An Investigation of Wrack at Cattle Point: Algal Composition, Spatial Distribution, and Sampling Method Comparison

Joelle Worthley

Research partners: Nicole Seiger & Yssy Wallace-Wells
Friday Harbor Laboratories, University of Washington
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Dr. Terrie Klinger
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Abstract

Deposits of drift macroalgae in the intertidal zone serve as an important source of nutrients for herbivores in beach systems that are otherwise sparsely vegetated. We investigated the algal composition and spatial distribution of the high tide wrack line on a gravel beach at Cattle Point, San Juan Island. We employed two different sampling methods to measure algal composition, spatial distribution, and size distribution, hypothesizing that the two methods would return different results. We expected both size of detritus and algal type to vary spatially along the beach. For the first sampling method, we laid a transect through the high tide wrack line and took point samples of single algal pieces at half meter marks, combining the samples into four groups corresponding to four equal sections of transect. For the second sampling method, we cut 10-cm diameter cores from the wrack line every 5 meters, again grouped by section. We then sorted the samples by algal type and took size measurements from the point samples. Our results for overall algal composition were equivalent between the two sampling methods, showing that both methods were effective for determining composition of the wrack. Kelps were most prevalent in our sampling, followed by other brown algae, filamentous red algae, and red blades. Seagrasses and green algae were least prevalent. We did not find a detectable pattern of spatial distribution by size or algal type between the four sections of the transect, which suggests that size and algal type are roughly evenly distributed along the wrack. These results can potentially provide context to investigations of food web dynamics in marine-terrestrial transition zone ecosystems on San Juan Island.

Introduction

Wrack deposits are rafts of marine macroalgae that are deposited on beaches by the tides. Wrack plays an important ecological role in beach ecosystems that are often devoid of other vegetation due to constantly shifting sediments. Intertidal herbivores such as amphipods feed on deposited wrack, often preferentially feeding on certain species over others (Pennings 2000, Rodil 2008). Crabs and other invertebrates feed on these herbivores, and are in turn eaten by other intertidal predators, making wrack a valuable component of the food web within the transition zone between the marine and terrestrial environments (Lewis 2007). In part because the herbivores that feed on wrack favor certain species over others, it follows that species composition and distribution of algae in the wrack at the high tide line play a role in shaping the structure of supralittoral macrofauna (MacMillan 2012). It has also been suggested that wrack may play a role in plant dispersal (Minchinton 2006).

Species composition and spatial distribution of wrack deposits are influenced by many factors. Among these are physical beach characteristics such as topography (Gómez 2013), substrate, and wave exposure (Orr 2005), as well as morphology of macroalgae (Gómez 2013) and seasonality (Barreiro 2011). In addition to seasonal differences in species composition (Gonçalves 2011), wrack composition is known to vary with tides and time of day (Colombini 2007). Macroalgal detritus deposited on beaches also varies in composition with age as some species are consumed faster than others (Mews 2006).

This investigation addresses wrack characteristics local to San Juan Island, examining algal composition and spatial variation of wrack deposited in the high intertidal. Specifically, we investigated composition and spatial variation by algal type and size on an exposed pebble and sand beach following a high wind event. We chose to describe the overall composition of the wrack and compare two distinct sampling methods to gauge their best potential applications. We expected that the two sampling methods would not return equivalent results. We also hypothesized that both algal type and scrap size would vary spatially along the wrack line. The research site was a gravel and sand beach with high wave exposure and a large wrack deposit at the high tide line.

Methods

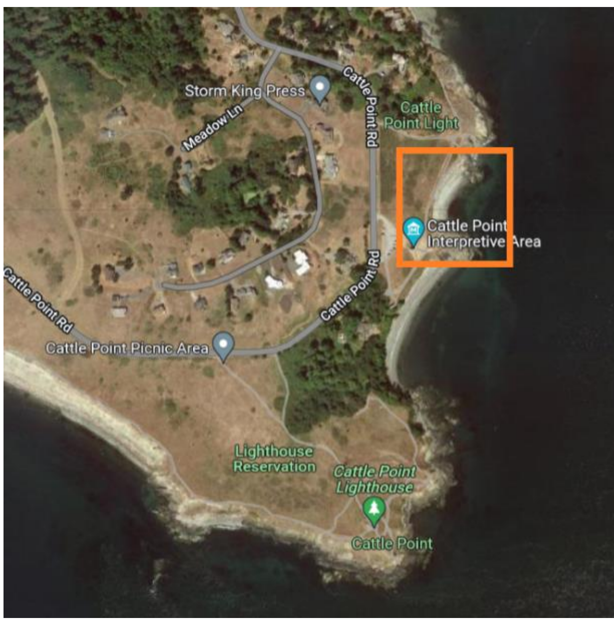

Figure 1. Map section showing Cattle Point, San Juan Island, with the research site outlined in orange.

Figure 2. Close up of research site showing approximate position of wrack line (green), transect tape (red), and division of spatial sections (black).

All sampling was conducted at Cattle Point on San Juan Island, on the beach directly north of the rock outcropping dividing the two beaches on the east side of the point (Figure 1). Placing the 0m mark at the southern end of the wrack, we ran transect tape through the middle of the wrack line, ending at 60m at the northern end. The transect line was divided into four 15-meter sections for sample collection.

Two sampling methods were employed. The first was a point contact method, in which samples were taken every 0.5 meters, skipping over bare points. A pointer was placed on the seaward side of the transect tape at the meter or half meter mark. The algae had been drying out for several hours, so the algal piece initially touched by the pointer was removed to expose the fresher algae below. The pointer was then placed again at the same mark on the newly exposed algae and the topmost piece of algae under the pointer was collected as the sample, with care taken to remove the piece intact. Samples were stored in buckets grouped by 15-meter sections. Pieces longer than 100cm were recorded but not removed from the beach. Samples were then processed by grouping into algal types (filamentous/branched reds, red blades, kelps, other browns, greens, or seagrasses) and the longest dimension of each algal piece was measured. It should be noted that seagrasses are angiosperms, not algae, but for the sake of concision they are included here when the word algae is used.

The second sampling method, dubbed the “cookie cutter” method, was employed along the same transect line. Upon returning to the research site later the same day, we laid the transect tape in the same manner and location as we did for the point count method. A 10cm-diameter clam gun was placed on the seaward side of the 0m mark and a knife was used to cut through the wrack around the circumference of the clam gun. All algal pieces within the circle cut from the wrack were included in the sample. This procedure was repeated at the 5m and 10m marks for a total of three samples from S1. Three samples each were then taken in the same manner from the other three sections of the transect line for a total of twelve samples grouped by section. If a sample point was bare of algae, the sample was instead taken at the next full meter mark (e.g.

26m instead of 25m). Samples were then processed by sorting all collected pieces into algal types. The data from both sampling methods was then assessed visually by generating bar charts and box plots in R. A PERMANOVA analysis was performed in R to examine the significance of the results.

Results

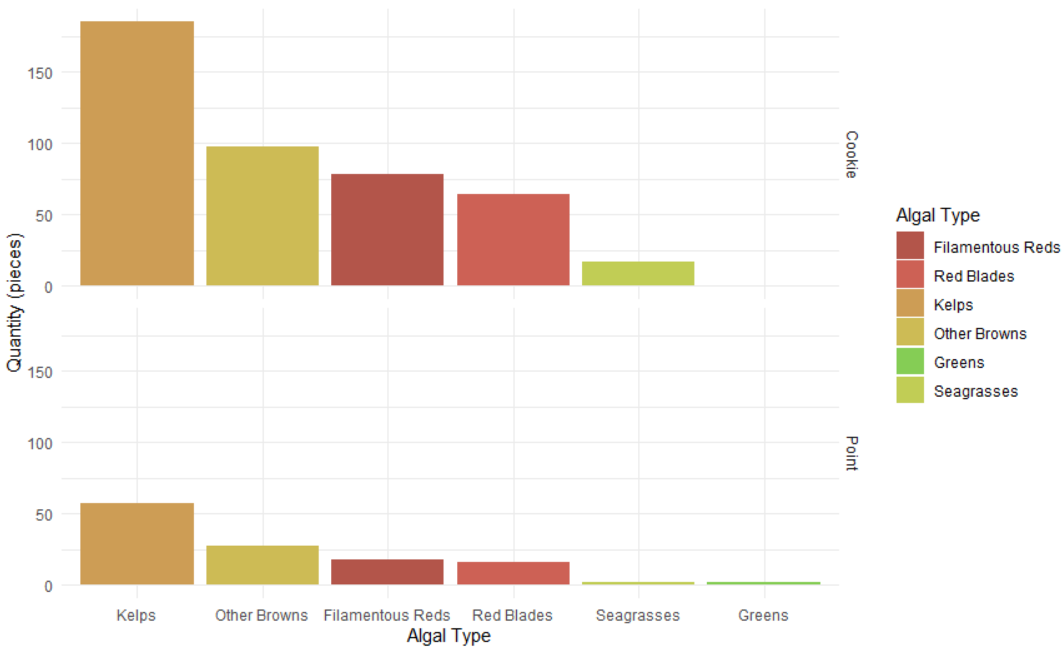

Figure 3. Total quantities of algal pieces recorded for each algal type faceted by method. Both sampling methods returned similar proportions of algal types in the wrack.

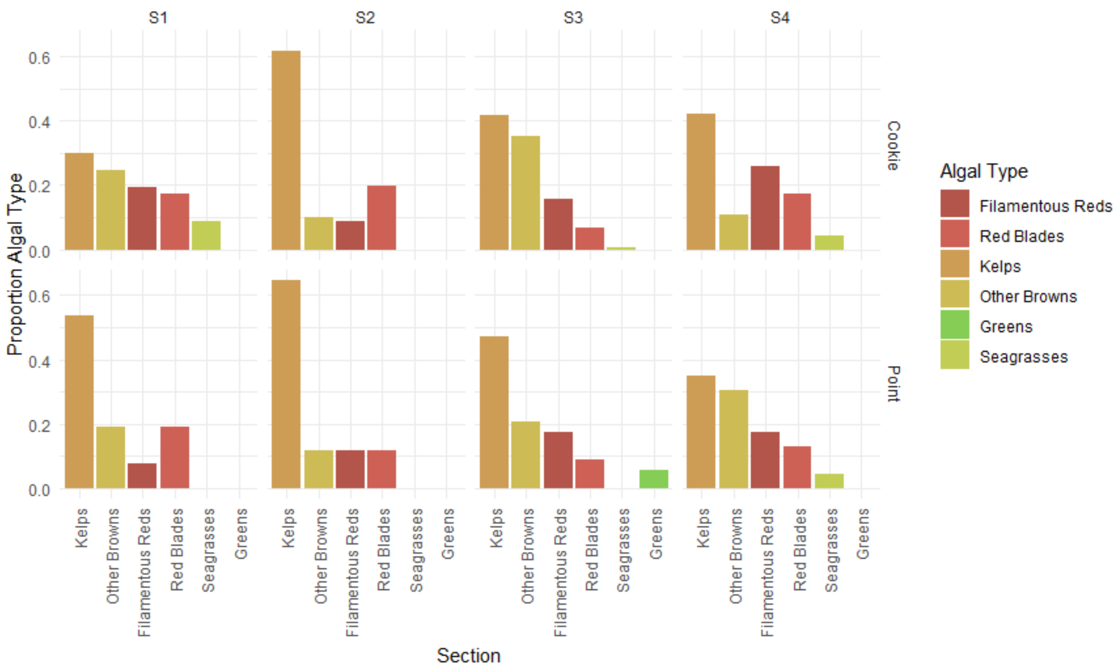

Figure 4. Proportions of algal types by transect section, faceted by method.

Our data show a consistent proportion of overall algal composition across the two sampling methods (Figure 3). When faceted by spatial section, the data does not appear to show a clear spatial relationship between transect section and algal composition (Figure 4). Kelps are the most prevalent in every section in both sampling methods, and greens or seagrasses are consistently the least prevalent. The proportions of other algal types vary by section and by sampling method, without showing a discernible spatial relationship. This result was supported by a PERMANOVA analysis performed in R which showed that after converting composition data to proportion to standardize across communities and sampling methods, there was no distinguishable difference between sections (P= .184, alpha=.05) or methods (P = .492, alpha=.05).

The size data recorded from the algal pieces collected in the point contact method showed no clear spatial relationship to the length of the algal pieces that made up the wrack (Figure 5).

Most algal pieces were less than 50cm. The median and mean lengths are roughly comparable across all sections, although the range of lengths found in section one is narrower than in the other three sections.

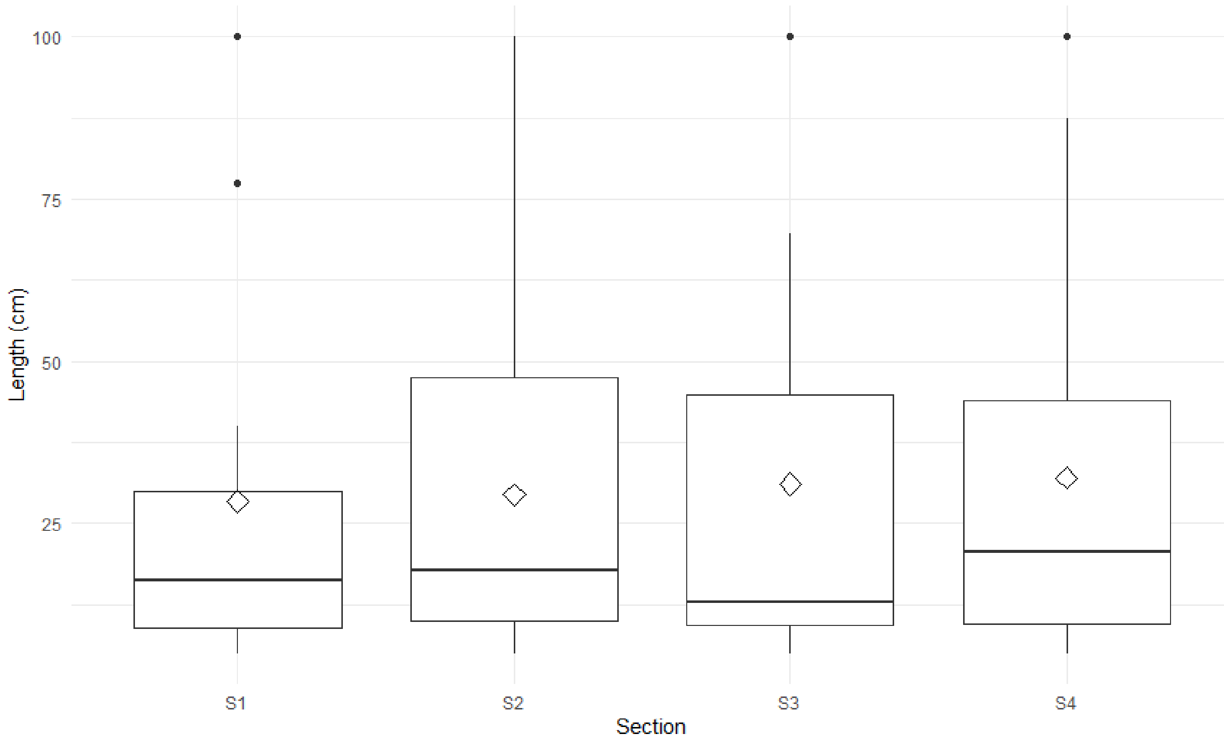

Figure 5. Length of algal pieces by transect section. Means are shown as diamonds.

Discussion

The overall algal composition of the wrack was consistent across both sampling methods, indicating that the two sampling methods were equally effective at measuring composition. While the variation between the spatial sections was inconsistent, the two different methods returned statistically similar results. Contrary to our hypothesis, it appears that both the point contact method and the cookie cutter method are effective at determining proportion of algal types within the wrack.

The prevalence of kelps in the samples is consistent with previous findings that gravel beaches retain more brown algae than green or red, possibly due to buoyancy properties of the algae interacting with the substrate (Orr 2005). The relatively low levels of seagrasses and green algae are consistent with findings that these algal types are most prevalent on protected sandy beaches (Orr 2005). *Ulva* spp., one of the most abundant green algae locally, has been shown to have a turnover (decomposition) rate of <1 day (Mews 2006), which may partially explain the lack of green algae in our samples as the wrack had been drying for several hours. Beach length to area ratio can affect wrack species composition (Barreiro 2011), so our choice of a small beach for our research site may have influenced composition results along with factors previously discussed.

Our data show no discernible variation in composition or size between spatial sections of the transect line. This was contrary to our hypotheses that these factors would display spatial variation along the beach. The size of the beach may have played a role in this result (Barreiro 2011), and repetitions of wrack transects at other sites on the island would be necessary to make comparisons that could illuminate influencing variables.

Our results have the potential to contribute context to studies of high intertidal ecosystem structures on San Juan Island. Because data were collected at the same site on the same day, it remains unknown how algal communities in the wrack line may vary across time or at different locations on San Juan Island.

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