

Intertidal Biota Monitoring in the
Cherry Point Aquatic Reserve
2013-2015 Monitoring Report



Prepared for:

Cherry Point Aquatic Reserve Citizen Stewardship Committee

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Publication Information

This Monitoring Report describes the research and monitoring study of intertidal biota conducted in the summers of 2013-2015 in the Cherry Point Aquatic Reserve.

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>.

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Intertidal Biota Monitoring in the Cherry Point Aquatic Reserve

2013-2015 Monitoring Report

Abstract

The Cherry Point Aquatic Reserve Citizen Stewardship Committee conducted intertidal surveys seasonally beginning in 2013 through 2015 in the Cherry Point Aquatic Reserve 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

While extensive historic data exists on the flora and the fauna of the intertidal zone of the Cherry Point Aquatic Reserve (CPAR) (e.g., Kyte 2012, Sylvester and Wennekens 1956), data gaps still exist. This intertidal monitoring project is intended to provide a baseline for detection of changes and trends. Acquired baseline information can be used for natural resource damage assessment, reserve management, and protection of critical habitats and protected species.

Background

The CPAR is one of seven aquatic reserves in Puget Sound managed by the 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. This grant, “Ensuring Regulatory Effectiveness in Puget Sound’s Most Special Places”, focused on pairing local environmental groups with stakeholder groups 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 CPAR Citizen Stewardship Committee (CPAR 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.

Cherry Point Aquatic Reserve

WA DNR designated the CPAR (Figure 1) as an Environmental Reserve, an area of biological importance requiring special protective management where continued monitoring is a priority. The main purpose for establishing Cherry Point as a reserve was to preserve critical spawning habitat for a late-spawning stock of Pacific herring. A broader purpose was to continue to conserve and enhance native habitats and associated plant and wildlife species, with special emphasis on herring, salmon, resident and migratory birds, Dungeness crab, groundfish rearing areas, and marine mammals (WA DNR 2010).

Most of the uplands adjacent to the Reserve are privately owned by five entities: BP, Pacific International Terminals, Alcoa-

Intalco, Phillips 66, and Cherry Point Industrial Park. North of the industrial area are private residential lots and a small county-owned public access area south and east of Point Whitehorn. Birch Bay State Park adjoins the aquatic reserve to the north and east. The Lummi Indian Reservation is adjacent to the south boundary of the reserve.



Figure 1. Map of the Cherry Point Aquatic Reserve with the locations of sites surveyed. Neptune, Intalco, and Point Whitehorn Park were surveyed each year during 2013 – 2015. The Birch Bay State Park survey site was sampled in 2013 and 2014. The Point Whitehorn Point survey site was sampled in 2015. Figure adapted from Cherry Point Environmental Aquatic Reserve Plan (WA DNR 2010).

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. The 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 are 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) as well as infaunal species (those animals living within the sediment). 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 CPAR CSC, and knowledgeable citizen scientists provided training in Whatcom County for volunteers from the CPAR CSC, the Whatcom County Marine Resources Committee, and other volunteers. Similar training was held in Skagit County, and volunteers could attend either training and be qualified to conduct surveys.

In Whatcom County, 27 citizen scientists were trained in 2-hour sessions on April 9, 16, and 23, and received three hours of field training on May 9, 2015. Training included protocols for measuring slope, identifying and counting plants and animals, estimating percent cover of plants and colonial animals, and completing data sheets.

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.

Four types of data were collected:

1. **Profile Data-** Elevation profile data are taken along a transect perpendicular to the beach face. Data recorded include beach slope and substrate type. If species present data were not collected in swath counts, profile data collectors would also collect which species were present for each elevation interval surveyed.
2. **Quadrat Data: Percent Cover-** Four randomly placed 19.8 inches X 19.8 inches (50 cm X 50 cm) quadrats were located at each of three tidal elevations: +1 foot, 0 foot, and -1 foot MLLW. Colonial and aggregating animal species, sea grass, and macroalgae cover were 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. **Species Lists-** 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, 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 species were being missed by this ephemeral algae covering other countable biota.

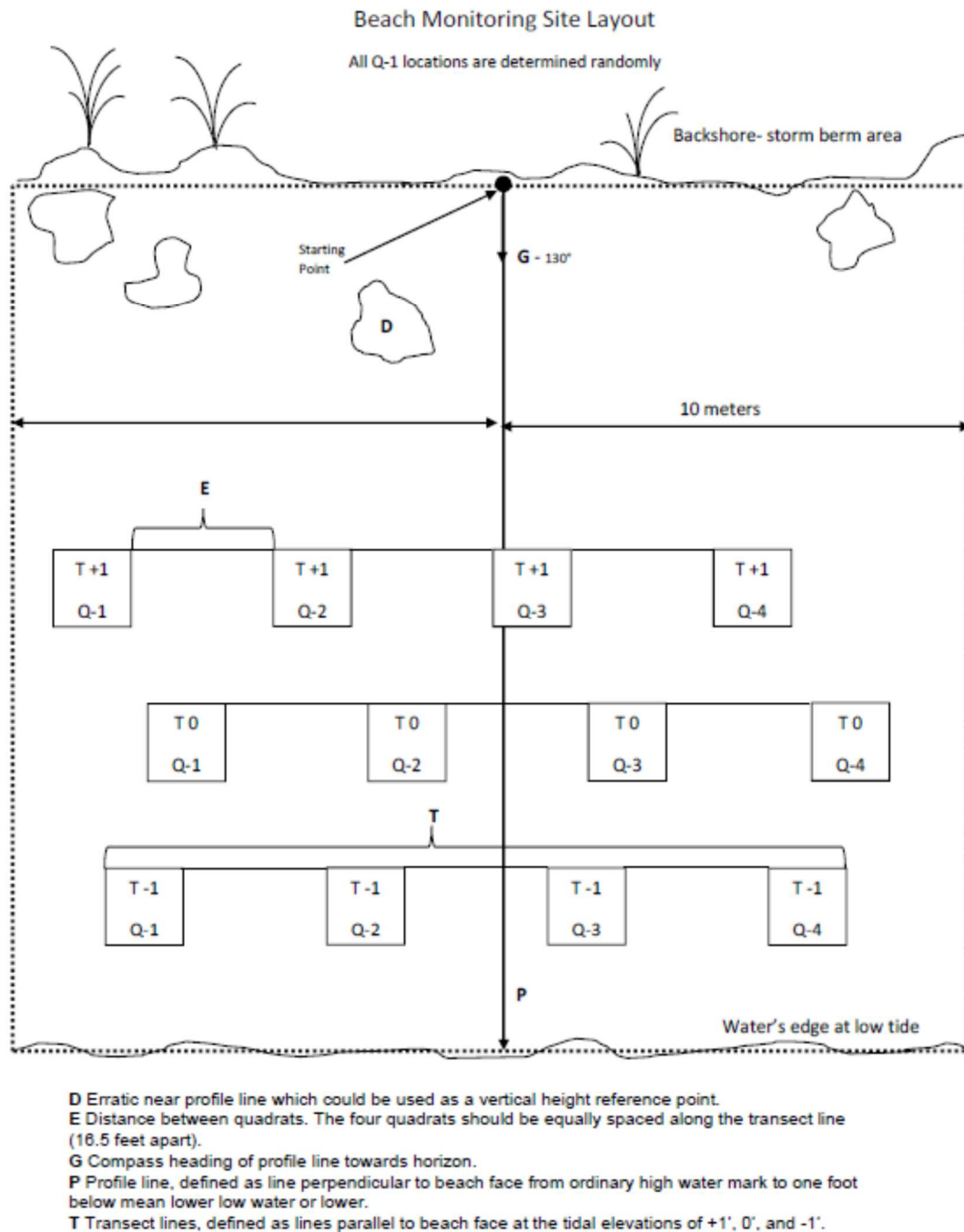


Figure 2. Layout of survey sites adapted from Island County/Washington State University Beach Watchers (2003). For the studies in this report, a fourth quadrat was added to each surveyed tidal height.

Survey Site Locations

Four sites were chosen for monitoring in the CPAR (Figure 1). See the *Results and Discussion* section below for descriptions of each site. These sites were chosen based on representativeness and accessibility. Table 1 gives details of the site locations. Table 2 provides sample dates for each year. Surveys were limited 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. The Birch Bay State Park site was dropped in 2015 due to lack of valuable information while Point Whitehorn Point was added with the intention to improve the use of limited monitoring resources.

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

Site	Compass Bearing 1	Compass Bearing 2	Compass Bearing 3	Latitude (N)	Longitude (W)
Birch Bay	Point Whitehorn- 230°	Point Lily at Point Roberts- 275°	Birch Point- 230°	48.89830	122.77841
Point Whitehorn Park	Outer end of the Cherry Point pier - 135°	North edge of Sucia Island - 205°	West edge of Point Roberts - 260°	48.87778	122.77838
Intalco Beach	Left hand corner of first white shack on Intalco pier perpendicular to shore - 181°	First black stack from shore on BP pier - 283°	Pointy, triangular, flat surfaced rock that faces shore - 325°	48.85062	122.72043
Neptune Beach	Northeast corner of tan shed on pier - 311°	State Park Red entrance marker - 182°	Mount Constitution on Orcas Island - 208°	48.82030	122.70952
Point Whitehorn Point	Description instead of 3 bearings taken for this site. Start from under flag pole and align profile out towards "Molar Rock" on the point, i.e. big rock about 500 m out and still emerged from water at high tide.			48.894070	122.793570

Table 2. CPAR Intertidal Monitoring survey sites and dates sampled during 2013-2015.

Site	2013	2014	2015
Birch Bay	May 26	May 18	N/A
Point Whitehorn Point	N/A	N/A	June 4
Point Whitehorn Park	May 25	May 17	May 18
Intalco	July 19	July 11	July 1
Neptune	July 21	July 13	July 3

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.org¹. The 2015 species lists for each site are in Appendix C.

All the monitoring sites exhibited variations of typical beach morphology (Figure 3). In some cases where 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.

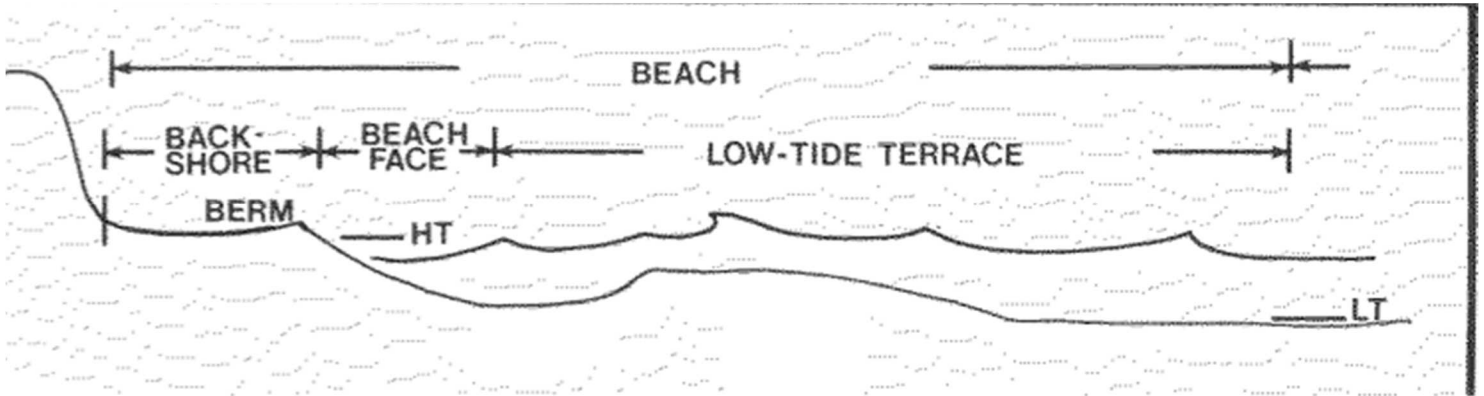


Figure 3. Typical beach morphology.

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

Birch Bay



Photo 1. *Quadrat 3 at 0' tide height from the 2014 survey.*

Site description: The Birch Bay survey site was located to the west of the south end of Birch Bay State Park (Table 1, Figure 1). This site was surveyed in 2013 and 2014. The CPAR CSC decided to not survey Birch Bay in 2015 due to the minimal occurrence of species at the site and difficulty in determining tidal elevation. The survey effort outweighed the need to continue surveys at this location. Point Whitehorn Point was added in 2015 to replace the Birch Bay survey site. The results from Birch Bay can be found in the 2013-2014 Cherry Point report, available online.²

² 2013-2014 Cherry Point Intertidal Survey available online at: <https://sites.google.com/a/re-sources.org/main-2/programs/cleanwater/whatcom-and-skagit-county-aquatic-reserves>

Point Whitehorn Point



Photo 2. Trained citizen science volunteers help document sea stars on “Big Rock” found at the end of the Point Whitehorn Point profile transect.

Site description: Point Whitehorn Point (Table 1, Figure 1) was examined in 2015 when the Birch Bay site was discontinued. The site was on the tip of Point Whitehorn northeast of Point Whitehorn Park and southwest of Birch Bay State Park. This site is different from Point Whitehorn Park, which has been also known as “Point Whitehorn” in 2013 and 2014 reports. Access to this site is by either walking about a mile south-southwest along the beach from the boat launch at Birch Bay State Park, or with special permission from private property owners between the state park and Point Whitehorn. Upland and on top of beachside bluffs is an area of private residences.

The profile coincides with the alignment of the treated wastewater outfall for the Birch Bay Water and Sewer District. The outfall terminates offshore at approximately -50 feet below MLLW and is completely covered by boulders and other materials through the intertidal zone.

Due to the extreme diversity of microhabitats, relatively high abundances of epifauna individuals and species, and the profile length, the CPAR CSC evaluated whether a different site might be a better location for monitoring. The proposed new site for this will be at “Barnacle Rock”, located approximately 330 feet to the northeast of Point Whitehorn Point. The new location has been studied in the past, will have a shorter profile, and is expected to have an adequate variety of biota for monitoring. The Barnacle Rock site was studied from 1969-1984 by various scientific contractors for the Ferndale Refinery. A detailed database for this site already exists and may be used to compare with our newly collected data in the future should this new site be adopted. (Personal communication with Michael Kyte, June 28, 2016.)

Beach profile and substrate: Profile survey sections were taken at 20 foot or more intervals. Because of time constraints, survey intervals ranged from 20 to 100 feet, leaving the possibility that pools, bumps, and other features may have been left out of this profile. At 550 feet, this profile was the longest measured at any CPAR monitoring site; the next longest profile is only about 240 feet at Point Whitehorn Park (Figure 7).

The beach face had relatively steep slope, while the low tide terrace was comparatively level, and as a

result broad (Figure 4). The beach face extended for 200 feet, the beach dropped in elevation by an average of 1 foot vertically per 20 feet of profile. The beach then flattened in the low tide terrace for the next 300 feet before a small decline at the -1 foot elevation. This site's profile transect terminated at "Big Rock" on the low tide terrace (Photo 2).

The beach was characterized by cobble/boulder substrate throughout and bedrock outcrops in the low tide terrace. The backshore was narrow because of the steep bluff immediately behind the high berm. The berm and upper beach face consisted of gravel, cobbles, and boulders, dominated by boulders. At lower tidal heights, more shell debris, clay/silt, and sand were in the mix of gravel, cobbles, and boulders. At the time of the survey, much of this substrate was covered with macroalgae.

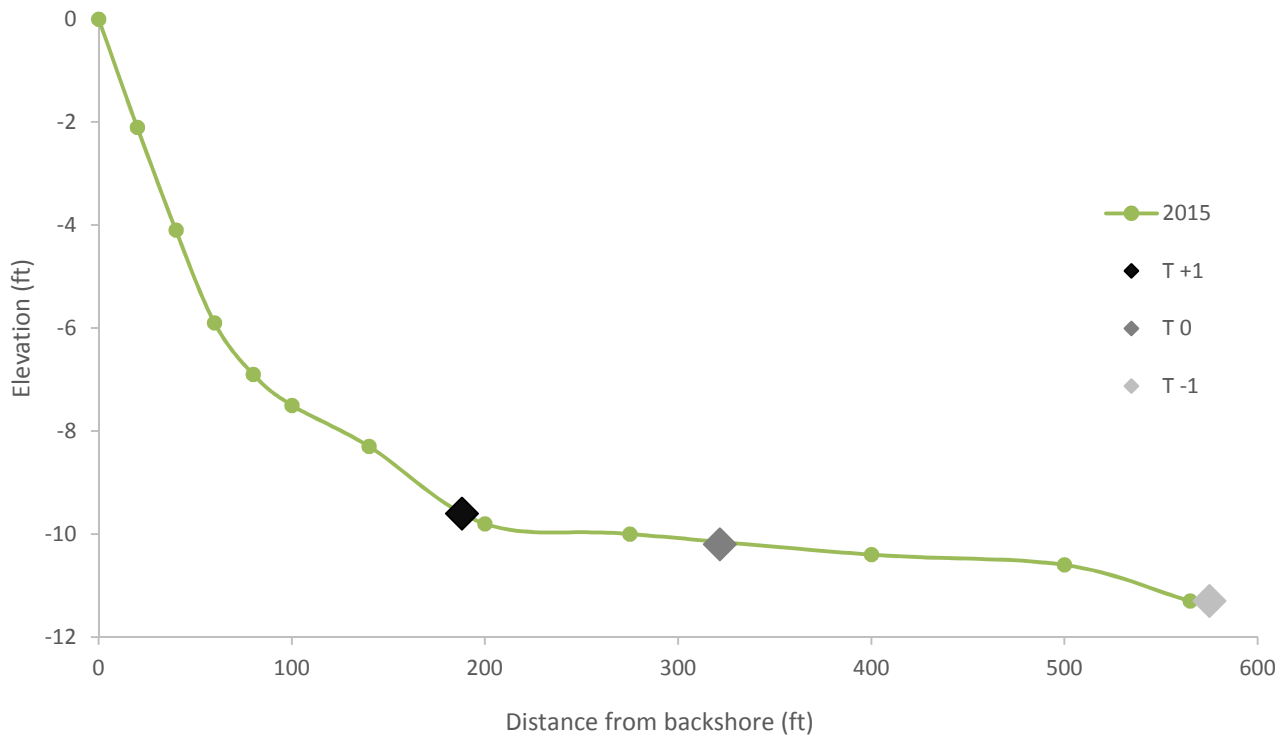


Figure 4. Beach elevation profile for Point Whitehorn Point collected in 2015.

Species by percent cover: At the tidal heights of +1 foot and 0 foot, green algae covered about half of the quadrats (Figure 5). At -1 foot, green, red, and brown, and barnacles were almost evenly distributed and together covered nearly 80% of the quadrats.

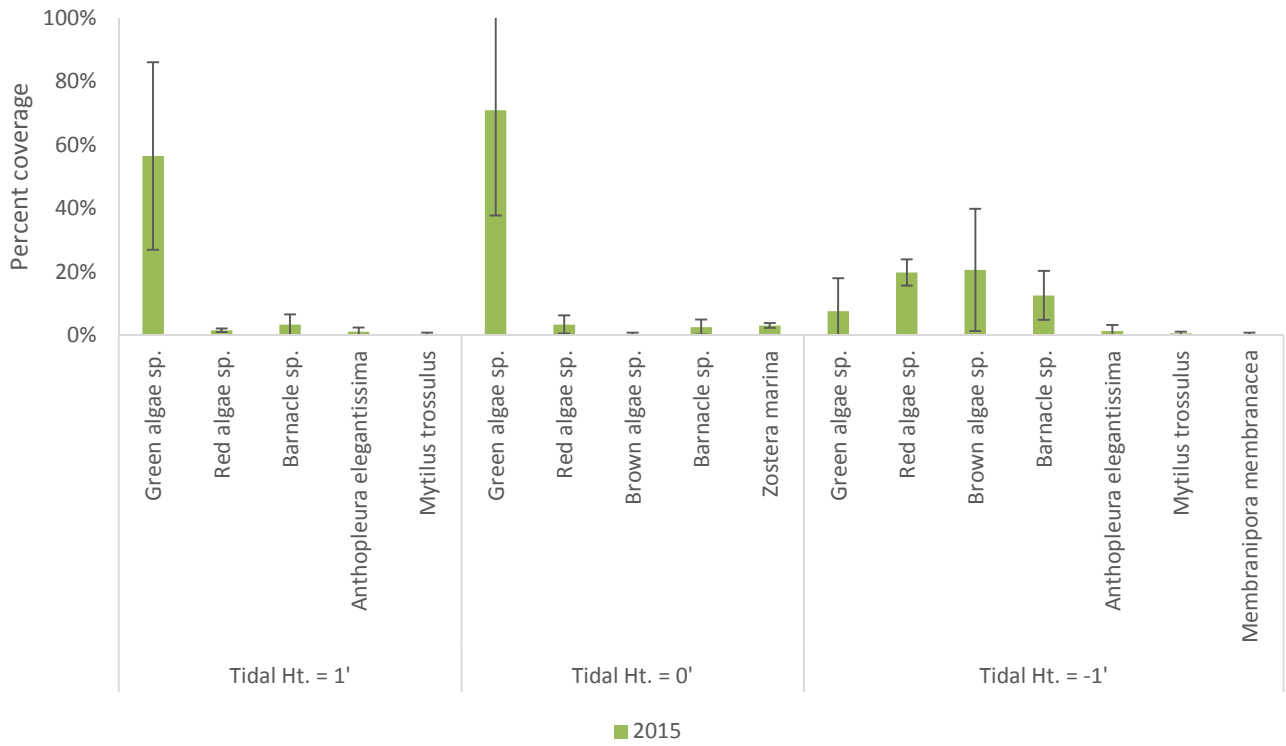


Figure 5. Average percent cover of plants and non-individual animal counts at Point Whitehorn Point.

Individual species counts: Before removal of *Ulva* sp., very low levels of individuals were found at +1 foot and 0 foot (Figure 6). Limpets and anemones, before removal of *Ulva* sp., were the most common species at -1 foot, although the amounts were variable among the four quadrats. As shown in Figure 6, the counts increased at tidal heights +1 foot and 0 foot after removal of *Ulva* sp., where most of the green algae occurred (Figure 5).

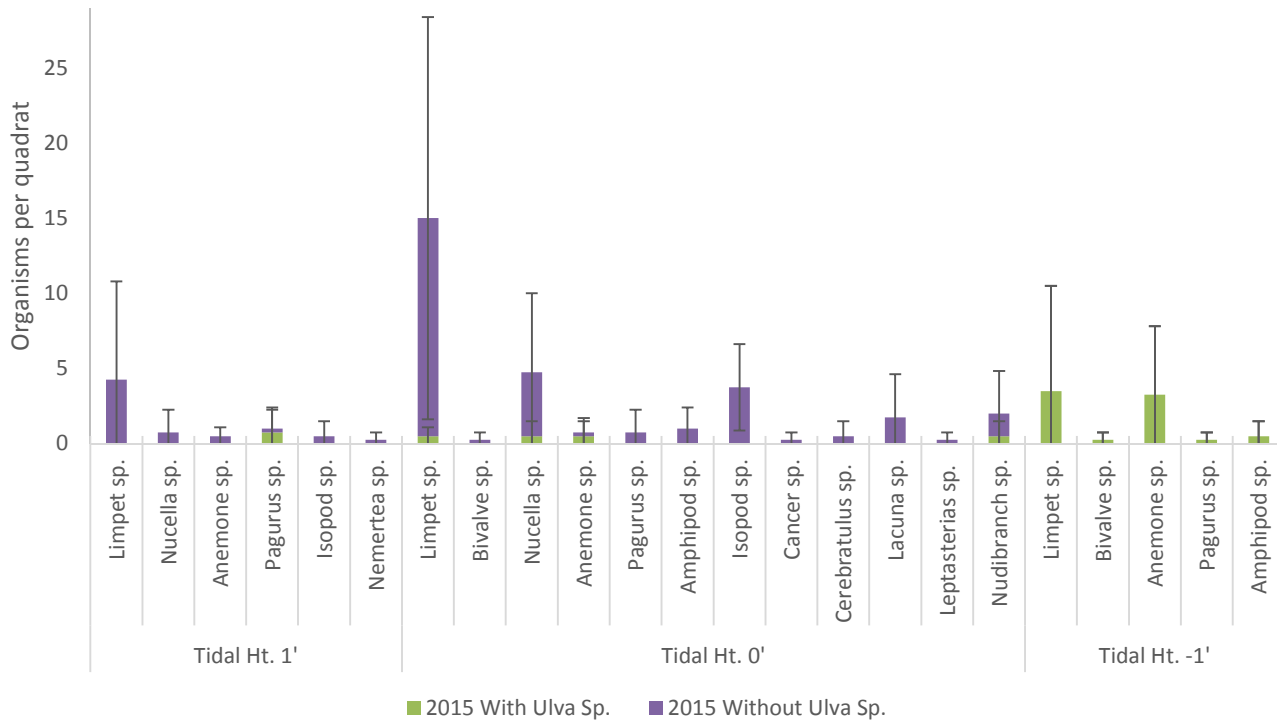


Figure 6. Average number of individual animals in quadrats at Point Whitehorn Point surveyed in 2015.

Point Whitehorn Park Results and Discussion



Photo 3. Mackenzie Johnson, Lyle Anderson, and Marie Hitchman from left to right at Point Whitehorn Park surveying in 2015.

Site description: In past reports, this site may have been referred to as “Point Whitehorn”; however, with the addition of the site “Point Whitehorn Point”, the change in name was made in 2015 for better distinction between these two sites to “Point Whitehorn Park”.

The Point Whitehorn Park site (Table 1, Figure 1) is located in the northern third of the CPAR, and is in the Whatcom County Point Whitehorn Marine Reserve, northwest of the industrial Cherry Point piers and southeast of private property. The monitoring site is accessed using a trail through the reserve to shoreline.

Beach profile and substrate: The 2013 profile elevation data were collected in 20-foot intervals, while the 2014 and 2015 data were measured in 10-foot intervals increasing the resolution of the profile (Figure 7). Thus, the 2013 profile may have missed features that subsequent years captured. In addition, the profile starting point may have varied each year. The variance of the location of the transect heights along the profile for 2014 and 2015 (the years that the tidal height of each transect was recorded) may indicate the variability of the starting point. The years 2013 and 2014 yielded similar profile lines, while 2015 also showed a similar profile slope, though shifted up in elevation. The most likely explanation for this shift is human error, opposed to natural processes accreting sediment.

However, variation from predicted tide heights could also explain some of these differences. Data from the National Oceanic and Atmospheric Administration National Ocean Service Cherry Point tidal station (<http://www.co-ops.nos.noaa.gov/waterlevels.html?id=9449424>) recorded variations from predicted tidal heights in 2015 between 0.2 and 0.4 feet.

Gravel, cobbles, boulders, and large woody debris characterized the narrow backshore, high tide berm, and beach face. The low tide terrace consisted mostly of sand with occasional boulders.

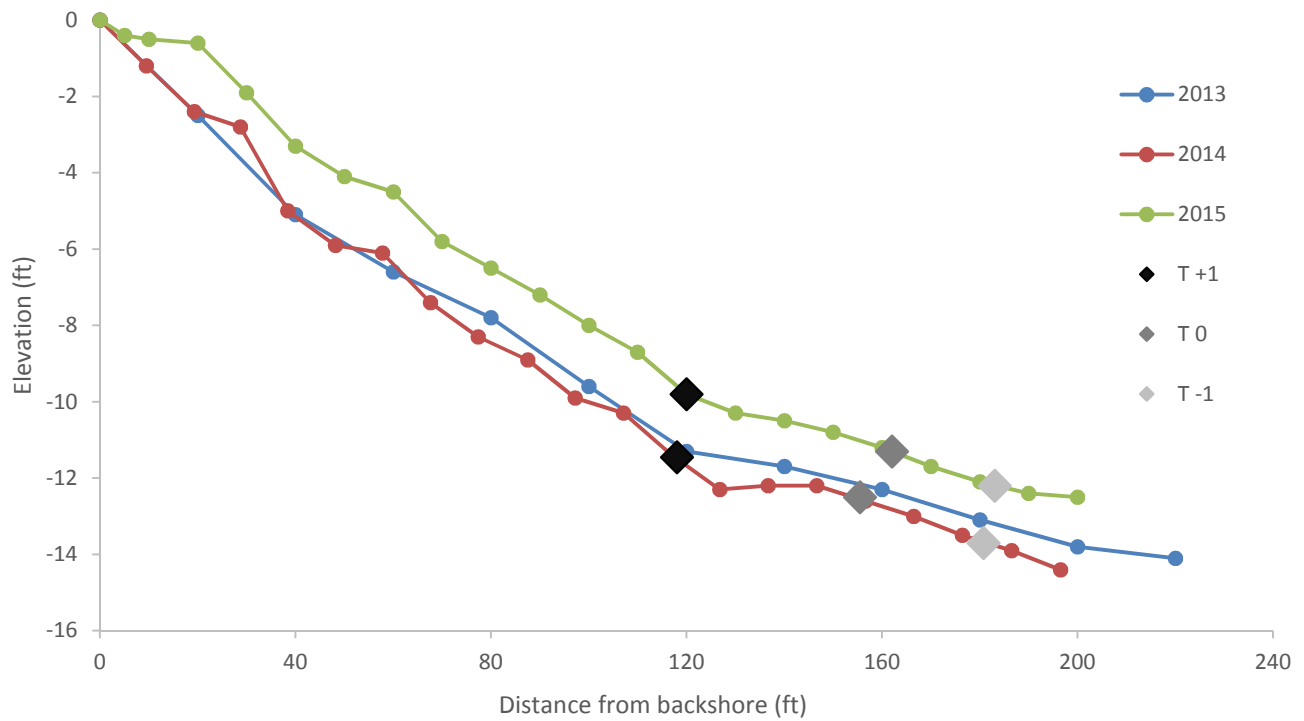


Figure 7. Beach elevation profile for Point Whitehorn Park from 2013-2015 surveys.

Planning for the 2016 intertidal monitoring season will include updating protocols and training to ensure that profiles begin at consistent locations and citizen scientists correctly identify substrate types. Permanent markers to demarcate the start of profiles for each site will be installed.

Species by percent cover: Percent cover (Figure 7) varied from year to year, with coverage being highest at the +1 foot tidal elevation in 2014 and 2015. This fact could be attributable to a more diverse substrate found at the +1 foot elevation in these years. At all other elevations and years, the primary substrate was sand. Common species included green algae (including *Ulva* sp.), red algae, barnacles, and the aggregating anemone *Anthopleura elegantissima*. The percent cover estimates in 2013 were composed of relatively few species, although individual species counts were higher in 2013 than any other year for tide heights 0 foot and -1 foot.

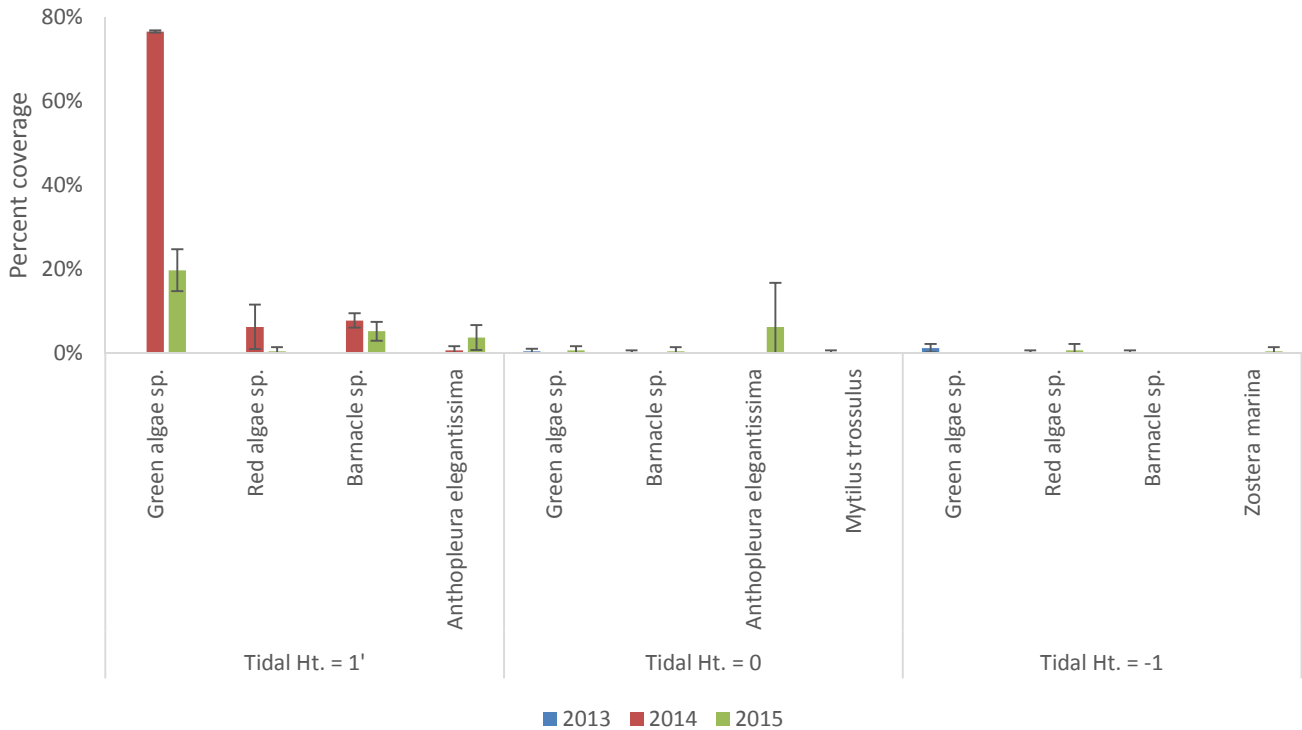


Figure 8. Average percent cover of plants and non-individual count animals in quadrats at Point Whitehorn Park by tidal height for 2013-2015 surveys.

Individual species counts: The average number of individual species (Figure 9) was relatively low and varied from year to year, with more individual species found in 2014 and 2015 at +1 foot and in 2013 at 0 foot and -1 foot. The most common species included limpets, *Nucella* snail species, and polychaete worms. There were some species, such as limpet species, *Nucella*, isopods, and *Lacuna* species that were found after *Ulva* sp. removal at tidal heights +1 foot and 0 foot.

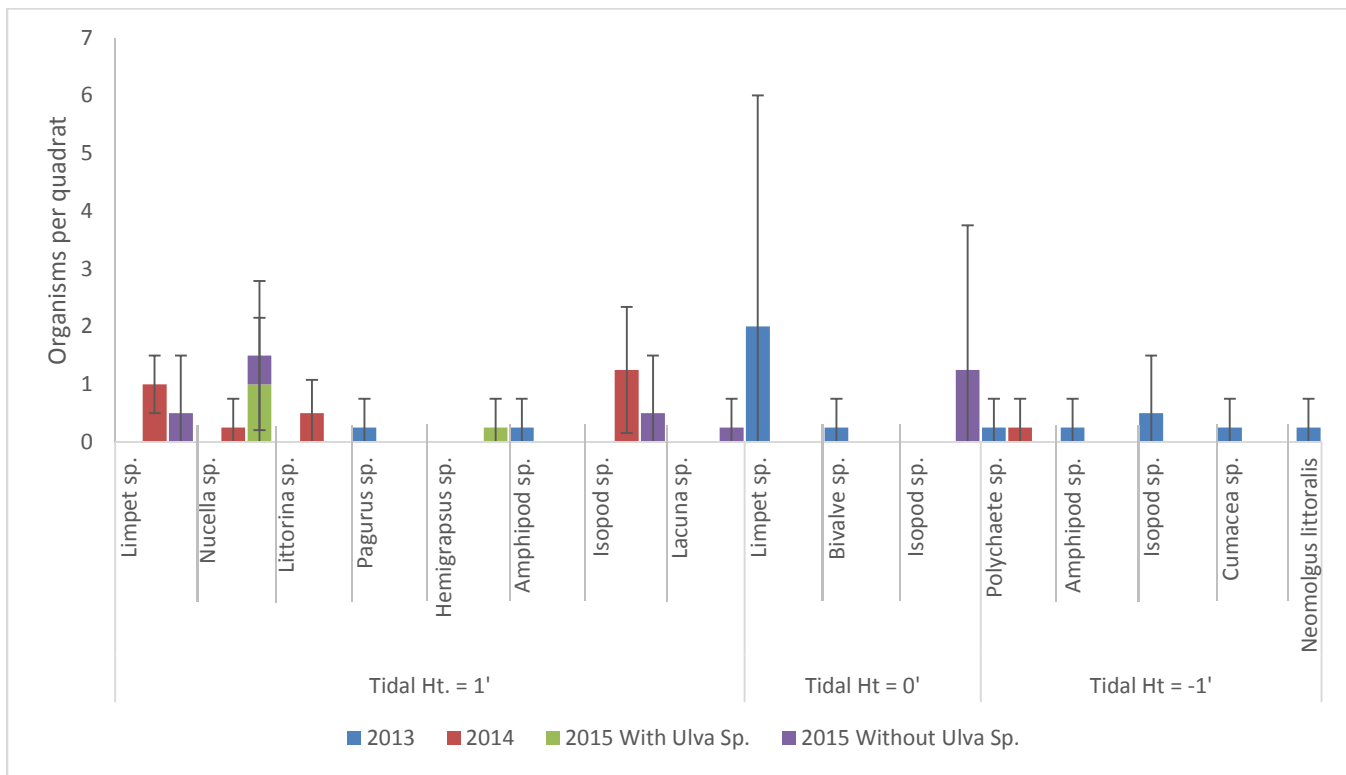


Figure 9. Average number of individual animals in quadrats at Point Whitehorn Park by tidal height for 2013-2015 surveys.



Photo 4. Volunteer citizen scientists pose for a photo after the July 2015 survey was completed.

Site description: Intalco (Table 1, Figure 1) is located southeast of Point Whitehorn Park and north of Neptune Beach. The property on which the site is located and the access to it is owned by Intalco and can only be used with permission from the landowner. In each year, Intalco personnel provided a trail and an escort from Intalco's marine terminal to the shoreline to avoid the unsafe conditions on the riprap protecting the fill at the head of the pier.

Beach profile and substrate: The elevation profiles from 2013-2015 are in Figure 10. The Intalco beach is subject to high wave energy, and the profile at this beach changed more than at any other site. A substantial high tide berm of gravel and sand appeared in 2014 (Figure 10) and persisted through 2015. This berm created an apparent backshore because it separated a portion of the upper intertidal zone from the extreme high line where the profile began. This berm was present with a lower elevation in 2015. The apparent lateral movement was likely due to the spreading of the berm by wave action.

The beach face below the pronounced berm was loose sand and gravel with a relatively steep slope. This material was mobile and was observed to move easily with wave action or human walking. The toe or bottom of the beach face was at or below -1 foot tidal height.

The apparent source of the sand and gravel that formed the high tide berm and beach face was the low tide terrace adjacent to the beach face. The relative elevation of the low tide terrace appeared to decrease between 2013 and 2014 because of the removal of large quantities of material and deposition on the beach face and high tide berm.

The dominant substrate at Intalco was sand and gravel in the beach face with occasional embedded boulders at and below -1 foot tidal height.

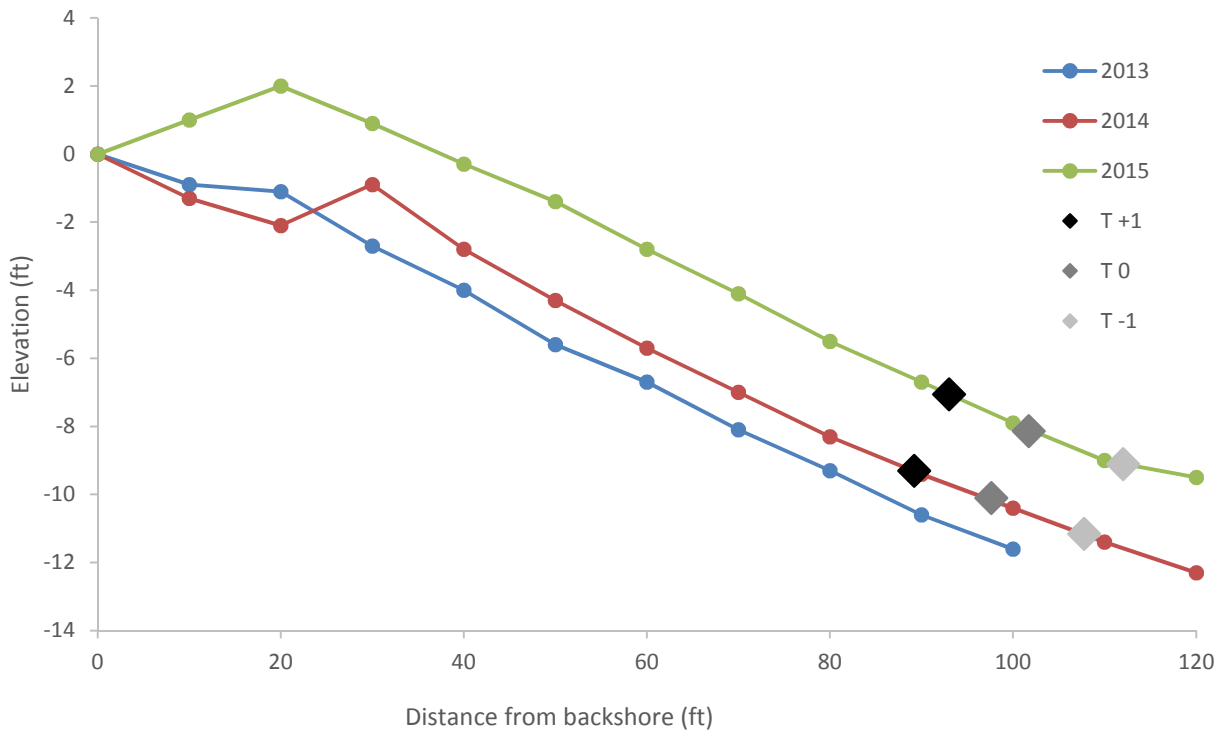


Figure 10. Beach elevation profile for Intalco from each survey event from July 2013-2015, showing approximately where the tidal height fell on the profile line for 2014 and 2015.

Species by percent cover: Percent cover (Figure 11) was characterized by the presence of algae and colonial organisms at lower tidal elevations in 2013 and 2015, but had a complete absence in 2014 on all transects. Common percent cover species found included green, red, and brown algae and barnacles. Greater cover and diversity was observed at -1 foot because of the presence of boulders on the transect. No species were present at +1 foot for any of the years because of the loose sand and gravel.

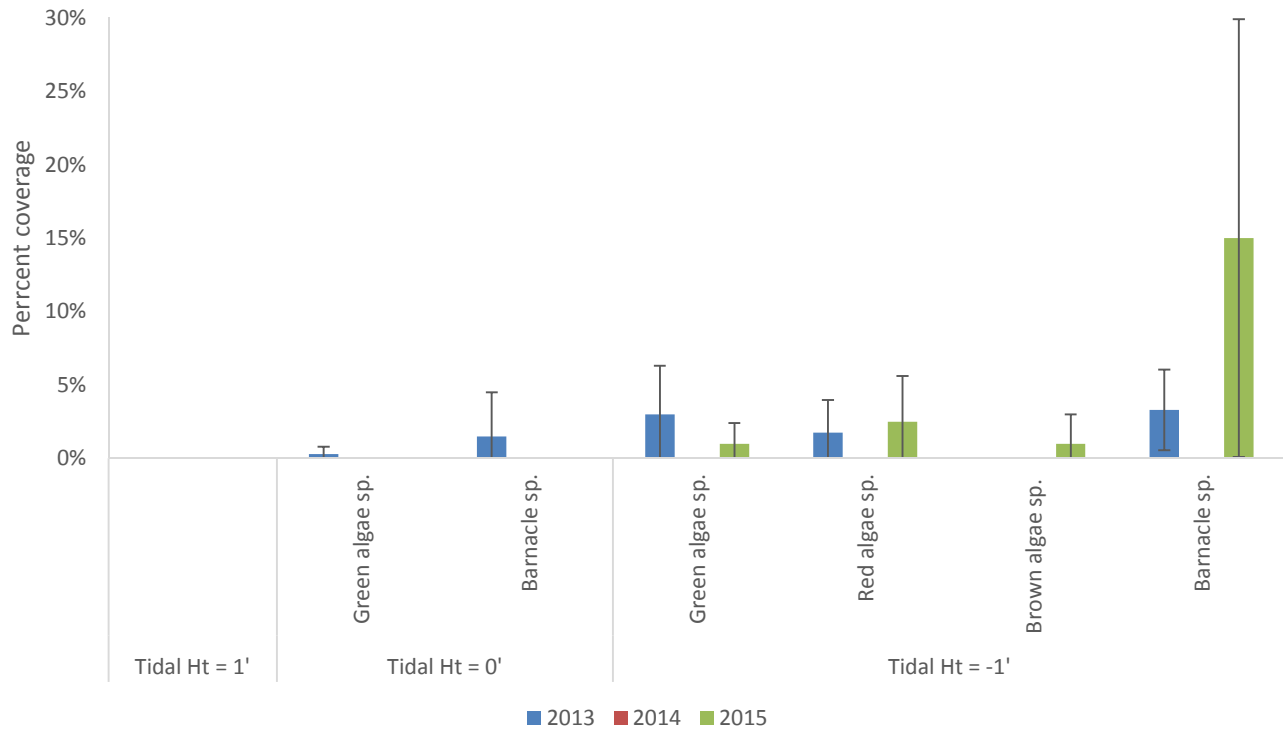


Figure 11. Average percent cover of plants and non-individual count animals in quadrats at Intalco.

Individual species counts: The average numbers of species counted as individuals (Figure 12) was also low at Intalco across all years and transect elevations. As with the colonial species, a greater diversity and number of species was observed at -1 foot because of the presence of boulders. Because there was a low cover of *Ulva* sp. at this site, there were no differences in counts of species before and after *Ulva* removal.

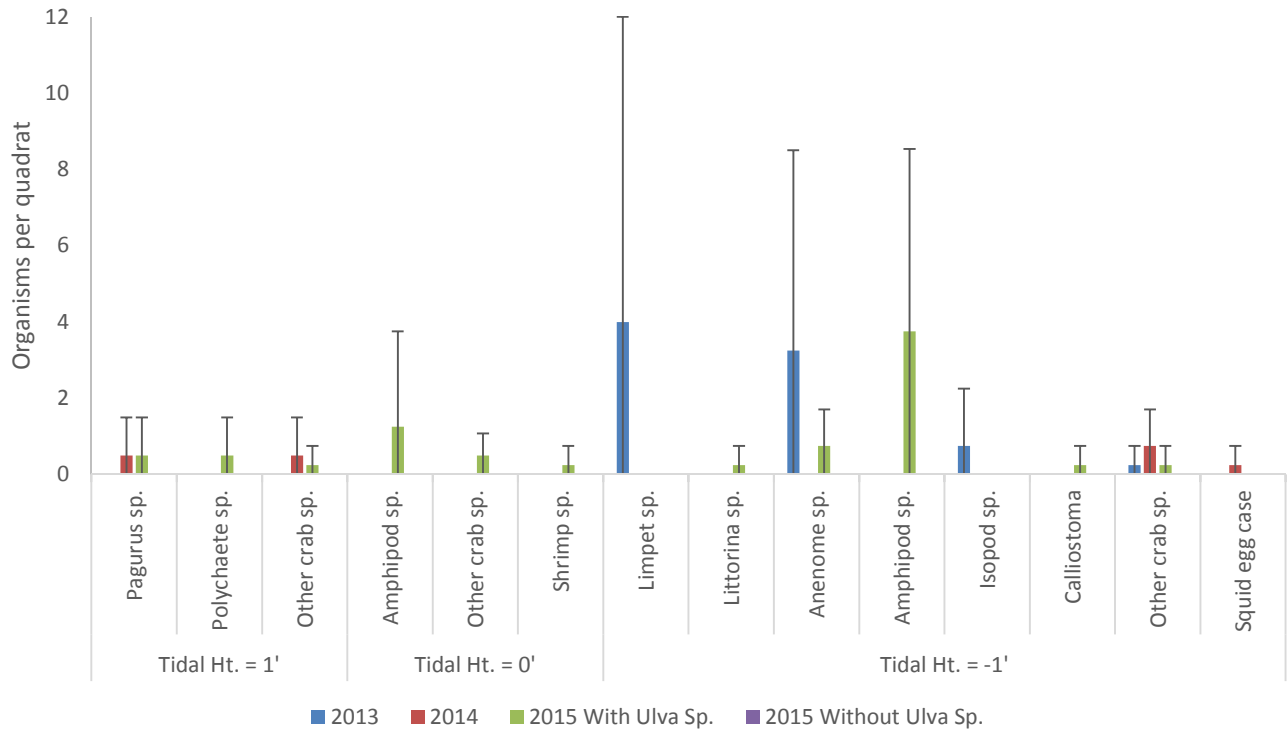


Figure 12. Average number of individual animals in quadrats at Intalco surveyed in July of 2013-2015.

Neptune Beach



Photo 5. *Volunteers at Neptune Beach conduct quadrat species counts in 2015.*

Site description: Neptune Beach (Table 1, Figure 1) is the furthest south of the CPAR survey sites and is south of all the industrial piers. The site is accessed with the permission of the Lummi Indian Tribe and Phillips 66 Ferndale Refinery, which own the tidelands at the access point and monitoring site and the adjacent uplands.

Neptune Beach has the most abundant biota of the five sites surveyed over the previous three years. This circumstance may be attributed to its diverse substrate, which contains cobble, sand, boulders, and shell debris at all three tidal elevations.

Beach profile and substrate: Elevation profile transects for Neptune Beach were moderately sloped (Figure 13). A high tide berm was present approximately 20 feet from the start of the profiles in 2013. It was more pronounced in 2014 and was notably reduced in 2015. The relatively pronounced berm and steeper beach face conditions are similar to but reduced in degree from the situation at Intalco because of less wave exposure. The profiles do not line up exactly, which may be due to human sampling error, accretion or erosion of the beach, or a combination of both.

The upper beach face, especially shoreward of the high tide berm is notably sandy. The amount of gravel increased with decreasing elevation to the toe of the beach face. The low tide terrace was covered with cobble and small and medium boulders laying on a matrix of sandy gravel. Interspersed among the boulders below -1 foot MLLW were sand bars.

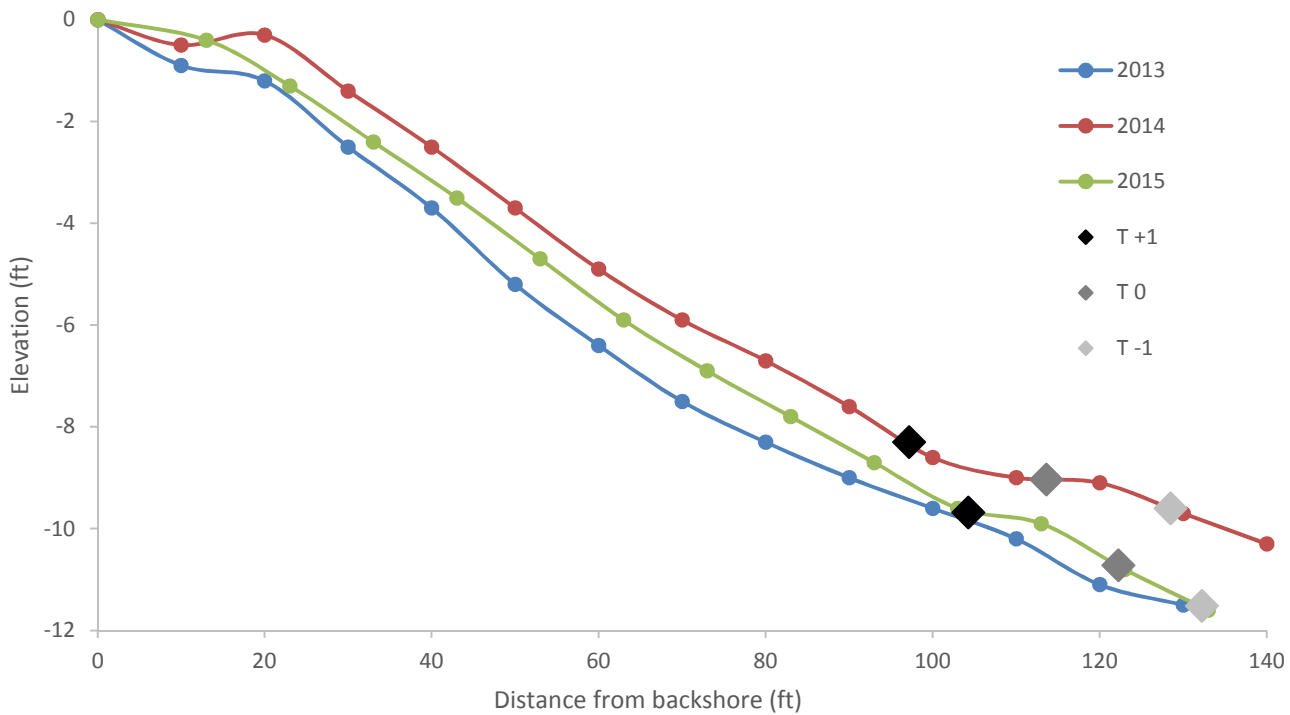


Figure 13. Beach elevation profile for Neptune Beach, sampled annually in July, showing approximately where the tidal height fell on the profile line for 2014 and 2015.

Species by percent cover: In order of percent cover (Figure 14), green algae, barnacles, and red algae are the dominant species. Over the last three years, the diversity and amounts of these species has remained relatively constant across all tidal elevations.

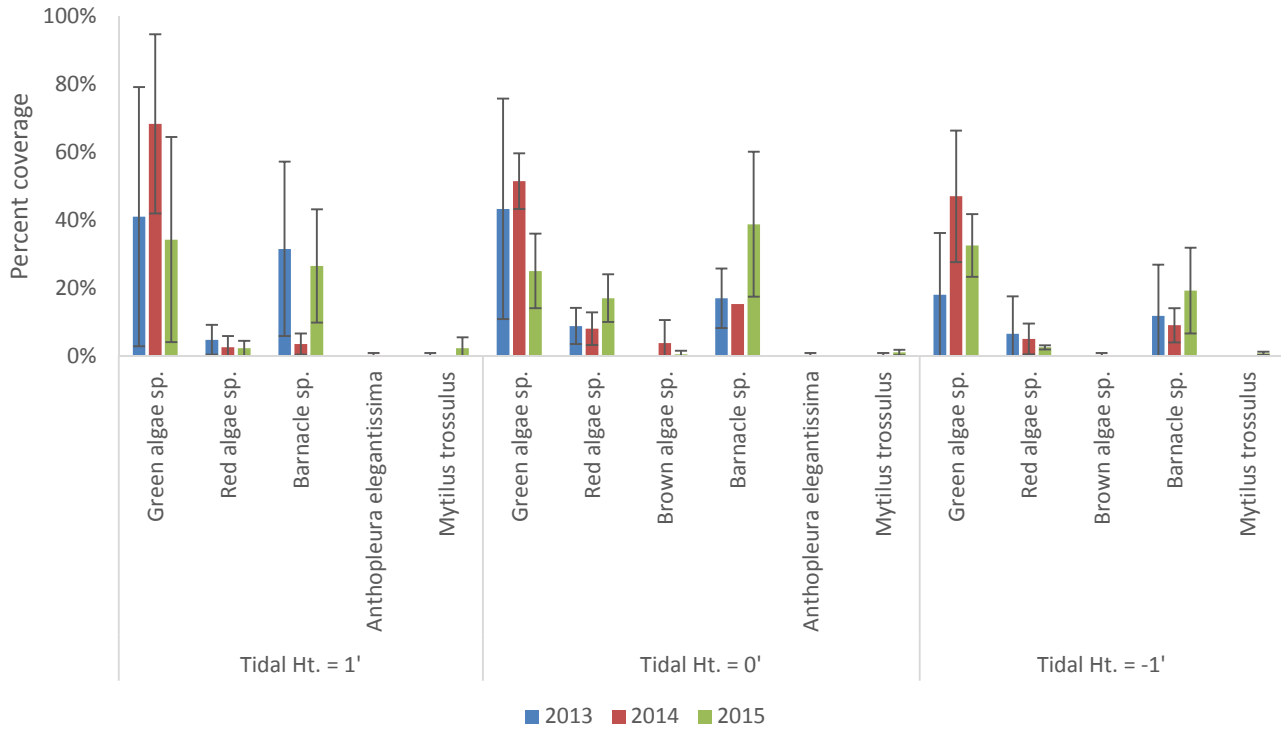


Figure 14. Average percent cover of plants and non-individual count animals in quadrats at Neptune Beach.

Individual species counts: Neptune Beach also had the highest number of individuals (Figure 15) recorded of the five sampled beaches. Anemones (*A. elegantissima*) occurred at each of the three tidal heights and were a dominant species in each of the three years. Other common species included limpets, particularly at 0 feet during 2013 and 2014.

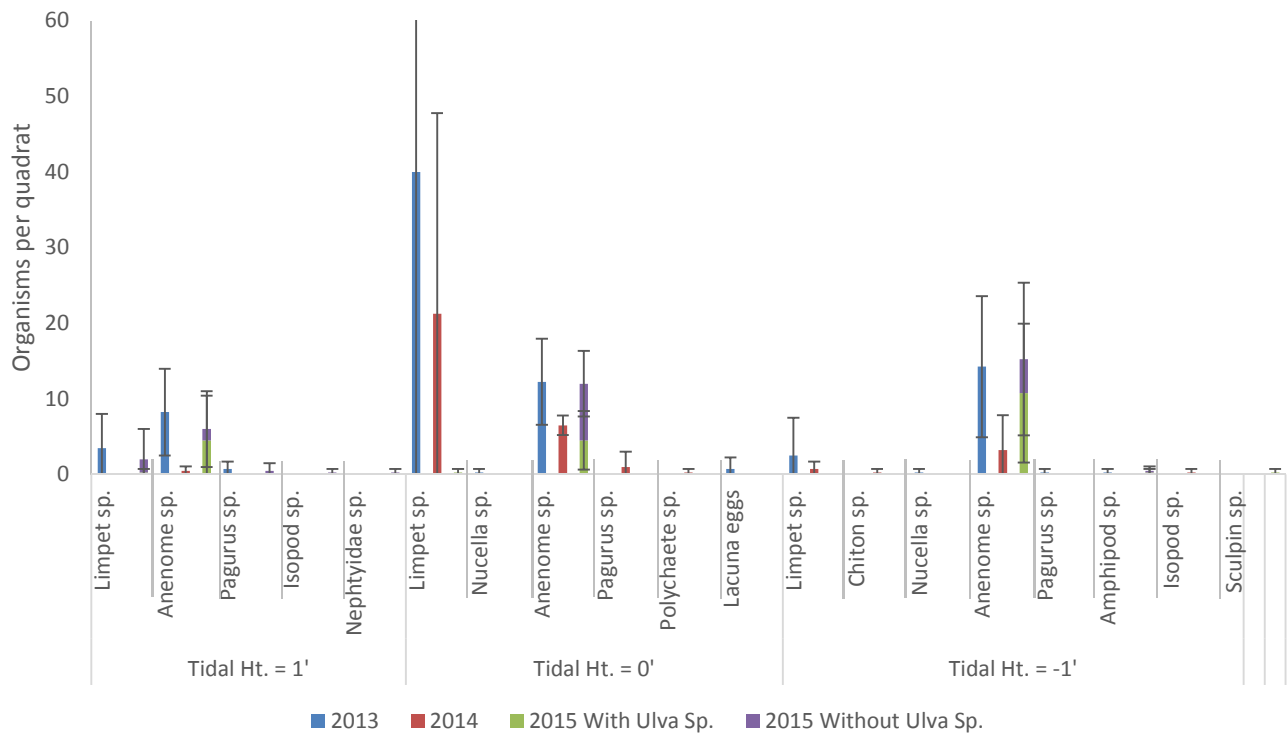


Figure 15. Average number of individual animals in quadrats at Neptune Beach.

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, and 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 [Cherry Point and Fidalgo Bay] 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.” After three years, we have collected data on beach slope, substrate, and biodiversity at five separate sites in the Cherry Point 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.

Across all five sites monitored, the percent cover and epifauna species abundance was highest at Neptune and Point Whitehorn Point. This was consistent with other findings that indicate that areas with a mixed substrate consisting of cobbles, gravel, and sand provide habitats that support more abundance and diversity (Dethier and Schoch 2005).

Two of the five survey sites, Birch Bay and Intalco, were dominated by sandy sediments and had little observable biota in all three years. Because of this, Birch Bay was replaced in 2015 by Point Whitehorn Point. Sandy and muddy sediments are not as suitable as attachment substratum for seaweeds and other plants, and diatoms and other microscopic forms that live attached to sand grains or between them are typically found with small animals and interstitial animals and plants (Kozloff 1983 p. 260), which are not counted in this study. Thus, it is not surprising that little countable epiflora and fauna was found at Intalco, which is both sandy and has relatively high wave action. Birch Bay is sandy but more sheltered from wave action than Intalco.

Recommendations

In Years 1 (2013) and 2 (2014), a number of recommendations were made to improve the training, data collection, and quality control for the monitoring. 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 one 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 categories (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.

YEAR 2

- Training clarified what debris 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 lands on uneven surfaces/rocks, estimates will be made using a strictly vertical view.
- When a quadrat lands on a boulder such that the elevation is not representative of the transect line, the quadrat will be moved to a more representative spot on the transect line. Determination of this is somewhat subjective. If the boulder raises the elevation by more than 6 inches, 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 were transferred where appropriate from the detailed list to the general list.
- The use of scientific names and the practice of identifying organisms down to species or 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.
- Birch Bay as a survey beach was discontinued as there were relatively few organisms on the beach and tidal elevation was difficult to ascertain: This beach was replaced by Point Whitehorn Point.
- 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: We will ensure that GPS information includes 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 these 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 any Natural Resources Damage Assessment 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 CPAR CSC should review the results to evaluate what value the data may have to CPAR 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 Point Whitehorn Point for 2015.

Pt. Whitehorn Point		Date: 6/4/2015: WITH ULVA				
Transect Elevation	Species	Quadrat, ft.				Average percent
		1	2	3	4	
1'	<i>Acrosiphonia</i> sp. (GA)	0%	0%	0%	1%	0.25%
	<i>Ulva intestinalis</i> (GA)	0%	0%	0%	3%	0.75%
	<i>Ulva lactuca</i> (GA)	0%	0%	0%	36%	9.00%
	<i>Ulva</i> sp. (GA)	90%	71%	24%	1%	46.50%
	Green algae sp. (SUM)	90%	71%	24%	41%	56.50%
	<i>Porphyra</i> sp. (BIRA)	0%	2%	0%	0%	0.50%
	<i>Cryptosiphonia woodii</i> (BrRA)	0%	0%	2%	0%	0.50%
	<i>Polysiphonous</i> sp. (FRA)	1%	0%	0%	1%	0.50%
	Red algae sp. (SUM)	1%	2%	2%	1%	1.50%
	<i>Cthamalus dalli</i> (B)	7%	3%	0%	0%	2.50%
	<i>Balanus glandula</i> (B)	1%	0%	1%	0%	0.50%
	<i>Semibalanus cariosus</i> (B)	0%	0%	0%	1%	0.25%
	Barnacle sp. (SUM)	8%	3%	1%	1%	3.25%
	<i>Mytilus trossulus</i>	1%	0%	0%	0%	0.25%
	<i>Anthopleura elegantissima</i>	0%	0%	1%	3%	1.00%
Substrate		C, S, G	C, S, G, Sh	S, Sh	C, S, Sh	
0'	<i>Ulva</i> sp. (GA)	75%	97%	89%	0%	65.25%
	<i>Ulva lactuca</i> (GA)	0%	0%	0%	20%	5.00%
	<i>Ulva intestinalis</i> (GA)	0%	0%	0%	3%	0.75%
	Green algae sp. (SUM)	75%	97%	89%	23%	71.00%
	<i>Mastocarpus</i> sp. (BIRA)	0%	0%	1%	0%	0.25%
	<i>Cryptosiphonia woodii</i> (BrRA)	0%	0%	0%	7%	1.75%
	<i>Polysiphonous</i> sp. (FRA)	1%	1%	3%	0%	1.25%
	Red algae sp. (SUM)	1%	1%	4%	7%	3.25%
	<i>Leathesia difformis</i> (BA)	0%	0%	1%	0%	0.25%
	<i>Balanus crenatus</i> (B)	0%	2%	6%	0%	2.00%
	<i>Balanus glandula</i> (B)	1%	0%	0%	1%	0.50%
	Barnacle sp. (SUM)	1%	2%	6%	1%	2.50%

	<i>Zostera marina</i>	0%	0%	0%	3%	0.75%
Substrate		C, S, Sh	C/S, C, S, G, Sh	C, S, Sh	C, S, Sh	
-1'	<i>Acrosiphonia</i> sp. (GA)	1%	0%	0%	0%	0.25%
	<i>Ulva</i> sp. (GA)	21%	8%	0%	0%	7.25%
	Green algae sp. (SUM)	22%	8%	0%	0%	7.50%
	<i>Mastocarpus</i> sp. (BIRA)	6%	4%	0%	15%	6.25%
	<i>Porphyra</i> sp. (BIRA)	1%	6%	0%	0%	1.75%
	<i>Microcladia</i> sp. (BrRA)	0%	1%	0%	0%	0.25%
	<i>Odonthalia floccosa</i> (BrRA)	8%	14%	21%	2%	11.25%
	<i>Hildenbrandia</i> sp. (ERA)	1%	0%	0%	0%	0.25%
	Red algae sp. (SUM)	16%	25%	21%	17%	19.75%
	<i>Fucus distichus</i> (BA)	1%	0%	0%	0%	0.25%
	<i>Fucus spiralis</i> (BA)	0%	0%	3%	0%	0.75%
	<i>Fucus</i> sp. (BA)	0%	0%	0%	3%	0.75%
	<i>Sargassum muticum</i> (BA)	0%	0%	5%	0%	1.25%
	<i>Nereocystis</i> sp. (BA)	0%	0%	0%	2%	0.50%
	<i>Alaria marginata</i> (BA)	1%	30%	35%	2%	17.00%
	Brown algae sp. (SUM)	2%	30%	43%	7%	20.50%
	<i>Semibalanus cariosus</i> (B)	16%	0%	20%	2%	9.50%
	<i>Balanus crenatus</i> (B)	0%	12%	0%	0%	3.00%
	Barnacle sp. (SUM)	16%	12%	20%	2%	12.50%
	<i>Mytilus trossulus</i>	1%	1%	0%	0%	0.50%
	<i>Anthopleura elegantissima</i>	0%	0%	4%	1%	1.25%
	<i>Membranipora membranacea</i>	0%	0%	1%	0%	0.25%
Substrate		S, B, Sh	S, B, Sh	C, S, B	B	

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., BIRA = Bladed red algae sp., BrRA = Branched red algae sp., FRA = Filamentous red algae sp., B = Barnacle sp., BA = Brown algae sp.

Table A2. Individual species count data collected for each quadrat at each tide height at Point Whitehorn Point for 2015.

Pt. Whitehorn Point		Date: 6/4/2015		Countable Organisms: WITH ULVA			
Transect Elevation	Species	Quadrat				Average Count	
		1	2	3	4		
1'	<i>Pagurus</i> sp.	0	3	0	0	0.75	
Substrate		C, S, G	C, S, G, Sh	S, Sh	C, S, Sh		
0'	<i>Lottia pelta</i> (Lp)	0	0	1	0	0.25	
	<i>Tectura scutum</i> (Lp)	0	0	0	1	0.25	
	Limpet sp. (SUM)	0	0	1	1	0.5	
	<i>Nucella lamellosa</i> (N)	0	2	0	0	0.5	
	<i>Onchidoris bilamellata</i> (Nu)	2	0	0	0	0.5	
	<i>Anthopleura artemisia</i> (An)	0	0	0	2	0.5	
	<i>Lacuna</i> eggs	0	0	1	0	0.25	
Substrate		C, S, Sh	C/S, C, S, G, Sh	C, S, Sh	C, S, Sh		
-1'	<i>Tectura persona</i> (Lp)	14	0	0	0	3.50	
	Bivalve sp.	1	0	0	0	0.25	
	<i>Urticina coriacea</i> (An)	0	0	1	0	0.25	
	<i>Metridium</i> sp. (An)	0	1	1	0	0.50	
	<i>Anthopleura artemisia</i> (An)	1	9	0	0	2.50	
	Anemones (SUM)	1	10	2	0	3.25	
	<i>Pagurus</i> sp.	0	1	0	0	0.25	
	Amphipod sp.	2	0	0	0	0.50	
Substrate		S, B, Sh	S, B, Sh	C, S, B	B		

Key: Lp = Limpet sp., N = Nucella sp., Nu = Nudibranch sp., An = Anemone sp.

Table A3. Percent cover data collected for each quadrat at each tide height at Point Whitehorn Park for 2015.

Pt. Whitehorn Park		Date: 5/18/2015: WITH ULVA				
Transect	Species	Quadrat, ft.				Average
Elevation		1	2	3	4	percent
1'	<i>Acrosiphonia</i> sp. (GA)	7%	3%	1%	11%	5.50%
	<i>Ulva</i> sp. (GA)	14%	10%	19%	14%	14.25%
	Green algae sp. (SUM)	14%	10%	19%	14%	14.25%
	<i>Odonthalia</i> sp. (BrRA)	0%	0%	2%	0%	0.50%
	<i>Balanus crenatus</i> (B)	0%	2%	0%	0%	0.50%
	Barnacle sp. (B)	7%	0%	6%	6%	4.75%
	Barnacle sp. (SUM)	7%	2%	6%	6%	5.25%
	<i>Anthopleura elegantissima</i> (An)	1%	3%	8%	3%	3.75%
Substrate		S,B	S	S,C	S,C	
0'	<i>Ulva</i> sp.	0%	1%	2%	0%	0.75%
	Green algae sp. (SUM)	0%	1%	2%	0%	0.75%
	<i>Balanus crenatus</i> (B)	0%	2%	0%	0%	0.50%
	<i>Anthopleura elegantissima</i> (An)	0%	22%	1%	2%	6.25%
Substrate		S	S	S	S	
-1'	<i>Smithora</i> sp. (BIRA)	0%	0%	0%	1%	0.25%
	<i>Mastocarpus</i> sp. (BIRA)	0%	0%	0%	2%	0.50%
	Red algae sp. (SUM)	0%	0%	0%	3%	0.75%
	<i>Zostera marina</i>	0%	0%	0%	2%	0.50%
Substrate		S	S	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., BrRA = Branched red algae sp., B = Barnacle sp., An = Anemone sp., BIRA = Bladed red algae sp.

Table A4. Individual species count data collected for each quadrat at each tide height at Point Whitehorn Park for 2015.

Pt. Whitehorn Park		Date:	Countable Organisms: WITH ULVA			
Transect	Species	Quadrat				Average
Elevation		1	2	3	4	Count
1'	<i>Nucella lamellosa</i> (N)	0	2	0	2	1
	<i>Hemigrapsis nudus</i> (He)	1	0	0	0	0.25
Substrate		S, B	S	S, C	S, C	
0'	none					
Substrate		S	S	S	S	
-1'	none					
Substrate		S	S	S	S	

Key: N = Nucella sp., He = Hemigrapsus sp.

Table A5. Percent cover data collected for each quadrat at each tide height at Intalco for 2015.

Intalco		Date: 7/01/2015: WITH ULVA				
Transect	Species	Quadrat, ft.				Average
Elevation		1	2	3	4	percent
1'						
Substrate		S	S	S	S, G	
0'						
Substrate		S, G	N/R	S, G	S, G	
-1'	<i>Ulva</i> sp. (GA)	0%	0%	1%	3%	1.00%
	Filamentous red algae	1%	0%	1%	1%	0.75%
	<i>Neorhodomela</i> sp. (BrRA)	0%	0%	0%	5%	1.25%
	<i>Hildenbrandia</i> sp. (ERA)	0%	0%	1%	1%	0.50%
	Red algae sp. (SUM)	1%	0%	2%	7%	2.50%
	<i>Sargassum muticum</i> (BA)	0%	0%	0%	4%	1.00%
	<i>Balanus crenatus</i> (B)	0%	0%	0%	1%	0.25%
	<i>Balanus glandula</i> (B)	3%	2%	23%	31%	14.75%
	Barnacle sp. (SUM)	3%	2%	23%	32%	15.00%
Substrate		Co, G	C/S, S, B, G, Sh	S, G, B, C	C, B	

Bold 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., BrRA = Branched red algae sp., ERA = Encrusting red algae sp., BA = Brown algae sp., B = Barnacle sp.

Table A6. Individual species count data collected for each quadrat at each tide height at Point Whitehorn Park for 2015.

Intalco	7/1/2015	Countable Organisms: WITH ULVA				
Transect Elevation	Species	Quadrat				Average Count
		1	2	3	4	
1'	<i>Pagurus</i> sp.	2	0	0	0	0.5
	Polychaete sp.	0	0	0	2	0.5
	<i>Cancer oregonensis</i> (Cr)	1	0	0	0	0.25
Substrate		S	S	S	S, G	
0'	Amphipod sp.	0	0	0	5	1.25
	<i>Cancer oregonensis</i> (Cr)	1	1	0	0	0.5
	Shrimp sp.	0	1	0	0	0.25
Substrate		S, G	S	S, G	S	
-1'	<i>Littorina sitkana</i> (Lt)	0	1	0	0	0.25
	<i>Anthopleura artemisia</i> (An)	0	2	1	0	0.75
	Amphipod sp.	0	10	5	0	3.75
	<i>Calliostoma</i>	0	0	0	1	0.25
	<i>Cancer oregonensis</i> (Cr)	0	0	1	0	0.25
Substrate		C, G	C/S, S, B, G, SH	C, S, B, G	C, B	

Key: Cr = Other crab sp., Lt = *Littorina* sp., An = *Anemone* sp.

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

Neptune		Date: 7/03/2015: WITH ULVA				
Transect	Species	Quadrat, ft.				Average
Elevation		1	2	3	4	percent
1'	<i>Ulva intestinalis</i> (GA)	0%	1%	0%	0%	0.25%
	<i>Ulva lactuca</i> (GA)	77%	24%	29%	6%	34.00%
	Green algae sp. (SUM)	77%	25%	29%	6%	34.25%
	<i>Porphyra</i> sp. (BIRA)	0%	1%	4%	0%	1.25%
	<i>Neorhodomela larix</i> (BrRA)	1%	1%	0%	0%	0.50%
	<i>Polysiphonia</i> sp. (FRA)	0%	1%	0%	0%	0.25%
	<i>Mastocarpus</i> sp. (ERA)	0%	0%	1%	0%	0.25%
	Red algae sp. (SUM)	1%	3%	5%	0%	2.25%
	<i>Cthamalus dalli</i> (B)	0%	0%	15%	0%	3.75%
	<i>Balanus glandula</i> (B)	7%	30%	0%	0%	9.25%
	<i>Balanus crenatus</i> (B)	0%	0%	32%	22%	13.50%
	Barnacle sp. (SUM)	7%	30%	47%	22%	26.50%
	<i>Mytilus trossulus</i>	0%	7%	1%	1%	2.25%
	Substrate		C, G, Sh	C, S, Sh	NA	C, S, B, G
0'	<i>Ulva</i> sp. (GA)	13%	22%	0%	0%	8.75%
	<i>Ulva lactuca</i> (GA)	0%	0%	25%	40%	16.25%
	Green algae sp. (SUM)	13%	22%	25%	40%	25.00%
	<i>Neorhodomela larix</i> (BrRA)	18%	10%	5%	2%	8.75%
	<i>Hildenbrandia</i> sp. (ERA)	0%	1%	1%	0%	0.50%
	<i>Mastocarpus</i> sp. (ERA)	8%	4%	2%	15%	7.25%
	Red algae sp. (SUM)	26%	15%	8%	17%	16.5%
	<i>Fucus</i> sp. (BA)	0%	0%	2%	0%	0.50%
	<i>Balanus crenatus</i> (B)	0%	30%	10%	20%	15.00%
	<i>Balanus glandula</i> (B)	33%	0%	0%	0%	8.25%
	<i>Cthamalus dalli</i> (B)	0%	0%	60%	2%	15.50%
	Barnacle sp. (SUM)	33%	30%	70%	22%	38.75%
	<i>Mytilus trossulus</i>	1%	1%	0%	2%	1.00%
	Substrate		C, S, Sh	C, S, B, Sh	C, S, B, D, Sh	C, S, B, D, Sh
-1'	<i>Ulva lactuca</i> (GA)	40%	0%	0%	31%	17.75%
	<i>Ulva</i> sp. (GA)	0%	39%	20%	0%	14.75%
	Green algae sp. (SUM)	40%	39%	20%	31%	32.50%
	<i>Mazzaella splendens</i> (BIRA)	0%	0%	0%	1%	0.25%
	<i>Neorhodomela larix</i> (BrRA)	0%	0%	0%	1%	0.25%
	Filamentous red (FRA)	0%	0%	1%	0%	0.25%
	<i>Hildenbrandia</i> sp. (ERA)	2%	1%	1%	0%	1.00%
	<i>Mastocarpus</i> sp. (ERA)	1%	1%	0%	1%	0.75%
	Red Algae sp. (SUM)	3%	2%	2%	3%	2.50%
	<i>Balanus crenatus</i> (B)	35%	15%	5%	22%	19.25%
	Barnacle sp. (SUM)	35%	15%	5%	22%	19.25%

	<i>Mytilus trossulus</i>	1%	1%	0%	1%	0.75%
Substrate		C, S, Sh	C/S, S, B, C, Sh	S, Sh, C	C, B, S, G, Sh	

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., BIRA = Bladed red algae sp., BrRA = Branched red algae sp., FRA = Filamentous red algae sp., ERA = Encrusting red algae sp., B = Barnacle sp., BA = Brown algae sp.

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

Neptune	7/3/2015	Countable Organisms: WITH ULVA				Average Count
Transect Elevation	Species	Quadrat				
		1	2	3	4	
1'	<i>Lottia pelta</i> (Lp)	0	1	0	0	0.25
	<i>Anthopleura artemisia</i> (An)	0	13	4	1	4.5
Substrate		C, G, Sh	C, S, Sh	NA	C, S, B, G	
0'	<i>Tectura persona</i> (Lp)	0	0	0	1	0.25
	<i>Anthopleura artemisia</i> (An)	4	10	3	1	4.5
Substrate		C, S, Sh	C, S, B, Sh	C, S, B, D, Sh	C, S, B, D, Sh	
-1'	Amphipod sp.	0	0	1	0	0.25
	Sculpin sp.	1	0	0	0	0.25
	<i>Anthopleura artemisia</i> (An)	0	7	15	21	10.75
Substrate		C, S, Sh	C/S, S, B, C, Sh	S, Sh, C	C, B, S, G, Sh	

Key: Lp = Limpet sp., An = Anemone sp.

Appendix B: Field Forms

The following data forms were used in this project:

Form	Purpose	Page Number in this Report
Profile Data Sheet	Field data collection on beach elevations profiles along with data on substrate and species types present.	37
Cherry Point Species Checklist	Swath analysis of species present in 20 foot swaths along profile line.	38
Quadrat Data Sheet	Species counts (individual and percent cover) for each quadrat before and after <i>Ulva sp.</i> removal.	45
Binary Estimation Sheet	Assist in assessing percentage coverage in the field for quadrat surveys.	48

Profile Data Sheet:

Profile data sheets included substrate type presence/absence data collection. Species presence/absence information was collected in the profile swaths instead of during profile data collection. This field sheet was taken from Island County/ WSU Beach Watchers (2003).

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	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 Nemertean	W Polychaetes	Green Seaweeds	Red Seaweeds	Brown Seaweeds	Seagrass	A rachnid	Shrimp	Other			
1																																							
2																																							
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4																																							
5																																							
6																																							
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18																																							
19																																							
20																																							
21																																							

Figure B1. Profile field data sheets.

Cherry Point Species Checklist – scientific nomenclature and common names

Site:	Date & Time:	Expert & Scribe:	Section along profile line (ft)			
PORIFERA	Sponges					
<i>Clathria (Ophlitaspongia) pennata</i>	Red sponge					
<i>Haliclona</i> sp.	Brown sponge					
PLATYHELMINTHES						
<i>Kaburakia excelsa</i>	"giant flatworm"			<input type="checkbox"/>		
CNIDARIA: ANTHOZOA	anemones					
<i>Anthopleura elegantissima</i>	Aggregating anemone			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Anthopleura artemisia</i>	Moonglow anemone			<input type="checkbox"/>		<input type="checkbox"/>
<i>Urticina coriacea</i>	Stubby rose anemone			<input type="checkbox"/>		
<i>Urticina felina</i> (formerly <i>crassicornis</i>)	Red and green anemone			<input type="checkbox"/>		
<i>Metridium farcimen</i>	Plumose anemone			<input type="checkbox"/>		
<i>Urticina</i> sp.	unidentified <i>Urticina</i>			<input type="checkbox"/>		
BRYOZOA				<input type="checkbox"/>		
<i>Membranipora</i> sp.	encrusting bryozoan			<input type="checkbox"/>		
NEMERTEA						
<i>Paranemertea peregrina</i>	ribbon worm (purple nemertid)					<input type="checkbox"/>
<i>Tubulanus polymorphus</i>	Nemertea - orange					
<i>Carinoma mutabilis</i>	Nemertea - white					

ANNELIDA						
	Polychaete			<input type="checkbox"/>	<input type="checkbox"/>	
Polychaeta sp.				<input type="checkbox"/>	<input type="checkbox"/>	
Polynoidae spp.	scale worms			<input type="checkbox"/>	<input type="checkbox"/>	
	unidentified tube worm					
Tubicolous polychaete						
<i>Spirorbis bifurcatus</i>	no common name					<input type="checkbox"/>
	-					<input type="checkbox"/>
Glyceridae sp.						<input type="checkbox"/>
Nereidae spp.	Pile worm				<input type="checkbox"/>	<input type="checkbox"/>
MOLLUSCA	Gastropoda					
<i>Littorina scutulata</i>	Checkered Periwinkle	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Littorina sitkana</i>	"Sitka periwinkle"	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
<i>Lirabuccinum dira</i>	Dire whelk	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
<i>Calliostoma ligatum</i>	"blue topsnail"	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
<i>Nucella lamellosa</i>	"frilled dogwinkle"				<input type="checkbox"/>	<input type="checkbox"/>
<i>Nucella ostrina (emarginata)</i>	"emarginate dogwinkle"	<input type="checkbox"/>		<input type="checkbox"/>		
<i>Nucella canaliculata</i>	channeled dogwinkle	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
<i>Lacuna</i> sp. eggs	gastropod eggs	<input type="checkbox"/>		<input type="checkbox"/>		
<i>Aeolidia papillosa</i>	nudibranch: "shag-rug aeolis"					
<i>Onchidoris bilamellata</i>	"barnacle-eating onchidoris"					
Nudibranch eggs	eggs					<input type="checkbox"/>
<i>Haminoea vesicula</i>	"blister glassy-bubble"	<input type="checkbox"/>	<input type="checkbox"/>			
<i>Pododesmus macroschisma</i>	"alaska jingle"	<input type="checkbox"/>	<input type="checkbox"/>			
<i>Lottia digitalis</i>	"ribbed limpet"	<input type="checkbox"/>	<input type="checkbox"/>			

<i>Lottia pelta</i>	"Shield limpet"			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Tectura scutum</i>	"Plate limpet"			<input type="checkbox"/>		<input type="checkbox"/>
<i>Tectura persona</i>	"Mask limpet"	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
<i>Lottia alveus</i>	eelgrass limpet	<input type="checkbox"/>	<input type="checkbox"/>			
<i>Lottia digitalis</i>	Finger limpet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Mopalia muscosa</i>	Mossy chiton	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
<i>Mopalia lignosa</i>	Woody chiton	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
<i>Mopalia (ciliata)kennerleyi</i>	"Northern hairy chiton"	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
MOLLUSCA: Bivalvia						
<i>Mytilus trossulus</i>	Pacific blue mussel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Tresus capax</i>	"fat gaper"	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
<i>Leukoma (Protothaca) staminea</i>	"Pacific littleneck"	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
ARTHROPODA						
<i>Gnorimosphaeroma orgonensis</i>	Pill bug isopod				<input type="checkbox"/>	<input type="checkbox"/>
<i>Pentidotea (Idotea) resecata</i>	"Eelgrass isopod"					
<i>Pentidotea (Idotea) stenops</i>	seaweed isopod					
<i>Pentidotea (Idotea) vosnesenskii</i>	Rockweed isopod					<input type="checkbox"/>
<i>Cirolana harfordi</i>	Harford's isopod					
<i>Heptacarpus spp.</i>	"shrimp"					<input type="checkbox"/>
<i>Pagurus sp.</i>	Hermit Crab			<input type="checkbox"/>		
Decapoda: unknown family	"Juvenile crab"			<input type="checkbox"/>		
<i>Oregonia gracilis</i>	Decorator crab			<input type="checkbox"/>		

<i>Cancer productus</i>	red rock crab			<input type="checkbox"/>		
<i>Pagurus beringanus</i>	"Bering hermit"			<input type="checkbox"/>		
<i>Pagurus granosimanus</i>	"grainyhand hermit"					<input type="checkbox"/>
<i>Pagurus hirsutiusculus</i>	"hairy hermit"					<input type="checkbox"/>
<i>Lophopanopeus bellus</i>	"blackclawed crestleg crab"					<input type="checkbox"/>
<i>Hemigrapsus nudus</i>	"purple shore crab"			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Hemigrapsus oregonensis</i>	"yellow shore crab"			<input type="checkbox"/>		<input type="checkbox"/>
<i>Balanus sp.</i>				<input type="checkbox"/>		
<i>Balanus glandula</i>	Acorn Barnacle	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Balanus crenatus</i>	Crenate Barnacle					<input type="checkbox"/>
<i>Neomolgus littoralis</i>	red velvet mite					<input type="checkbox"/>
<i>Semibalanus cariosus</i>	Haystack Barnacle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Chthalamus dalli</i>	Little brown barnacle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Balanomorpha	unidentified acorn barnacle					
Crustacea: Amphipoda: Gammaridea	gammarid amphipod	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Caprellidae	caprella amphipod	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ECHINODERMATA: Holothuroidea						
<i>Cucumaria miniata</i>	orange sea cucumber	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Eupentacta quinquesemita</i>	white sea cucumber	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ECHINODERMATA: Echinoidea	urchins					
<i>Strongylocentrotus drobachiensis</i>	green sea urchin					

ECHINODERMATA: Asteroidea	Seastars					
<i>Evasterias troschelii</i>	Mottled seastar					
<i>Henricia pumila</i>	"dwarf mottled henricia"					
<i>Henricia leviuscula</i>	Blood star					
<i>Leptasterias hexactis</i>	six-arm seastar					
<i>Pisaster ochraceus</i>	ochre seastar					
ECHINODERMATA: Ophiuroidea	brittle star					
<i>Amphiodia occidentalis</i>	"long-armed brittle star"					
<i>Amphipholis squamata</i>	brooding or small brittle star					
CHORDATA: Pisces						
<i>Oligocottus maculosus</i>	"Tidepool sculpin"					
<i>Gobiesox maeandricus</i>	"Northern clingfish"					
<i>Pholis ornata</i>	"Saddleback gunnel"					
Cottidae	unidentified sculpin					
Pholidae	gunnels/blennies					
Pleuronectidae	flatfish - sole					
PLANTAE: Tracheophyta						
<i>Zostera marina</i>	eelgrass					
<i>Zostera japonica</i>	Japanese eelgrass					
<i>Leymus (Elymus) mollis</i>	"American dunegrass"					
<i>Artemisia ("artemesia sp.") sp.</i>	Absinth wormwood					
<i>Cakile (cackile sp.) edentula</i>	American sea-rocket					

<i>Distichlis spicata</i>				<input type="checkbox"/>		
<i>Atriplex patula</i>	saltbush			<input type="checkbox"/>		
<i>Salicornia</i> sp.				<input type="checkbox"/>		
<i>Equisetum</i> sp. (not salt tolerant sp)	horsetail	<input type="checkbox"/>				
PLANTAE: Chlorophyta	Green algae					
<i>Ulva lactuca</i>	Sea lettuce (foliose)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Ulva intestinalis</i>	Sea lettuce (filamentous)		<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
<i>Ulva linza</i>	Sea lettuce		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Ulva</i> sp.	Sea lettuce		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Codium fragile</i>	Dead man's fingers		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PLANTAE: Ochrophyta	Brown algae					
<i>Alaria marginata</i>	"ribbon kelp"					
<i>Costaria costata</i>	Five-ribbed kelp					
<i>Leathesia</i> sp.	sea cauliflower					
<i>Saccharina (Laminaria) latissima</i>	Sugar kelp					
<i>Sargassum muticum</i>	Japanese wireweed					
<i>Fucus distichus</i>	Rockweed "Two-headed Wrack"			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Fucus</i> sp.					<input type="checkbox"/>	<input type="checkbox"/>
PLANTAE: Rhodophyta	Red algae					
Filamentous Rhodophyta	filamentous red algae				<input type="checkbox"/>	
<i>Cryptosiphonia woodii</i>	"bleached brunette"				<input type="checkbox"/>	
<i>Hildenbrandia</i> sp.	"rusty rock"				<input type="checkbox"/>	<input type="checkbox"/>

<i>Mastocarpus</i> sp.	Turkish towel or washcloth			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Porphyra</i> sp.	"nori"			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Mazzaella (Iridaea) splendens</i>	"splendid iridescent seaweed"				<input type="checkbox"/>	
<i>Ralfsia fungiformis</i>	Sea Fungus				<input type="checkbox"/>	
<i>Neorhodomella larix</i>	black pine				<input type="checkbox"/>	<input type="checkbox"/>
<i>Odonthalia flacosa</i>	sea brush				<input type="checkbox"/>	
<i>Ceramium</i> sp.	staghorn felt				<input type="checkbox"/>	<input type="checkbox"/>
<i>Polysiphonia</i> complex	filamentous red algae				<input type="checkbox"/>	<input type="checkbox"/>
<i>Prionitis</i> sp.	"bleach weed"				<input type="checkbox"/>	<input type="checkbox"/>
<i>Scytosiphon</i> sp.	"soda straws"				<input type="checkbox"/>	<input type="checkbox"/>
					<input type="checkbox"/>	<input type="checkbox"/>

Figure B2. Field data collection sheet of species expert intertidal identifiers used to indicate presence of species in particular distance intervals along the profile within 10 m of the profile on either side.

Quadrat Data Sheet

Aquatic Reserve Intertidal Biotic monitoring **QUADRAT DATA SHEET** **BEFORE**

Site: _____ Date and Time _____

Identifier: _____ Recorder: _____

Other team members: _____ and _____

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

OUR QUADRAT DATA: BEFORE ULVA REMOVAL

Transect elevation (circle one): +1' 0' -1'

Quadrat #: _____ Quadrat distance Along Transect line : _____ Along Profile line _____

Substrate in Quadrat (circle all):

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

PERCENT COVERAGE ORGANISMS: algae, plants and colonial organisms*:

transferred information from QUADRAT ESTIMATION worksheet

	Organism Name	% Cover	Estimation Method
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

What is the
Total %

Visually,
does this
seem accurate?

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

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

COUNTABLE ANIMALS:

	Organism Name	Number
1		
2		
3		
4		
5		
6		
7		

	Organism Name	Number
8		
9		
10		
11		
12		
13		
14		

Notes: _____

OUR QUADRAT DATA: AFTER ULVA REMOVAL

Transect elevation (circle one): +1' 0' -1'
 Quadrat #: _____ Quadrat distance Along Transect line : _____ Along Profile line _____

PERCENT COVERAGE ORGANISMS: algae, plants and colonial organisms*:
 transferred information from QUADRAT ESTIMATION worksheet

	Organism Name	% Cover	Estimation Method
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

What is the
Total %

Visually,
does this
seem accurate?

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

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

COUNTABLE ANIMALS:

	Organism Name	Number
1		
2		
3		
4		
5		
6		
7		

	Organism Name	Number
8		
9		
10		
11		
12		
13		
14		

Notes: _____

Figure B3. Quadrat field sheets with data collect before and after *Ulva* sp. removal.

Grand Total:

Organism: _____

Row Totals

Grand Total:

Organism: _____

Row Totals

Grand Total:

Organism: _____

Row Totals

Grand Total:

Organism: _____

Row Totals

Grand Total:

Grand Total:

Figure B4. Field sheets to assist quadrat surveys by using the binary estimation method for percent cover.

Appendix C: Species Lists

Species lists from 2014 and 2013 are available electronically upon request. Contact Eleanor Hines at RE Sources (eleanorh@re-sources.org) to request data in electronic format.

Table C1. Complete species list from monitoring at Point Whitehorn Park in 2015. P indicates the presence of biota at the indicated swath interval along the profile line.

Site: Point Whitehorn Park	Date & Time: 5/19/15	Expert & Scribe:						Section along profile line, in feet				
		Bob	Bob	Bob	Bob	Bob	Bob	Doug	Doug	Doug, Bob	Bob	Doug
		0-20'	20-40'	40-70'	70-90'	90-120'	120-140'	150-170'	170-190'	190-210'	200-210'	210-220'
CNIDARIA: ANTHOZOA	anemones											
<i>Anthopleura elegantissima</i>	Aggregating anemone			P	P	P	P	P	P	P	P	P
<i>Anthopleura artemisia</i>	Moonglow anemone						P	P	P			
<i>Urticina coriacea</i>	Stubby rose anemone									P		P
<i>Urticina felina</i> (formerly <i>crassicornis</i>)	Red and green anemone								P	P		P
<i>Metridium farcimen</i>	Plumose anemone								P	P		P
NEMERTEA												
<i>Paranemertea peregrina</i>	ribbon worm (purple nemertid)					P						
ANNELIDA												
Polychaeta sp.	Polychaete			P	P	P						
Polynoidae spp.	scale worms											P
MOLLUSCA												
<i>Littorina scutulata</i>	Checkered Periwinkle			P	P	P						
<i>Littorina sitkana</i>	"Sitka periwinkle"				P							
<i>Lirabuccinum dira</i>	Dire whelk											P
<i>Nucella lamellosa</i>	"frilled dogwinkle"				P	P	P	P	P	P		P

<i>Aeolidia papillosa</i>	nudibranch: "shag-rug aeolis"										P		
Nudibranch eggs	eggs										P		
<i>Mytilus trossulus</i>	Pacific blue mussel						P						
<i>Lottia digitalis</i>	"ribbed limpet"			P	P								
<i>Lottia pelta</i>	"Shield limpet"				P	P	P	P	P	P			P
<i>Tectura persona</i>	"Mask limpet"			P	P								
<i>Lottia digitalis</i>	Finger limpet							P					
<i>Mopalia lignosa</i>	Woody chiton										P		P
MOLLUSCA: Bivalvia													
<i>Mytilus trossulus</i>	Pacific blue mussel				P	P							
ARTHROPODA													
<i>Gnorimosphaeroma oregonensis</i>	Pill bug isopod				P	P	P						
<i>Pentidotea (Idotea) wosnesenskii</i>	Rockweed isopod					P	P	P	P	P			P
<i>Pagurus</i> sp.	Hermit Crab				P								
<i>Oregonia gracilis</i>	Decorator crab										P		P
<i>Cancer productus</i>	red rock crab										P		P
<i>Pagurus granosimanus</i>	"grainyhand hermit"									P	P		P
<i>Pagurus hirsutiusculus</i>	"hairy hermit"				P	P							
<i>Lophopanopeus bellus</i>	"blackclawed crestleg crab"												P
<i>Hemigrapsus nudus</i>	"purple shore crab"			P	P	P							
<i>Hemigrapsus oregonensis</i>	"yellow shore crab"				P	P							
<i>Balanus glandula</i>	Acorn Barnacle			P	P	P	P	P	P	P			P

<i>Balanus crenatus</i>	Crenate Barnacle						P	P	P	P		P
<i>Semibalanus cariosus</i>	Haystack Barnacle				P	P		P	P			P
<i>Chthalamus dalli</i>	Little brown barnacle			P	P			P				
Crustacea: Amphipoda: Gammaridea	gammarid amphipod		P	P	P	P		P				
ECHINODERMATA : Holothuroidea												
<i>Cucumaria miniata</i>	orange sea cucumber											P
ECHINODERMATA : Asteroidea	Seastars											
<i>Pisaster ochraceus</i>	ochre seastar						P				P	P
CHORDATA: Pisces												
<i>Gobiosox maeandricus</i>	"Northern clingfish"											P
Pholidae	gunnels/blennies											P
PLANTAE: Tracheophyta												
<i>Atriplex patula</i>	saltbush	P										
PLANTAE: Chlorophyta	Green algae											
<i>Ulva lactuca</i>	Sea lettuce (foliose)											P
<i>Ulva</i> sp.	Sea lettuce			P	P	P	P	P				
PLANTAE: Ochrophyta	Brown algae											
<i>Saccharina (Laminaria) latissima</i>	Sugar kelp											P
<i>Sargassum muticum</i>	Japanese wireweed											P
<i>Fucus distichus</i>	Rockweed "Two-headed Wrack"			P	P							
PLANTAE: Rhodophyta	Red algae											
Filamentous Rhodophyta	filamentous red algae							P				

<i>Cryptosiphonia woodii</i>	"bleached brunette"					P						
<i>Hildenbrandia</i> sp.	"rusty rock"				P							P
<i>Mastocarpus</i> sp.	Turkish towel or washcloth				P	P		P				P
<i>Porphyra</i> sp.	"nori"			P	P	P	P	P				P
<i>Neorhodomella larix</i>	black pine											P
<i>Odonthalia flacosa</i>	sea brush											P
<i>Polysiphonia</i> complex	filamentous red algae					P	P					
<i>Prionitis</i> sp.	"bleach weed"											P
<i>Scytosiphon</i> sp.	"soda straws"											P
<i>Callophyllus</i> sp.	red algae					P						
	marine earwig		P									
<i>Acrosiphonia</i>						P						P
<i>Platyhelminthes</i>						P						
<i>Nereocystos</i>	bull kelp											P
	Sculpin											P
<i>Mopalia ciliata</i>												P
<i>Urticina lofotensis</i>												P
<i>Tresus capax</i>								P	P	P		
<i>Bossiela</i> sp.												P
	right eyed flounder											P
<i>Constantinia</i>												P
	sand lance										P	

Gracilariaaiopsis	red spaghetti											P
Tonicella lineata	lined chiton											P
Colpomenia	brown algae											P
Hermisenda crassicornis	opalescent nudibranch							P				
Cryptosiphonia woodii								P				

Table C2. Complete species list from intertidal monitoring at Point Whitehorn Point in 2015. P indicates the presence of biota at the indicated swath interval along the profile line.

Site: Point Whitehorn Point	Date & Time: 6/4/15	Section along profile line, in feet: 0-20	20-130	130-190	190-270	270-570
BRYOZOA						
<i>Membranipora</i> sp.						P
PLATYHELMINTHE S						
<i>Kaburakia excelsa</i>	"giant flatworm"					P
CNIDARIA: ANTHOZOA	anemones					
<i>Anthopleura elegantissima</i>	Aggregating anemone		P	P	P	P
<i>Anthopleura artemisia</i>	Moonglow anemone				P	P
<i>Urticina felina</i> (formerly <i>crassicornis</i>)	Red and green anemone					P
<i>Metridium farcimen</i>	Plumose anemone					P
NEMERTEA						
<i>Paranemertea peregrina</i>	ribbon worm (purple nemertid)				P	P
<i>Carinoma mutabilis</i>	Nemertea - white					P
<i>Emplectonema gracile</i>					P	
ANNELIDA						

Polychaeta sp.	Polychaete			P		
Polynoidae sp.	scale worms			P	P	
Tubicolous polychaete	unidentified tube worm			P		
Glyceridae sp.						P
Nereidae spp.	Pile worm		P			
<i>Oligochaete</i> sp.			P			
MOLLUSCA						
<i>Littorina scutulata</i>	Checkered Periwinkle		P			
<i>Littorina sitkana</i>	"Sitka periwinkle"		P			
<i>Nucella lamellosa</i>	"frilled dogwinkle"		P	P	P	P
<i>Nucella lamellosa</i> eggs						P
<i>Nucella ostrina</i> (<i>emarginata</i>)	"emarginate dogwinkle"			P	P	
<i>Onchidoris bilamellata</i>	"barnacle-eating onchidoris"				P	P
<i>Mytilus trossulus</i>	Pacific blue mussel		P	P	P	P
<i>Onchidella borealis</i>	Barnacle nudibranch				P	
MOLLUSCA						
<i>Lottia digitalis</i>	"ribbed limpet"		P	P		
<i>Lottia pelta</i>	"Shield limpet"		P	P	P	
<i>Tectura scutum</i>	"Plate limpet"		P			
<i>Tectura persona</i>	"Mask limpet"		P			P
<i>Lottia digitalis</i>	Finger limpet			P		
<i>Mopalia muscosa</i>	Mossy chiton		P			

<i>Mopalia lignosa</i>	Woody chiton					P
MOLLUSCA: Bivalvia						
<i>Mytilus trossulus</i>	Pacific blue mussel			P	P	
ARTHROPODA						
<i>Gnorimosphaeroma orgonensis</i>	Pill bug isopod		P		P	
<i>Pentidotea (Idotea) vosnesenskii</i>	Rockweed isopod				P	P
<i>Pagurus</i> sp.	Hermit Crab					P
<i>Cancer productus</i>	red rock crab					P
<i>Metacarcinus magister</i>	Dungeness crab					P
<i>Pagurus granosimanus</i>	"grainyhand hermit"			P	P	
<i>Pagurus hirsutiusculus</i>	"hairy hermit"		P	P		
<i>Pagurus juvenile</i>					P	
<i>Hemigrapsus oregonensis</i>	"yellow shore crab"		P		P	
<i>Balanus glandula</i>	Acorn Barnacle		P	P	P	
<i>Semibalanus cariosus</i>	Haystack Barnacle		P	P	P	
<i>Chthamalus dalli</i>	Little brown barnacle		P	P	P	
Crustacea: Amphipoda: Gammaridea	gammarid amphipod	P	P		P	P
<i>Telmessus cheiragonus</i>					P	
<i>Ligia pelosi</i>			P			
	Earwig	P				
ECHINODERMATA: Holothuroidea						
<i>Cucumaria miniata</i>	orange sea cucumber					P

ECHINODERMATA: Asteroidea	Seastars					
<i>Evasterias troschelii</i>	Mottled seastar				P	
<i>Henricia leviuscula</i>	Blood star					P
<i>Leptasterias hexactis</i>	six-arm seastar					P
<i>Pisaster ochraceus</i>	ochre seastar		P		P	P
CHORDATA: Pisces						
Pholidae	gunnels/blennies					P
PLANTAE: Tracheophyta						
<i>Zostera marina</i>	eelgrass				P	P
<i>Zostera japonica</i>	Japanese eelgrass			P	P	P
<i>Cakile (cackile sp.) edentula</i>	American sea-rocket	P				
<i>Atriplex patula</i>	saltbush	P				
PLANTAE: Chlorophyta	Green algae					
<i>Ulva lactuca</i>	Sea lettuce (foliose)					P
<i>Ulva</i> sp.	Sea lettuce		P	P	P	
<i>Acrosiphonia</i> sp.					P	P
PLANTAE: Ochrophyta	Brown algae					
<i>Alaria marginata</i>	"ribbon kelp"					P
<i>Saccharina (Laminaria) latissima</i>	Sugar kelp				P	P
<i>Sargassum muticum</i>	Japanese wireweed				P	P
<i>Fucus distichus</i>	Rockweed "Two-headed Wrack"		P	P	P	P
PLANTAE: Phaeophyceae						

<i>Leathesia</i> sp.	sea cauliflower				P	
<i>Nereocystis</i> sp.	mermaids bladder					P
<i>Desmarestia aculeata</i>						P
<i>Saccharina sessilis</i>						P
<i>Desmarestia viridis</i>						P
PLANTAE: Rhodophyta	Red algae					
<i>Cryptosiphonia woodii</i>	"bleached brunette"				P	P
<i>Hildenbrandia</i> sp.	"rusty rock"			P	P	
<i>Mastocarpus</i> sp.	Turkish towel or washcloth			P	P	P
<i>Porphyra</i> sp.	"nori"		P	P	P	P
<i>Mazzaella (Iridaea) splendens</i>	"splendid iridescent seaweed"			P		P
<i>Neorhodomella larix</i>	black pine				P	
<i>Odonthalia flacosa</i>	sea brush				P	P
<i>Polysiphonia</i> complex	filamentous red algae			P	P	
<i>Prionitis</i> sp.	"bleach weed"				P	
<i>Constantinea</i> sp.						P
<i>Smithora</i> sp.					P	
<i>Farlowia mollis</i>					P	
<i>Smithora naiadum</i>						P
<i>Palmaria mollis</i>						P
<i>Chondracanthus</i> sp.	Turkish towel					P
<i>Gracilariopsis sjoestedtii</i>						P

PISCES						
Liparidae	Snailfish					P

Table C3. Complete species list from intertidal monitoring at Intalco in 2015. P indicates the presence of biota at the indicated swath interval along the profile line.

Site: Intalco	Date & Time: 7/1/15	Expert & Scribe: Section along profile line, in feet 0-20'	10-20'	20-50	50-90	90-100	100-120
CNIDARIA: ANTHOZOA	anemones						
<i>Anthopleura artemisia</i>	Moonglow anemone						P
MOLLUSCA							
<i>Littorina scutulata</i>	Checkered Periwinkle				P		
<i>Calliostoma ligatum</i>	"blue topsnail"						P
<i>Nucella lamellosa</i>	"frilled dogwinkle"						P
<i>Mytilus trossulus</i>	Pacific blue mussel				P		P
MOLLUSCA							
<i>Tectura persona</i>	"Mask limpet"					P	P
MOLLUSCA: Bivalvia							
<i>Mytilus trossulus</i>	Pacific blue mussel				P		
ARTHROPODA							
<i>Cancer productus</i>	red rock crab					P	P
<i>Balanus glandula</i>	Acorn Barnacle				P	P	P
<i>Balanus crenatus</i>	Crenate Barnacle						P
<i>Semibalanus cariosus</i>	Haystack Barnacle						P
<i>Chthalamus dalli</i>	Little brown barnacle				P		
Crustacea: Amphipoda: Gammaridea	gammarid amphipod		P	P	P		
ECHINODERMATA : Asteroidea	Seastars						

<i>Pisaster ochraceus</i>	ochre seastar						P
PLANTAE: Tracheophyta							
<i>Leymus (Elymus) mollis</i>	"American dunegrass"	P					
<i>Cakile (cackile sp.) edentula</i>	American sea-rocket	P					
<i>Atriplex patula</i>	saltbush	P					
<i>Franseria chamissonius</i>	silver bur ragweed	P					
PLANTAE: Chlorophyta	Green algae						
<i>Ulva lactuca</i>	Sea lettuce (foliose)					P	P
<i>Ulva intestinalis</i>	Sea lettuce (filamentous)				P		
PLANTAE: Ochrophyta	Brown algae						
<i>Sargassum muticum</i>	Japanese wireweed						P
PLANTAE: Rhodophyta	Red algae						
Filamentous Rhodophyta	filamentous red algae						P
<i>Hildenbrandia</i> sp.	"rusty rock"				P		P
<i>Mastocarpus</i> sp.	Turkish towel or washcloth				P	P	P
<i>Porphyra</i> sp.	"nori"					P	
<i>Neorhodomella larix</i>	black pine						P

Table C4. Complete species list from intertidal monitoring at Neptune in 2015. P indicates the presence of biota at the indicated swath interval along the profile line.

Site: Neptune	Date & Time: 7/3/15	Expert & Scribe: Section along profile line, in feet 90-110'	110-140	140-160
PORIFERA	Sponges			
	brown sponge			P
BRYOZOAN				
	Orange bryozoan			P
<i>Membranipora membranacea</i>	Kelp encrusting bryozoan			P
CNIDARIA: ANTHOZOA	anemones			
<i>Anthopleura artemisia</i>	Moonglow anemone	P		P
<i>Urticina coriacea</i>	Stubby rose anemone			P
<i>Metridium farcimen</i>	Plumose anemone			P
NEMERTEA				
<i>Paranemertea peregrina</i>	ribbon worm (purple nemertid)	P		
ANNELIDA				
Nereidae sp.	Pile worm	P		
Spirorbidae	Dwarf calcareous tube worm	P		
MOLLUSCA				
<i>Nucella lamellosa</i>	"frilled dogwinkle"	P		
<i>Nucella canaliculata</i>	Channelled dog winkle	P		
<i>Mytilus trossulus</i>	Pacific blue mussel	P		
<i>Lottia pelta</i>	"Shield limpet"	P		P

<i>Mopalia muscosa</i>	Mossy chiton	P		
<i>Mopalia lignosa</i>	Woody chiton			P
<i>Mopalia ciliata</i>	Hairy chiton			P
ARTHROPODA				
<i>Gnorimosphaeroma organensis</i>	Pill bug isopod	P		
<i>Pentidotea (Idotea) wosnesenskii</i>	Rockweed isopod	P		
<i>Heptacarpus</i> spp.	"shrimp"	P		P
<i>Pagurus hirsutiusculus</i>	"hairy hermit"	P		P
<i>Hemigrapsus oregonensis</i>	"yellow shore crab"	P		
<i>Balanus glandula</i>	Acorn Barnacle	P		P
<i>Balanus crenatus</i>	Crenate Barnacle	P		P
<i>Chthamalus dalli</i>	Little brown barnacle	P		
ECHINODERMATA: Holothuroidea				
<i>Cucumaria miniata</i>	orange sea cucumber			P
<i>Eupentacta quinquesemita</i>	white sea cucumber			P
ECHINODERMATA: Asteroidea	Seastars			
<i>Pisaster ochraceus</i>	ochre seastar		P	P
ECHINODERMATA: Ophiuroidea	brittle star			
<i>Amphiodia occidentalis</i>	"long-armed brittle star"			P
CHORDATA: Pisces				
<i>Oligocottus maculosus</i>	"Tidepool sculpin"			P
<i>Gobiesox maeandricus</i>	"Northern clingfish"		P	

<i>Pholis ornata</i>	"Saddleback gunnel"			P
Pholidae	gunnels/blennies			P
PLANTAE: Tracheophyta				
<i>Zostera marina</i>	eelgrass			P
PLANTAE: Chlorophyta	Green algae			
<i>Ulva lactuca</i>	Sea lettuce (foliose)	P		P
Site:	Date & Time:	Expert & scribe: Section along profile line, in feet		
		90-110	110-140	140-160
PLANTAE: Ochrophyta	Brown algae			
<i>Alaria marginata</i>	"ribbon kelp"			P
<i>Saccharina (Laminaria) latissima</i>	Sugar kelp			P
<i>Sargassum muticum</i>	Japanese wireweed			P
<i>Fucus distichus</i>	Rockweed "Two-headed Wrack"			P
PLANTAE: Rhodophyta	Red algae			
<i>Hildenbrandia</i> sp.	"rusty rock"	P		
<i>Mastocarpus</i> sp.	Turkish towel or washcloth	P		
<i>Porphyra</i> sp.	"nori"	P		P
<i>Mazzaella (Iridaea) splendens</i>	"splendid iridescent seaweed"			P
<i>Neorhodomella larix</i>	black pine	P		P