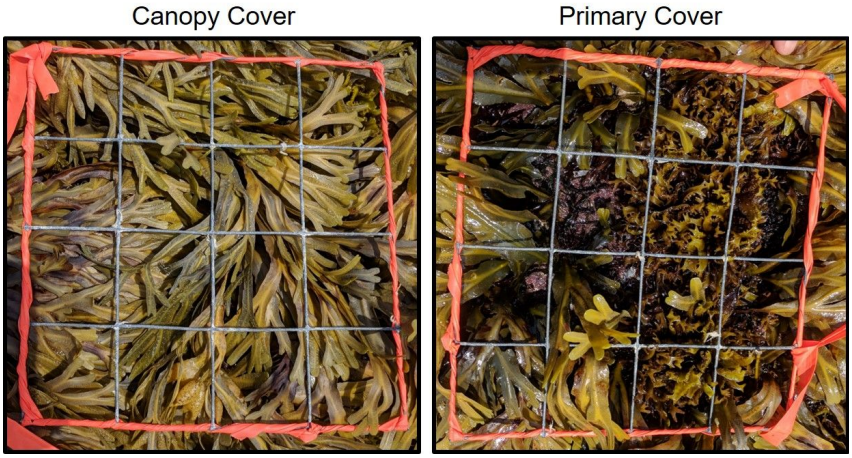

Figure 4. Visualization of canopy (left) versus primary cover (right) species assessment—each square represents roughly 6% of the full quadrat. In this example, students would record 100% Fucus sp. *canopy cover then move the canopy away to assess species living beneath. The smaller* Fucus *individuals and* Mastocarpus stellatus *form a second canopy layer of ~ 9% and 30%, respectively. Increasing the total canopy cover to 139%. Abundance of primary cover species should add up to 100%.*

> CATEGORY SPECIES

Many organisms are extremely difficult to quantify objectively and consistently, so we will assign their abundances to categories. These include most epiphytes and epizoonts, as well as small and scattered organisms on the rock such as hydroids and bryozoa. Many algae (especially ephemerals) are sometimes epiphytic or sometimes not, so we simplify their quantification by simply categorizing them. See the field checklist for a list of common category species. In addition, any species typically quantified as percent cover (e.g., *Ascophyllum*, barnacles, etc), but is <3% cover should be quantified as a category species. We will reconcile these different quantification methods after data collection (see *Data Management* below).

For all these category species, count the number of small squares (out of 16) containing any amount of that species. Note that this is different than quantifying percent cover. Field sheet data entries will thus be an integer between 0 and 16.

> COUNTS

Organisms that have distinct individuals will be counted. Mobile animals (i.e., snails, crabs, etc. that are not attached to primary substrate) should be counted in the entire 20x20cm quadrat. For sessile species that are very numerous (e.g., barnacles, mussels), count the numbers in 3 randomly chosen small squares within the quadrat, and use that figure to estimate a total. Include moving organisms that are within the frame when you place it, but later move out. Ignore organisms that move in after you place the frame.

> SIZES

The size distribution of the animals provides information about their age and population structure. For each quadrat, record the number of barnacles and mussels in the requested size class categories. Do this simultaneously with the Counts (see above), or estimate the proportion of barnacles and mussels in each size class and then estimate numbers (Data entry should be in numbers not percentage/proportions). For the algae, measure the length of the longest branch of the largest plant.

Note the size ranges and data required for each species. These species are listed on the field checklist and data entry spreadsheet.

Semibalanus balanoides
Mytilus edulis
Modiolus modiolus
Fucus species (record length AND species)
Ascophyllum nodosum (record length and number of nodes (air bladders) along main axis)

The field checklist will be provided and is an excel file that can be printed and brought out in the intertidal with you as a "cheat sheet" as a reminder of all the data that needs to be collected.

6. DATA MANAGEMENT

All data collected will be entered into an excel spreadsheet:
"TRANSECT_Datasheet_Template_2018_CES"

Enter all data from your field notebooks into the appropriate sheets (Percent cover, Category, Counts, Sizes).

Data entry rules:

A. Quality control. Once entered, work with your partner and check your data entry for mistakes. Best practice is to have one person read back from the spreadsheet and the other person checks with the notebook.
B. Enter "0" for all empty cells that were quantified but had no species presence
C. Enter "ND" (no data) for empty cells that were not completed, but should have been (e.g., you forgot to measure longest Ascophyllum in your quadrat but did everything else).
D. Enter "NA" (not applicable) for all empty cells that data could not be quantified (e.g., longest Ascophyllum if no Ascophyllum was present in your quadrat, levels that were not surveyed, etc.).
E. For every entry in the "Category" sheet multiply the number of squares times 0.2 and enter the result into the appropriate column in the "Percent cover" sheet. DO NOT enter a formula into the "Percent cover" sheet to automate this!!!!! This will cause problems later on. The easiest way is to work in pairs with one person on the "Category" sheet doing the math and the partner entering it on the "Percent cover" sheet.
F. Make sure to save the spreadsheet as a new spreadsheet with the format: "SML_YYYY_Transect_XX". For example: "SML_2018_Transect_05".
G. Triple check that the file name and the first 5 columns (Year, Transect, Level, Replicate, Data taken) are all correct for the Transect you are working on! It's super easy to forget this and has caused lots of confusion in subsequent years!

APPENDIX A. BRIEF HISTORY OF SML TRANSECT PROTOCOL CHANGES

1972-1983: SML establishes 29 transect sites around Appledore Island. The goal of the transect system was, and remains, to teach undergraduate students observational skills, survey methods, species identification and natural history, and rocky intertidal ecology. Transects are surveyed annually as part of courses; students typically worked in pairs and were assigned a transect site to study; that is, each transect was sampled by a unique student pair. Data is unavailable, but a report of transects from neighboring Star Island is available from Shoals Marine Laboratory (shoals.lab@unh.edu)

1983 & 1984: Field data sheets are available from Shoals Marine Laboratory (shoals.lab@unh.edu) and will be digitize and added to this data set in the near future.

1985-1991: The number of replicates is variable among levels; 1-3 quadrats were surveyed per level during this time period.

1992: Students begin to consistently survey 3 replicate quadrats per level; however, the number of transects surveyed are dependent on course enrollment.

1997: An intensive data entry effort occurred; note that data prior to 1982 are missing.

1998: Intensive data entry effort continued.

2007: No transects are surveyed this year but an intensive data entry effort occurs.

2008: Only 1 transect is surveyed and data entry continues.

2011: Annual surveys of transect sites are conducted by four undergraduate interns per year under the supervision of two mentors. The trained interns survey 5-6 transects during their time at SML (https://www.shoalsmarinelaboratory.org/intertidal-ecology-internship). Additionally, data entry now occurs annually by the interns.

2018: Intensive data clean-up and organization effort is made by student intern, An Nguyen to ready the complete data set for publication. A small modification to the scoring and use of ‘Category Species’ is made and the protocol was updated to include data management steps.