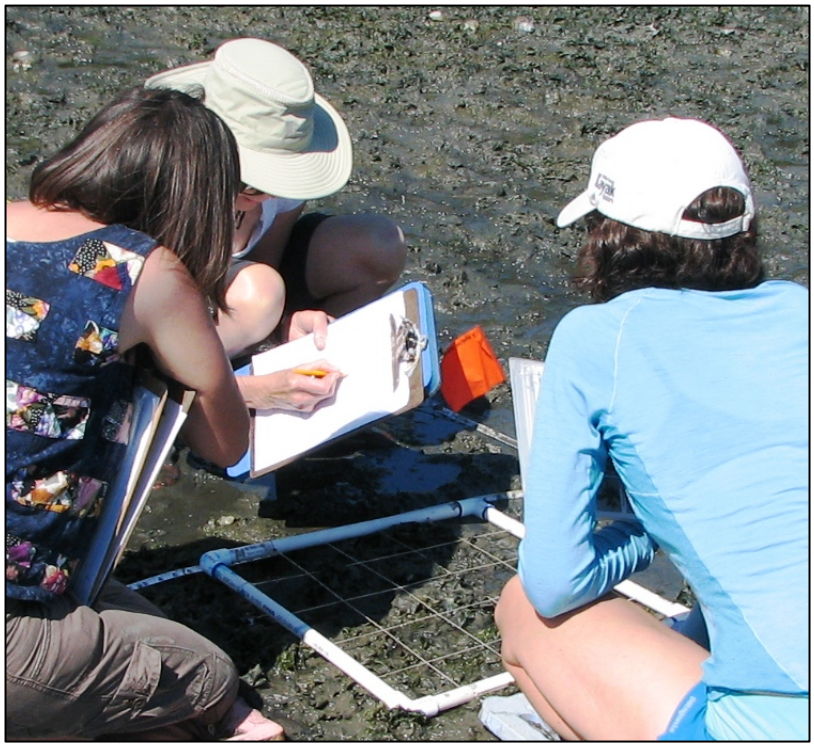
Intertidal Biota Monitoring in the Fidalgo Bay Aquatic Reserve

2013-2015 Monitoring Report



Prepared for:

Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee

Prepared by:
Michael Kyte
Independent Marine Biologist
and
Wendy Steffensen and Eleanor Hines
RE Sources for Sustainable Communities

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Copies of this Monitoring Report will be available at https://sites.google.com/a/re-sources.org/main-2/programs/cleanwater/whatcom-and-skagit-county-aquatic-reserves.

Author and Contact Information

Wendy Steffensen
North Sound Baykeeper,
RE Sources for Sustainable Communities

Eleanor Hines
Lead Scientist,
RE Sources for Sustainable Communities
2309 Meridian Street
Bellingham, WA 98225
eleanorh@re-sources.org

Michael Kyte
Independent Marine Biologist
ardea42@gmail.com

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Jerry Joyce
Washington Environmental Council
1402 Third Avenue
Seattle, WA 98101
206-440-8688
JerryJoyce@MoonJoyce.com

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Intertidal Biota Monitoring in the Fidalgo Bay Aquatic Reserve

2013-2015 Monitoring Report

Abstract

The Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee conducted intertidal surveys annually beginning in 2013 through 2015 in the Fidalgo Bay Aquatic Reserve in Skagit County, Washington to document beach conditions including slope, substrate, and intertidal animals and plants along profiles at each of four sites. On each profile, the number of individual animals and areal coverage of plants, algae, and colonial and aggregating animals within four 19.8 inch X 19.8 inch (50 cm X 50 cm) quadrats at the +1 foot (ft), 0 ft, and -1 ft (+0.3 meter [m], 0 m, and -0.3 m) mean lower low water (MLLW) tidal elevations were recorded. Methods were modified from those of the Sound Water Stewards of Island County, formerly the Washington State University Island County Extension Beach Watchers (Beach Watchers 2003). The purpose of the monitoring was to collect data to establish a robust baseline for detecting trends and changes.

Introduction

The Fidalgo Bay Aquatic Reserve is one of seven aquatic reserves in Puget Sound, managed by Washington Department of Natural Resources (WA DNR). In 2013, citizen science programs were developed as part of a grant awarded to People for Puget Sound and transferred to Washington Environmental Council. The grant "Ensuring Regulatory Effectiveness in Puget Sound's Most Special Places" focused on pairing local environmental groups with stakeholders to steward designated aquatic reserves through education and outreach, technical review of development proposals, and citizen science. Since then, this program has continued through grants and other financial support.

This document reports on the third year of the monitoring program conducted by the FBAR Citizen Stewardship Committee (FBAR CSC), and provides a comparison of years 2013-2015. The project included training citizen scientists to identify intertidal species and to measure species distribution and abundance within the aquatic reserve.

Fidalgo Bay Aquatic Reserve

The WA DNR designated the Fidalgo Bay Aquatic Reserve as an Environmental Reserve (Figure 1). An environmental reserve is an area of environmental importance established for the continuance of environmental baseline monitoring, and/or areas of historical, geological, or biological interest requiring special protective management. One of the primary reasons for establishing a reserve in Fidalgo Bay was the preservation of critical habitat for forage fish spawning. A broader purpose was to conserve and enhance native habitats and associated plant and wildlife species, with a special emphasis on forage fish, salmonids, and migratory birds (WA DNR 2008).

Figure 1. The Fidalgo Bay Aquatic Reserve and surrounding area. The blue area shows the boundaries of the reserve. This map shows location for sites surveyed (Adapted from WA DNR 2008).

The Swinomish Indian Tribal Community owns three tideland parcels adjacent to the reserve, and the Samish Tribe owns five. The area of the reserve south of the trestle was transferred from the Skagit Land Trust to WA DNR, with the condition that it is a conservation easement. The easement requires that the area be used for fish and wildlife enhancement while limiting human activities.

Historically, Fidalgo Bay was home to both the Samish Indian Nation and the Swinomish Tribe, who have both fished for salmon and harvested shellfish in this bay for centuries. The Swinomish Tribal Community is located southeast of Fidalgo Bay with some land holdings on the east side of the bay. Samish Tribe properties are located on the western shore of

Fidalgo Bay. Tesoro and Shell refineries own properties on March Point, on the eastern shore of the reserve. Other property owners adjacent to the reserve include the City of Anacortes as well as smaller landholders.

Goals and Objectives

The goal of this project is to provide a baseline for detection of changes. The specific objective is to collect baseline data on beach slope, substrate, and intertidal biota at four monitoring sites. This monitoring provides a baseline for detecting changes in intertidal habitats, species composition, and species abundance due to natural or human-caused events, including the appearance of invasive species. Intertidal monitoring data is also intended to be applied to natural resource damage assessment in the event of an oil spill or other event, and to reserve management.

Methods

This project documents animals and plants living on the beach surface sediments (epibiota) and animals living within the sediment (infaunal). Monitoring methods were based on those established by the Sound Water Stewards of Island County, formerly Washington State University Beach Watchers, Intertidal Monitoring Program (Beach Watchers 2003). These modifications were made to enhance the representativeness of the data, while retaining key elements to ensure that this monitoring was comparable to other Beach Watchers studies. Monitoring uses scientifically and statistically sound methods to ensure that data are comparable across monitoring sites, monitoring studies in other reserves, and monitoring years. The protocols used for this project are detailed in Steffensen and Joyce (2013). Quality assurance and quality control measures are implemented in all project steps.

Citizen Science Training

RE Sources, the FBAR CSC, knowledgeable FBAR CSC citizen scientists trained in Skagit County, the Skagit County Marine Resources Committee, Salish Sea Stewards, and the general population. Similar training was held in Whatcom County. Volunteers could attend training in either Whatcom County or Skagit County and be qualified to conduct surveys.

In Skagit County, sixteen citizen scientists were trained in a six-hour classroom session on April 19th. On May 17th, twenty-three citizen scientists were trained in the field for a three-hour session. Training included protocols for measuring beach slope and substrate, identifying and counting plants and animals, estimating percent cover of plants and colonial animals, and completing data sheets. Two trained university students taught the Anacortes High School environmental class on the survey which included; rationale, method, and simulations of estimating percent coverage. Their teacher supplemented this training with training materials. Fully trained citizen volunteers supervised high school students participating in surveys.

Field Data Collection

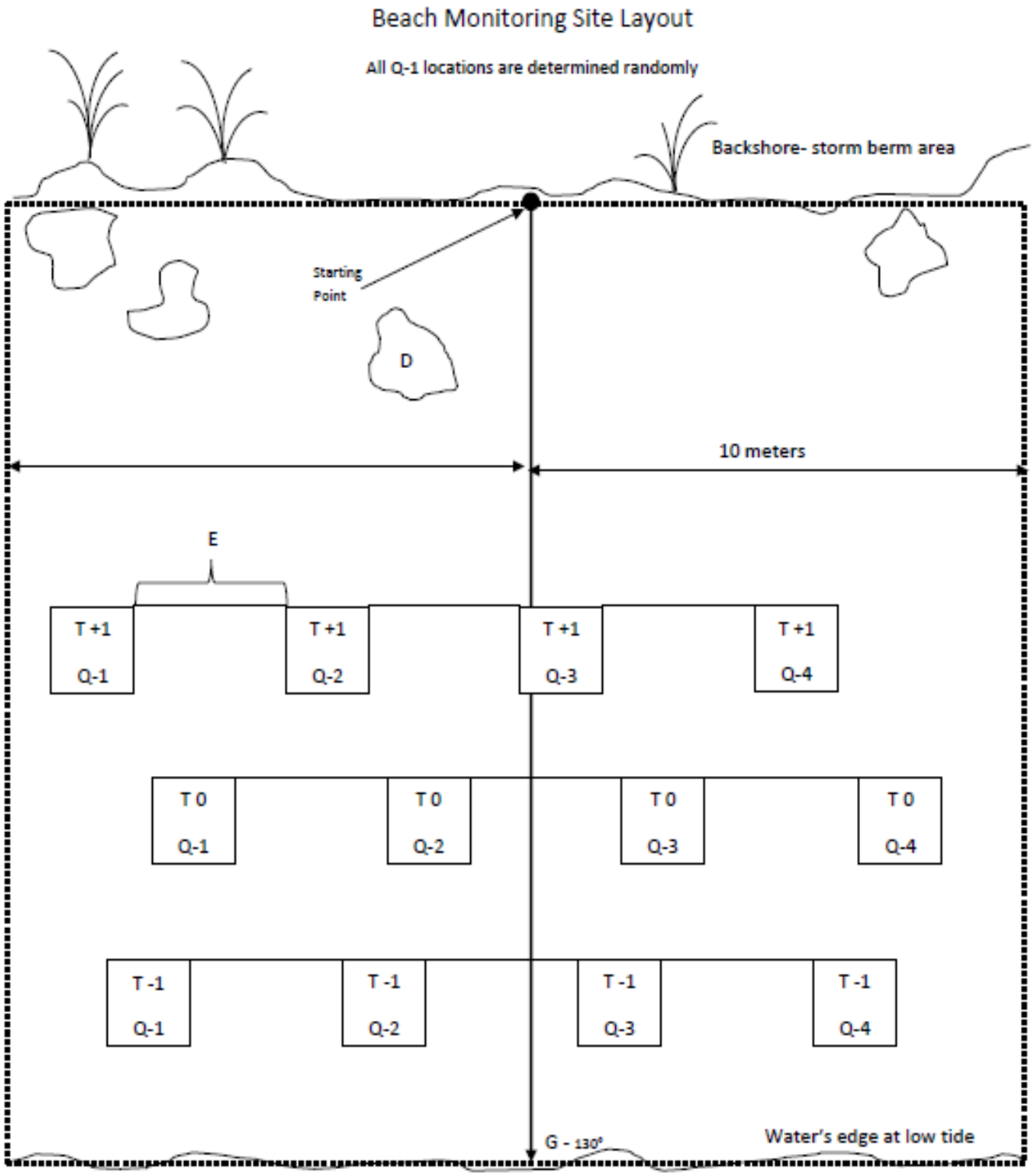
The study used a transect/quadrat model with a profile line from approximately ordinary high water to one foot below mean lower low water (-1 ft MLLW) or lower, if the tide allowed (Figure 2). The Beach Waters (2003) protocols were modified to include four randomly placed quadrats on each transect.

Five types of data were collected:

1. **Profile Data**: Elevation profile data were taken along a transect perpendicular to the beach face. Data recorded included beach slope and substrate type. If species present data was not collected in swath counts, profile data collectors would note which species were present for each elevation interval.

2. **Quadrat Data (Percent Cover):** Four randomly placed 19.8 inches X 19.8 inches (50 cm X 50 cm or 0.25 square meters) quadrats were located at each of three tidal elevations: +1 ft, 0 ft, and -1 ft MLLW. Cover by colonial and aggregating animal species, sea grass, and all macroalgae was estimated in each quadrat.
3. **Quadrat Data (Individual Species):** Individual epifauna species were counted within the same quadrats as those for percent cover. Organisms smaller than 3 mm were not counted.
4. **Infaunal Data:** A core of 5.9 inches x 11.8 inches (14.9 cm X 30cm or 0.017 square meters) was taken to the right of each quadrat. Species retained on a 0.5 square inches (1.27 square cm) mesh sieve were identified and counted.
5. **Present Species Data:** Knowledgeable citizen scientists (i.e., "Lead Naturalists") compiled species lists along each profile by sections. Each section was 10-feet or more long and 65.6 feet (20 m) wide [32.8 feet (10 m) centered on the profile. This list was more detailed and intensive than the profile data and required more observation time. These data are presented in Appendix C. The lists reflect only species presence.

In 2015, a new protocol was added after discussion about usefulness of collected data. This new protocol included counting species individually and by percent cover in each quadrat with minor removal of debris, the same as was done in 2013 and 2014. Next, the citizen scientists removed all *Ulva* sp., a green algae that often covers large portions of quadrats when present. *Ulva* removal was added to assess if the ephemeral algae covered other countable biota.



D Erratic near profile line which could be used as a vertical height reference point.
E Distance between quadrats. The three quadrats should be equally spaced along the transect line (16.5 feet apart).
G Compass heading of profile line towards horizon.

Figure 2. Layout of survey sites from Beach Watchers (2003). For the studies in this report, a fourth quadrat was added to each surveyed tidal height.

Survey Site Locations

Citizen scientists surveyed four locations in the FBAR in 2015. Locations were chosen based on permitted access to the site, physical accessibility (many of the sites were too muddy to safely walk on), and diversified habitats. See the Results and Discussion section below for site descriptions. The Custom Plywood site was added in 2015, following a beach reconstruction project. The Otter site is meant to serve as a reference site for Custom Plywood as organisms settle the new substrate at this beach.

A permanent profile line was established at each location, extending seaward perpendicular from the shore. Table 1 gives details the location of each profile. Table 2 provides sample dates for each year. Survey dates were constrained to tides lower than -1 foot during daylight hours and were scheduled as close as possible to within a week of the previous year's survey.

Table 1. Survey site locations and compass bearings for orienting start locations for each transect at the high tide line.

Site	Physical Description	Compass Bearing 1	Compass Bearing 2	Compass Bearing 3	Vertical Height	Compass bearing for profile line	Lat. (N)	Long. (W)
Trestle	West end of trestle on Tommy Thompson trail (TT), north side. Measurements taken from steel pole at trail edge.	Cap Sante head/ summit, 329°	North point of TT threshold arch, 85°	Tall white square tower at refinery, 104°	10' 6 "	103° magnetic	48.47943	122.58045
Fir	North side of Weaverling Spit, on Samish Indian Nation land; large Douglas fir	Peak of red roof house along TT, 321°	Top of rocky cliff on Cap Sante, 360°	White stand-alone tower to right of refinery, 72°	Un-known	30° true	48.48428	122.59298
Otter	On TT, headed E from 34th st., profile line is at start of Ska-atl otter sculpture	Eastern most point of Cap Sante bluff at waterline, 333°	Northern-most point of March Point, 41°	Samish clubhouse 115°	3' 11 "	41° magnetic	48.49208 (Magellan explorist); 48.49155 (Garmin)	122.59958 (Magellan explorist); 122.59985 (Garmin)
Custom Plywood	Not available for this site.						48.4962	122.60094

Table 2. Survey sites and dates sampled between 2013-2015.

Site	2013	2014	2015
Trestle	May 10	May 15	May 18
Fir	May 24	May 28	May 20
Otter	August 19	August 10	August 1
Custom Plywood	N/A	N/A	July 31

Results and Discussion

Results and discussion for each survey site are presented below, starting from the furthest north site and ending with the most southerly site (Figure 1). Results for the quadrat and profile data from 2013-2015 are shown in figures below by site. Graphs for quadrats depict averages of species by general groupings for each tidal-height transect, with standard deviations shown as error bars. Data showing species identifications to the lowest practical level for 2015 are in Appendix A. Similar tables showing species identification for 2013 and 2014 were presented in earlier reports and are available electronically from www.re-sources.org[1]. The 2015 species lists for each site are in Appendix C.

The four monitoring sites exhibited variations of typical beach morphology (Figure 3). In some cases riprap was present, little or no backshore, high tide berm, or beach face was present, and the low tide terrace began at the toe or bottom of the riprap.

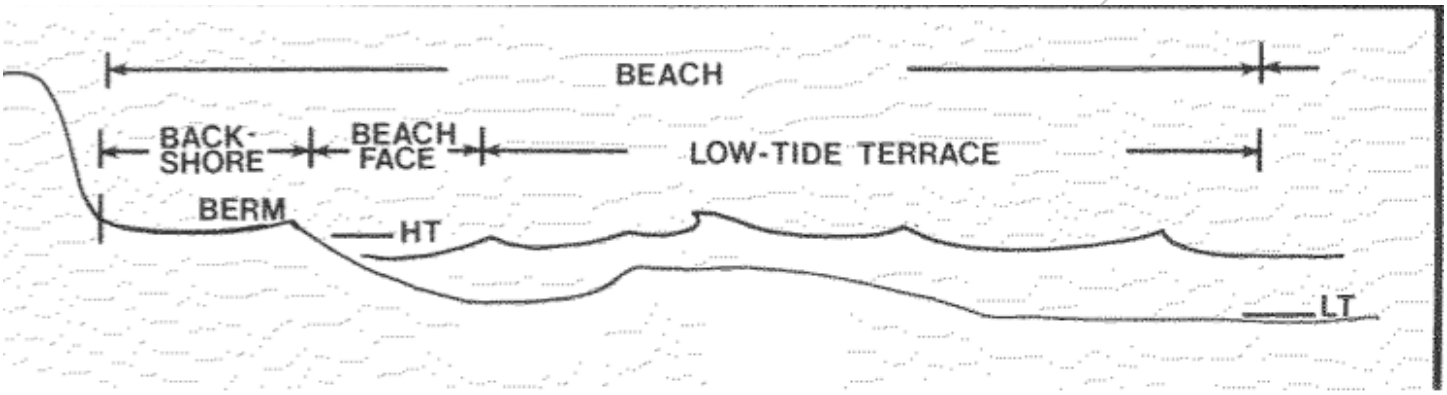


Figure 3. Typical Beach Morphology

[1] Full URL: http://www.re-sources.org/programs/cleanwater/whatcom-and-skagit-county-aquatic-reserves

Custom Plywood Results and Discussion

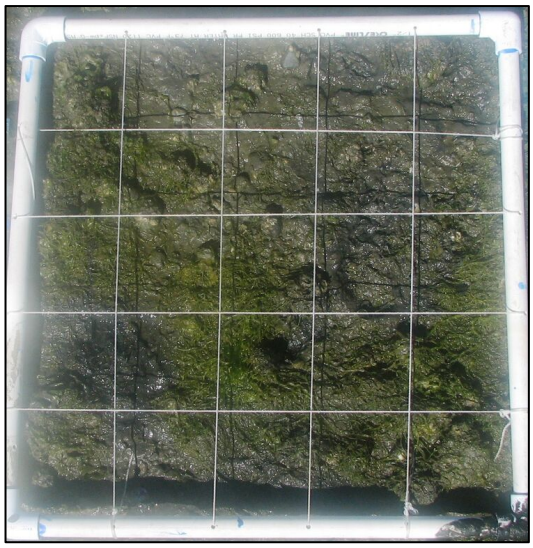


Photo 1. A typical quadrat at Custom Plywood before the removal of *Ulva* sp.

Site description: The Custom Plywood Mill site was originally a waterfront mill and box factory. This site has undergone extensive cleanup-up under the state's Puget Sound Initiative. Custom Plywood was a shoreline enhancement project as a Phase II interim remedial action during 2013. A new aquatic jetty/spit extension was built to prevent erosion from waves, tripling the habitat-friendly shoreline.[2] Custom Plywood was established as a monitoring site to evaluate how intertidal species settled into this newly created habitat.

Beach profile and substrate: The beach at Custom Plywood had a relatively uniform slope with a low high tide berm, and long beach face (Figure 4) until about 120 feet from the backshore. The beach then flattened at the toe of the beach face for about 20 feet before making a slight dip and leveling again as the low tide terrace. The substrate was a mixture of sand and gravel with few cobbles.

[2] https://fortress.wa.gov/ecy/gsp/Sitepage.aspx?csid=4533

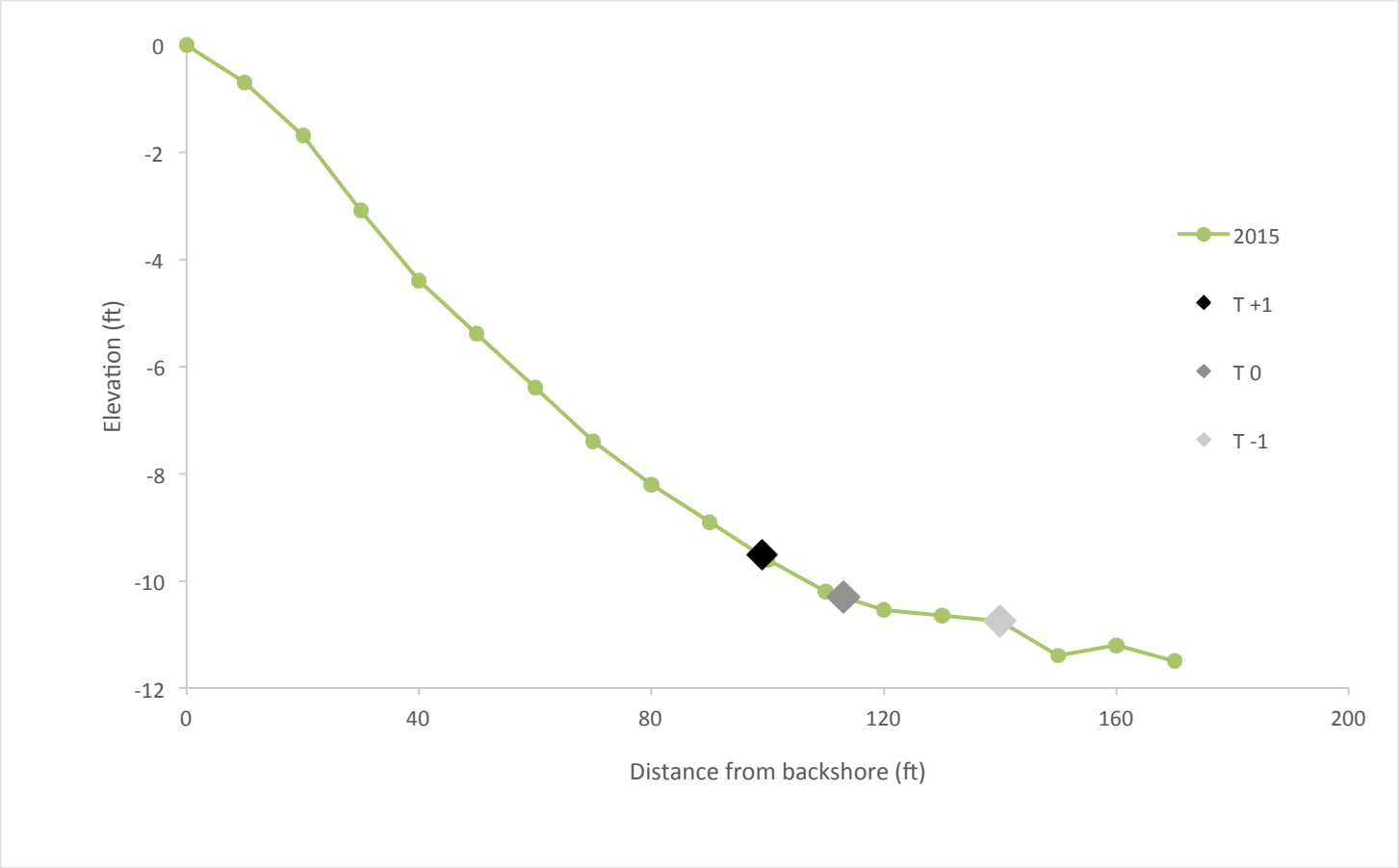


Figure 4. Custom Plywood beach elevation profile.

Species by percent cover: The highest percent cover at the Custom Plywood beach was by green algae, followed by barnacles (Figure 5). Green algae (mainly *Ulva* sp.) made up the highest percentage of cover at the +1 ft and -1 ft heights. Barnacles made up a slightly larger percent of the total coverage at the 0 ft height. All other species in the percent cover estimates were less than 5% cover.

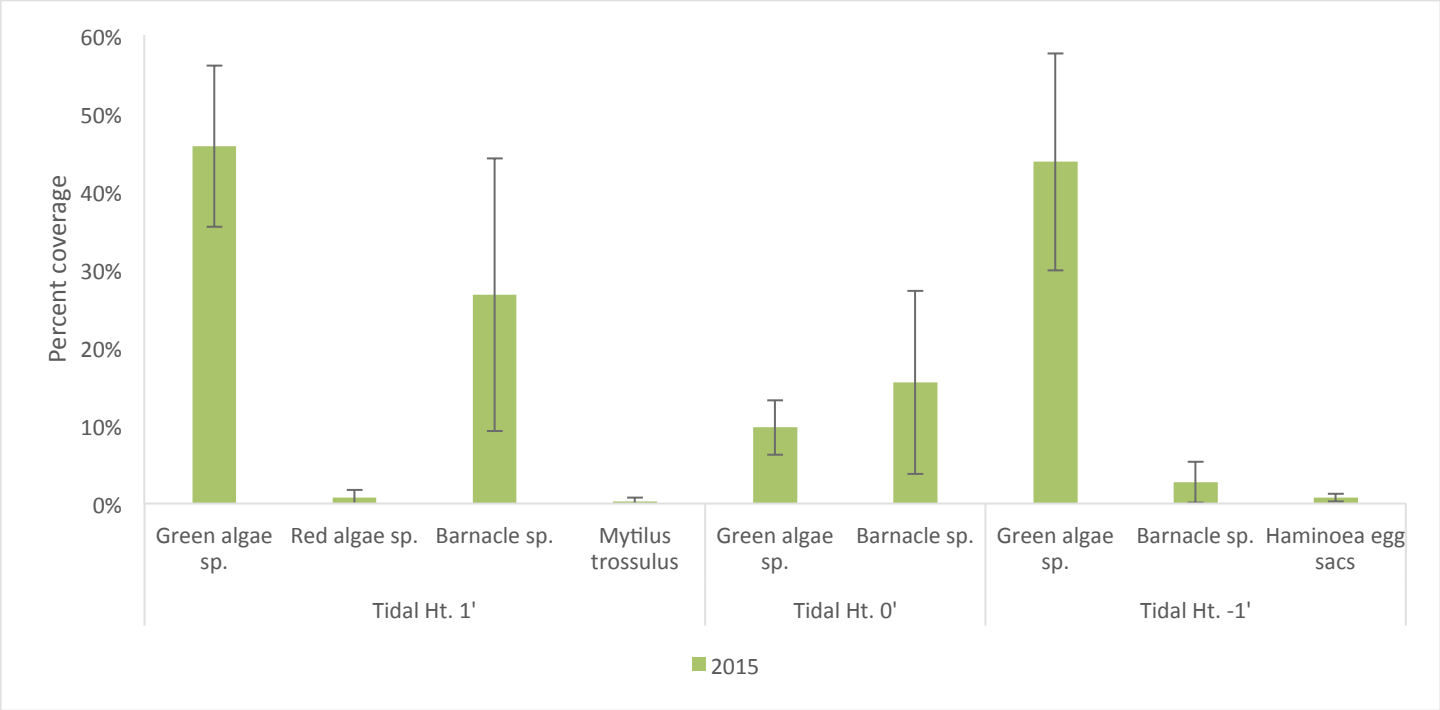


Figure 5. Average percent cover of plants and non-individual count animals in the four quadrats per tidal height at Custom Plywood sampled in July of 2015.

Individual species counts: Individual organisms were not commonly found before *Ulva* sp. removal (Figure 6). No organisms were found at multiple tidal heights, except *Haminoea* sp. After *Ulva* removal, Quadrats 2, 3, and 4 for all tidal heights had zero counts of individual species (Appendix A). Quadrat 1 was the only quadrat for any tidal heights that had countable species present for all tidal heights. This may indicate that the far end of the transect lines of the profile where quadrat 1 was for each transect may have different characteristic than the rest of the survey swath.

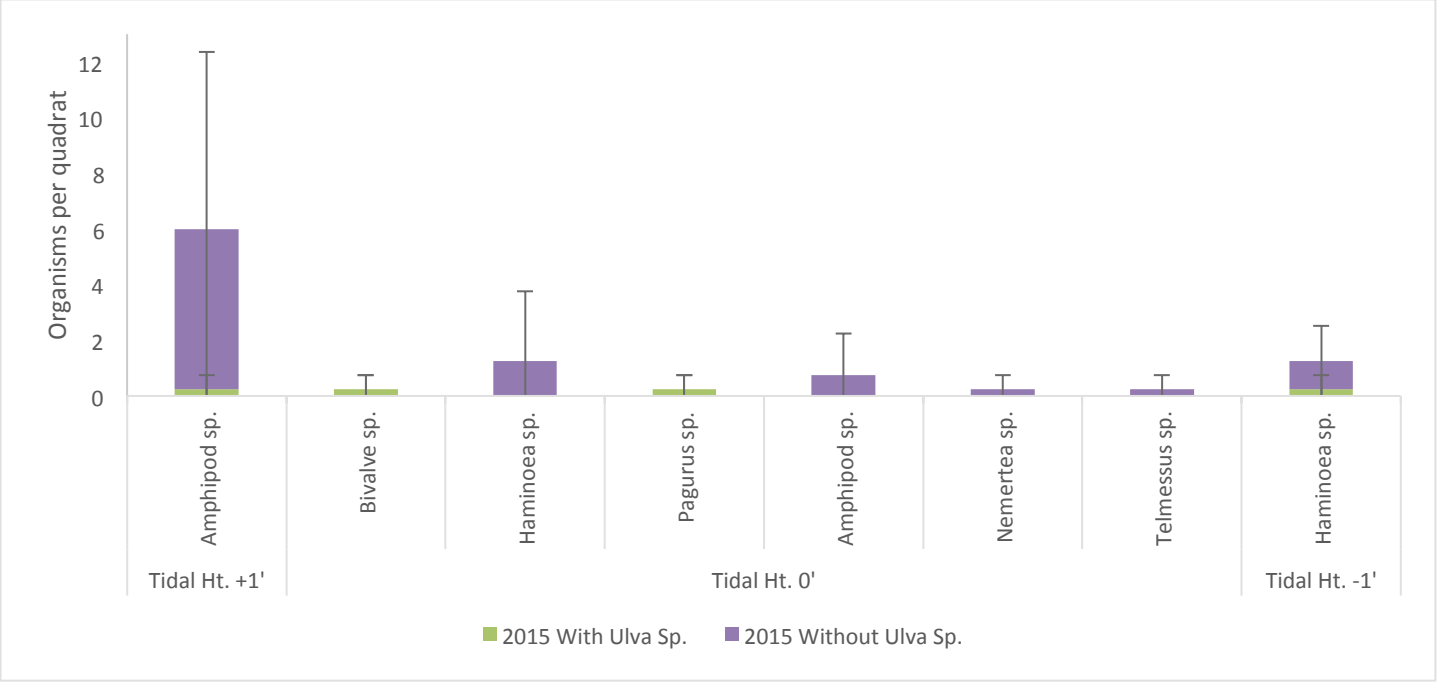


Figure 6. Average number of individual animals in quadrats at Custom Plywood sampled in July of 2015.

Infaunal species counts: There were five infaunal species found at the Custom Plywood beach (Figure 7). *Macoma inquinata* was the only species found at each tidal height.

Figure 7. Average number of infaunal animals in sediment cores at Custom Plywood sampled in July of 2015.

Otter Results and Discussion

Photo 2. Otter surveys in 2014, looking down at most of the survey area.

Site description: The Otter site gets its name from the sculpture of an Otter that is on the Tommy Thompson trail, south of the Custom Plywood Site. This site serves as a reference site for the Custom Plywood site.

Beach profile and substrate: Beach elevation profiles were similar for 2013 and 2014, but had an apparent substantial decrease in elevation in 2015 (Figure 8). A mixture of gravel, cobble, boulders, and ground shell debris characterized the substrate. Riprap and boulders were present at the upper elevations, and silt and clay dominated at the lower end.

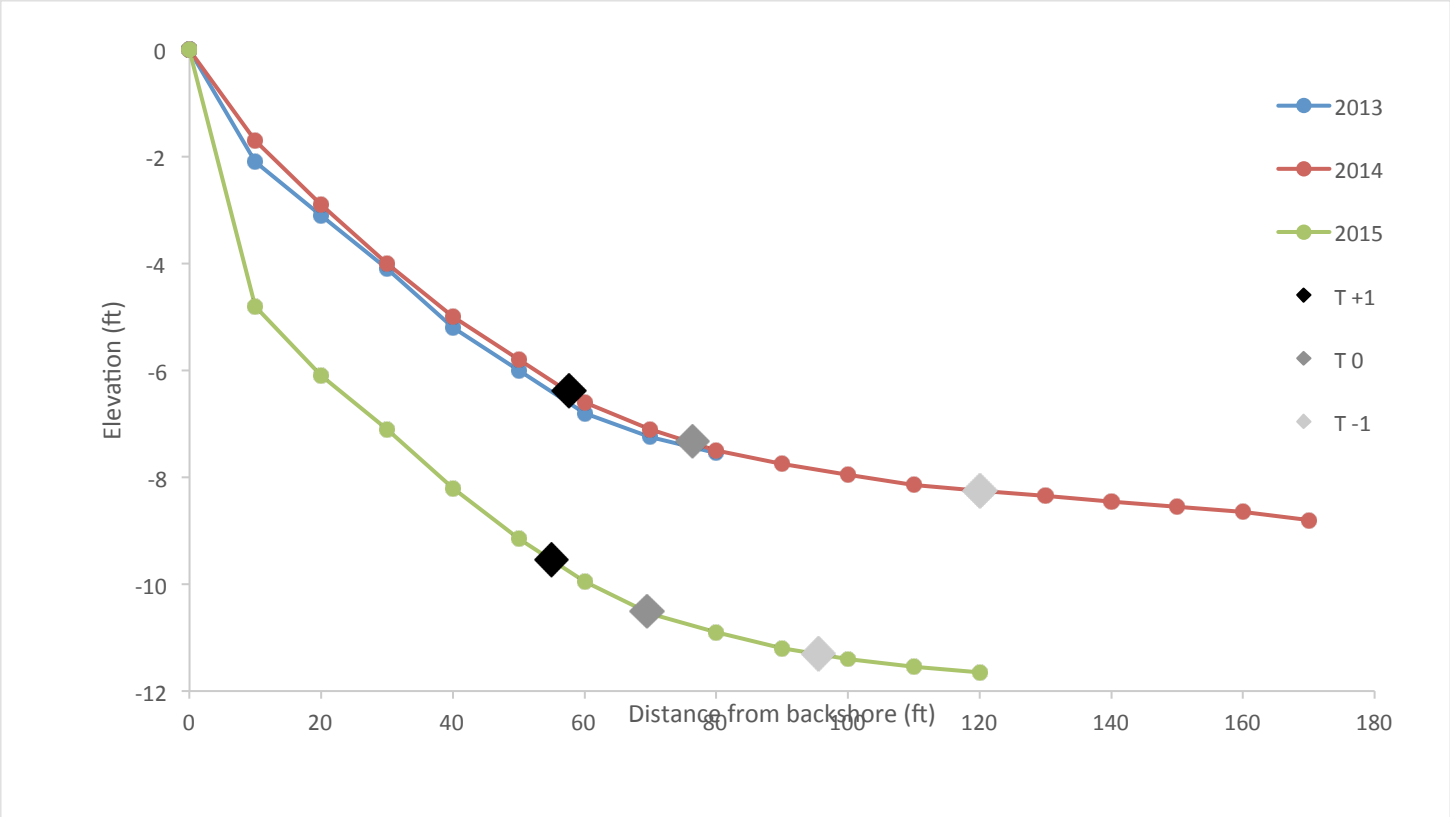


Figure 8. Otter beach elevation profiles.

Species by percent cover: Green algae had the most percent cover at each height for every year except at the +1 ft in 2013 when barnacles occupied the most area. Green algae and barnacles were both consistent in percent cover at the +1 ft tidal height over the three-year period. Green algae percent coverage declined at 0 ft and -1 ft from 2013 to 2015 by 68% and 96% respectively.

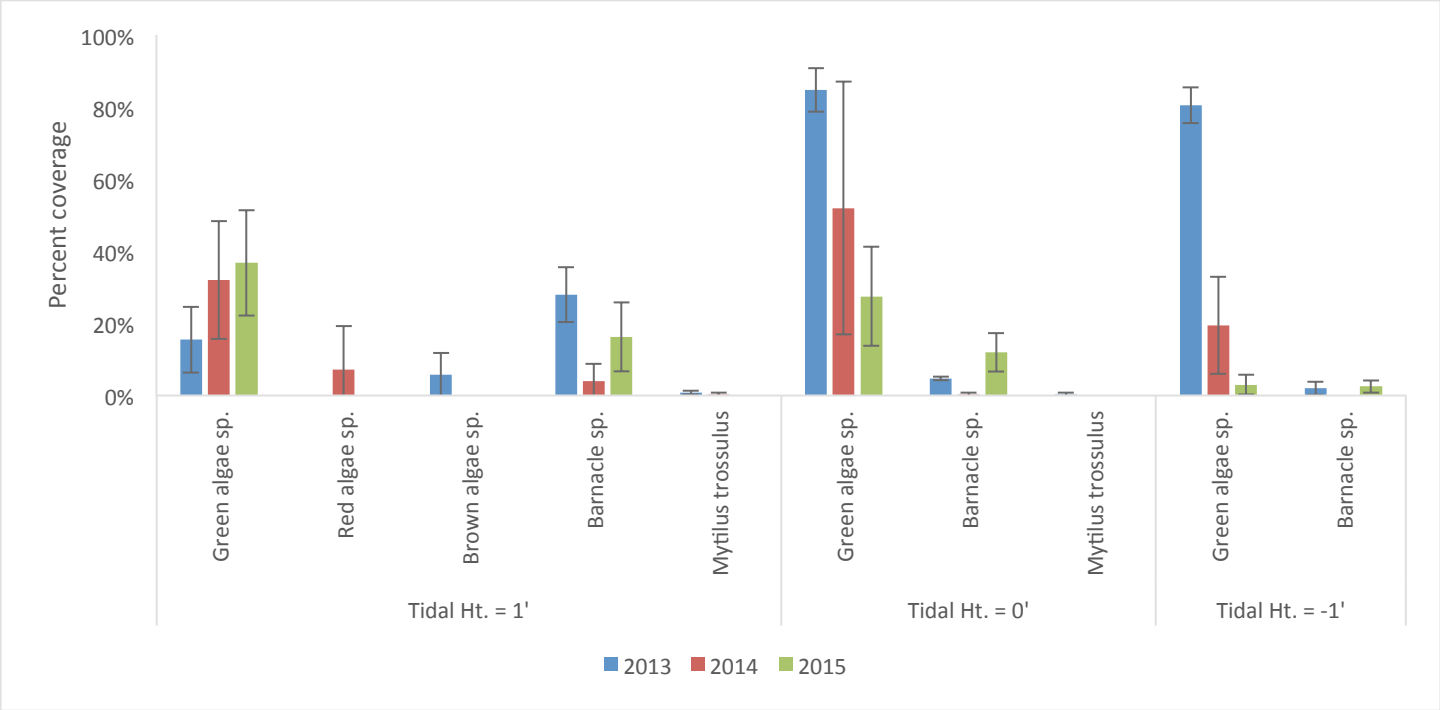


Figure 9. Average percent cover of plants and non-individual count animals at Otter.

Individual species counts: The individual organisms recorded at Otter were highly variable from year to year (Figure 10). The two species groups found each year were limpets at the +1 ft and *Pagurus* sp. at 0 ft. Limpets occurred at more than ten times the amount found in 2013 than in 2014 and 2015. Many of the organisms occurred with varying frequency at different tidal heights.

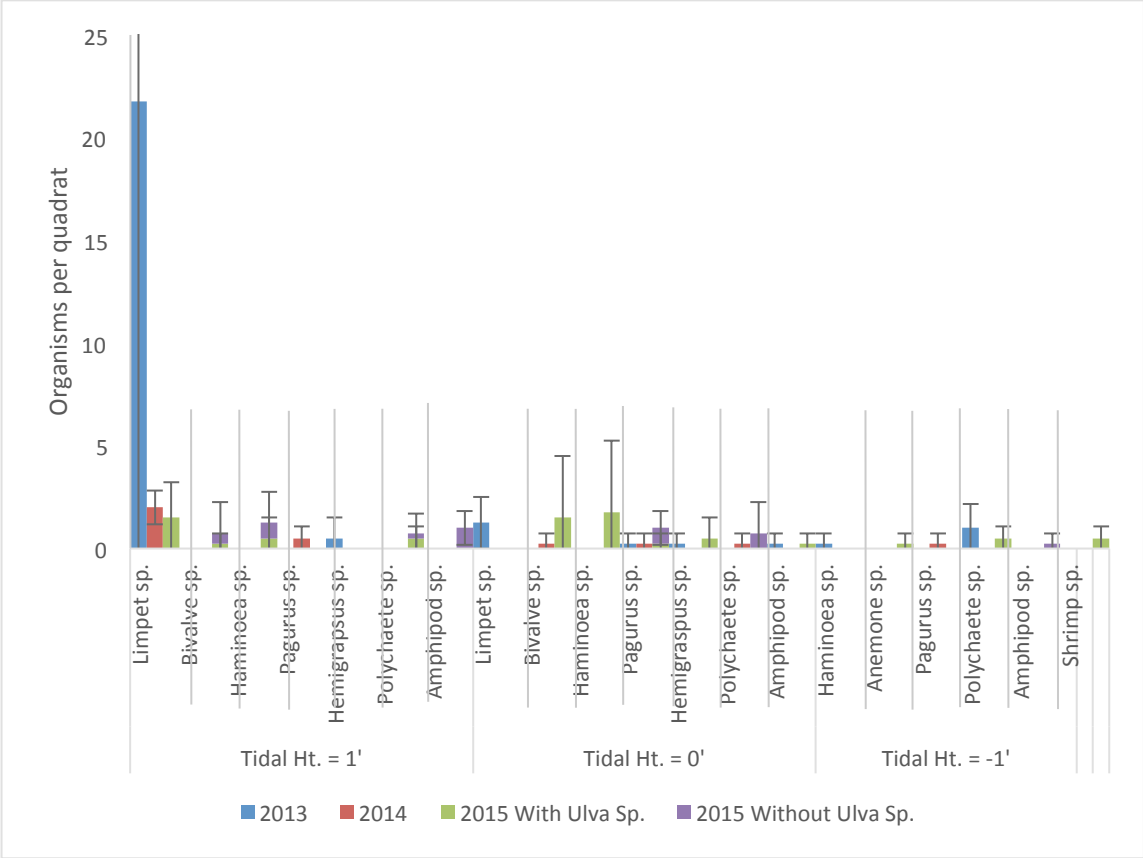


Figure 10. Average number of individual animals in quadrats at Otter.

Infaunal species counts: Results from the infaunal samples indicate a relatively high diversity (Figure 11). At least six species were found in core samples at each height over the three years. Both the +1 ft and 0 ft were variable from year to year. At the +1 foot, *Macoma inquinata* and *Ruditapes philippinarum* were the most common. At the 0 ft, *Macoma nasuta* consistently occurred in cores. At -1 ft, *M. nasuta* was found with highest frequency each year.

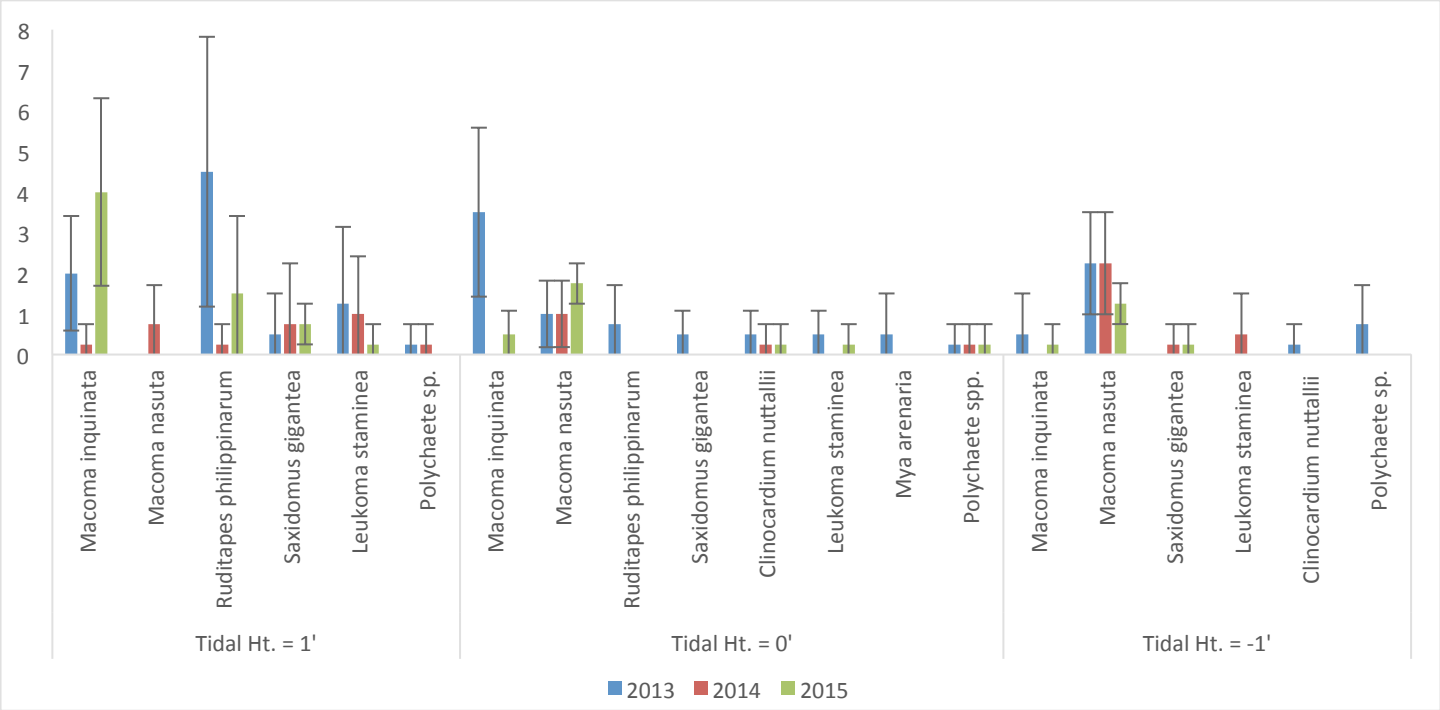


Figure 11. Average number of infaunal animals in sediment cores at Otter.

Fir Results and Discussion

Photo 3. High school students conducting beach profile transects at Fir in 2014.

Site description: The Fir site was named for a large Douglas fir tree at which the profile line started, and is located in the Fidalgo Bay Resort at the base and on the north side of Weaverling Spit.

Beach profile and substrate: Upper beach elevation profiles were similar for 2014 and 2015, but an apparent prominent high tide berm was removed between 2013 and 2014 (Figure 12). In addition, the lower part of the beach face decreased in elevation between 2014 and 2015 and increased between 2013 and 2014. However, these apparent fluctuations are likely due to mistakes in the placement of the starting point for the profile. Because of the relatively

protected nature of this site, the accretionary nature of the substrate, and the lack of other causes, it is unlikely that the site varied over 4 feet of elevation.

The substrate of the high tide berm and beach face was characterized by sandy gravel with muddy fine sand, occasional cobbles, and small boulders on the low tide terrace. The backshore consisted of semi-permanent drift logs and lawn.

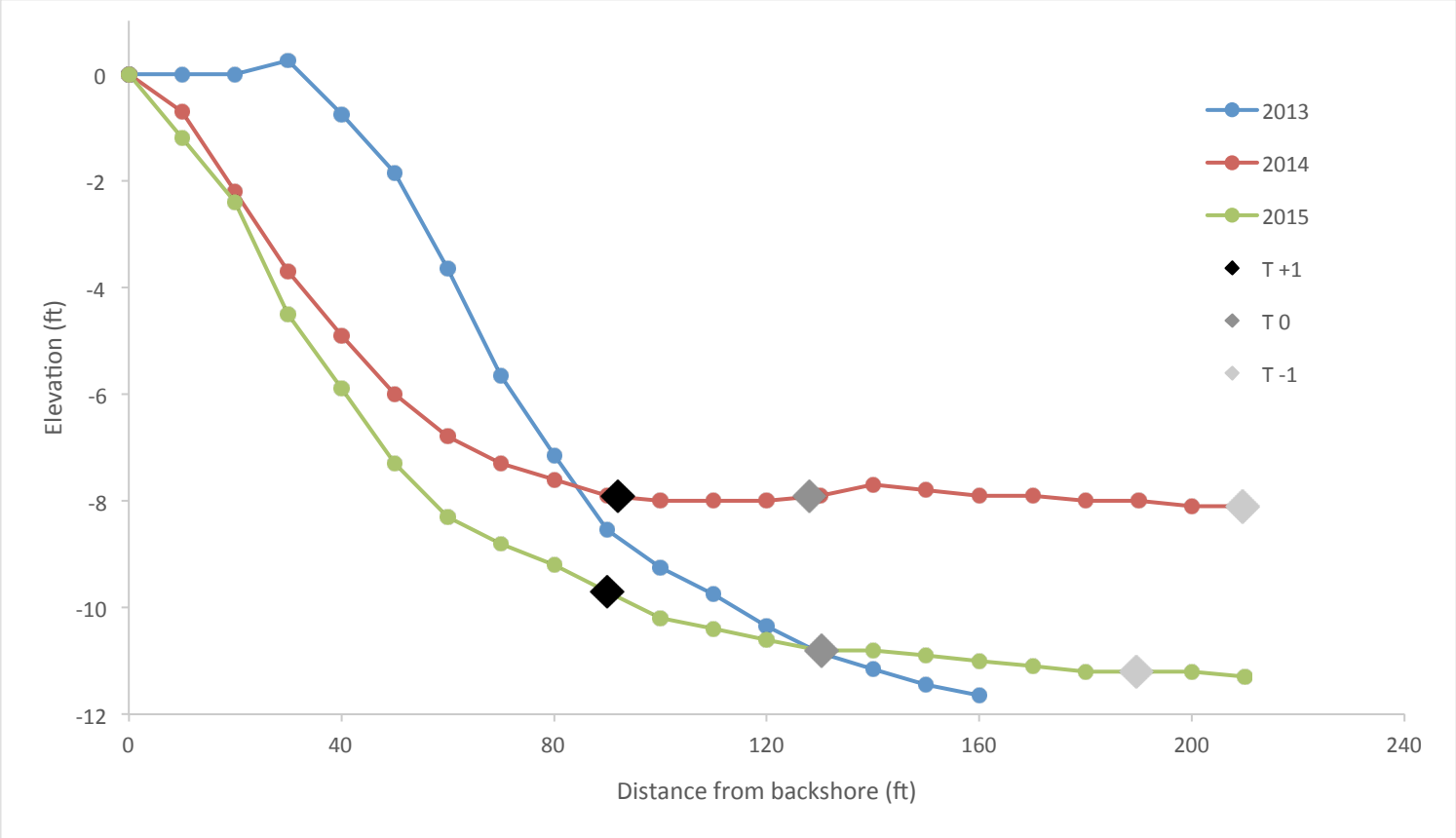


Figure 12. Fir beach elevation profiles.

Species by percent cover: Percent cover at Fir was dominated by green algae species (Figure 13). While green algae varied at the +1 ft, its percent coverage decreased notably at the 0 ft and -1 ft from 2013 to 2015. While other organisms were present, their coverage was relatively minor.

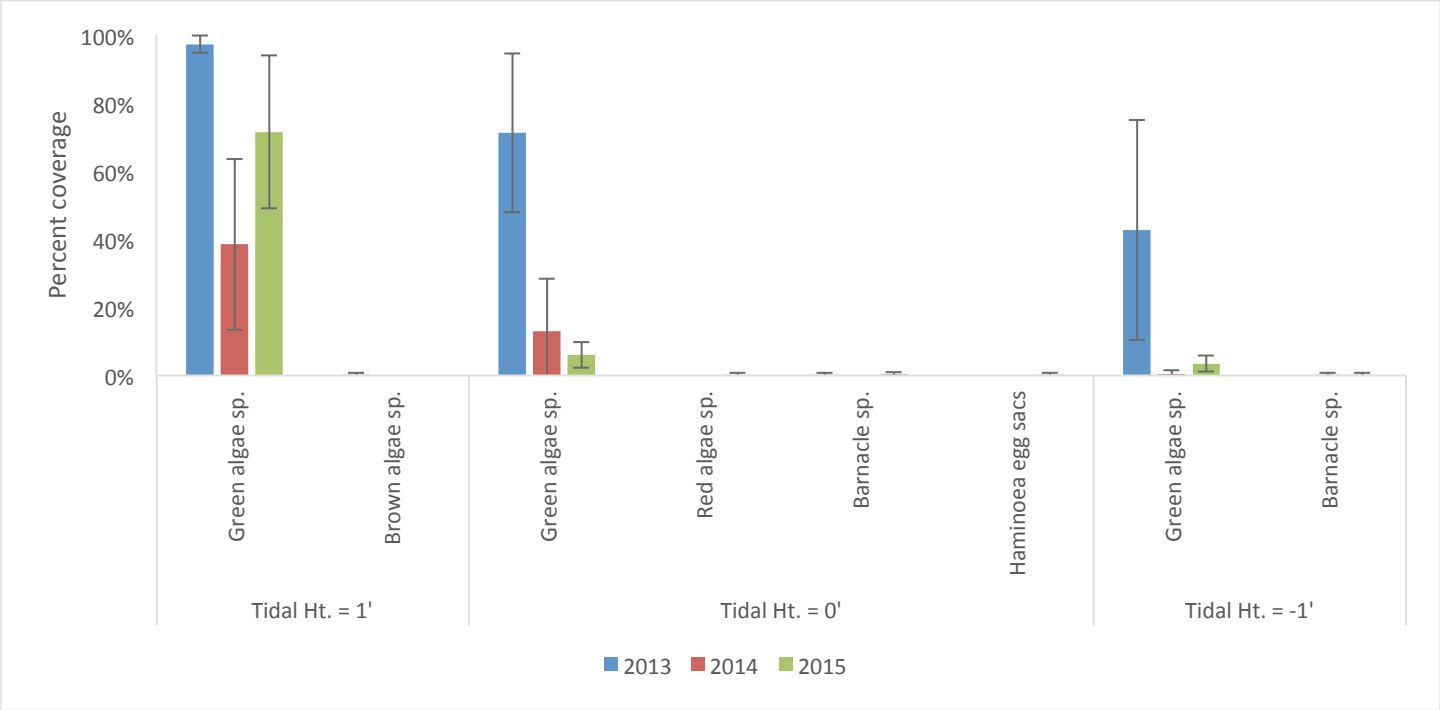


Figure 13. Average percent cover of plants and non-individual count animals at Fir.

Individual species counts: *Haminoea sp.* and polychaetes were not present at +1 in 2013, but dominated at all levels in 2014 (Figure 14). In contrast, the other species found in the quadrats were inconsistent in their occurrence over the years and relatively low in numbers.

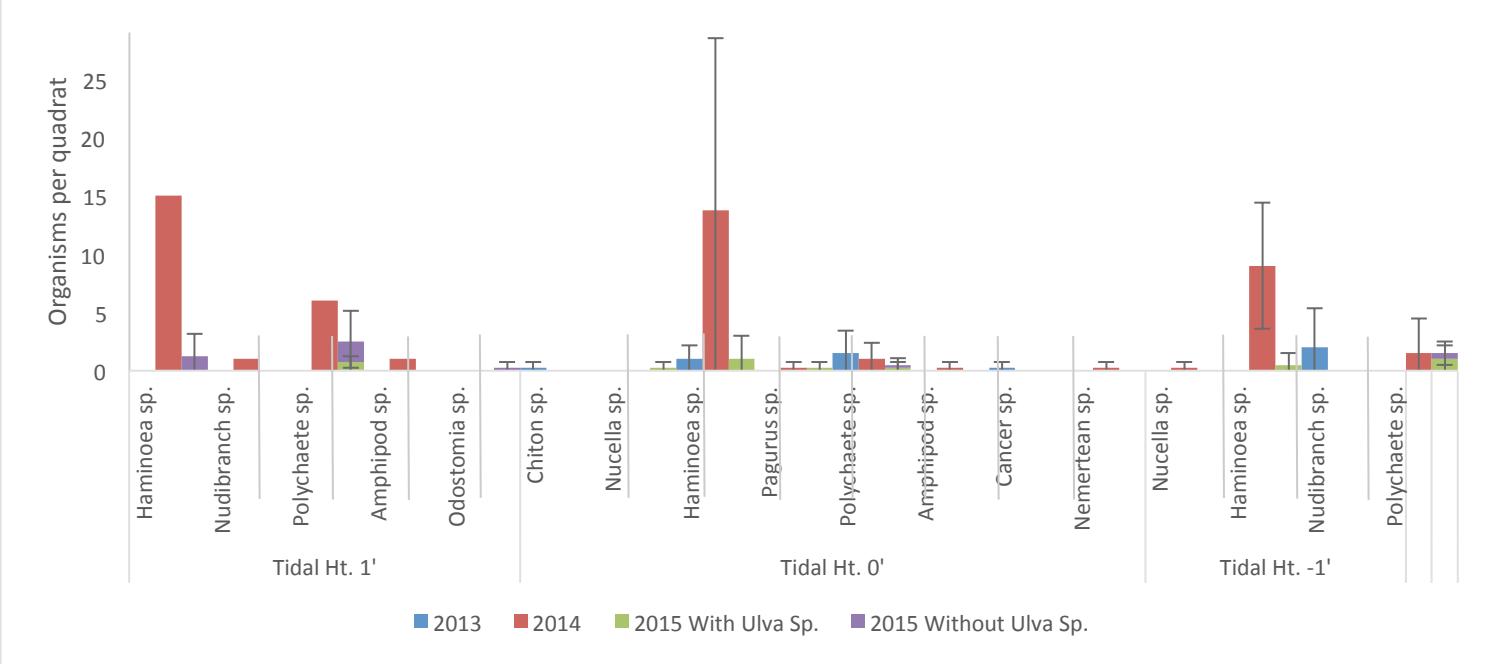


Figure 14. Average number of individual animals in quadrats at Fir.

Infaunal species counts: Most of the infaunal species were variable in their abundance from year to year (Figure 15). *Macoma inquinata* was the most commonly identified bivalve at +1 ft each year. *Leukoma staminea* and *Clinocardium nuttalli* were also found each year at the highest tidal height. Diversity at 0 feet decreased from 2013 to 2014 as the number of species decreased from seven to two, and remained at two in 2015. *Macoma nasuta* was the dominant infaunal species at -1 ft.

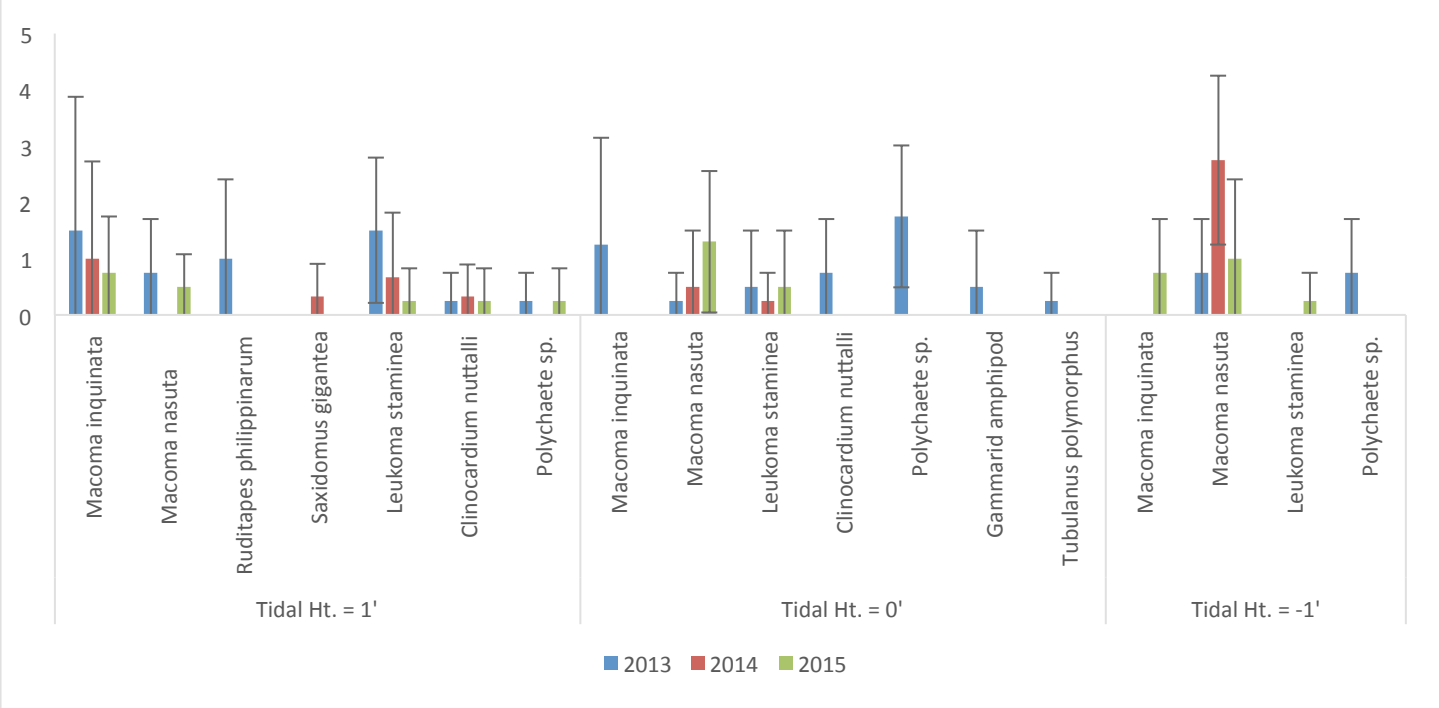


Figure 15. Average number of infaunal animals at Fir.

Trestle Results and Discussion

Photo 4. Trestle Beach survey site in 2014.

Site description: The Trestle site is located on the Tommy Thompson trail at the west end and north side of the trestle connecting the east end of Weaverling Spit to the shore of March Point.

Beach profile and substrate: The apparent substantial increase in the height of the beach face and low tide terrace in 2014, as at Otter and Fir sites, was likely due to an error in placing the starting point of the profile.

The profiles in 2013 and 2015 were relatively similar with 1 foot or less variation between the two years. The steep initial slope of the beach face was due to the fact that the start of the beach elevation profile was in the midst of riprap. The lower part of the beach face is sandy gravel and cobble with riprap boulders (Photo 3). At the toe of the beach face, a muddy low tide terrace with occasional riprap boulders near the beach face begins and continues for a substantial distance northwards into Fidalgo Bay.

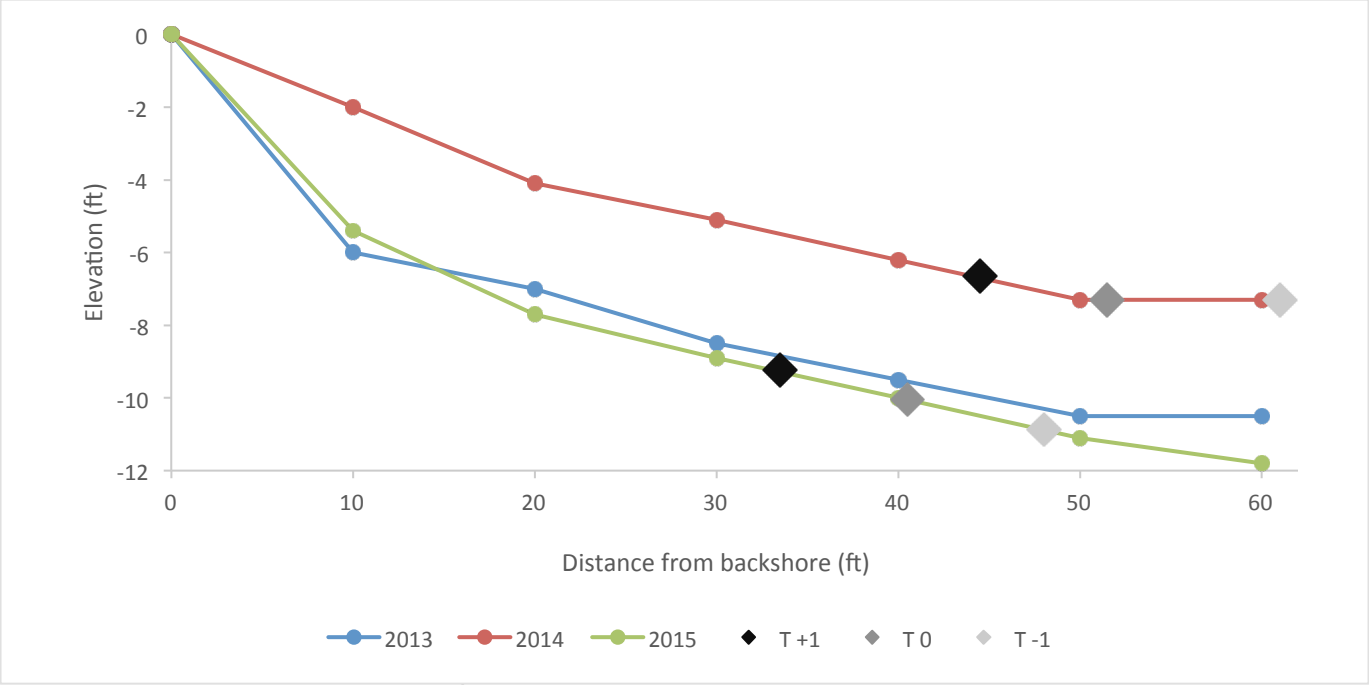


Figure 16. Trestle beach elevation profiles.

Species by percent cover: Green algae constituted most of the cover at Trestle (Figure 17). This group was relatively substantially over the years at each tidal height, but was dominant in each year. While barnacles covered almost 20% of the beach at both the +1 ft and 0 ft heights in 2013, barnacles decreased in their abundance and only made up a small percentage in 2015.

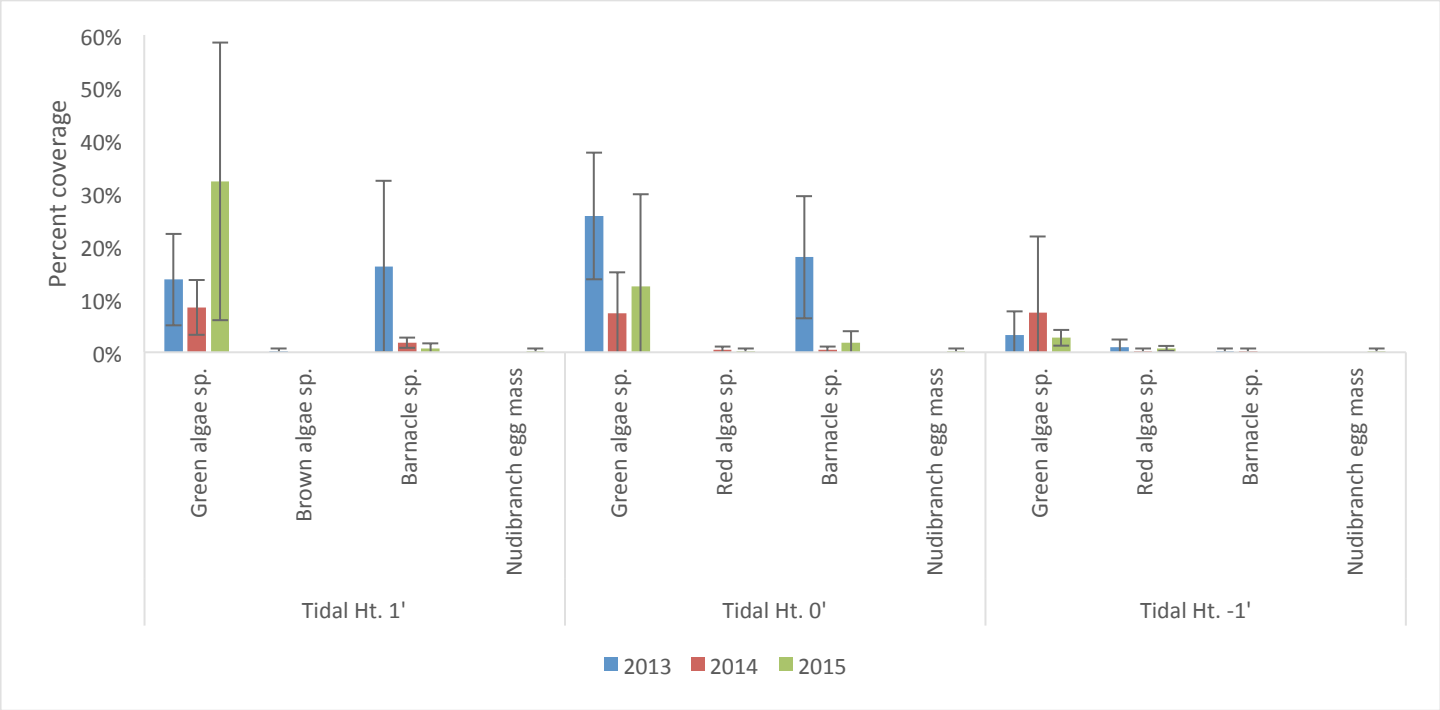


Figure 17. Average percent cover of plants and non-individual count animals at Trestle.

Individual species counts: Limpets were the only organisms found at both the +1 foot and 0 feet levels in each of the three years (Figure 18). No other organism was recorded in more than one year at 0 feet. At the -1 ft tidal height, both *Pagurus* sp. and polychaetes were found in each year of monitoring. As at Fir, a definite increase in the number of organisms occurred in 2014. However, while this increase at Fir was composed primarily of *Haminoea* sp., a small nudibranch snail, the increase at Trestle consisted of a variety of species including limpets, *Nucella* sp., and polychaetes.

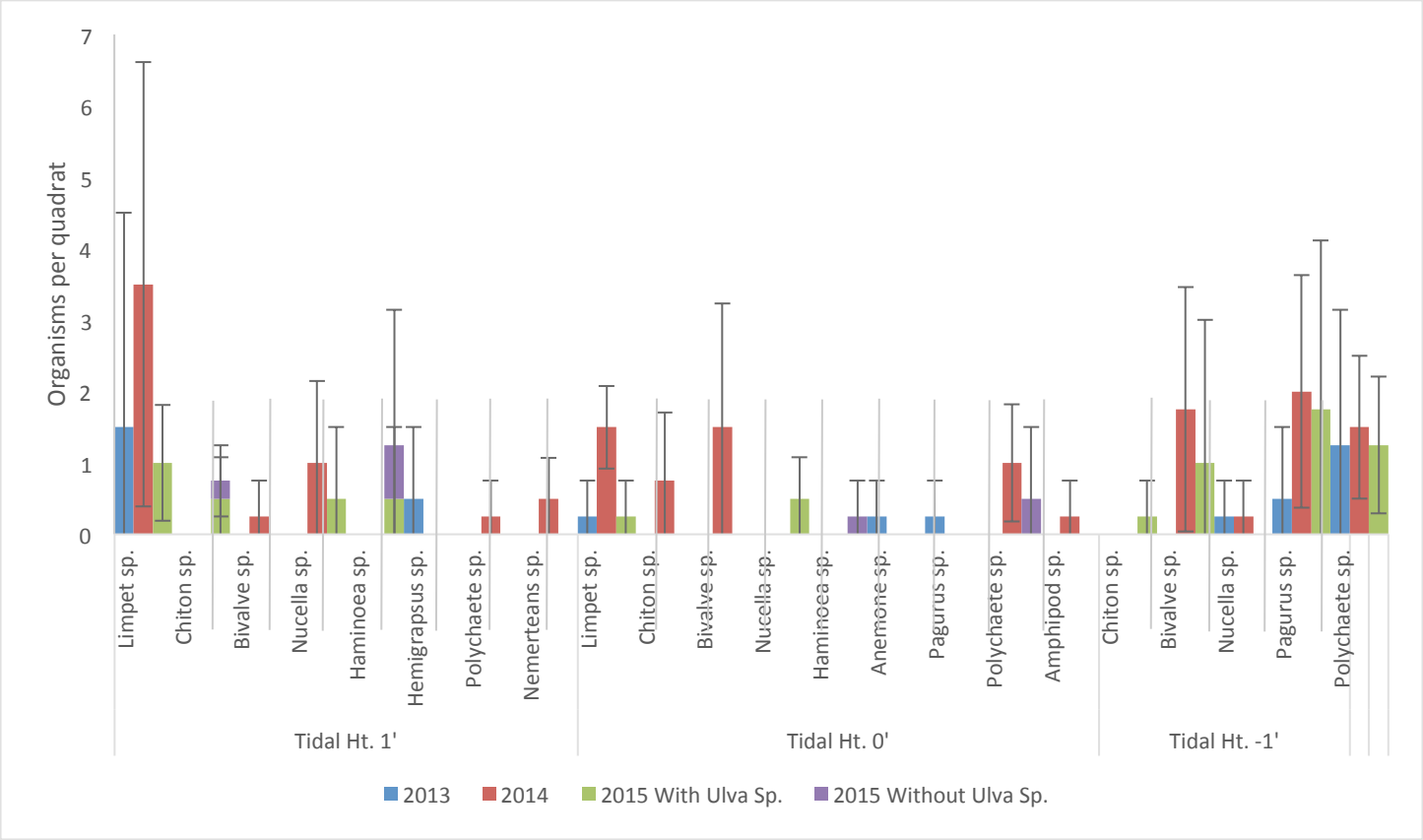


Figure 18. Average number of individual animals at Trestle sampled.

Infaunal species counts: *Macoma inquinata* was the most common infaunal species at Trestle occurring every year at each tidal height (Figure 19). The -1 ft tidal height decreased in the number of species from 2013 to 2014 and again in 2015. Nine different infaunal species were identified in 2013, but only three were present in 2014 and 2015.

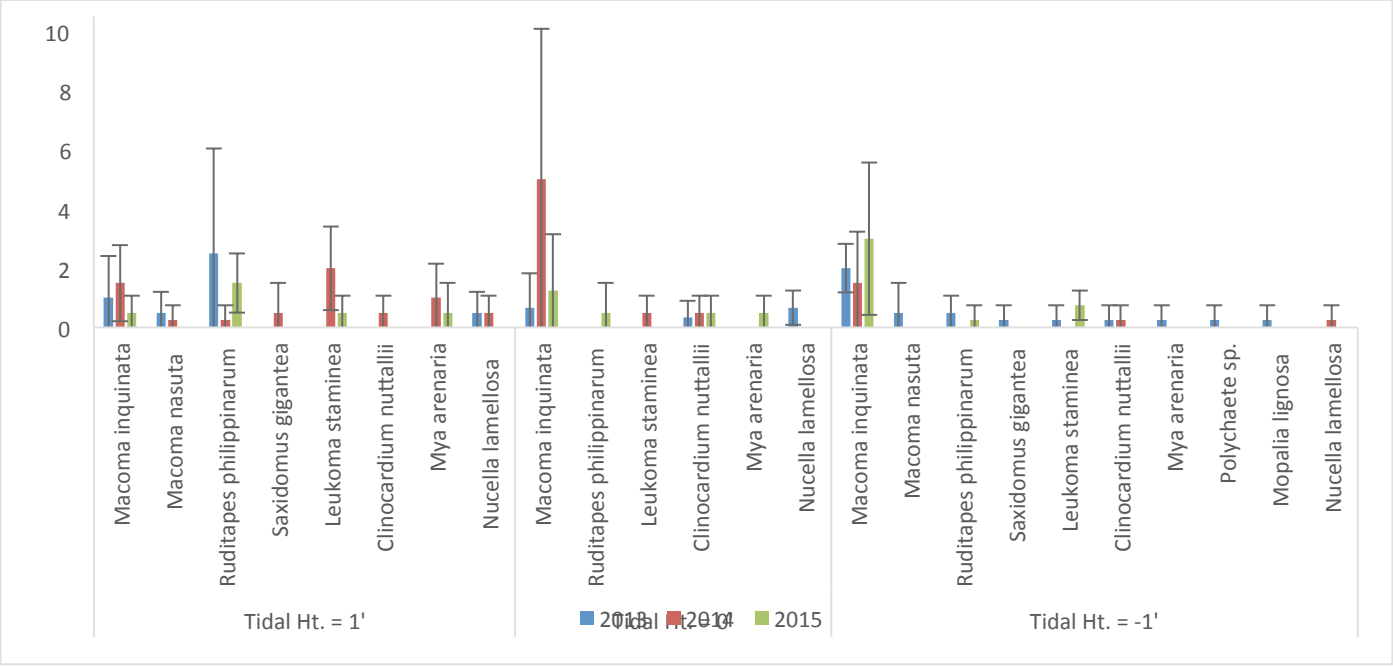


Figure 19. Average number of infaunal animals in sediment cores at Trestle.

General Discussion

The goal of this project is to provide a baseline for detection of future changes and the objective is to collect baseline data on beach slope, substrate, intertidal biotic abundance, and diversity at four monitoring sites. The project was completed in the three years as intended. The data presented in this report is the third year of a baseline data. It is hoped that baseline data will continue to be collected such that a robust baseline is generated, and that trends will be detectable in the future.

According to the QAPP, "The goals and objectives of the intertidal monitoring in the two reserves [Fidalgo Bay and Cherry Point] are to collect baseline data over time at specific monitoring sites and to document changes over time in beach slope, substrate, and biodiversity, using scientifically and statistically sound methods that will provide data comparable across reserves and monitoring years." In this third year, we have collected data on beach slope, substrate, and biodiversity at three separate sites in the Fidalgo Bay Aquatic Reserve. With continued sampling, we may be able to compare changes in these parameters over time. An initial conclusion is that there appears to be much variability in these systems, so defining trends and changes may be difficult.

The predominant substrate on the low tide terrace at all sites was sandy mud, although it seemed qualitatively to be finer with more clay at the Trestle site. The QAPP indicated that the Wentworth scale should be used to identify substrate, but it was not used consistently at the quadrat scale.

Ulva sp. was the predominant algae with less overall density observed in 2013 and 2014 with very small amounts of red algae and barnacles present at some locations. Countable species both on the surface and in cores were generally low in number at all sites. The Fir site was notable for its high density of *Haminoea vesicula* (listed as *H.* sp. in the text) on the surface. The Trestle site was notable for its high diversity of epifauna.

Infaunal animals were diverse with a similar diversity seen in 2013 and 2014, but the *Macoma inquinata, Macoma nasuta,* and *Ruditapes philippinarum* increased from 2013 to 2014.

A total of twenty-seven volunteers were trained and participated in the surveys. Quality control (QC) protocols described in the QAPP were satisfactory given the parameters and limitations of the study, and these were improved each subsequent year of study (see planned program and procedure improvements below). The main exception of QC being followed was the protocol for placing the starting points of the profiles. The profile starting point protocol was reviewed and improved for 2016.

Recommendations

In Years 1 (2013) and 2 (2014), we made a number of recommendations to improve the training, data capture, and quality control for the surveys. The implementation of some of these recommendations provided a better-trained cadre of volunteers and a more efficient and accurate quality control process. There remain some recommendations to be better implemented or considered, and some clarifications to be made.

Implemented Recommendations from Years 1 and 2

The following recommendations and changes were implemented:

YEAR 1

- Training: Identification emphasis was placed on common organisms.
- Training: Emphasis was placed on identification of invasive species
- Photographing quadrats: Photos were taken after removing debris and unattached algae.

- Data management: Each quadrat had at least 1 data sheet; quadrats were not pooled on 1 sheet
- Data collection: The distance along the profile line was noted for each transect level.
- Quality Control: The on-the beach portion included:
    - Ensuring that all blanks were filled out;
    - Ensuring that animals and plants were placed in correct category (percent coverage vs. countable species);
    - Asking that participants total the entire percent coverage—and having them assess whether that was reasonable (some previous estimates were greater than 100%);
    - On-site QC specialist reviewed estimates and verified that these seemed reasonable, on-site.

YEAR 2

- Training clarified that debris that should be removed: Debris was defined as all dead/ unattached algae and litter if it did not have attached life and/or appeared as drift.
- When a quadrat landed on uneven surfaces such as larger boulders, estimates should be made taking a strictly vertical view.
- When a quadrat lands on a boulder where the elevation was not representative of the transect line, the quadrat would be moved to a more representative spot on the transect line. Determination of the destination was somewhat subjective. If the boulder raises the elevation by more than 6 inches to 1 foot, it can be considered non-representative. If the substrate is very rocky and the substrate is uneven, then 6 inches tidal elevation likely is not great enough to be non-representative. In the event that a quadrat lands on a non-representative boulder, reorder the entire quadrat series using a new series of random numbers.
- The general species list (Beach Watcher D-4, Field data sheet) does not need to be filled out when expert identifiers are compiling species on the detailed species list (Species Checklist_latin, 2p). Data was transferred where appropriate from the detailed list to the general list.
- The use of scientific names and the practice of identifying organisms down to the lowest practical level (i.e., genus and species where possible), was emphasized in training of volunteers to decrease confusion stemming from the use of common names.
- A procedure to remove *Ulva* sp. where present, in accordance with practices by Dr. Megan Dethier, University of Washington, Friday Harbor Laboratories, was implemented to ascertain how many additional organisms might be covered by *Ulva* sp.. We did this because some intertidal specialists do this as a routine practice because *Ulva* growth can cover all other species present. Our work did uncover additional species; we will continue this practice for an additional year, and then make a decision as to whether it will be a standard part of the protocol.

The following recommendations from previous years were not implemented but will be implemented or considered in Year 4 (2016):

- Station identification: GPS information will include units and consistent coordinate format (decimal degrees) and that compass readings include declination.

The following recommendations were made at the end of Year 3 (2015) and will be implemented in Year 4 (2016):

- While analyzing the beach profile data, the amount of associated uncertainty indicates that the protocol and training for beach profiles needs to be more rigorous. Adding in room for deflections along profile transects has also been suggested. This means that where there is a bump up and not a constant slope downward, this needs to be accurately captured in the beach profile data by adjusting interval lengths. Permanent markers for profile starting points will be installed where possible.

- Assessing the same swaths, with the same swath distance, each year is recommended. This means looking at historical swaths, preparing guidelines for determining swaths that allows some flexibility given dynamic field conditions.
- The decision to keep the protocol to first count and estimate percent cover for species with *Ulva* sp. and then without, will be kept for at least another year. There were considerable differences seen in comparison between with and without *Ulva* sp. counts.
- Some species could be lumped next year. The lumped species would be the species most difficult to identify quickly and accurately (e.g., barnacles, limpets, *Ulva* sp.) to decrease identification errors. Species lumped into single categories together will have to be similar enough that no valuable data will be lost. For example, in some cases, barnacles may be lumped together simply as barnacles rather than by species.
- In terms of counting eggs, the following changes will be made to the protocols in terms of counting eggs:
    - Nudibranch eggs and *Nucella* egg masses will be counted by percent coverage
    - *Lacuna* eggs will be counted individually because theses egg masses occur discretely
- Counting bivalves. Bivalves are infaunal and should not be counted when below the surface and only a hole or siphon may be seen that indicates, but does not confirm, that a bivalve is present or specifically what species is present. When live bivalves are found on the surface, they will be noted as individual species (with the exception of mussel species, which are recorded as percent cover). Holes or sightings of siphons can be noted in the comments section, but will not be counted. There is some discussion on whether or not to count bivalves on the surface and this protocol should be reviewed next year.

Possible future uses of this data

Ongoing annual surveys will allow comparisons from year to year. In this way, changes in overall species abundance and assemblage composition may be detected. After detection, causes may be evaluated and potentially investigated or remedied. These surveys may also be used in Natural Resources Damage Assessments in the event of an oil spill or other event, and to identify invasive species presence. Additionally, these surveys may fill in existing data gaps. The FBAR CSC should review the results to evaluate what value the data may have to FBAR and how these surveys can be used to improve management of the aquatic reserve.

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Appendix A: Tables of 2015 Quadrat Data

Averages were calculated from whole numbers. Because numbers of organisms were so low in many instances, calculated averages were used; numbers in tables are shown with a higher degree of precision than provided by the data to document the presence of organisms and provide the data used in the corresponding graph.

For a complete set of data for this project, please contact Eleanor Hines at RE Sources at 360-733-8307 or eleanorh@re-sources.org. Past data reports can be found online at: https://sites.google.com/a/re-sources.org/main-2/programs/cleanwater/whatcom-and-skagit-county-aquatic-reserves#TOC-CITIZEN-SCIENCE

Table A1. Percent cover data collected for each quadrat at each tide height at Custom Plywood for 2015.

Custom Plywood		Date: 7/31/2015: WITH ULVA				
Transect	Species	Quadrat, ft.				
Elevation	[redacted]	**1**	**2**	**3**	**4**	Average percent
1'	*Ulva* (bladed) (GA)	43%	0%	0%	0%	10.75%
	Ulva (tubular) (GA)	0%	12%	0%	0%	3.00%
	Ulva intestinalis (GA)	0%	0%	1%	0%	0.25%
	Ulva lactuca (GA)	0%	27%	60%	40%	31.75%
	Green algae sp. (SUM)	43%	39%	61%	40%	45.75%
	Balanus crenatus (B)	2%	0%	0%	0%	0.50%
	Balanus glandula (B)	14%	11%	30%	50%	26.25%
	Barnacle sp. (SUM)	16%	11%	30%	50%	26.75%
	Porphyra sp. (RA)	0%	1%	0%	2%	0.75%
	Mytilus trossulus	0%	0%	0%	***1%***	0.25%
	Substrate	C/S, C, G	C/S, C, S, G	C/S, G	C/S, G	[redacted]
[redacted]		**1**	**2**	**3**	**4**	[redacted]
0'	*Ulva* (bladed) (GA)	11%	0%	0%	0%	2.75%
	Ulva lactuca (GA)	0%	2%	5%	7%	3.50%
	Ulva intestinalis (GA)	0%	0%	1%	1%	0.50%
	Ulva (tubular) (GA)	3%	9%	0%	0%	3.00%
	Green algae sp. (SUM)	14%	11%	6%	8%	9.75%
	Balanus crenatus (B)	10%	28%	6%	5%	12.25%
	Balanus glandula (B)	13%	0%	0%	0%	3.25%
	Barnacle sp. (SUM)	23%	28%	6%	5%	15.50%
	Substrate	C, G	C/S, C, G	C/S, G	C/S, G	[redacted]
[redacted]		**1**	**2**	**3**	**4**	[redacted]
-1'	*Ulva* (tubular) (GA)	45%	22%	45%	50%	40.50%
	Ulva intestinalis (GA)	***1%***	0%	0%	0%	0.25%
	Ulva lactuca (GA)	5%	0%	4%	2%	2.75%
	Ulva (bladed) (GA)	0%	1%	0%	0%	0.25%
	Green algae sp. (SUM)	51%	23%	49%	52%	43.75%
	Balanus crenatus (B)	1%	5%	2%	5%	3.25%
	Haminoea eggs	0%	1%	1%	1%	0.75%
	Substrate	C/S,G	C/S, G	C/S, G	C/S, G	[redacted]

Substrate Key: C/S; Clay/Silt, S; Sand, G; Gravel, C; Cobbles, B; Boulders, E; Erratic
Bold italic denotes instances where the species was present at less than 1%

Key: GA = Green algae sp., B = Barnacle sp., RA = Red algae sp.

Table A2. Individual species count data collected for each quadrat at each tide height at Custom Plywood for 2015.

Custom	Date: 7/31/2015	Countable Animals WITH ULVA				
Transect	Species	Quadrat				Average
Elevation		1	2	3	4	Count
1'	Amphipod sp.	1	0	0	0	0.25
Substrate		C/S, G, C	C/S, C, S, G	C/S, G	C/S, G	
0'	*Pagurus hirsutiusculus (Pa)*	1	0	0	0	0.25
	Mya arenaria	1	0	0	0	0.25
Substrate		C,G	C/S, C, G	C/S, G	C/S, G	
-1'	*Haminoea* sp.	0	1	0	0	0.25
Substrate		C/S,G	C/S, G	C/S, G	C/S, G	

Table A3. Infaunal data collected for each quadrat at each tide height at Custom Plywood for 2015.

Custom Plywood	Date: 7/31/2015					
Transect	Species	Quadrat				Average
Elevation		1	2	3	4	Count
1'	*Macoma inquinata*	0	1	0	0	0.25
	Saxidomus gigantea	1	0	0	0	0.25
	Mya arenaria	0	0	2	0	0.50
	Tresus sp.	1	0	0	0	0.25
	DEPTH (cm)	30	30	15	12	
0'	*Macoma inquinata*	0	4	0	0	1.00
	Clinocardium nuttallii	0	0	0	1	0.25
	DEPTH (cm)	30	30	30	20	
-1'	*Macoma inquinata*	0	1	0	0	0.25
	Clinocardium nuttallii	0	0	1	0	0.25
	DEPTH (cm)	30	30	20	25	

Table A4. Percent cover data collected for each quadrat at each tide height at Otter for 2015.

Otter Site 8/1/2015 Participants: FBARCS & Community Members

Transect Elevation	Species	Quadrat, ft.				Average percent
		1	2	3	4	
1'	*Ulva* sp. (bladed) (GA)	0%	0%	27%	0%	6.75%
	Ulva sp. (tubular) (GA)	0%	5%	18%	0%	5.75%
	Ulva lactuca (GA)	28%	12%	0%	30%	17.50%
	Ulva intestinalis (GA)	18%	0%	0%	5%	5.75%
	*Ulva prolifera (*GA)	4%	0%	0%	0%	1.00%
	Green algae sp. (SUM)	50%	17%	45%	35%	36.75%
	Balanus crenatus (B)	11%	20%	0%	25%	14.00%
	Balanus glandula (B)	3%	1%	4%	1%	2.25%
	Barnacle sp. (SUM)	14%	21%	4%	26%	16.25%
	Substrate	C/S, S, C, Sh	C/S, S, C, G, Sh	C/S, S, C, Sh	C/S, S, G, C, Sh	
		1	2	3	4	
0'	*Ulva lactuca* (GA)	5%	32%	28%	35%	25.00%
	Ulva prolifera (GA)	3%	0%	0%	0%	0.75%
	Ulva sp. (tubular) (GA)	0%	4%	0%	3%	1.75%
	Green algae sp. (SUM)	8%	36%	28%	38%	27.50%
	Balanus crenatus	13%	12%	5%	18%	12.00%
	Substrate	C/S, S, C, G, Sh	C/S, S, C, G, Sh, B	C/S, S, C, G, Sh	C/S,	
		1	2	3	4	
-1'	*Ulva lactuca* (GA)	7.0%	1.0%	1.0%	**1.0%**	2.50%
	Ulva intestinalis (GA)	0.0%	0.0%	1.0%	**1.0%**	0.50%
	Green algae sp. (SUM)	7.0%	1.0%	2.0%	2.0%	3.00%
	Balanus crenatus	2.0%	2.0%	5.0%	1.0%	2.50%
	Barnacle sp. (SUM)	2.0%	2.0%	5.0%	1.0%	2.50%
	Substrate	C/S, Sh	C/S, G	C/S, C, G	C/S, S, G, Sh	

nr= not recorded; C/S; Clay/Silt ,S; Sand, G; Gravel, C; Cobbles, B; Boulders, E; Erratic

Bold italic denotes instances where the species was present at less than 1%

Key: GA = Green algae sp., B = Barnacle sp.

Table A5. Individual species count data collected for each quadrat at each tide height at Otter for 2015.

Otter Date 8/1/2015						
Countable Animals in Quadrats						
Transect	Species	Quadrat				Average
Elevation		1	2	3	4	Count
1'	*Lottia pelta* (Lp)	0	0	2	0	0.50
	Lottia persona (Lp)	0	0	0	3	0.75
	Tectura scutum (Lp)	0	0	1	0	0.25
	Limpet sp. (SUM)	0	0	3	3	1.50
	Protothaca staminea (Bi)	0	0	1	0	0.25
	Haminoea sp.	0	0	0	2	0.50
	Hesionidae (P)	1	0	0	0	0.25
	Tube worm (P)	0	0	0	1	0.25
	Polychaete sp. (SUM)	1	0	0	1	0.50
	Substrate	C/S, S, C, Sh	C/S, S, C, G, Sh	C/S, S, C, Sh	C/S, S, G, C, Sh	
0'	*Macoma inquinata* (Bi)	0	0	0	6	1.50
	Haminoea sp.	0	0	0	7	1.75
	Pagurus sp.	0	1	0	0	0.25
	Hemigrapsus oregonensis (He)	0	2	0	0	0.50
	Traskorchestia traskiana (A)	1	0	0	0	0.25
	Substrate	C/S, S, C, G, Sh	C/S, S, C, B, G, Sh	C/S, S, C, G, Sh	C/S	
-1'	*Haliplanella lineata* (P)	0	1	0	0	0.25
	Hesionidae (P)	1	0	0	1	0.50
	Polychaete sp. (SUM)	1	0	0	1	0.50
	Shrimp	1	0	1	0	0.50
	Substrate	C/S, Sh	C/S, G, Sh	C/S, C, G	C/S, S, G, Sh	

Substrate Types: C/S; Clay/Silt ,S; Sand, G; Gravel, C; Cobbles, B; Boulders, E; Erratic

Key: Lp = Limpet sp., Bi = Bivalve sp., P = Polychaete sp., He = Hemigrapsus sp., A = Amphipod sp.

Table A6. Infaunal species data collected for each quadrat at each tide height at Otter for 2015.

Animals Found in Sediment Core

Otter	8/1/2015					
Transect	Species	Quadrat				Average
Elevation		1	2	3	4	
1'	*Macoma inquinata*	6	2	2	6	4.00
	Ruditapes philippinarum	2	0	0	4	1.50
	Saxidomus gigantea	1	1	1	0	0.75
	Leukoma staminea	0	0	1	0	0.25
CORE	DEPTH	15	20 cm	12 cm	30 cm	
0'	*Macoma inquinata*	0	1	0	1	0.50
	Macoma nasuta	1	2	2	2	1.75
	Leukoma staminea	0	0	0	1	0.25
	Clinocardium nuttallii	1	0	0	0	0.25
	Nereis sp. (P)	1	0	0	0	0.25
CORE	DEPTH	15 cm	12 cm	12 cm	12 cm	
-1'	*Macoma inquinata*	0	0	1	0	0.25
	Macoma nasuta	1	2	1	1	1.25
	Saxidomus gigantea	0	1	0	0	0.25
CORE	DEPTH	15 cm	30 cm	30 cm	30 cm	

Key: P = Polychaete sp.

Table A7. Percent cover data collected for each quadrat at each tide height at Fir for 2015.

Fidalgo Fir Site: 5/20/2015		**Date 5/20/15: WITH ULVA**				
Transect	Species	Quadrat, ft.				Average
		1	2	3	4	
1'	*Ulva* sp. (bladed) (GA)	65%	90%	38%	21%	53.50%
	Ulva sp. (tubular) (GA)	5%	10%	7%	50%	18.00%
	Green algae sp. (SUM)	70%	100%	45%	71%	71.50%
	Substrate	C/S, S, G	C/S, S, G, C	C/S, S, G, C	C/S, S, G	
		1	2	3	4	
0'	*Ulva intestinalis* (GA)	1%	1%	3%	0%	1.25%
	Ulva lactuca (GA)	0%	6%	3%	0%	2.25%
	Ulva sp. (GA)	0%	0%	0%	10%	2.50%
	Green algae sp. (SUM)	1%	7%	6%	10%	6.00%
	Polysiphonia sp. (RA)	0%	0%	0%	1%	0.25%
	Balanus crenatus (B)	1%	0%	***1%***	0%	0.50%
	Haminoea Egg sacs	0%	***1%***	0%	0%	0.25%
	Substrate	C/S, S	C/S	C/S, S, G	C/S, S, G, C	
		1	2	3	4	
-1'	*Ulva intestinalis* (GA)	0%	0%	***1%***	0%	0.25%
	Ulva lactuca (GA)	0%	0%	1%	0%	0.25%
	Ulva sp. (GA)	***1%***	6%	0%	5%	3.00%
	Green algae sp. (SUM)	***1%***	6%	2%	5%	3.50%
	Balanus crenatus (B)	0%	0%	1%	0%	0.25%
	Substrate	C/S, S	C/S, S	C/S, S	C/S, S	

Bold italic denotes instances where the species was present at less than 1%
nr = not recorded, C/S: Clay/Silt, S: Sand, G: Gravel, C: Cobbles, B: Boulders, E: Erratic
Key: GA = Green algae sp., RA = Red algae sp., B = Barnacle sp.

Table A8. Individual species count data collected for each quadrat at each tide height at Fir for 2015.

Fidalgo Fir Site: 5/20/2015		Countable Animals: WITH ULVA				
Transect	Species	Quadrat, ft.				Average
Elevation		1	2	3	4	
1'	*Hesionidae* sp. (P)	0	1	1	1	0.75
Substrate		C/S, S, G	C/S, S, G, C	C/S, S, G, C	C/S, S, G	
0'	*Nucella lamellosa* (N)	0	0	1	0	0.25
	Haminoea vesicula (H)	0	0	0	4	1.00
	Pagurus sp.	0	0	0	1	0.25
	Hesionidae sp. (P)	0	0	0	1	0.25
Substrate		C/S, S	C/S	C/S, S, G	C/S, S, G, C	
-1'	*Haminoea vesicula* (H)	0	0	0	2	0.50
	Hesionidae sp. (P)	0	2	2	0	1.00
Substrate		C/S, S	C/S, S	C/S, S	C/S, S	

Substrate codes = C/S: Clay/Silt, S: Sand, G: Gravel, C: Cobbles, B: Boulders, E: Erratic

Key: P = Polychaete sp., N = Nucella sp., H = Haminoea sp.

Table A9. Infaunal data collected for each quadrat at each tide height at Fir for 2015.

Fidalgo Fir Site: 5/20/2015						
Transect	Species	Quadrat				Average
Elevation		1	2	3	4	Count
1'	*Macoma inquinata*	0	1	2	0	0.75
	Macoma nasuta	1	0	0	1	0.50
	Leukoma staminea	1	0	0	0	0.25
	Clinocardium nuttallii	1	0	0	0	0.25
	Nereidae sp.	1	0	0	0	0.25
	DEPTH (cm)	4	10	13	15	
0'	*Macoma nasuta*	1	3	1	0	1.25
	Leukoma staminea	0	0	0	2	0.50
	DEPTH (cm)	30	20	30	30	
-1'	*Macoma inquinata*	0	2	0	1	0.75
	Macoma nasuta	0	0	3	1	1.00
	Leukoma staminea	0	1	0	0	0.25
	DEPTH (cm)	30	20	30	25	

Data not included, for T+1, Q4 due to the use of incorrect protocol.

Key: P = Polychaete sp.

Table A10. Percent cover data collected for each quadrat at each tide height at Trestle for 2015.

Fidalgo Trestle Site		Date: 5/18/2015: WITH ULVA				
Transect	Species	Quadrat, ft.				Average
Elevation		**1**	**2**	**3**	**4**	percent
1'	*Ulva* (bladed) (GA)	0%	0%	0%	16%	4.00%
	Ulva (tubular) (GA)	0%	0%	0%	4%	1.00%
	Ulva sp. (GA)	38%	5%	66%	0%	27.25%
	Green algae sp. (SUM)	38%	5%	66%	20%	32.25%
	Chthalamus dalli (B)	2%	0%	0%	0%	0.50%
	Barnacle sp. (B)	0%	0%	**1%**	0%	0.25%
	Barnacle sp. (SUM)	2%	0%	**1%**	0%	0.75%
	Nudibranch egg mass	1%	0%	0%	0%	0.25%
	Substrate	C/S, G, C, B	C/S, G	C/S, C, G	C/S, G, C	
		1	**2**	**3**	**4**	
0'	*Ulva* sp. (bladed) (GA)	0%	0%	0%	38%	9.50%
	Ulva sp. (GA)	1%	9%	2%	0%	3.00%
	Green algae sp. (SUM)	1%	9%	2%	38%	12.50%
	Balanus crenatus (B)	0%	0%	0%	2%	0.50%
	Balanus glandula (B)	0%	0%	0%	3%	0.75%
	Barnacle sp. (B)	0%	**1%**	**1%**	0%	0.50%
	Barnacle sp. (SUM)	0%	**1%**	**1%**	5%	1.75%
	Polysiphonous complex (RA)	0%	0%	0%	1%	0.25%
	Nudibranch egg mass	0%	0%	1%	0%	0.25%
	Substrate	C/S, B	C/S, G, B	C/S, C, B	C/S, S, G, C	
		1	**2**	**3**	**4**	
-1'	*Ulva* sp. (bladed) (GA)	0%	0%	4%	**1%**	1.25%
	Ulva sp. (GA)	4%	2%	0%	0%	1.50%
	Green algae sp. (SUM)	4%	2%	4%	**1%**	2.75%
	Polysiphonous complex (RA)	1%	1%	0%	**1%**	0.75%
	Nudibranch egg mass	**1%**	0%	0%	0%	0.25%
	Substrate	C/S, G	C/S	C/S	C/S	

Substrate Key: C/S; Clay/Silt, S; Sand, G; Gravel, C; Cobbles, B; Boulders, E; Erratic

Bold italic denotes instances where the species was present at less than 1%

Key: GA = Green algae sp., B = Barnacle sp., RA = Red algae sp.

Table A11. Individual species count data collected for each quadrat at each tide height at Trestle for 2015.

Trestle	Date: 5/18/2015	Countable Animals WITH ULVA				
Transect	Species	Quadrat				Average
Elevation		1	2	3	4	Count
1'	*Tectura persona* (Lp)	0	0	1	0	0.25
	Tectura scutum (Lp)	0	0	1	0	0.25
	Lottia pelta (Lp)	1	0	0	1	0.50
	Limpet sp. (SUM)	1	0	2	1	1.00
	Mopalia mucosa (C)	0	1	0	1	0.50
	Nucella lamellosa (N)	2	0	0	0	0.50
	Haminoea sp.	2	0	0	0	0.50
Substrate		C/S, G, C, B	C/S, G	C/S, C, G	C/S, G, C	
0'	*Tectura persona* (Lp)	0	1	0	0	0.25
	Nucella lamellosa (N)	1	0	0	1	0.50
Substrate		C/S, B	C/S, G, B	C/S, C, B	C/S, S, G, C	
-1'	*Mopalia ciliata* (C)	0	0	1	0	0.25
	Crassostrea gigas (Bi)	0	0	0	3	0.75
	Olympia oyster (Bi)	0	0	0	1	0.25
	Bivalve sp.(SUM)	0	0	0	4	1.00
	Pagurus granosimanus (Pa)	0	2	0	0	0.50
	Pagurus sp. (Pa)	0	0	0	5	1.25
	Pagurus sp. (SUM)	0	2	0	5	1.75
	Polychaeta sp. (P)	0	1	0	2	0.75
	Hesionidae (P)	2	0	0	0	0.50
	Polychaete sp. (SUM)	2	1	0	2	1.25
Substrate		C/S, G	C/S	C/S	C/S	
Substrate Key: C/S; Clay/Silt, S; Sand, G; Gravel, C; Cobbles, B; Boulders, E; Erratic						

Key: Lp = Limpet sp., C = Chiton sp., N = Nucella sp., Bi = Bivalve sp., Pa = Pagurus sp., P = Polychaete sp.

Table A12. Infaunal data collected for each quadrat at each tide height at Trestle for 2015.

Trestle	Date: 5/18/2015					
Transect	Species	Quadrat				Average
Elevation		1	2	3	4	Count
1'	*Macoma inquinata*	0	1	1	0	0.50
	Ruditapes philippinarum	2	2	2	0	1.50
	Leukoma staminea	1	1	0	0	0.50
	Mya arenaria	2	0	0	0	0.50
	DEPTH (cm)	20	10	5	6	
0'	*Macoma inquinata*	0	1	4	0	1.25
	Ruditapes philippinarum	0	0	2	0	0.50
	Clinocardium nuttallii	0	1	0	1	0.50
	Mya arenaria	0	1	1	0	0.50
	DEPTH (cm)	10	10	15	12	
-1'	*Macoma inquinata*	0	6	4	2	3.00
	Ruditapes philippinarum	0	1	0	0	0.25
	Leukoma staminea	1	1	1	0	0.75
	DEPTH (cm)	12	15	20	30	

Appendix B: Field Data Forms

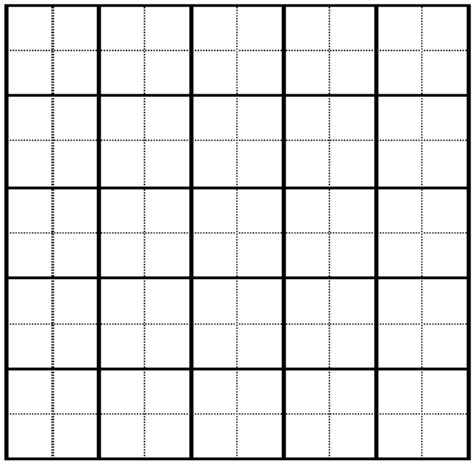
The following data forms were used in this project:

Form	Purpose
Quadrat Binary Estimation Worksheet	Assess percentage coverage
Skagit Quadrat Sheet	Quadrat analysis for percent cover, individual counts, and coring data
Beach Watchers Profile Data Sheet	Profile elevation (Beach Watchers form D4, side A)
Species Checklist	Species identification in swath surveys

Quadrat Binary Estimation Worksheet

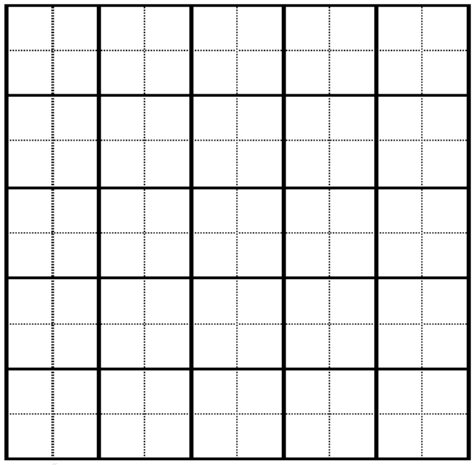
Site_____ Date and Time_____
Identifier:_____ Recorder_____
Other Team members:_____ and _____
Transect Elevation (circle one): +1' 0' -1
Quadrat Number _____, Quadrat Distance along transect line _____

Organism: _____ Row Totals



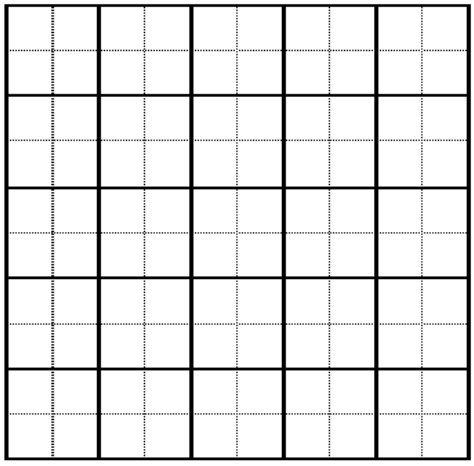
Grand Total:

Organism: _____ Row Totals



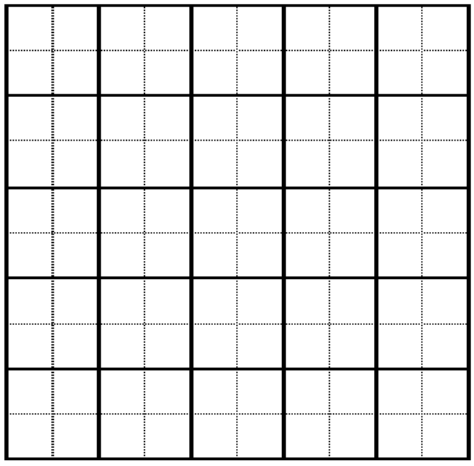
Grand Total:

Organism: _____ Row Totals



Grand Total:

Organism: _____ Row Totals



Grand Total:

Skagit Quadrat Sheet

Aquatic Reserve Intertidal Biotic monitoring QUADRAT DATA SHEET

Site: _____ Date and Time _____

Team Members: _____

_____

Tide Level: _____Quadrat #: _____ Quadrat distance onTransect line : _____ On Profile line_____

Photo after debris removal _____ (initial) QC check_____ (initial)

Photo after *Ulva* sp. removal _____ (initial) QC check_____ (initial)

Substrate in Quadrat (circle all):

Clay/ Silt	Sand (.002" -.08")	Gravel (.08" - 2")	Other:___
Cobbles (2" - 10")	Boulders (>10")	Erratic	Shell debris

PERCENT COVERAGE METHOD: algae, plants and aggregating organisms*:

If using the QUADRAT ESTIMATION worksheet, transfer that information here.

Estimation Methods: VE = visual estimate, B= Binary, 1P= 1% Method

* Barnacles, mussels, sponge, bryozoans, colonial ascidians, & Anthopleura elegantissima

	Organism Name	BEFORE ULVA REMOVAL	Estimation Method	AFTER ULVA REMOVAL	Estimation Method
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

What is the % Total? WITH *Ulva* sp. _____ Visually does this seem accurate?_____

What is the % Total? WITHOUT *Ulva* sp._____ Visually does this seem accurate?_____

*Countable animals and infuanal species on other side

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COUNTABLE ANIMALS

	Organism Name	TOTAL BEFORE ULVA REMOVAL	TOTAL AFTER ULVA REMOVAL
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

ANIMALS BURIED IN THE SEDIMENT

	Organism Name	Number
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Core Depth _____ cm

NOTES

_____

_____

_____

_____

_____

Beachwatcher, Field Data Sheet for Profile Elevation

SIDE A **Profile data sheet** Page ___of ___ ***** Please complete additional information on the back of this form**

Directions: In column A record the number of feet traveled for each reading. Column B is the running total of column A. Column C is the actual profile reading (be sure to include + or -). Check the substrates, seaweeds, and animals found within each profile section.

	A	B	C	Substrate (check all that apply)							Seaweeds and Invertebrates (check all that apply)																												
Entry (1,2,3, etc.)	Length of survey section	Cumulative Distance (optional)	+ or - Survey Reading	Ground shell debris	Clay/Silt	Sand (.002" - .08")	Gravel (.08" - 2")	Cobbles (2" - 10")	Boulders (>10")	Erratics (BIG ROCKS!)	Amphipods	Anemones	Barnacles	Chitons	Clams	Crabs	Fish	Insects	Isopods	Limpets	Mussels	Nudibranchs	Sand Dollars	Sea Cucumbers	Seastars	Snails	Urchins	W Flat Worms	W Nemerteans	W Polychaetes	Green Seaweeds	Red Seaweeds	Brown Seaweeds	Seagrass	Arachnid	Shrimp	Other
1																																					
2																																					
3																																					
4																																					
5																																					
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19																																					
20																																					
21																																					

Species Checklist – scientific nomenclature

Site:	Date & Time:	Expert & scribe: Section along profile line, in feet								
PORIFERA	sponges									
Halichondria sp.	Bread crumb sponge									
PLATYHELMINTHES										
Kaburakia excelsa	"giant flatworm"									
CNIDARIA: Anthozoa	sea anemones									
Metridium farcimen	Plumose anenome									
Haliplanella (?) lineata	striped anemone									
NEMERTEA										
Paranemertea peregrina	ribbon worm (purple nemertid)									
Carinoma mutabilis	Nemertea - white									
Tubulanus polymorphus	Nemertea - orange									
ANNELIDA										
Polychaeta sp.	Polychaete									
Tubiculous polychaete	unidentified tube worm									
Chaetopteridae	Bamboo worm									
Hesionidae sp.	"bristle worm" Polychaete									
Lumbrineridae	genus/sp. unidentified									
Nephtyidae spp.	Goddess worm									
Nereidae spp.	Pile worm									
Polynoidae	scale worms									

Syllidae										
Terebellidae	"spaghetti worm"									
Site:	**Date & Time:**	Expert & scribe:					Section along profile line, in feet			
MOLLUSCA: Gastropoda	Snails									
Lacuna sp.	"lacuna"									
Littorina scutulata	Checkered Periwinkle									
Littorina sitchana (sitkana)	"Sitka periwinkle"									
Lirabuccinum dirum (Searlesia dira)	Dire whelk									
Nassarius fossatus	"Channeled nassa"									
Amphissa (?) columbiana	"wrinkled Amphissa"									
Nucella lamellosa	"frilled dogwinkle"									
Nucella ostrina (emarginata)	"emarginate dogwinkle"									
Nucella canaliculata	Channeled dogwinkle									
Odostomia tenuisculpta	no common name									
Batillaria zonalis (attramentaria, cumingii)	"Japanese false cerith"									
Haminoea vesicula (includes egg masses)	"blister glassy-bubble" (white bubble shell)									
Nudibranch sp.	unidentified nudibranch									
Lottia pelta	"Shield limpet"									
Tectura scutum	"Plate limpet"									
Tectura persona	"Mask limpet"									
Lottia digitalis	Finger limpet									
MOLLUSCA: Bivalvia	Clams and Mussels									

Mytilus trossulus	Pacific blue mussel									
Leukoma (Protothaca) staminea	"Pacific littleneck"									
Pododesmus macroschisma	"alaska jingle"									
Ruditapes (Venerupis) philippinarum	"Japanese littleneck"									
Saxidomus gigantea	"Washington butterclam"									
Tresus capax	"fat gaper"									
Macoma balthica	"Baltic macoma"									
Macoma inquinta	"pointed" or "stained" macoma									
Macoma nasuta	"bent-nose macoma									
Nuttallia obscurata	"purple mahogany-clam"									
Clinocardium nuttallii	"Nuttall cockle" (heart cockle)									
MOLLUSCA: Gastropoda	Snails									
Mya arenaria	"softshell clam"									

Site:	**Date & Time:**	Expert & scribe:					Section along profile line, in feet			
Crassostrea gigas	"Pacific oyster"									
MOLLUSCA: Polyplacophora	Chitons									
Mopalia muscosa	Mossy chiton									
Mopalia lignosa	Woody chiton									
Lepidochitonidae	chiton									
ARTHROPODA:Crustacea:Malaconstraca										
Neomolgus littoralis	red velvet mite									
Gnorimosphaeroma orgonensis	Pill bug isopod									

Pagurus sp.	Hermit Crab									
Pagurus hirsutiusculus ?	"hairy hermit"									
Pagurus granosimanus	"grainy hand hermit"									
Crustacea: Amphipoda: Gammaridea	gammarid amphipod									
Caprellidae	caprella amphipod									
Hemigrapsus nudus	"Purple shore crab"									
Hemigrapsus oregonensis	"yellow shore crab"									
Hapalogaster mertensii	"hairy crab"									
Telmessus cheiragonus	"helmet crab"									
Upogebia pugettensis	"blue mud shrimp" (burrow entrance only)									
ARTHROPODA:Crustacea:Maxillopoda										
Balanus glandula	Acorn Barnacle									
Balanus crenatus	Crenate Barnacle									
Semibalanus cariosus	Haystack Barnacle									
Chthalamus dalli	Little brown barnacle									
Balanus sp.										
Balanomorpha	unidentified acorn barnacle									
ECHINODERMATA: Ophiuroidea	brittle star									
Amphipholis squamata (?)	brooding or small brittle star									
Site:	**Date & Time:**	Expert & scribe:					Section along profile line, in feet			
PLANTAE										
Cakile sp.										

Distichlis spicata										
Atriplex patula										
Salicornia sp.										
Fucus distichus	Rockweed "Two-headed Wrack"									
Laminaria saccharina	ribbon kelp									
Sargassum muticum	Japanese wireweed (invasive species)									
Scytosiphon lomentaria	soda straws									
Ulva lactuca	Sea lettuce (foliose)									
Ulva intestinalis	Sea lettuce (filamentous or "tubular")									
Ulva sp. (form unidentified)	Sea lettuce (form unidentified)									
Filamentous Rhodophyta	filamentous red algae									
Hildenbrandia sp.	Rusty rock									
Porphyra sp.	Purple laver									
Polysiphonia complex	filamentous red algae									
Mastocarpus papillatus	Turkish washcloth, tarspot									
Zostera marina	Eelgrass									

Appendix C: 2015 Species Lists

Species lists from 2013-2015 are available electronically upon request. Contact Eleanor Hines at RE Sources (eleanorh@re-sources.org) to request data in electronic format.