Intertidal Biota Monitoring in the Fidalgo Bay Aquatic Reserve

2013 Monitoring Report

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Washington State Department of Natural Resources

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Intertidal Subcommittee

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Cover Photo: Citizen Scientists Bob Weathers, Bob Lemon, and Morty Cohen, taking a core sample next to a quadrat at the Otter site, 2013. RE Sources.

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Contents

Abstract 5
Introduction 5
Background 5
Goals and Objectives 6
Data-Collection Methodology 7
Narrative of the Field Research 7
Results 11
Otter results 12
Otter discussion 15
Fir results 16
Fir discussion 19
Trestle Results 20
Trestle discussion 23
Discussion 24
Recommendations for any Modification of the Procedures and the Overall Program 24
Highlights 24
Recommendations 25
Additional discussion 25
References 26
Acknowledgments 27
Appendix A: Data Forms 29
Appendix B: Field Instructions 41
Appendix C: List of Additional Personnel Involved in the Fidalgo Bay Aquatic Reserve Study 43

Tables

Table 1. Site Information 8
Table 2. Survey information 10
Table 3. Percentage coverage at Otter Site 12
Table 4. Individual Animal Species at Otter Site 13
Table 5. Infaunal Animal species at Otter Site 14
Table 6. Profile elevation, substrate, and species type at Otter Site 14
Table 7. Percentage coverage at Fir Site 16
Table 8. Individual Animals at Fir Site 17
Table 9. Infaunal animals at Fir Site 18
Table 10. Profile elevation, substrate, and species type at Fir Site 19
Table 11. Percentage coverage at Trestle Site 20
Table 12. Individual Animals at Trestle Site 21
Table 13. Infaunal Animals at Trestle Site 22
Table 14. Profile elevation, substrate, and species type at Trestle Site 23

Figures

Figure 1: The Fidalgo Bay Aquatic Reserve and surrounding area. 6
Figure 2: In class training, photo credit; RE Sources 7
Figure 3: Field Training, photo credit: Pete Haase 8
Figure 4: Michael Kyte demonstrates coring 8
Figure 5. Locations of the survey sites 10
Figure 6: Percentage coverage at Otter Site 12
Figure 7. Individual Animal Species at Otter Site 13
Figure 8. Infaunal Animal species at Otter Site 14
Figure 9. Depiction of profile elevation at Otter site 15
Figure 10. Percentage coverage at Fir Site 16
Figure 11. Individual Animals at Fir Site 17
Figure 12. Infaunal animals at Fir Site 18
Figure 13. Depiction of profile elevation at Fir site 19
Figure 14. Percentage coverage at Trestle Site 20
Figure 15. Individual Animals at Trestle Site 21
Figure 16. Infaunal Animals at Trestle Site 22
Figure 17. Depiction of profile elevation at Trestle site 23
Figure 18: Estimating percent coverage at the Otter site 24

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Abstract

The Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee instituted intertidal surveys in 2013 in the Fidalgo Bay Aquatic Reserve to assess the beach slope, substrate, and diversity of intertidal animals and plants along three profiles in the reserve area. At each of these profiles, the number of individual animals, areal coverage of plants, algae, and colonial animals within 4- 19.8" X 19.8" (50 cm X 50 cm) quadrats at the +1' ,0', and -1' MLLW tidal elevations were also recorded. Methodology closely followed that of Beach Watchers (WSU, 2003), with a few noted exceptions.

In general, the sites were dominated by the green algae, *Ulva* spp. and barnacles. Infaunal animals were diverse with frequent occurrences of the bivalves *Macoma inquinata, Macoma nasuta,* and *Ruditapes philippinarum.* The data presented in this report is the first year of a baseline data. It is hoped that baseline data will continue to be collected to produce a robust baseline and that the potential for trend detection will be possible in the future.

Introduction

Fidalgo Bay Aquatic Reserve (FBAR) is one of seven aquatic reserves in Puget Sound, managed by Washington State Department of Natural Resources (WDNR), where new citizen-science programs were developed in 2013. This document reports on surveys conducted in 2013 to measure and monitor the diversity, distribution, and abundance of intertidal species within the aquatic reserve. Assessment and monitoring methods were based on those established by the Washington State University Beach Watcher (WSU BW) Intertidal Monitoring Program. Modifications in the Beach Watchers monitoring protocol were made to enhance the representativeness of the data, while retaining key elements such that the studies will be largely comparable to other studies. The monitoring is intended to establish a long-term baseline for intertidal biota in FBAR with the potential of tracking changes in distribution, biodiversity, and population. Acquired baseline information can be used for natural resource damage assessment, reserve management, protection of critical habitats, tracking non-native or invasive species, and management of protected species.

Background

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

Three tideland parcels adjacent to the reserve are owned by the Swinomish Indian Tribal Community, and five are owned by the Samish Tribe. The area of the reserve south of the trestle was transferred from the Skagit Land Trust to WDNR, with the condition that it is a conservation easement. The easement requires that the area be used for fish and wildlife enhancement and limits human activities. The area of the reserve is shown in Figure 1.

Historically, Fidalgo Bay is home to both the Samish Indian Nation and the Swinomish Tribe. Both tribes 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 also are proximate to the reserve and these 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.

Figure 1: The Fidalgo Bay Aquatic Reserve and surrounding area. The blue area shows the boundaries of the reserve.
Source: (WDNR 2008)

Goals and Objectives

The goals and objectives of this intertidal monitoring are to collect baseline data over time at specific monitoring sites within the reserve 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. This monitoring is essential to determine if the reserve beaches are changing and the extent of those changes. In addition, the

monitoring program is intended to detect the impact of natural and human-induced events on the reserve intertidal biota and beach structure.

Data-Collection Methodology

The study used a transect/quadrat model with a transect line from the ordinary high water mark to -1' mean lower low water (MLLW) or lower if the tide allowed. The methodology is based on protocols developed by the WSU BW Intertidal Monitoring Program (WSU ICBW, 2003). The protocol for selection of sampling locations has been modified from this methodology by randomizing the placement of the quadrats to improve the statistical robustness of the study. Additionally, infaunal sampling was conducted. Substantial portions of the sampling were conducted by high-school students enrolled in upper level biology classes, trained in data-collection methodology, and overseen by trained citizen scientists. Details of the sampling regime, as well as additional details regarding the development and design of the program, are given in the Quality Assurance Project Plan (QAPP) for this project (Steffensen and Joyce, 2013).

Five types of data were collected:

1) **Quadrat Data: Percent Cover**. Four randomly placed 19.8" X 19.8" (50cm X 50cm) quadrats were located at each of three tidal elevations: +1', 0', and -1' (+0.3m, 0m and -.3m) MLLW. Colonial and aggregating animal and plant cover was estimated in each quadrat. Colonial and aggregating animals included barnacles, aggregating anemones, and mussels. *Littorina* spp. and limpets were not considered aggregating and were counted as individuals.
2) **Quadrat Data: Individual Species**. Using the same quadrats as those for percent cover, individual animals were counted.
3) **Core data**: A core of 5.866" x 11.8" (14.899 cm X 30cm) was taken to the right of each quadrat and species caught in a 0.5 sq." (1.27 sq. cm) mesh sieve were identified and counted.
4) **Profile Data**. Profile data were taken along a transect perpendicular to the beach face. Data recorded included beach slope and elevation, substrate type, and organism types, every 10' (3.0 m).
5) **Species Lists**. Species lists were compiled for each 10' (3.0 m) length of beach profile covering a swath 65.6' (20 meters) wide [32.8' (10 m) on either side of the profile line]. This list is more detailed and intensive than the profile data, requiring considerably more observation time. These data are presented as an Addendum to the report.

Narrative of the Field Research

Basic trainings were given in Skagit County, targeting citizen-scientist volunteers from the FBARCSC, the Skagit County Marine Resources Committee, Skagit County Beach Watchers, Trail Tales partners, and other Skagit volunteers. Similar training was also provided in Whatcom County, targeting citizen-scientist volunteers from the Cherry Point Aquatic Reserve Citizen Stewardship Committee, the Whatcom County Marine Resources Committee, Whatcom County Beach Watchers, and other Whatcom volunteers. The people who could not attend Skagit County trainings had the option to attend Whatcom County

Figure 2: In class training, photo credit: RE Sources

trainings to qualify to conduct surveys. Figure 2shows one of the classroom training sessions.

In Skagit County, 29 citizen scientists were trained in one five-hour classroom session on April 21, and one field session April 28. Training included basic protocol for measuring slope, identifying and counting plants and animals, estimating percent coverage of plants and colonial animals, and completing field data sheets. Training was also dedicated to learning the organisms by sight using key characteristics and common and scientific names.

Figure 3: Field Training, photo credit: Pete Haase

Two FBARCSC members who are professional teachers, taught two high school classes on the survey, including rationale, method, and simulations of estimating percent coverage. Trainings were then furthered in these classes by their own teachers who were given training materials.

Three locations in the FBAR were surveyed. Locations were chosen based on whether the committee could get permission to access the site, the site was physically accessible (many of the sites were too muddy to safely walk on), and to represent a diversity of habitats. A permanent profile line was established at each location, extending seaward perpendicular from the shore.

Along each profile line, three-65.6ft (20 m) transects were placed perpendicular to the profile line and approximately parallel to the shore. The transects were located one each on the +1', 0', and -1' MLLW tidal elevations. On each transect, four quadrats were randomly placed. Within each quadrat, substrates were noted, all plant and animal species were identified, percent cover was estimated for each colonial (e.g., sponge) or aggregating (e.g., barnacles) plant and animal species, and the number of each solitary animal species was recorded. In addition, a core sample was taken to the immediate right of each quadrat to a depth of 11.8 in (30 cm). Because rocky substrate precluded a full core in some locations, the depth of the core was noted at each station. After sieving through a 0.16 sq inch (1 sq. cm) mesh sieve, numbers and types of bivalve mollusks, crustaceans, and large worms were identified. Table 1 and Figure 5 provide information on the survey sites and Table 2 provides information on the survey scheduling.

Figure 4: Michael Kyte demonstrates coring; photo credit: Pete Haase

Table 1. Site Information

Site	Physical Description	Compass Bearing 1	Compass Bearing 2	Compass Bearing 3	Vertical Height	Magnetic Compass bearing for profile line	Lat.	Long.
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 deg	North point of TT threshold arch, 85 deg	Tall white square tower at refinery, 104 deg	10' 6 "	103°	N48.28.766	W 122.34.827
Fir	North side of Weaverling Spit, on Samish Indian Nation land; large Douglas fir	Peak of red roof house along TT, 321 deg	Top of rocky cliff on Cap Sante, 360 deg	White stand-alone tower to right of refinery, 72 deg	Un-known	30°	N 48.48428	W122.59298
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 deg	Northern-most point of March Point, 41 deg	Samish clubhouse 115 deg	3' 11 "	41°	N 48.49208 (Mag explorist); N48.49155 (Garmin)	W 122.59958 (Mag explorist); W 122.59985 (Garmin)

Table 2. Survey information

Site	Date	Low tide time	Low tide elevation	Number of total surveyors	Number of High Sch. surveyors*
Trestle/ "3"	5/10/2013	11:28AM	- 0.9’	38	28
Fir/ "1"	5/24/2013	10:30AM	- 2.3’	29	19
Otter/ "2"	8/19/2013	9:30AM	- 1.5’	13	0

*High School surveyors were given an abbreviated training in class. Where high school students participated in surveys, they were supervised by fully trained citizen volunteers.

Figure 5. Locations of the survey sites

Dates of sampling occurred on three low-tide days. To accommodate class schedules and incorporate high school students, weekdays were chosen, and one low tide day did not meet the requisite low tide below -1'. (5/10/13).

Results

Five sets of results were taken for each site.

1) Quadrat Data: Percent Cover
2) Quadrat Data: Individual Species
3) Core data: Individual Species
4) Profile Data: Beach slope and elevation, substrate type, and organism types
5) Species lists, by distance along profile line

Results for the quadrat and core data are shown as tables and graphs below. The tables show coverage estimates and individual counts as well as averages of estimates or counts for each species or species group. Coverage values in italics indicate that the estimate was less than the number recorded. Averages were calculated from whole numbers. Because numbers of organisms are so low in many instances, calculated averages are used; numbers in tables are shown with a higher degree of precision than known to illustrate the presence of organisms and provide the data used in the corresponding graph. Graphs depict averages of quadrat data for each tidal-height transect as colored bars and standard errors equivalent to 1 standard deviation of the sample population are shown as lines.

The conventions used in these tables and graphs include the following:
For calculated numbers, the fraction has been retained in order to show presence of infrequent individuals. Actual calculated values are used to display the graphics. The abbreviation “spp.” is used to indicate multiple species. When the term “SUM” is used, it sums all of the species of a certain genera and includes those individuals not identified down to species level.

The profile data are given in Tables 6, 10, and 14 and shown in Figures 9, 13, and 17 within the results section. The tables show the land profile, along with substrate and categories of plants and animals present. The figures depict the slope of the beach profile showing the decrease in elevation by distance from the backshore. Species lists are shown as tables as an Addendum to the report.

Data presented are for sites North to South, “Otter,” “Fir,” and “Trestle.”

Otter results

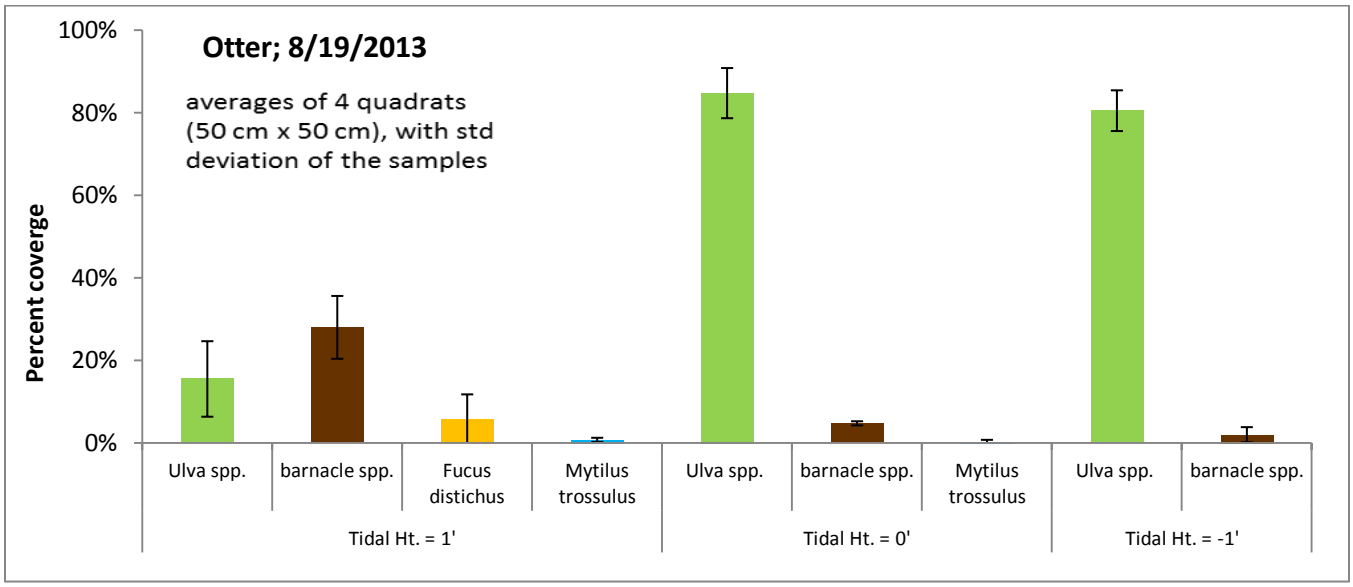

Figure 6. Percentage coverage at Otter Site

Table 3. Percentage coverage at Otter Site

Otter	**8/19/2013 Participants: FBARCS & Community Members**					
Transect Elevation	**Species**	**Quadrat, ft.**				**Average percent**
		1	2	3	4	
1'	*Ulva* sp (tubular)	1%	1%	11%	1%	3.5%
	Ulva sp (bladed)	4%	24%	10%	10%	12.0%
	Ulva spp. (SUM)	5%	25%	21%	11%	15.5%
	Balanus crenatus	24%	0%	39%	0%	15.8%
	Balanus glandula	0%	27%	0%	22%	12.3%
	Barnacle spp. (SUM)	24%	27%	39%	22%	14.0%
	Fucus distichus	0%	3%	14%	6%	5.8%
	Mytilus trossulus	0%	***1%***	1%	***1%***	0.8%
	Substrate in quadrat:	nr	M, G, C	nr	M, S, C	
		1	2	3	4	
0'	*Ulva sp (tubular)*			27%		27.0%
	Ulva sp (bladed)			52%		52.0%
	*Ulva spp. **	80%	90%	79%	90%	84.8%
	Balanus crenatus			4%		4.0%
	Semibalanus cariosus			0%		0.0%
	Barnacle spp.*	5%	5%	4%	5%	4.8%
	Mytilus trossulus	0%	0%	***1%***	0%	0.3%
	Substrate in quadrat:	M	nr	M, G	M, silt	
		1	2	3	4	
-1'	*Ulva sp (tubular)*	52%	74%	18%		48.0%
	Ulva sp (bladed)	35%	1%	62%		32.7%
	*Ulva spp. **	87%	75%	80%	80%	80.5%
	Balanus glandula	1%	0%	0%		0.3%
	Chthalamus dalli	2%	0%	0%		0.7%
	Balanus crenatus	0%	0%	***1%***		0.3%
	Barnacle spp.*	3%	0%	1%	4%	2.0%
	Substrate in quadrat:	M	M, SH	M	M	

nr= not recorded; M, S, G, C, SH, R = mud, sand, gravel, cobble, shell debris, rocks

*= field sheet in error for T0, Q1,2,and 4, and T-1, Q4; estimates from photos by expert biologist

"1%"(bold and italicized) = less than 1%

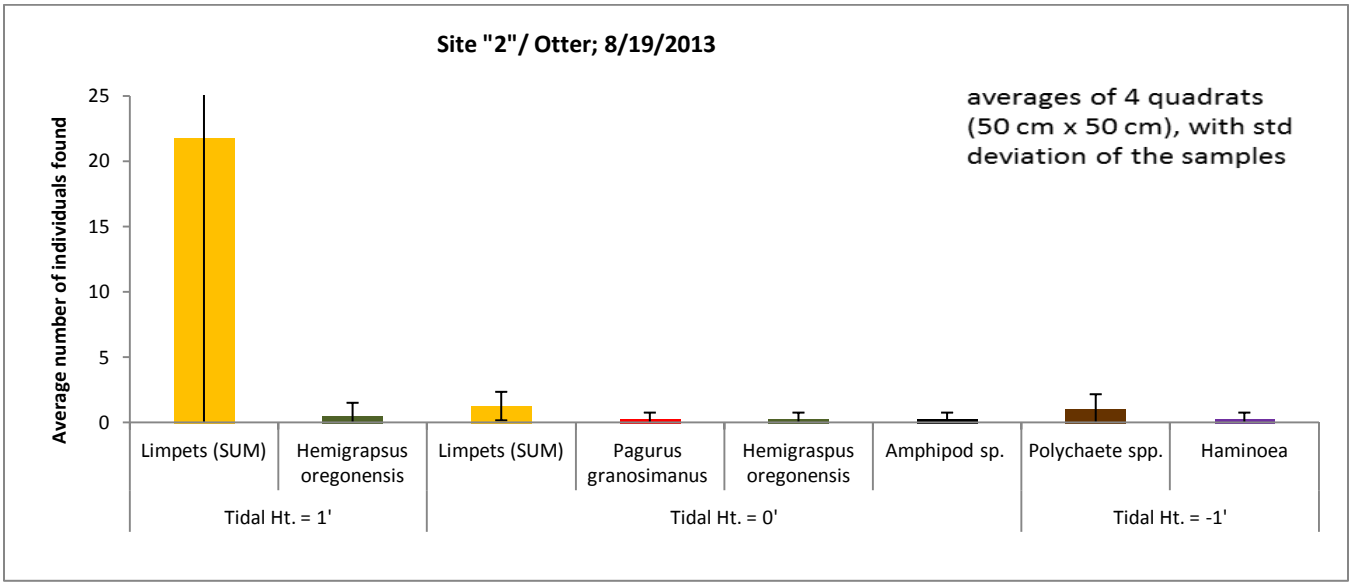

Figure 7. Individual Animal Species at Otter Site

Table 4. Individual Animal Species at Otter Site

Otter	5/24/13	Countable Animals in Quadrats				
Transect	Species & Substrate	Quadrat				Average
Elevation		1	2	3	4	Count
1'	*Tectura persona*	0	43	0	0	10.8
	Tectura scutum	0	0	0	1	0.3
	Lottia pelta	0	35	0	6	10.3
	Lottia alveus	0	0	2	0	0.5
	Limpets (SUM)	0	78	2	7	21.8
	Hemigrapsus oregonensis	0	2	0	0	0.5
	Substrate in quadrat:	nr	M, C, G	nr	M, C, S	
0'	*Tectura persona*	0	0	1	0	0.3
	Tectura scutum	0	1	0	0	0.3
	Lottia pelta	0	1	0	1	0.5
	Lottia digitalis	0	1	0	0	0.3
	Limpets (SUM)	0	3	1	1	1.3
	Pagurus granosimanus	0	1	0	0	0.3
	Hemigraspus oregonensis	0	0	0	1	0.3
	Amphipod sp.	1	0	0	0	0.3
	Substrate in quadrat:	M	nr	M, G	M, silt	
-1'	Polynoidae (type of polychaete)	0	0	0	1	0.3
	Polychaete spp.	0	2	0	1	0.8
	Polychaete spp. (SUM)	0	2	0	2	1.0
	Haminoea sp.	0	0	1	0	0.3
	Substrate in quadrat:	M	M, shells	M	M	

Notes : 1 tube of a Chaetopteridae worm found at (-)1, Q2
nr = not recorded; M, S, G, C, SH, R = mud, sand, gravel, cobble, shell debris, rocks

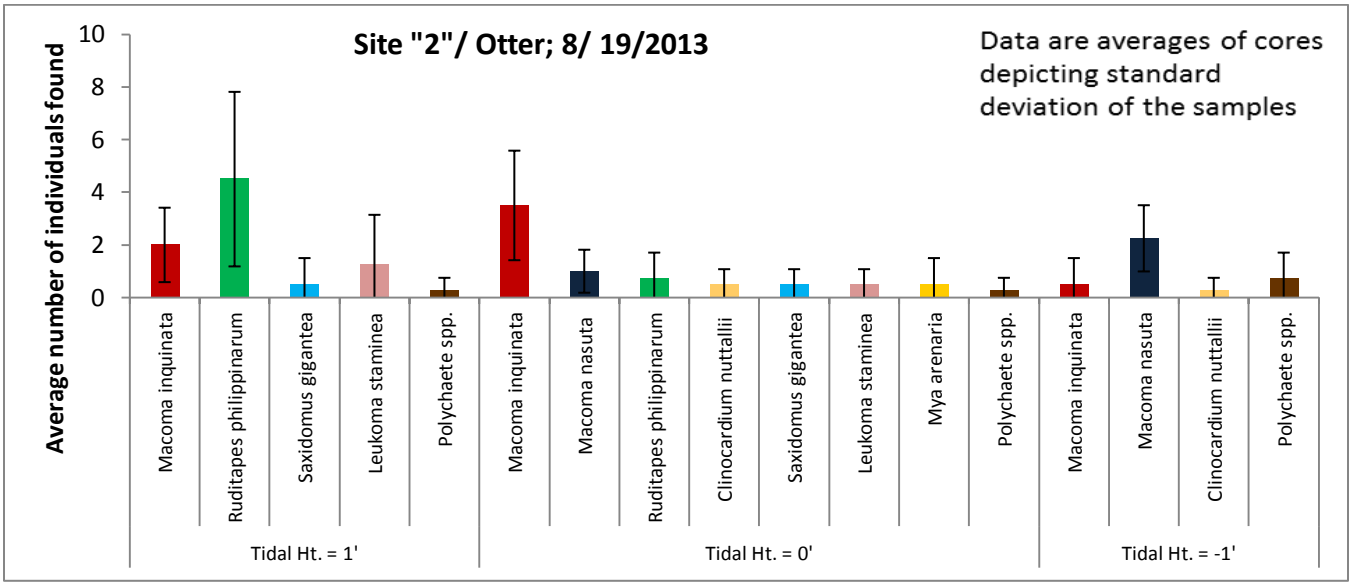

Figure 8. Infaunal Animal species at Otter Site

Table 5. Infaunal Animal species at Otter Site

Transect		Quadrat				Average
Elevation	Species	1	2	3	4	Count
1'	*Macoma inquinata*	0	3	2	3	2.0
	Venerupis philippinarum	0	7	4	7	4.5
	Saxidomus gigantea	0	2	0	0	0.5
	Leukoma staminea	4	1	0	0	1.3
	Nereididae (type of polychaete)	0	1	0	0	0.3
Core	depth	10 cm	30 cm	30 cm	30 cm	
0'	*Macoma inquinata*	4	3	6	1	3.5
	Macoma nasuta	2	1	1	0	1.0
	Venerupis philippinarum	0	2	1	0	0.8
	Clinocardium nuttallii	1	1	0	0	0.5
	Saxidomus gigantea	1	1	0	0	0.5
	Leukoma staminea	0	1	1	0	0.5
	Mya arenaria	2	0	0	0	0.5
	Lambrineris (type of polychaete)	0	0	1	0	0.3
CORE	DEPTH	30	20	30	11	
-1'	*Macoma inquinata*	0	2	0	0	0.5
	Macoma nasuta	4	2	1	2	2.3
	Clinocardium nuttallii	0	0	1	0	0.3
	Nephtyidae (a type of polychaete)	0	0	0	2	0.5
	Polychaete spp.	0	0	1	2	0.8
CORE	DEPTH	15	20	15	12	

Table 6. Profile elevation, substrate, and species type at Otter Site

Otter				Substrate (check all)							Seaweeds and Invertebrates (check all that apply)																										
Entry	Length of survey section	cumulative distance	Survey Reading + or -	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	Nudibranch	Sand Dollars	Sea Cucumbers	Seastars	Snails	Urchins	Flat Worms	Nemerteans	Polychaetes	Green Seaweeds	Red Seaweeds	Brown Seaweeds	Seagrass	Arachnid	Shrimp
1	10	10	-2.1	X		X	X	X	X		X		X			X				X						X						X	X			
2	10	20	-1	X		X	X	X	X		X		X			X				X	X					X						X	X			
3	10	30	-1	X		X	X	X	X		X		X		X	X				X	X					X				X		X	X			
4	10	40	-1.1	X	X	X	X	X	X				X		X	X			X	X	X					X		X	X	X	X	X	X			
5	10	50	-0.8	X	X	X	X	X	X				X		X	X				X	X					X					X		X			
6	10	60	-0.8	X	X		X	X	X				X	X	X	X				X	X									X	X		X			
7	10	70	-0.45	X	X		X	X			X		X		X					X	X									X	X					
8	10	80	-0.3	X	X		X	X			X	X	X	X	X	X			X	X					X	X				X	X					

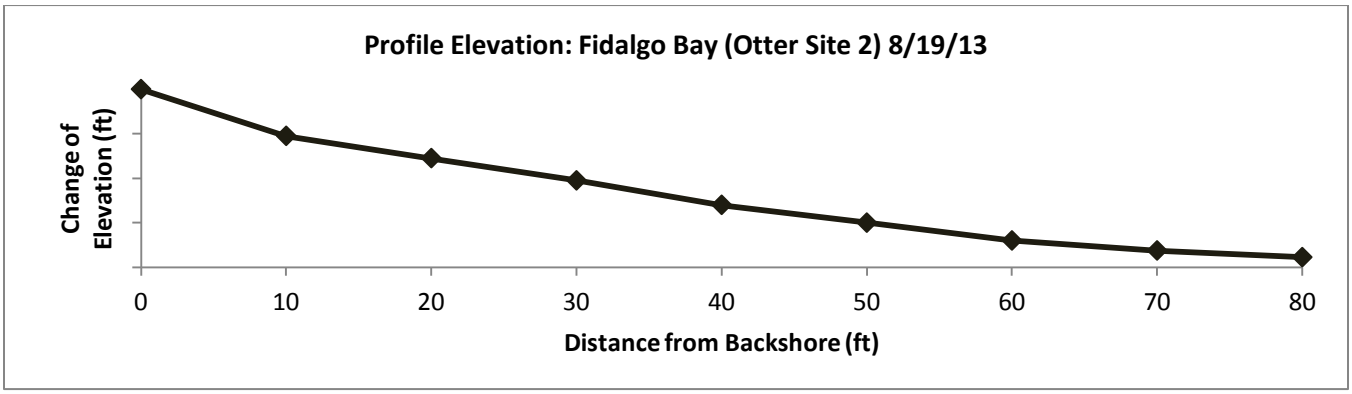

Figure 9. Depiction of profile elevation at Otter site

Otter discussion

The Otter site, so named, because of its adjacency to the Otter sculpture on the Tommy Thompson trail had a high percent of *Ulva* spp., especially at the 0' and -1' MLLW tidal elevations, where coverage was approximately 80%. Barnacles were also prevalent, being higher at the +1' elevation. Limpets and crabs were the most numerous animals on the surface. A wide variety of bivalves were found in the infaunal cores, with *Macoma inquinata* and *Ruditapes philippinarnum* usually found in the +1' and 0' elevations, and *Macoma nasuta* being found at the -1' elevation.

Fir results

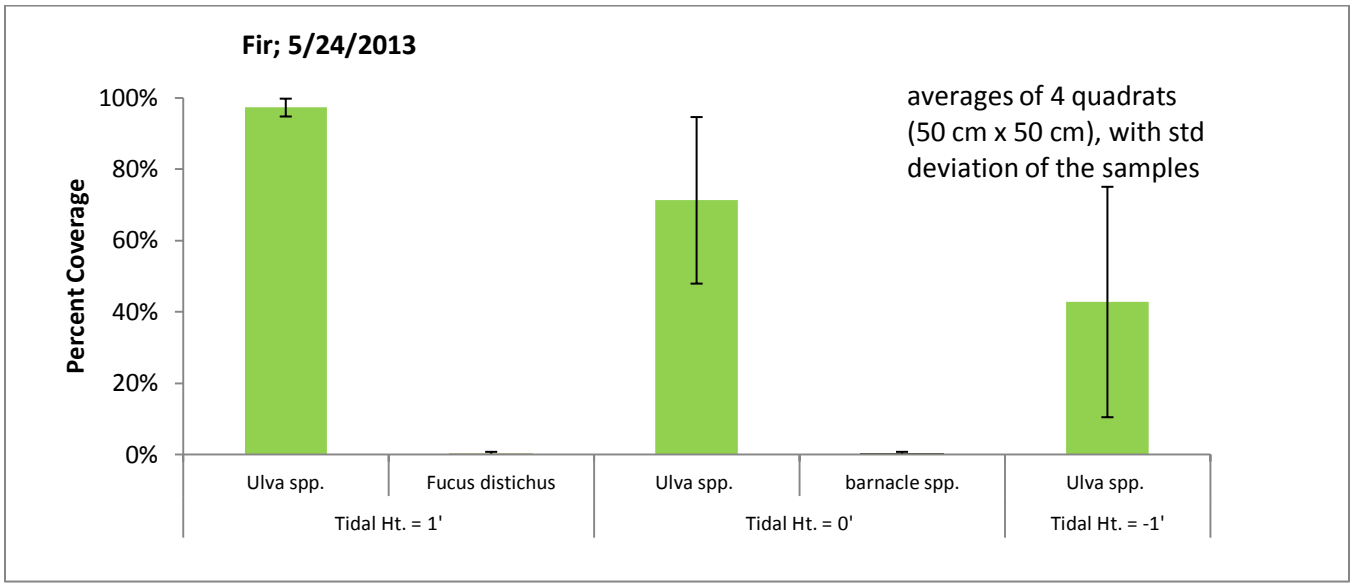

Figure 10. Percentage coverage at Fir Site

Table 7. Percentage coverage at Fir Site

Fir	5/24/2013	Participants: FBARCS & Anacortes HS				
Transect Elevation	Species	Quadrat, ft. 1	2	3	4	Average percent
1'	*Ulva (bladed)*	97%	67%	57%	39%	65.0%
	Ulva (tubular)	0%	27%	41%	61%	32.3%
	Ulva spp (SUM)	97%	94%	98%	100%	97.3%
	Fucus distichus	0%	0%	1%	0%	0.3%
	Substrate in quadrat:	M	nr	nr	M, G	
		1	2	3	4	
0'	*Ulva (bladed)*	12%	65%	51%	90%	54.5%
	Ulva (tubular)	27%	19%	19%	***2%***	16.8%
	Ulva spp. (SUM)	39%	84%	70%	92%	71.3%
	Barnacle spp.	1%	0%	0%	0%	0.3%
	Substrate in quadrat:	M, R	M, R	M, R	M	
		1	2	3	4	
-1'	*Ulva (bladed)*	18%	0%	71%	66%	38.8%
	Ulva (tubular)	12%	3%	0%	1%	4.0%
	Ulva spp. (SUM)	30%	3%	71%	67%	42.8%
	Substrate in quadrat:	M	M	M	M, R	

nr= not recorded; M, S, G, C, SH, R = mud, sand, gravel, cobble, shell debris, rocks

"1%" (bold and italicized) = less than 1%

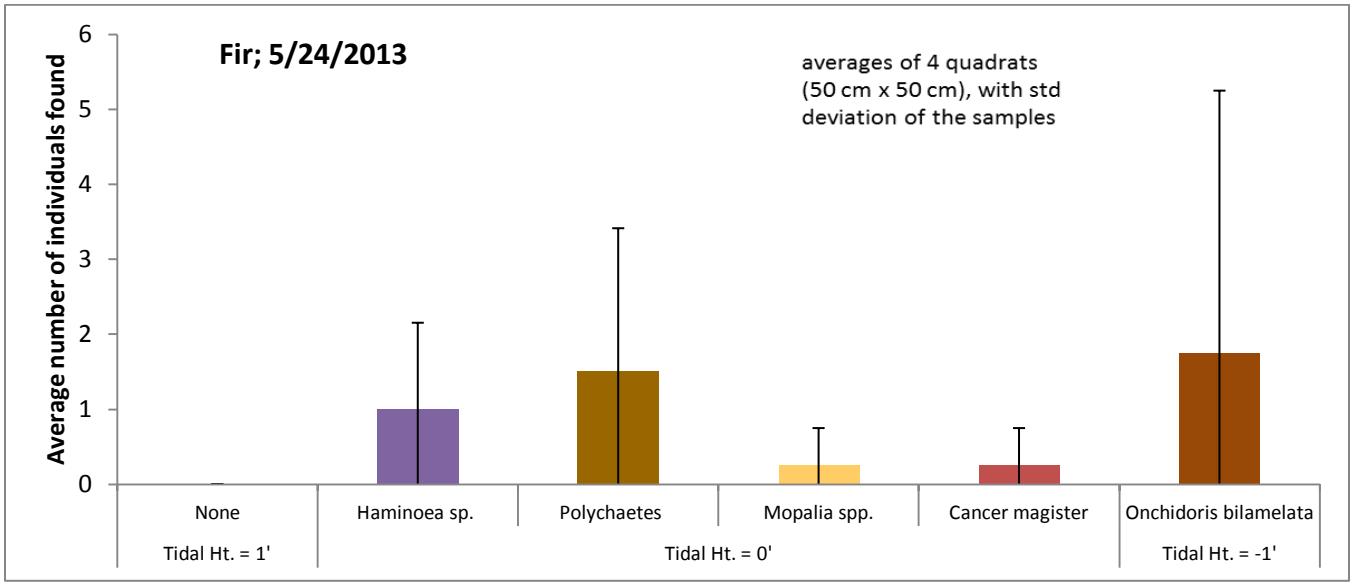

Figure 11. Individual Animals at Fir Site

Table 8. Individual Animals at Fir Site

Fir	**5/24/2013**	**Countable Animals**				
Transect		Quadrat				**Average**
Elevation	**Species**	1	2	3	4	**Count**
1'						
	Substrate in quadrat:	M	nr	nr	M, G	
0'	*Haminoea sp.*	2	0	0	2	1.0
	Hesionidae sp. (polychaete)	0	0	0	2	0.5
	Polychaete spp.	4	0	0	0	1.0
	Polychaete spp. (SUM)	4	0	0	2	1.5
	Mopalia sp.	0	1	0	0	0.2
	Cancer magister	0	0	0	1	0.2
	Substrate in quadrat:	M, R	M, R	M, R	M, R	
-1'	*Onchidoris bilamelata* (Sea slug)	0	0	7	1	2.0
	Substrate in quadrat:	M	M	M	M, R	

nr= not recorded; M, S, G, C, SH, R = mud, sand, gravel, cobble, shell debris, rocks

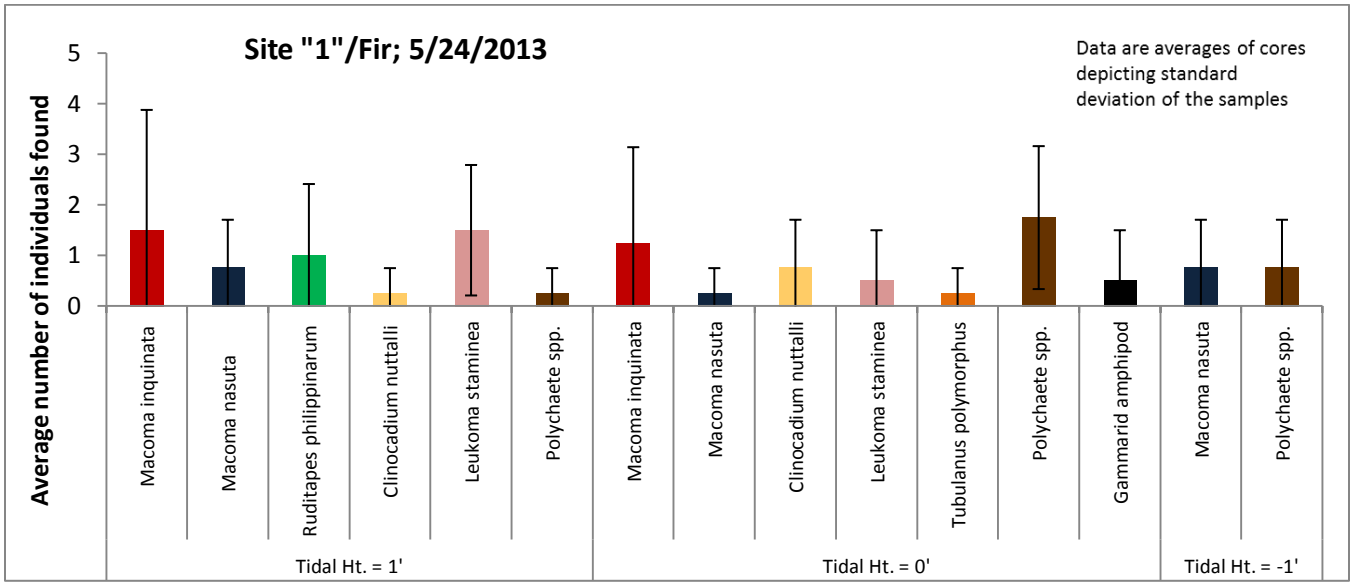

Figure 12. Infaunal animals at Fir Site

Table 9. Infaunal animals at Fir Site

Transect	Species	Quadrat				Average Count
Elevation		1	2	3	4	
1'	*Macoma inquinata*	0	1	5	0	1.5
	Macoma nasuta	0	1	0	2	0.8
	Venerupis philippinarum	1	0	3	0	1.0
	Clinocardium nuttalli	0	0	0	1	0.3
	Leukoma staminea	1	3	0	2	1.5
	Nephytidae	1	0	0	0	0.3
	Polychaete spp.	1	0	0	0	0.3
0'	*Macoma inquinata*	0	1	4	0	1.3
	Macoma nasuta	0	0	0	1	0.3
	Clinocardium nuttalli	1	0	0	2	0.8
	Leukoma staminea	0	0	2	0	0.5
	Tubulanus polymorphus	1	0	0	0	0.3
	Nereididae sp. (polychaete)	2	0	0	0	0.5
	Nephtys sp. (polychaete)	0	0	0	2	0.5
	Polychaete spp.	0	3	0	0	0.8
	Polychaete spp. (SUM)	2	3	0	2	1.8
	Gammarid amphipod	0	0	0	2	0.5
-1'	*Macoma nasuta*	2	1	0	0	0.8
	Nephtys sp. (polychaete)	0	0	2	0	0.5

Table 10. Profile elevation, substrate, and species type at Fir Site*

Site 1/ FIR				Substrate (check all)							Seaweeds and Invertebrates (check all that apply)																									
Entry	Length of survey section	cumulative distance	Survey Reading + or -	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	Nudibranch	Sand Dollars	Sea Cucumbers	Seastars	Snails	Urchins	Flat Worms	Nemerteans	Polychaetes	Green Seaweeds	Red Seaweeds	Brown Seaweeds	Seagrass	Arachnid	Shrimp
1	10'	30	+ 0.25																																	
2	10'	40	- 1.0																																	
3	10'	50	-1.1																																	
4	10'	60	-1.8																																	
5	10'	70	-2.0				X						X			X			X	X						X					X		X		X	
6	10'	80	-1.5				X						X		X	X				X	X								X	X	X					
7	10'	90	-1.4				X						X		X	X				X						X			X	X	X		X			
8	10'	100	-0.7	X	X	X	X	X					X			X				X						X				X	X		X			
9	10'	110	-0.5	X	X	X	X	X	X																				X		X		X			
10	10'	120	-0.6	X	X	X	X								X															X	X		X	X		
11	10'	130	-0.5	X	X	X	X																								X					
12	10'	140	-0.3	X	X		X	X																							X					
13	10'	150	-0.3	X	X		X																								X					
14	10'	160	-0.2	X	X		X																								X					

*some data was filled in from species list due to a lack of information on the field data sheet

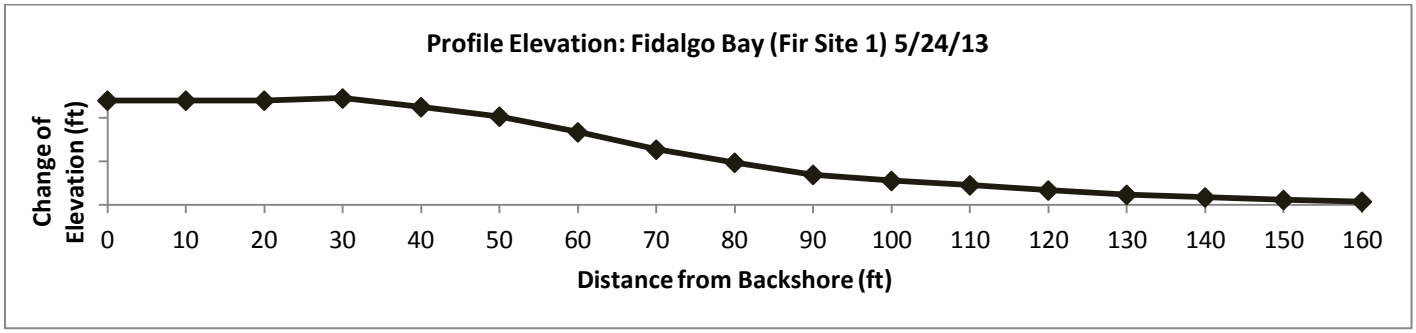

Figure 13. Depiction of profile elevation at Fir site

Fir discussion

Ulva spp. were predominant at the Fir site, so named for a large fir tree from which the profile line started. *Ulva* spp. were nearly 100 % at the +1' elevation and dropped to about 40% at the -1' level. Other epibiota species were present at low numbers in the quadrats. Limpets, which are usually fairly common, were not found in the quadrats. The Species List at the Fir site, did however, list limpets. Infaunal species were diverse.

Trestle Results

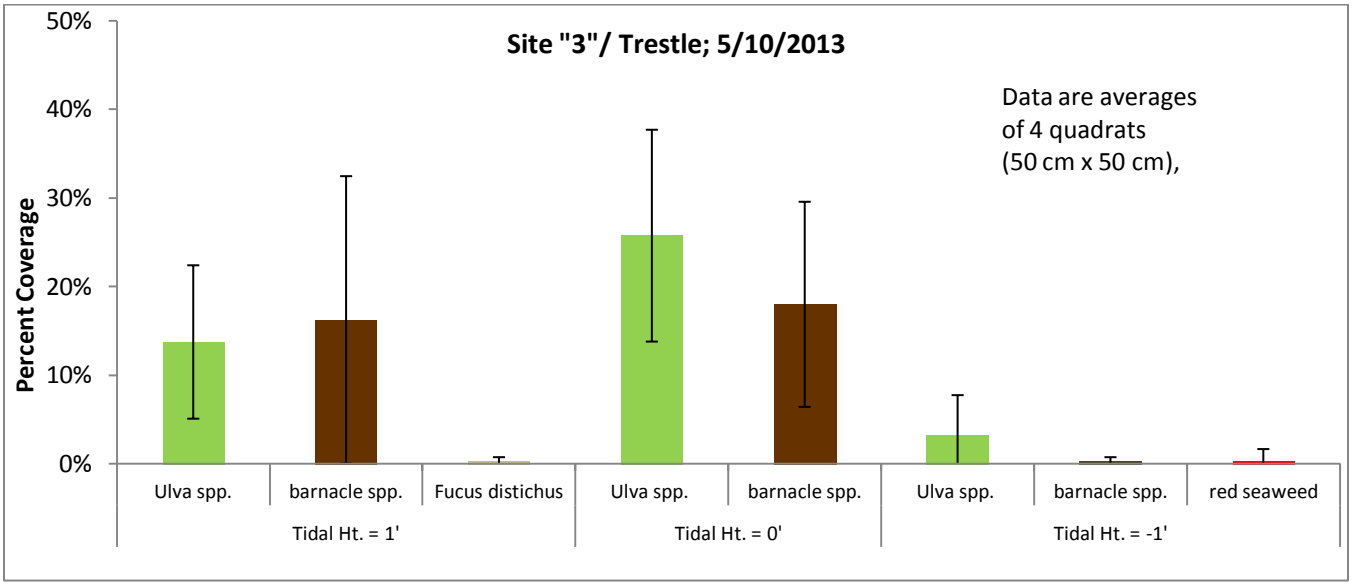

Figure 14. Percentage coverage at Trestle Site

Table 11. Percentage coverage at Trestle Site

Transect Elevation	Species and Substrates	Quadrat				Average Percent
		1	2	3	4	
1'	*Ulva* spp.	13%	18%	22%	2%	13.8%
	Barnacle spp.	2%	0%	0%	0%	0.5%
	Balanus crenatus	0%	0%	34%	0%	8.5%
	Balanus glandula	0%	0%	0%	26%	6.5%
	Barnacle spp. (SUM)	2%	3%	34%	26%	16.3%
	Fucus distichus	0%	0%	0%	1%	0.3%
	Substrate in quadrat:	M, G, SH	M	M, R	M, G	
		1	2	3	4	
0'	*Ulva* spp.	11%	28%	24%	40%	25.8%
	Barnacle spp.	7%	13%	34%	18%	18.0%
	Substrate in quadrat:	M, R	M, R	M	M,R	
		1	2	3	4	
-1'	*Ulva* spp.	10%	1%	***1%***	1%	3.3%
	Barnacle spp.	0%	0%	***1%***	0%	0.3%
	Red algae	3%	0%	0%	1%	1.0%
	Substrate in quadrat:	M	M	M	M,R	

"1%" (bold and italicized) = less than 1%

M, S, G, C, SH, R = mud, sand, gravel, cobble, shell debris, rocks

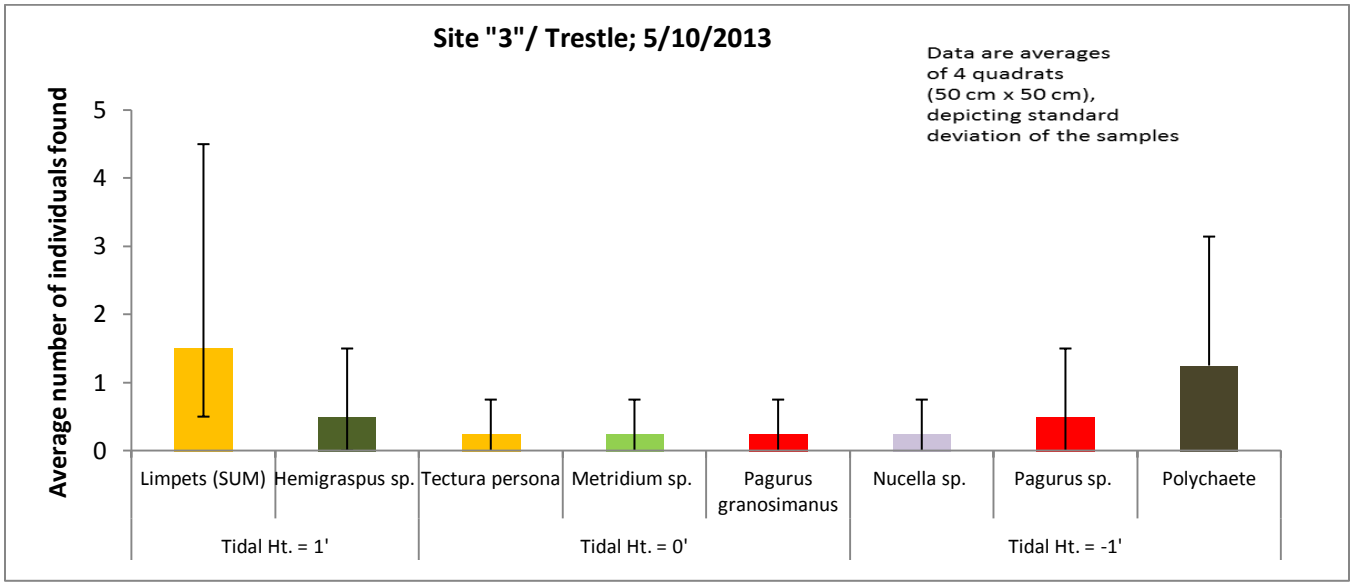

Figure 15. Individual Animals at Trestle Site

Table 12. Individual Animals at Trestle Site

Trestle	Date: 5/10/2013	Countable Animals				
Transect	Species	Quadrat				Average
Elevation		1	2	3	4	Count
1'	*Hemigraspus sp.*	2	0	0	0	0.5
	Limpets (SUM)	0	6	0	0	1.5
Substrate:		M, SH, G	M	M, R	M, G	
0'	*Metridium sp.*	0	0	0	1	0.3
	Pagurus granosimanus	0	0	1	0	0.3
	Tectura persona	0	0	0	1	0.3
Substrate:		M, R	M, R	M	M, R	
-1'	*Pagurus sp.*	2	0	0	0	0.5
	Nucella sp.	1	0	0	0	0.3
	Polychaete	1	0	0	4	1.3
Substrate:		M	M	M	M, R	

M,S, G, C, SH, R = mud, sand, gravel, cobble, shell debris, rocks

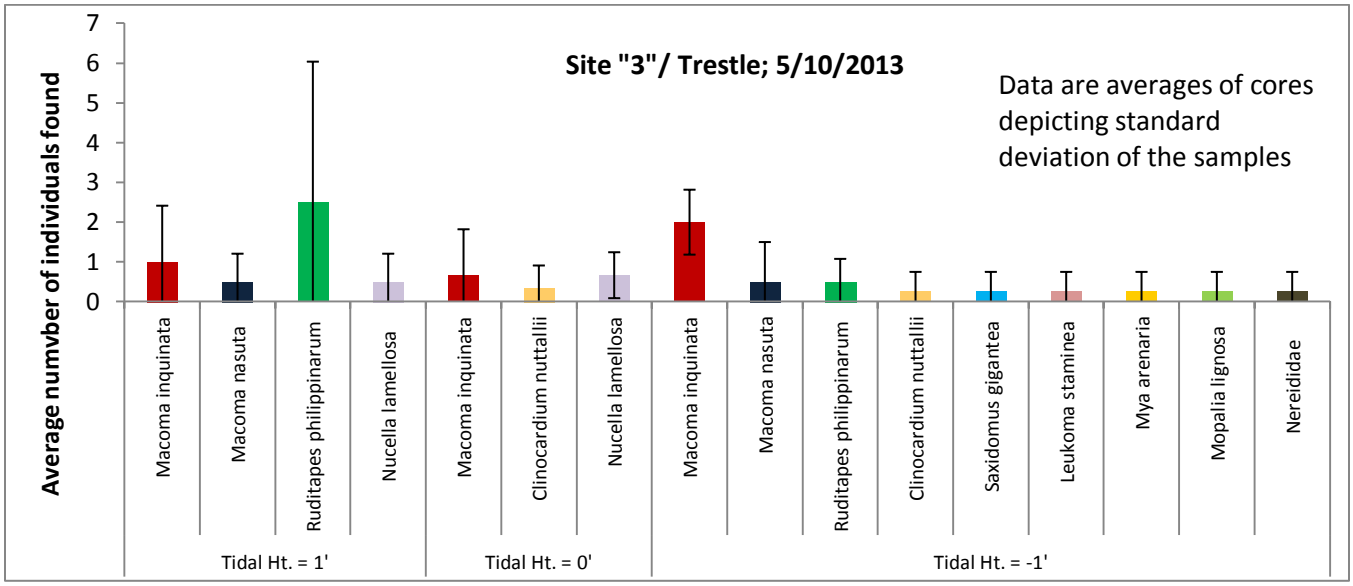

Figure 16. Infaunal Animals at Trestle Site

Table 13. Infaunal Animals at Trestle Site

No. cores	Species	Quadrats				Average Count
		1	2	3	4	
+1	*Macoma inquinata*	2	nd	nd	0	1.0
	Macoma nasuta	0	nd	nd	1	0.5
	Venerupis philippinarum	0	nd	nd	5	2.5
	Nucella lamellosa	0	nd	nd	1	0.5
0	*Macoma inquinata*	0	2	0	nd	0.7
	Clinocardium nuttallii	1	0	0	nd	0.3
	Nucella lamellosa	1	1	0	nd	0.7
-1	*Macoma inquinata*	1	2	2	3	2.0
	Macoma nasuta	0	0	0	2	0.5
	Venerupis philippinarum	0	1	0	1	0.5
	Clinocardium nuttallii	0	0	1	0	0.3
	Saxidomus gigantea	0	0	0	1	0.3
	Leukoma staminea	0	0	0	1	0.3
	Mya arenaria	0	0	0	1	0.3
	Mopalia lignosa	0	1	0	0	0.3
	Nereididae	0	0	1	0	0.3

nd= not done; rocky substrate precluded cores from being taken in some areas

Table 14. Profile elevation, substrate, and species type at Trestle Site

Site 3/ Trestle				Substrate (check all)							Seaweeds and Invertebrates (check all that apply)																									
Entry	Length of survey section	cumulative distance	Survey Reading + or -	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	Nudibranch	Sand Dollars	Sea Cucumbers	Seastars	Snails	Urchins	Flat Worms	Nemerteans	Polychaetes	Green Seaweeds	Red Seaweeds	Brown Seaweeds	Seagrass	Arachnid	Shrimp
1	10'	10	-6.0																																	
2	10'	20	-1.0	X	X	X	X	X	X		X		X			X				X	X					X					X		X			
3	10'	30	-1.5	X	X	X	X	X	X				X		X	X				X	X					X					X		X	X		
4	10'	40	-1.0	X	X	X	X	X	X		X		X	X	X	X		X	X		X					X					X					
5	10'	50	-1.0	X	X		X	X	X			X	X		X	X				X						X				X	X		X			

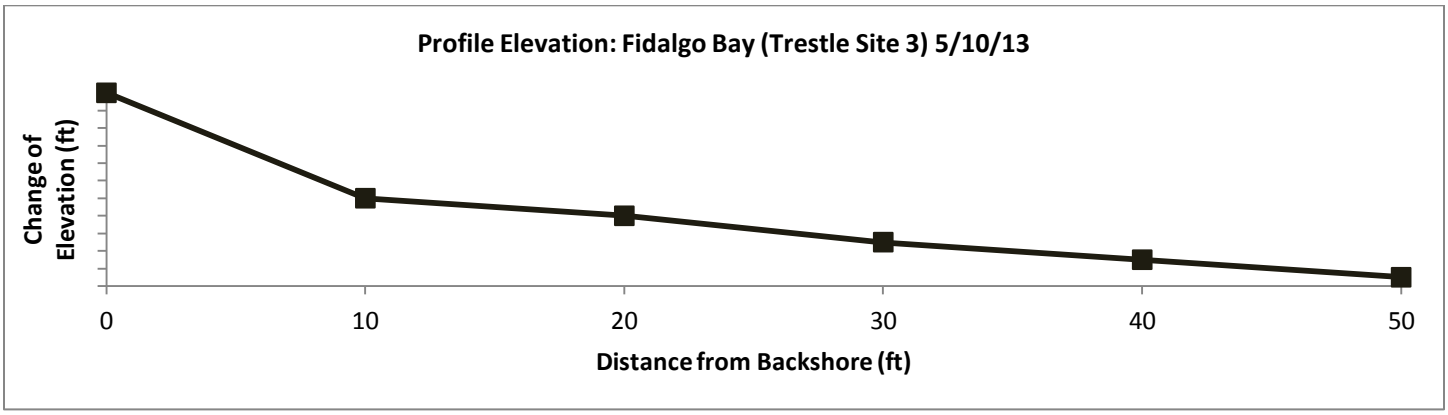

Figure 17. Depiction of profile elevation at Trestle site

Trestle discussion

The trestle site, located at the west end of the trestle across the Tommy Thompson trail, is a muddy and rocky site. The slope of the beach was measured from the steel pole marker on the trestle on the NW side of the walkway. The backshore is constructed of riprap and constitutes an unnatural beach. Thus, the actual backshore is considered to start at the 10' mark. Life in the +1' and 0' quadrats is comprised of mainly *Ulva* and barnacles. Infaunal animals were diverse, with *Macoma inquinata* being present at all three tidal heights measured.

Discussion

The predominant substrate present at all sites was mud, although it seemed to be muckier and stickier 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.

Figure 18: Estimating percent coverage at the Otter site. Photo credit: Pete Haase

Ulva was the predominant alga, with very small amounts of *Fucus distichus* and red algae present at some locations. There was nearly 100% coverage by *Ulva* at Fir, +1' and at Otter, 0' and -1'. All sites had relatively low diversity in terms of percent coverage, but the Fir site was the least diverse, showing *Ulva* in large amounts, with very limited sighting of barnacles and fucus.

Countable species were generally low in number at all sites, with various species of limpets and polychaetes being present and numerous occasions of *Pagurus* (hermit crab) and *Hemigrapus* sp. (shore crab) and *Haminoea* (bubble snail). One quadrat at the Otter site, +1', was the exception, where nearly 80 limpets were counted. The Fir site again was the least diverse, likely owing to having nearly 100% coverage of *Ulva* at +1'.

Many of the same animals were found in infaunal samples across the three sample sites. Species that were most predominant included the clams *Macoma inquinata* (pointed macoma), *Macoma nasuta* (bentnose *macoma*), and *Ruditapes phillpinarium* (Japanese littleneck). The latter was found predominantly at +1'.

According to the QAPP, "The goals and objectives of the intertidal monitoring in the two reserves are to collect baseline data over time at specific monitoring sites and to potentially 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 first year, we have collected data on beach slope, substrate, and biodiversity at three separate sites in the Fidalgo Bay Aquatic Reserve. With continued fine-tuning and sampling, we will be able to compare changes in these parameters over time.

Recommendations for any Modification of the Procedures and the Overall Program

Overall, we believe we have gathered valuable data and that this data paints an accurate picture of the intertidal life in Fidalgo Bay. From our learning over the past year, we highlight some things that served us particularly well, as well as several recommendations to increase the accuracy of our data.

Highlights

- Partnership with other like-minded and similarly trained groups helped fill recruitment for our beach days and mentorship for our high school students.
- Collaborating with high schools provided people to do the assessments and coring, and brought real connection between younger and older generations.
- Coring work helped round out the diversity of the species present on the beaches and helped generate additional interest.
- Having experts on the beach was essential, for those hard to identify organisms.

Recommendations

- Training: in the coming year we will place more of an emphasis on the organisms that were routinely found.
- Participation: All participants will need to have attended basic training; some of the high school students were brought as part of a class but did not have the same basic training.
- Coring: As part of procedure, remove any surface animals so they do no become counted as "infaunal"
- Photographing quadrats: Take photo after removing debris and unattached algae
- Quality Control: The on-the beach portion will include,
    - Ensuring that all blanks are filled out
    - Ensuring that animals and plants are placed in correct category (% coverage vs. countable species)
    - Asking that participants total the entire % coverage—and have them assess whether that is reasonable (Some estimates were greater than 100%)
    - QC specialist eyeballs estimates and verifies that these seem reasonable
- Station identification: We will ensure that GPS information includes units and reading unit (decimal degrees or degrees, minutes, seconds) and that compass readings include declination.
- Timing of surveys: It would be advantageous for all surveys to take place within the same month, so that they can be more easily compared. Adding additional survey sites: This would increase our understanding of the diversity in Fidalgo Bay.

Additional discussion

- Coring devices were set up to core to a depth of 30 cm. Initially, variable amounts of material were cored, but were not recorded. During the sampling season, the data sheet was amended so that this information could be recorded. Currently, the core data are semi-quantitative, as cores cannot be compared from one to another. It is possible that infaunal animals could be expressed per 10cm. However, because different animals may preferentially be located at different depths, it is not clear whether this would be scientifically valid.
- It would be of interest to explore the relationship of *Ulva* sp. at the different sites to other physical parameters that might explain the difference in coverage. Potential physical parameters might be stormwater/ freshwater inputs and finer resolution of any substrate differences.
- Additional quadrats and cores could be analyzed to increase the statistical robustness of the data.

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Acknowledgments

Most of the sampling protocols and procedures are based on the work of the Island County/WSU Beach Watchers. We thank them for the use of their materials and assistance. In particular, we thank Barbara Bennett, project coordinator for her assistance.

We also thank our partners at WDNR and especially Betty Bookheim for her assistance in refining the procedures. We thank Dr. Megan Dethier of University of Washington for her assistance in helping us resolve some of the theoretical issues in the sampling protocol.

We thank Michael Kyte, Bob Lemon, and John Miller for their assistance in the field, to help identify organisms.

We thank Tom Gries, Betty Bookheim, Michael Kyte, and Bob Lemon for their review and insightful comments and suggestions.

Gratitude is extended to Monica Tonty, Marissa McBride, and Taylor Garrod, tireless RE Sources interns who spent many hours entering data and making graphs, and to Maddie Foutch for tireless support throughout the entire project.

And, finally, a heartfelt thank you to the committee members and volunteers without which, this work would have not been possible.

Appendix A: Data Forms

The following data forms will be used in this project:

Form	Purpose
Quadrat Estimation Worksheet	Assess percentage coverage
Fidalgo Quadrat Sheet-Students, 2p	Quadrat analysis, Fidalgo Bay AR
Fidalgo Quadrat Sheet-Non-student, 2p	Quadrat analysis, Fidalgo Bay AR
Beachwatcher D- 4, Field data sheet	Profile elevation , substrate type and species type
Species Checklist_latin, 2p	Species identification
Profile Start Point Form	Record start point with multiple readings
Beachwatcher D- 2, Vertical Height Form	Record presence and dimensions of structure on or near the profile line
Beachwatcher D-3 Directions to Beach Form3	Identifies general location of beach and then provides specific information to locate start point

QUADRAT ESTIMATION worksheet: transfer totals to QUADRAT DATA sheet

Site_____ Date and Time_____

Identifier:_____ Recorder_____

Other Team members:_____ and _____

Transect Elevation (circle one): +1’ 0’ -1

Quadrat Number _____, Quadrat Distance along transect line _____ Along Profile line_____

Organism: _ Row Totals

Grand Total:

Organism: ___ Row Totals

Grand Total:

Organism: __ Row Totals

Organism: ____ Row Totals

FIDALGO BAY AQUATIC RESERVE INTERTIDAL BIOTIC MONITORING

LEAD:_____

Team names: _____and _____

Identifier:_____Recorder:_____

Site: _____

Date & Time of sampling: _____

For Profile # ____, from ___ ft to ___ ft.

LIST OF ORGANISMS IN OUR PROFILE RECTANGLE:

OUR QUADRAT DATA:

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

Quadrat #: _____

Distance of Quadrat along transect: _____

Substrate in quadrat _____

ALGAE, PLANTS, AND COLNIAL ANIMALS:

	Organism Name	% Cover		Organism Name	% Cover
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

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

Pg. 1/2

COUNTABLE ANIMALS:

	Organism Name	Number		Organism Name	Number

COUNTABLE ANIMALS:

	Organism Name	Number		Organism Name	Number
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

ANIMALS BURIED IN THE SEDIMENT:

	Organism Name	Number		Organism Name	Number
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

NOTES AND OBSERVATIONS (i.e weather, dominant vegetation, tide, invasives, etc)

Pg. 2/2

Aquatic Reserve Intertidal Biotic monitoring QUADRAT DATA SHEET

LEAD:_____

Team names: _____ and _____

Identifier: _____ Recorder: _____

Site: _____

Date and Time of sampling: _____

OUR QUADRAT DATA:

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

Quadrat #: _____

Quadrat distance: _____

Substrate in Quadrat: _____

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

transferred information from QUADRAT ESTIMATION worksheet

	Organism Name	% Cover		Organism Name	% Cover
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

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

COUNTABLE ANIMALS:

	Organism Name	Number		Organism Name	Number
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

NOTES AND OBSERVATIONS (i.e weather, dominant vegetation, tide, invasives, etc)

_____

_____

_____

ANIMALS BURIED IN THE SEDIMENT:

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

	Organism Name	Number
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Core Depth : *circle one* 10 cm 20 cm 30 cm

NOTES AND OBSERVATIONS (i.e weather, dominant vegetation, tide, invasives, etc)

Pg. 2/2

LEAD:_____

Team names: _____and _____

Identifier:_____Recorder:_____

Site: _____

Date & Time of sampling: _____

		Elevation Distances					
Genus/Species name	Common Name						
Tubulanus polymorphus	Orange ribbon worm						
Emplectonema gracile	Green ribbon worm						
Cerebratus sp.	Tan ribbon worm						
amphipourous sp.	Tan ribbon worm						
Arenicolidae	Lugworm						
Hesionidae	Bat star worm						
Glyceridae	Bloodworms						
Nephytidae	Goddess worms						
Nereidae	Pile worm						
Onuphidae sp.	Pile worm						
polynoidae	Scale worm						
Lumbrineridae sp.	Iridescent worms						
Batillaria cumingi	Mudflat snail						
Littorina stikana	Sitka periwinkle						
Lacuna sp	Chink shells						
Nucella lamellosa	Frilled dogwinkle						
Nucella canaliculata	Channeled dogwinkle						
Searlesia dira	Dire whelk						
Lottia pelts	Shield limpet						
Tectura scutum	Plate limpet						
Tresus capax	Horse clam						
Macoma nasuta	Bent-nose macoma						
Saxidomus gigantea	Butter Clam						
Venerupis philippinarum	Japanese littleneck						
Protothaca staminea	Pacific littleneck						
Genus/Species name	Common Name	Elevation Distances					
Clinocardium nuttallii	Heart Cockle						
Mytilus trossulus	Pacific blue mussel						

Genus/Species name	Common Name	Elevation Distances					
Clinocardium nuttallii	Heart Cockle						
Mytilus trossulus	Pacific blue mussel						
Hemigraspus oregonensis	Hairy shore crab						
Hemigraspus nudus	Purple shore crab						
Pagurus beringanus	Bering Hermit						
Balanus glandula	Acorn barnacle						
Balanus crenatus	Crenate barnacle						
Semibalanus cariosus	Haystack barnacle						
Chthamalus dalli	Little brown barnacle						
Ulva lactuca	Sea lettuce						
Ulva intestinalis	Sea lettuce						

APPENDIX D-1. PROFILE START POINT FORM

Start Point of Permanent Profile Line

BEACH SITE_____

Beach Watcher(s) _____

Date of Measurements _____

STARTING POINT -- 3 COMPASS READINGS

Compass Reading	Description of Point Sighted for Reading
1.	
2.	
3.	

LONGITUDE _____

LATITUDE _____

APPENDIX D-2. VERTICAL HEIGHT FORM

Vertical Height of Permanent Structure Close To or On Profile Line

BEACH SITE _____

Beach Watcher(s) _____

Date of Measurements _____

Description of the structure you are measuring: _____

_____

_____

_____

Where is the structure in relation to your profile line? _____

_____

_____

_____

Compass reading: _____(to clarify the direction measurement was made)

HEIGHT: _____(specify feet, inches, tenths, centimeters)

Attach a photo or sketch below to show how the above measurement was made.

APPENDIX D-3. DIRECTIONS TO BEACH FORM

Directions for Access to a Monitored Beach

Name of beach_____County_____

Monitoring Team Leader _____Phone_____

Nearest Town _____Nearest Body of Water _____

GPS Coordinates of Starting Point (if available)

GPS Brand_____GPS Model_____

Latitude_____Longitude_____PDOP_____

Directions to Beach Access (from major intersection or town):

Directions to Starting Point from Beach Access:

Compass Reading (magnetic) for Profile:_____
(from starting point to horizon over the water)

Appendix B: Field Instructions

Intertidal Monitoring STEP BY STEP:

REMIND Everyone NOT to walk below +1 before quadrats are set AND do Not walk in quadrats!

Placement of Profile Swath:

After the profile line is set, one can start setting the outer limits of the profile swath using small marker flags. The swath is 20 meters wide, thus mark 10 meters on each side the profile line, every 10 linear feet of the profile. In the =1, 0, -1 area of the profile, do not mark the area of the swath until after the quadrats have been placed.

Placement of Transect Lines:

As the tide is going out- place markers at +1, 0, and -1. To determine placement, use the nearest tide chart location and place the marker at the midway point as tide is lapping in and out at the time designated by the tide chart. Place a line or tape measure at the +1, 0, and -1 levels as soon as possible. The transect length should be 20 meters (66 feet). Place the tape with 0 feet at the left and 10 meters (33 feet) at the profile line.

Placement of Quadrats:

Place 4 quadrats as soon as possible after the transects are placed. In this way, quadrat placement demarcates the area where participants are not to walk. The location of the first quadrat is randomly selected and placement of subsequent quadrats are placed at equal intervals. To place the first quadrat use a prepared computer-generated randomization chart for the numbers 0-4. Add 5, 10, and 15 to the numbers to get your measure. (When materials are only in English units, transect length will be 66 ft, and random numbers will be from 0-16, and the numbers 16.5, 33, and 49.5 will be added to get the correct measure). Quadrats will be placed below the transect line with the top left corner of the quadrat placed on the random number. For example:

- For random number 4 (meters); place quadrats at: 4 m, 9m, 14m, 19m
- For random number 10 (feet); place quadrats at 10 ft, 26.5 ft, 49 ft, and 59.5 feet

Random numbers:

- 0-4:

  2 2 3 3 4 1 1 4 2 2 1 4 3 4 4 4 2

- 0-16:

  2 3 13 13 8 4 0 6 7 7 8 4 15 10 5 5 4

Measuring Elevation Using Profile Poles:

Begin at the starting point of the profile line. Person A has profile pole #1 with the peephole- This will always by the shoreward pole. Person B has profile pole #2. Person B walks profile pole #2 ten feet down the profile line towards shore. Level both poles. Person A peeks through profile pole #1 peephole and directs her line of sight across the water to the horizon. Person A then matches the horizon line with the height at which it intersects profile pole #2. Observe the height of this intersection as it is measured on pole #2 and record in the Profile Data Sheet. This tells us the elevation change of each profile section.

Person A then walks her pole down and levels it on exactly the same spot that Person B had pole #2. Person B then walks his pole #2 down 10 more feet. Repeat the process until the end of the profile line is reached (water's edge). Extra surveyors can be used to assist in leveling the poles and scribing.

Recording <u>Types of Organisms</u> on Profile Swath:

Record with a checkmark all of the types of substrates, plants and animals found within each profile section (10 feet long by 20 meters wide) in the *Profile Data Sheet*. Start at the highest profile section and work your way down the beach, one profile section at a time. The form indicates 1-10, 10-20, etc.. This refers to the distance in feet along the profile line, towards shore. Use a key to identify findings but at this point we only need to specify 'type' of organism. Gently lift rocks to investigate and gently roll rocks back over in the same position you found them. Depending on the number of surveyors, this can occur concurrently with 'Measuring Elevation'.

<u>Recording Species</u> on Profile Swath:

Record with a checkmark all of the species of plants and animals found within each profile section in the *Species Checklist Sheet*. Gently lift rocks to investigate and ensure to gently roll rocks back over in the same position you found them. Use a key to identify findings down to species. Add any plants or animals found that are not included on the form in the blank columns below. Have 'experts' present for this part of the survey. Depending on the number of surveyors, this can occur concurrently with 'Measuring Elevation' and 'Recording Types'.

- For Fidalgo surveys with students, they will each be assigned a rectangle corresponding to a section of the profile swath.

Recording Organisms in Quadrat:

REMINDERS:

We need to be consistent in which organisms get % coverage and which get counted. Having organisms presented in two different formats, makes data presentation difficult.

Core data and sediment data need to stay together.

All blanks should be filled out on the data sheet.

- Remove any debris, shells, unattached seaweeds or miscellaneous 'drift' that might hinder analysis. Photograph the quadrat with the appropriate quadrat identification label lying just beside the quadrat.
- Record all organisms within quadrat as species specific as possible in *Quadrat Data Sheet*. Have 'experts' present for this part of the survey.
- Estimate percent cover of seaweeds, seagrasses or colonial organisms (i.e.: barnacles, aggregating anemone). Use 2-4 people and average the estimates. Percent cover estimate methods are dynamic and can be combined. Binary method (estimators assign a value of 1 to each 1% grid section where coverage is greater than ½ for a specified organism, and 0 where coverage is less than ½ for that organism. The values are totaled to arrive at % coverage) works well for any organism that covers a large percentage of the area. Binary method is not preferred for organisms that cover small percentages of the area. Using a 1% card works well in both cases.
- Identify invertebrates as species specific as possible. Count the number of animals found and record.

Recording Organisms in Core:

- Core will be taken to the right of the quadrat at the mid-section, only where eelgrass is not present.
- Core will be sieved and organisms will be counted and identified.
- Sediment will be returned to the core from which it was taken

Appendix C: List of Additional Personnel Involved in the Fidalgo Bay Aquatic Reserve Study

FBAR Biotic Monitoring Subcommittee members:

Mira Lutz and Sylvia Yang-Subcommittee Co-leads:

Plan and lead subcommittee meetings, draft protocol specific to Fidalgo Bay Aquatic Reserve, delegate tasks related to training and data collection among subcommittee members and experts as needed, coordinate and help to lead volunteer training sessions, organize and direct intertidal biota data collection, organize data for presentation to WDNR, act as liaisons to Education and Outreach subcommittee for project sharing.

Shawn Arellano	Project Support
Pete Haase	Project Support
Morty Cohen	Project Support
Wayne Huseby	Project Support
Michael Kyte	Project support

Pattie Hutchins, Pete Haase -Skagit County Beach Watchers. Will recruit and coordinate Beach Watcher volunteers to attend trainings and gather data on monitoring days.

Project Volunteers

Skagit County Beach Watchers -attend biotic monitoring training sessions to learn protocol and practice organism ID; apply training to gather data on scheduled monitoring days.

Victor Garcia, Environmental Science Teacher, Anacortes High School (AHS) - coordinate training sessions and field trip for students to participate as volunteers.

Laurelynn Brooks, Marine Biology Teacher, Mount Vernon High School (MVHS)- coordinate training sessions and field trip for students to participate as volunteers.

AHS AP Environmental Science class and MVHS Marine Biology class -attend biotic monitoring training sessions to learn protocol and practice organism ID; apply training to gather data on scheduled monitoring days.