Intertidal Biota Monitoring in the Cherry Point Aquatic Reserve

2013 Monitoring Report

Prepared for:
Prepared for: Washington State Department of Natural Resources Grant #: PC-00J29801-0: Ensuring regulatory effectiveness in Puget Sound's most special places

Prepared by:

Cherry Point Aquatic Reserve Citizen Stewardship Committee
Intertidal Subcommittee

Wendy Steffensen
RE Sources for Sustainable Communities

And

Jerry Joyce
Washington Environmental Council

September 2014

Publication Information

This Monitoring Report describes intertidal biota surveys conducted in 2013 in the Cherry Point Aquatic Reserve. This project is funded by the National Estuary Program (NEP) of the United States Environmental Protection Agency (EPA) under assistance agreement PC-00J29801-0 to Washington Department of Natural Resources (WDNR).The contents of the report do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Copies of this Monitoring Report are available from the Washington State Department of Natural Resources at http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_rsve_aquatic_reserves_program.aspx, at the Aquatic Reserves website http://www.aquaticreserves.org/resources/ and at RE Sources website at https://sites.google.com/a/re-sources.org/main-2/programs/baykeeper.

Cover Photo: Citizen Scientists Steve Harvey and Lynn Pendleton, counting, estimating, and identifying organisms in a quadrat at Neptune Beach, 2013. RE Sources.

Author and Contact Information

Wendy Steffensen
North Sound Baykeeper, Lead Scientist,
RE Sources for Sustainable Communities
2309 Meridian Street
Bellingham, WA 98225
wendys@re-sources.org

Intertidal Subcommittee
Co-chair: John Stockman
Co-chair: Bob Cecile
Assistant Writer and Researcher: Ben Albers
Reviewer/Editor: Bill Beers
Reviewer/Editor: Kim Clarkin

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

Contents

Figures

Tables

Abstract

The Cherry Point Aquatic Reserve Citizen Stewardship Committee instituted intertidal surveys in 2013 in the Cherry Point Aquatic Reserve to assess the beach slope, substrate, distribution, and diversity of intertidal animals and plants along four profiles in the reserve. At these four profiles, the number of individual animals, areal coverage of plants, algae, and colonial and aggregating animals within four 19.8" X 19.8" (50 cm X 50 cm) quadrats at the+1' ,0', and -1' (+0.3, 0m, -0.3m) MLLW tidal elevation were recorded. Methodology closely followed that of Washington State University Island County Extension Beach Watchers, with a few noted exceptions. The beach with the highest counts, areal coverage, and diversity was Neptune Beach, which also had coarser and more varied substrate. Other beaches consisted mainly of sandy substrate at the +1', 0', and -1' MLLW tidal elevations and had low counts and coverage. The data presented in this report is the first year of a baseline dataset. It is hoped that baseline data will continue to be collected such that a robust dataset is generated with the potential of tracking changes in distribution and population in the future.

Introduction

The Cherry Point Aquatic Reserve (CPAR) is one of seven aquatic reserves in Puget Sound managed by the Washington Department of Natural Resources (WDNR). In 2013, citizen-science programs were developed as part of a grant awarded to People for Puget Sound and transferred to Washington Environmental Council in 2012. This grant, "Ensuring Regulatory Effectiveness in Puget Sound's Most Special Places" focused on pairing local environmental groups with committee stakeholder groups to steward designated aquatic reserves through education and outreach, technical review of development proposals, and citizen science.

This document reports on the first year of a monitoring effort conducted by the CPAR Citizen Stewardship Committee (CPARCSC). The project trained citizen scientists to identify intertidal species and to measure their distribution and abundance 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 were made to enhance the representativeness of the data, while retaining key elements in order to ensure that this study will be largely comparable to other Beach Watcher studies. The monitoring provides a baseline for detecting future changes, including the appearance of invasive species. It should also be useful for natural resource damage assessment in the event of an oil spill or other event, and in reserve management.

Background

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

Most of the uplands adjacent to the Reserve are privately owned, primarily by five entities: BP, Pacific International Terminals, Intalco-Alcoa, Phillips 66, and Cherry Point Industrial Park. North of the industrial area are private residential lots and a small county-owned public access area, Point Whitehorn Marine Park, just south and east of Point Whitehorn. Birch Bay State Park is located to the north and east of the residential lots and the aquatic reserve. The Lummi Indian Reservation is located adjacent to the south boundary of the Aquatic Reserve.

The following companies have existing use authorizations directly adjacent to or abutting the reserve (see Figure 1 showing easements, leased areas and cutouts, where a cutout is a small, designated area of tidal and subtidal lands removed from the CPAR to accommodate industrial marine docks):

- BP (lease and outfall easement),
- Intalco-Alcoa (lease and outfall easement),
- Phillips 66 (lease and outfall easement),
- Birch Bay Water and Sewer District, near Point Whitehorn (outfall easement)

The fourth cutout near the end of Gulf Rd is a proposed Pacific International Terminals industrial pier for which no use authorization has yet been approved and no federal permits obtained.

Goals and Objectives

The goal of this project is to support a baseline for intertidal macrobiota in the aquatic reserve and provide a framework to detect future changes—due to natural or human-caused events—in intertidal biotic habitats, species composition, distribution, and species abundance. The specific objective is to collect baseline data on beach slope, substrate, and intertidal biodiversity at four monitoring sites. Scientifically and statistically sound methods are used to ensure that data are comparable across monitoring sites, monitoring studies in other reserves, and monitoring years.

This project documents animals and plants living on the beach surface sediments. Core samples to observe organisms in sediments below the surface were not taken. In future years, we hope to include core sampling.

Data-collection Methodology

The study used a transect/quadrat model using a transect line from ordinary high water mark to -1' MLLW or lower if the tide allowed. The methodology is based on a protocol developed by the WSU BW Intertidal Monitoring Program (WSU BW, 2003). This protocol is slightly modified from this methodology to improve the statistical robustness of the study. Details of the sampling regime are given in Steffensen and Joyce (2013). Four types of data were collected:

1. Quadrat Data: Percent Cover. Four randomly placed 19.8" X 19.8" (50cm X 50 cm) quadrats were located at each of three tidal elevations: +1', 0', and -1'MLLW. Colonial and aggregating animal species, sea grass, and macroalgae cover were estimated in each quadrat.
2. Quadrat Data: Individual Species. Using the same quadrats as those for percent cover, individual animals were counted. Only epifauna were counted and organisms smaller than 3 mm were not included.
3. Profile Data. Profile data are taken along a transect perpendicular to the beach face. Data recorded include beach slope and elevation, substrate type, and organism types.
4. Species Lists. Species lists were compiled for each 10' length of beach profile covering a 65.6' (20 m) wide swath [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.

Figure 1: The Cherry Point Aquatic Reserve and surrounding area

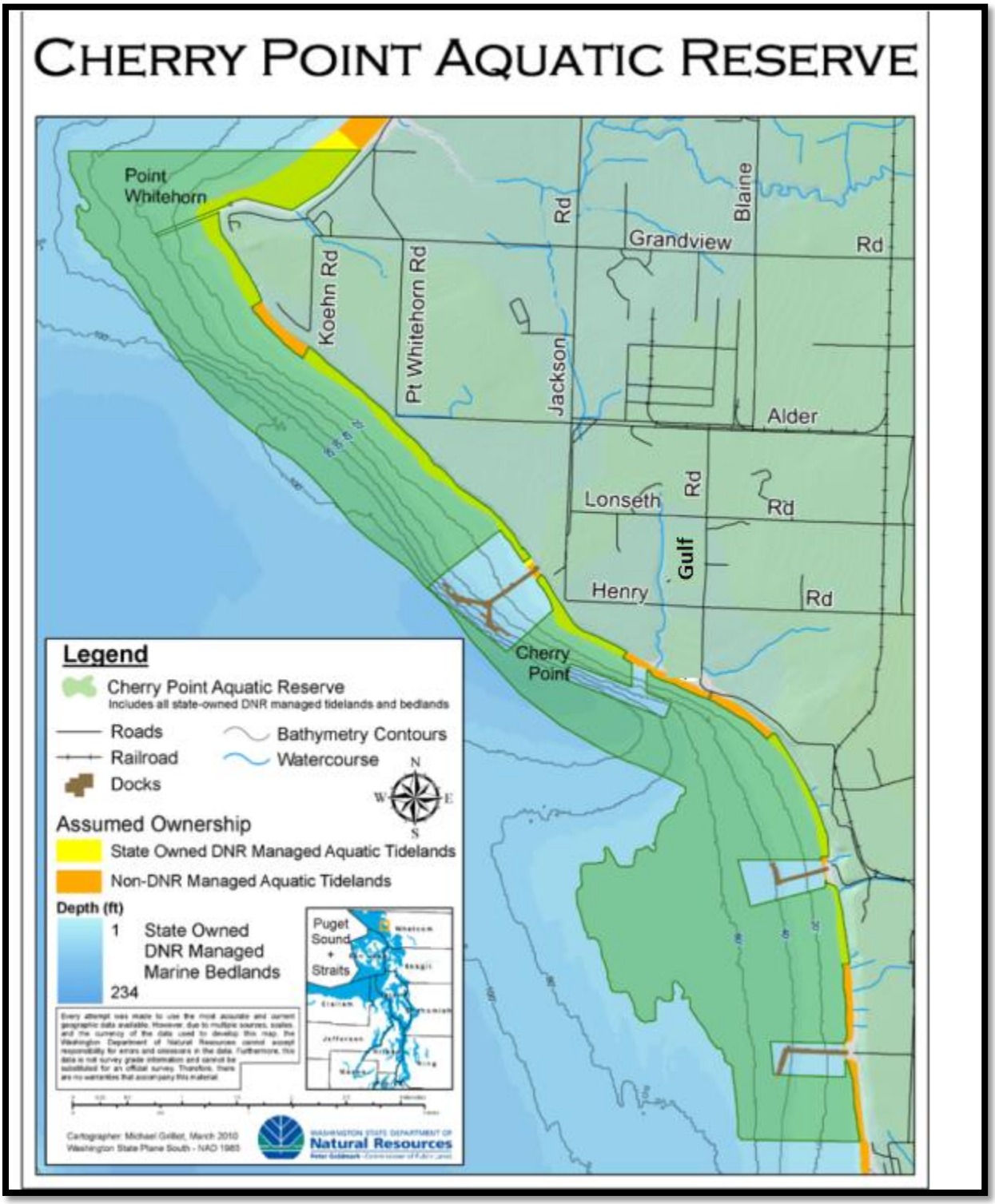


Figure 2, from the Island County Beach Watchers training manual (WSU BW, 2003), served as the basis for survey site layout. However, at Cherry Point four quadrats were randomly located along each tidal height transect. The purpose of the change was to increase the representativeness of the data and improve our ability to compare results between beaches.

Additional details regarding the development and design of the monitoring project are given in the Quality Assurance Project Plan (QAPP) (Steffensen & Joyce, 2013).

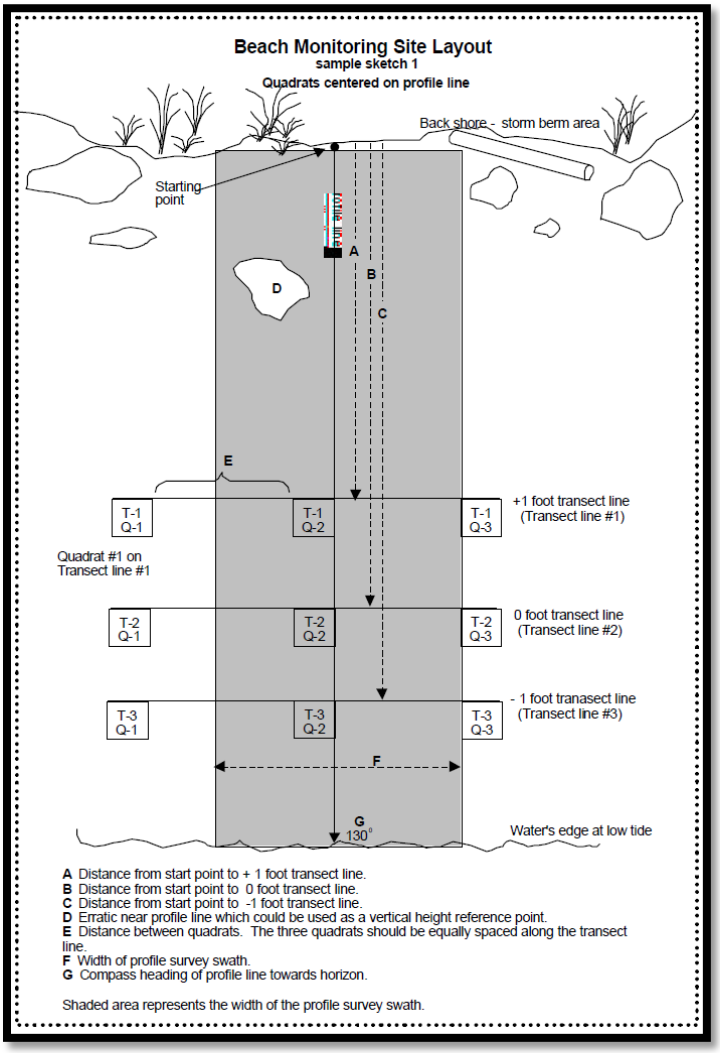


Figure 2: Layout of survey sites

Volunteer Training

Training sessions were provided in Whatcom County for citizen-scientist volunteers from the CPARCSC, the Whatcom County Marine Resources Committee, Whatcom County Beach Watchers, and other Whatcom volunteers. A similar training session was held in Skagit County. Volunteers who could not attend Whatcom County training could attend Skagit County training and be similarly qualified to conduct surveys.

Figure 3: Training on profile measurement.
Photo Credit: RE Sources

In Whatcom County, thirty-nine citizen scientists were trained in three 2-hour sessions on April 10, 17, and 24, and one field training session on April 27. Training included basic protocol for measuring slope, identifying and counting plants and animals, estimating percent coverage of plants and colonial animals, and filling out the data sheets. During the training, volunteers learned telltale markers and habitats for common organisms, as well as both common and scientific names.

Field Surveys and Results

Surveys of the CPAR beach were conducted in four locations on dates with a low tide below -1' MLLW. Locations were chosen from historical monitoring sites from published intertidal surveys (Geiger, 1982, and Schneider and Dube, 1969) and were limited to where we could obtain access (Tables 1 & 2; Figure 3).

Survey forms and instructions are included in Appendix A and B.

Table 1: Survey Information

Location	Date	Low tide time	Low tide elevation MLLW	Number of surveyors
Birch Bay (Seagrass Net)	5/25/13	12:03 PM	- 2.8'	13
Point Whitehorn County Park	5/26/13	12:49 PM	- 3.05'	14
Intalco Beach	7/19/13	9:03 AM	- 1.35'	15
Neptune Beach	7/21/13	10:42 AM	-2.49'	11

Table 2: Site Information

Site	Compass Bearing 1 (Mag)	Compass Bearing 2 (Mag)	Compass Bearing 3 (Mag)	Current Lat. (N)	Current Long. (W)	Historic Lat. (N)	Historic Long. (W)
Birch Bay	Point Whitehorn-230º	Point Lily at Point Roberts-275º	Birch Point-230º	48.89830	122.77841	48.89772	122.77863
Point Whitehorn	Outer end of the Cherry Point pier - 135º	North edge of Sucia Island - 205º	West edge of Point Roberts - 260º	48.87778	122.77838	48.88158	122.77838
Intalco Beach	Left hand corner of first white shack on Intalco pier perpendicular to shore - 181º	First black stack from shore on BP pier - 283º	Pointy, triangular, flat surfaced rock that faces shore - 325º	48.85062	122.72043	48.85075	122.72043
Neptune Beach	Northeast corner of tan shed on pier - 311º	State Park Red entrance marker - 182º	Mount Constitution on Orcas Island - 208º	48.82030	122.70952	48.82067	122.70968

Figure 4: Locations of the survey sites

Four sets of results were taken for each site.

1. Quadrat Data: Percent Cover.
2. Quadrat Data: Individual Species.
3. Profile Data: Beach slope and elevation, substrate type, and organism types.
4. Species lists: By distance along profile line

Results for the quadrat data are shown as tables (3-14) and related figures. 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 bold

italics indicate that the estimate was less than the number recorded. Averages were calculated from whole numbers with the fractions retained to show presence of infrequent individuals.

Graphs depict averages of quadrat data for each tidal height transect as colored columns, and standard deviations are shown as error bars. Calculated values are used to display the graphics.

The abbreviation “spp.” is used to indicate multiple species of the same genera.

The profile data are shown as a table within the results section and the species lists are given in a separate Addendum, Cherry Point Aquatic Reserve 2013 Intertidal Species Lists at Four Locations.

Birch Bay results

Figure 5: Average Percent Coverage in Quadrats of Colonial Animals and Plants at Birch Bay

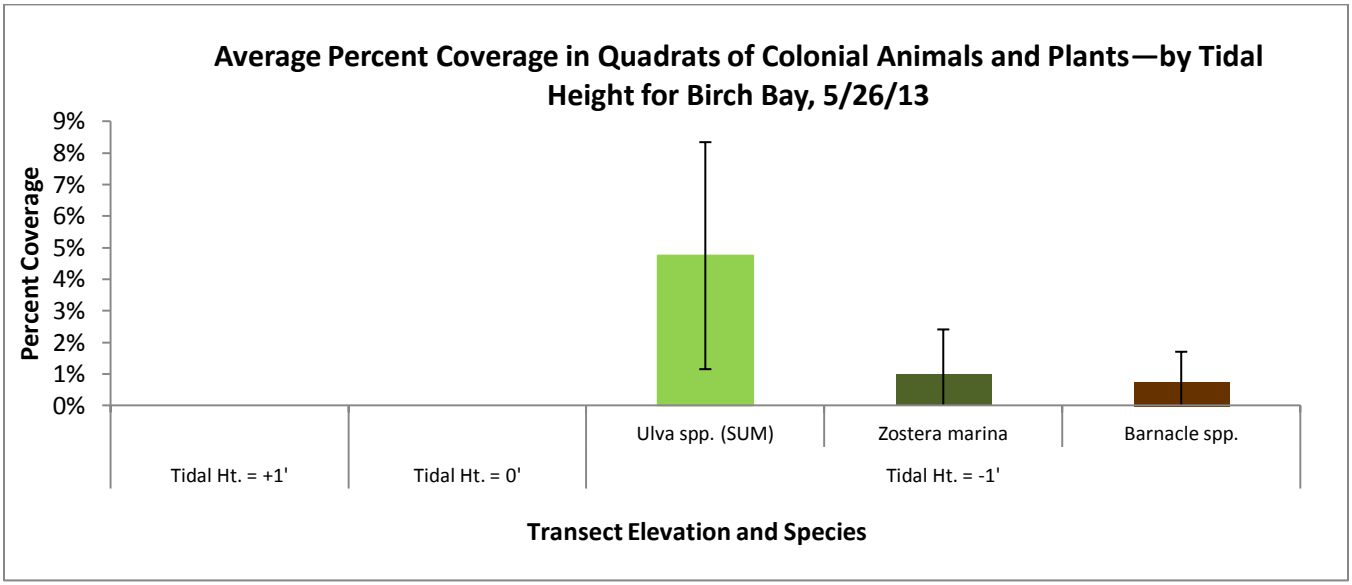


Table 3: Birch Bay Percent Coverage Data

Transect Elevation	Species	Quadrat (Q)				Average percent
		1	2	3	4	
+1'	Substrate	S	S	S	S	
		1	2	3	4	
0'	Substrate	S	S	S	S	
		1	2	3	4	
-1'	*Ulva sp.*	0%	3%	7%	*2%*	3.0%
	Ulva intestinalis	0%	***1%***	0%	6%	1.8%
	Ulva spp. (SUM)	0%	4%	7%	8%	4.8%
	Balanus crenatus	0%	***1%***	2%	0%	0.8%
	Zostera marina	3%	0%	0%	1%	1.0%
	Substrate	S	S	S	S	

1% (bold, italicized): denotes less than 1%, 2%

S= sand

Unattached brown diatoms were reported in the following transects and their respective quadrats: Transect +1', Q 1, 2, and 4; Transect 0', Q 1, 2, and 3; and Transect -1', Q 2.

Substrate noted in Transect +1', Q4 and Transect 0' Q2, 3 were not recorded in the field, but from photographic examination.

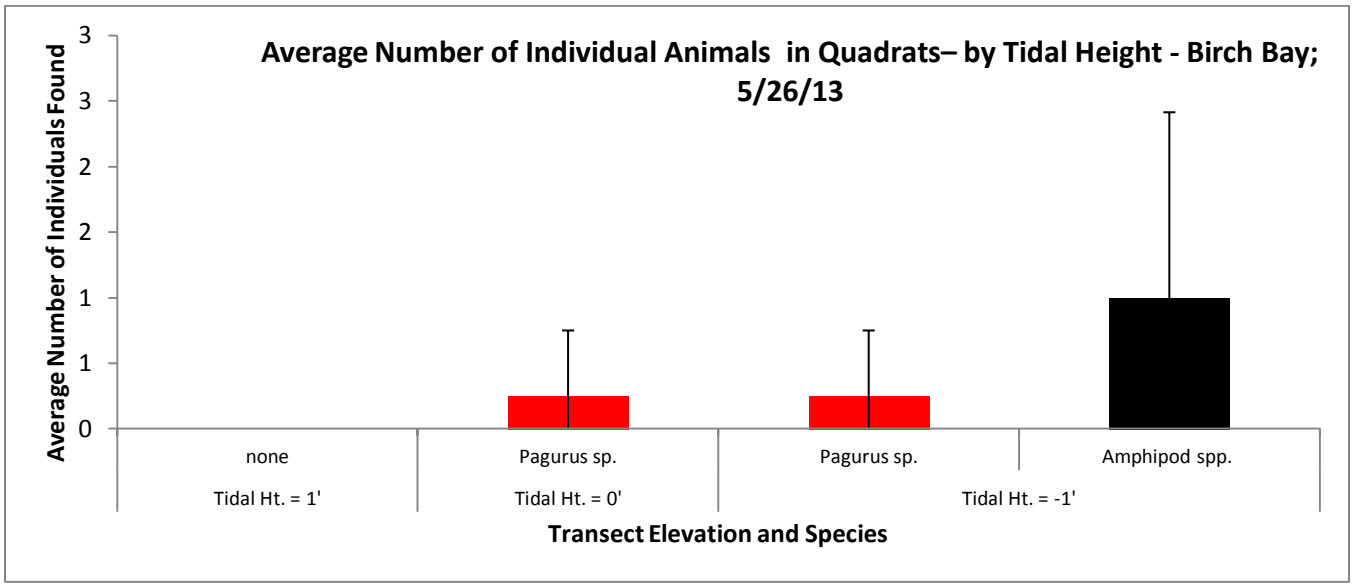


Figure 6: Average Number of Individual Animals in Quadrats at Birch Bay

Table 4: Birch Bay Individual Species

Transect	Species	Quadrat				Average
Elevation		1	2	3	4	Count
Tidal Ht. = 1'	none					
Tidal Ht. = 0'	*Pagurus* sp.	1	0	0	0	0.3
Tidal Ht. = -1'	*Caprella* sp.	1	0	0	0	0.3
	Amphipod	0	3	0	0	0.8
	Amphipod spp.	1	3	0	0	1.0
	Pagurus sp.	0	0	1	0	0.3

Figure 7: Birch Bay Profile. Photo credit: RE Sources

Table 5: Birch Bay Beach Profile Data: Elevation, Substrate, and Species Groups

BIRCH BAY				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	Nemerteas	Polychaets	GreenSeaweeds	RedSeaweeds	Brown Seaweeds	Seagrass	Arachnid	Shrimp
1	10'	10	-1.25				x	x			X																										
2	10'	20	-1.30			x	x	x			X		X			X																					
3	10'	30	-1.35			x	x	x			X		X			X																					
4	10'	40	-1.30				x				X		X		X	X			X	X	X					X				X	X	X	X			
5	10'	50	-1.00					x					X		X	X			X	X	X					X				X	X	X	X			
6	20'	70	-0.90			X						x	x		X	x	x		X	x	X					x		x	x	X	x	x	x			
7	20'	90	-0.10			x						x	x		x	x	x	x	x		x	x				x		x	x	X	x	x	x			
8	20'	110	+0.2			x																				x					x		x			
9	20'	130	-0.40			x					No Data collected																										
10	20'	150	-0.40			x																															
11	20'	170	-0.70			x																												x			
12	20'	190	-0.70	x	x	x			x				x								x																
13	10'	200	-0.30	x									x																		x			x			

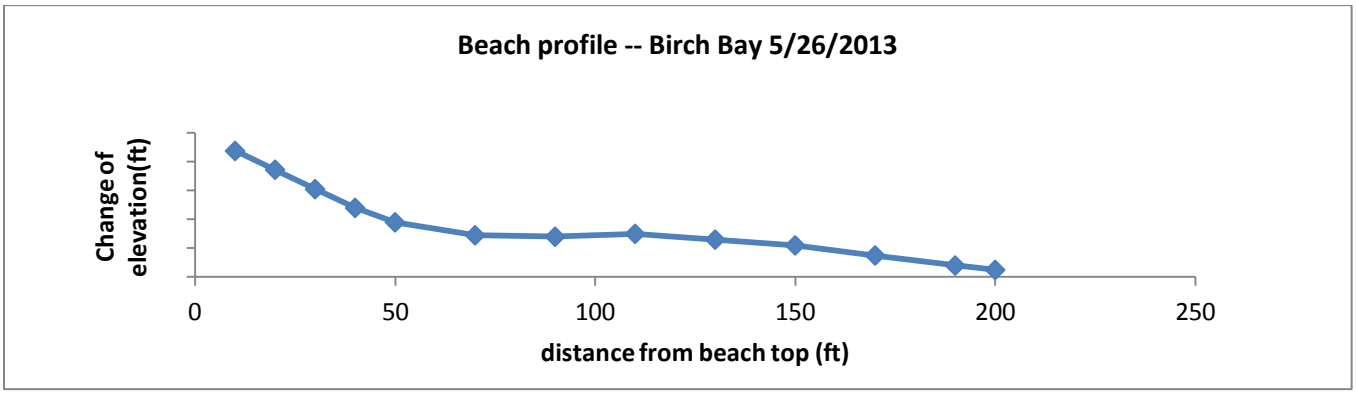


Figure 8. Beach profile elevation from backshore for Birch Bay

At the Birch Bay survey site, all quadrats were entirely on sand and fine sand. No colonial or aggregating species were present at +1' or 0'. Minimal coverage of *Ulva* sp., barnacles, and eelgrass was present at -1', with very few individual animal species throughout. Among the four survey sites, Birch Bay was distinguished by significant concentrations of unattached brown diatoms recorded at all tidal heights. It was also the only site where eelgrass was observed.

Point Whitehorn results

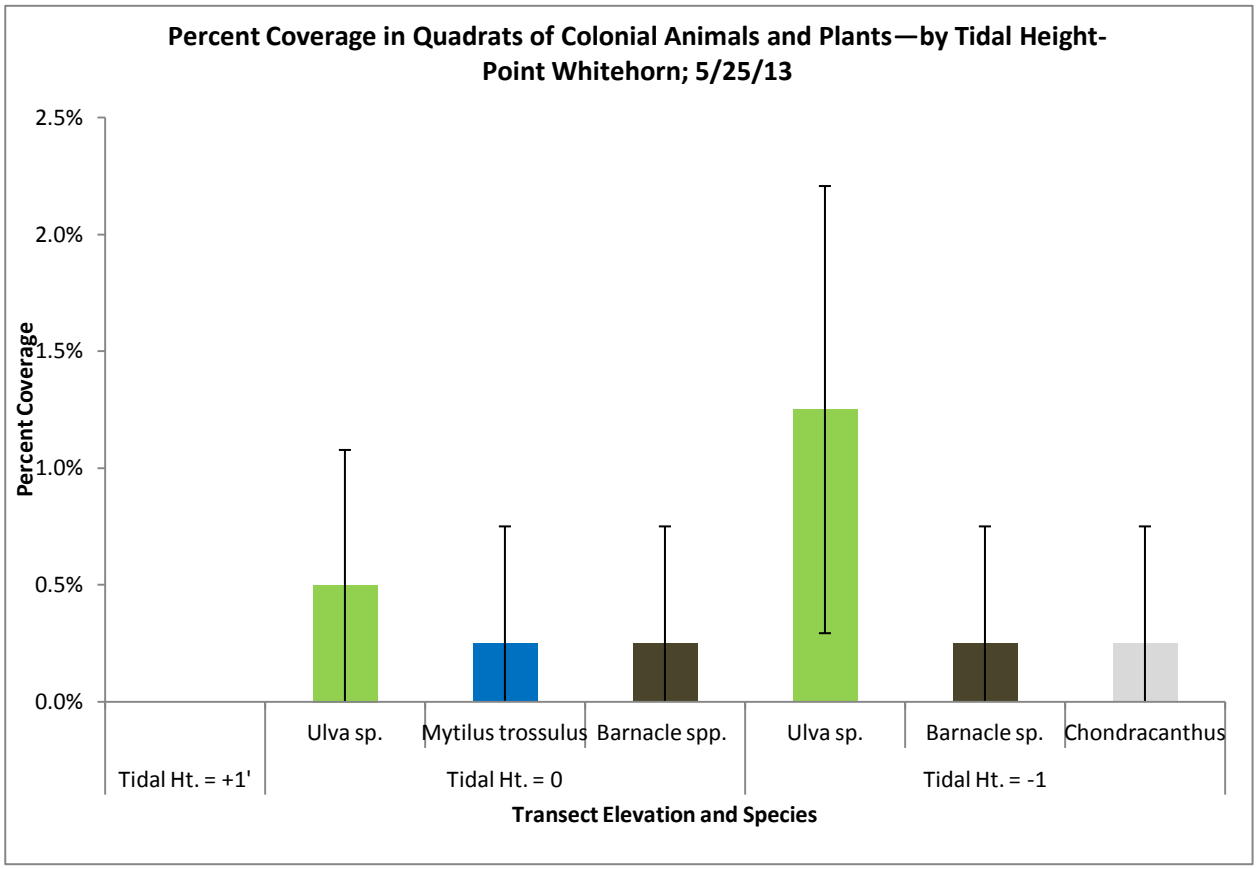


Figure 9: Percent Coverage in Quadrats of Colonial Animals and Plants at Pt. Whitehorn.

Table 6: Pt. Whitehorn Percent Coverage Data

Transect Elevation	**Species**	**Quadrat (Q)**				**Average percent**
		1, 13 ‘	2	3	4	
+1'						
	substrate	S	S	S	S	
0'		1	2	3, 8	4	
0'	*Ulva* spp.	1%	1%	0%	0%	0.5%
	Mytilus trossulus	***1%***	0%	0%	0%	0.3%
	Barnacle spp.	1%	0%	0%	0%	0.3%
	substrate	S	S	S	S	
0'		1	2	3	4	
-1'	*Ulva* spp.	0%	2%	2%	***1%***	1.3%
	Balanus crenatus	0%	0%	1%	0%	0.3%
	Chondracanthus	0%	0%	0%	***1%***	0.3%
	substrate	S	S	S	S	
1% (bold, italicized): denotes less than 1%						

S= sand

Substrate noted in Transect +1', Q2 and Transect 0' Q1, 2, 3 and Transect -1 Q2, 4 were not recorded in the field, but from photographic examination.

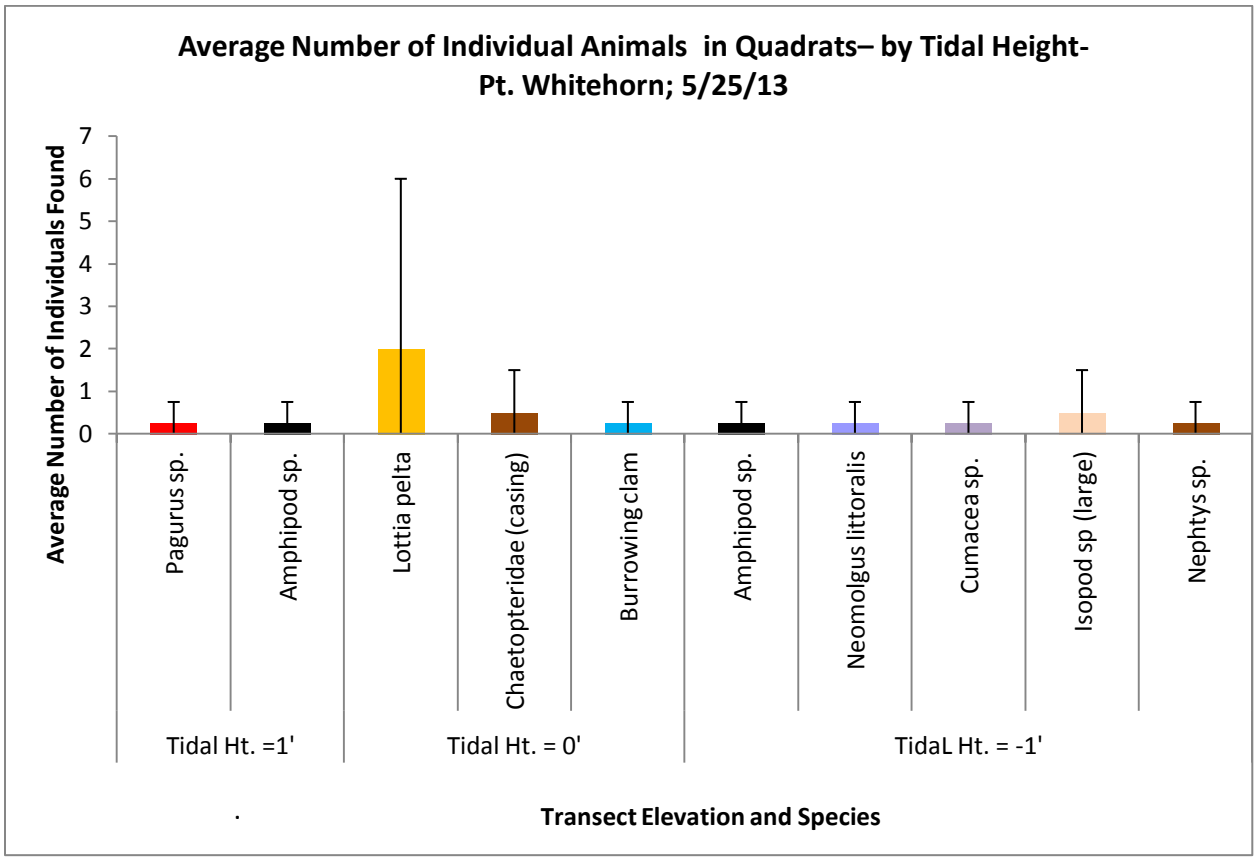


Figure 10: Average Number of Individual Animals in Quadrats at Pt. Whitehorn

Table 7: Pt. Whitehorn Individual Organisms Data

Transect Elevation	**Species**	**Quadrat**				**Average Count**
		1	2	3	4	
Tidal Ht. =+1'	*Pagurus* sp.	1	0	0	0	0.3
	Amphipod sp.	0	1	0	0	0.3
Tidal Ht. = 0'	*Lottia pelta (limpet)*	8	0	0	0	2.0
	Chaetopteridae (casing) (polychaete)	0	2	0	0	0.5
	Clam	0	0	0	1	0.3
Tidal Ht. = -1'	Amphipod sp.	1	0	0	0	0.3
	Neomolgus littoralis	0	1	0	0	0.3
	Cumacea	0	1	0	0	0.3
	Isopod sp (large)	0	0	2	0	0.5
	Nephtys sp. (polychaete)	0	0	0	1	0.3

Table 8: Point Whitehorn Beach Profile Data: Elevation, Substrate, and Species Groups

Point Whitehorn				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	20'	20	-2.5	x			x	x		x								x																		
2	20'	40	-2.6	x		x	x	x	x		x					x																				
3	20'	60	-1.5				x	x	x		x	x	x			x				x						x										
4	20'	80	-1.2	x		x	x	x	x			x	x			x				x						x										
5	20'	100	-1.8	x		x	x	x	x			x	x			x			x	x	x					x				x	x	x	x			
6	20'	120	-1.7	x		x	x	x	x			x	x			x			x	x	x					x				x	x	x	x			
7	20'	140	-0.4	x	x	x			x			x	x		x	x			x	x	x					x				x	x	x	x			
8	20'	160	-0.6	x	x	x			x			x	x		x					x	x										x	x				
9	20'	180	-0.8	x	x	x			x			x																								
10	20'	200	-0.7		x		x	x	x			x																								
11	20'	220	-0.3					x	x	x																										

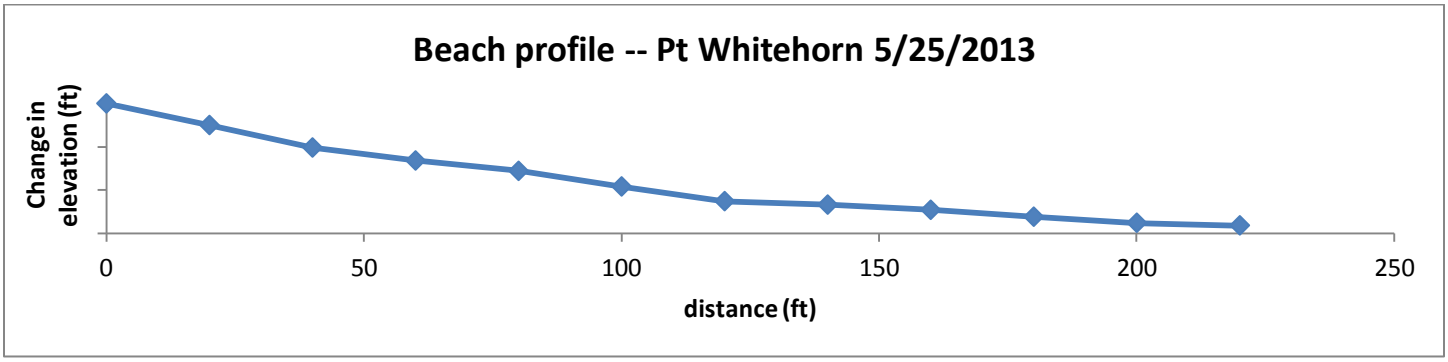


Figure 11: Beach profile elevation from backshore for Point Whitehorn

At Point Whitehorn, the substrate in the quadrats consisted entirely of sand. No animals or plants were present at +1'. The average cover at 0' and -1' was minimal, consisting of *Ulva* spp. with a few barnacles, mussels, and red algae present. We documented a total of 9 species groups and 17 individuals, the dominant species being *Lottia pelta*, which comprised 47% of the total individuals counted.

At tidal elevations below -1', the beach surface changed considerably, becoming rockier. In this area, a much higher diversity of plants and animals were observed, including the non-native seaweed *Sargassum muticum*. (Steffensen, 2014)

Figure 12: Profile and transect at Point Whitehorn. Photo credit: RE Sources

Intalco Beach results

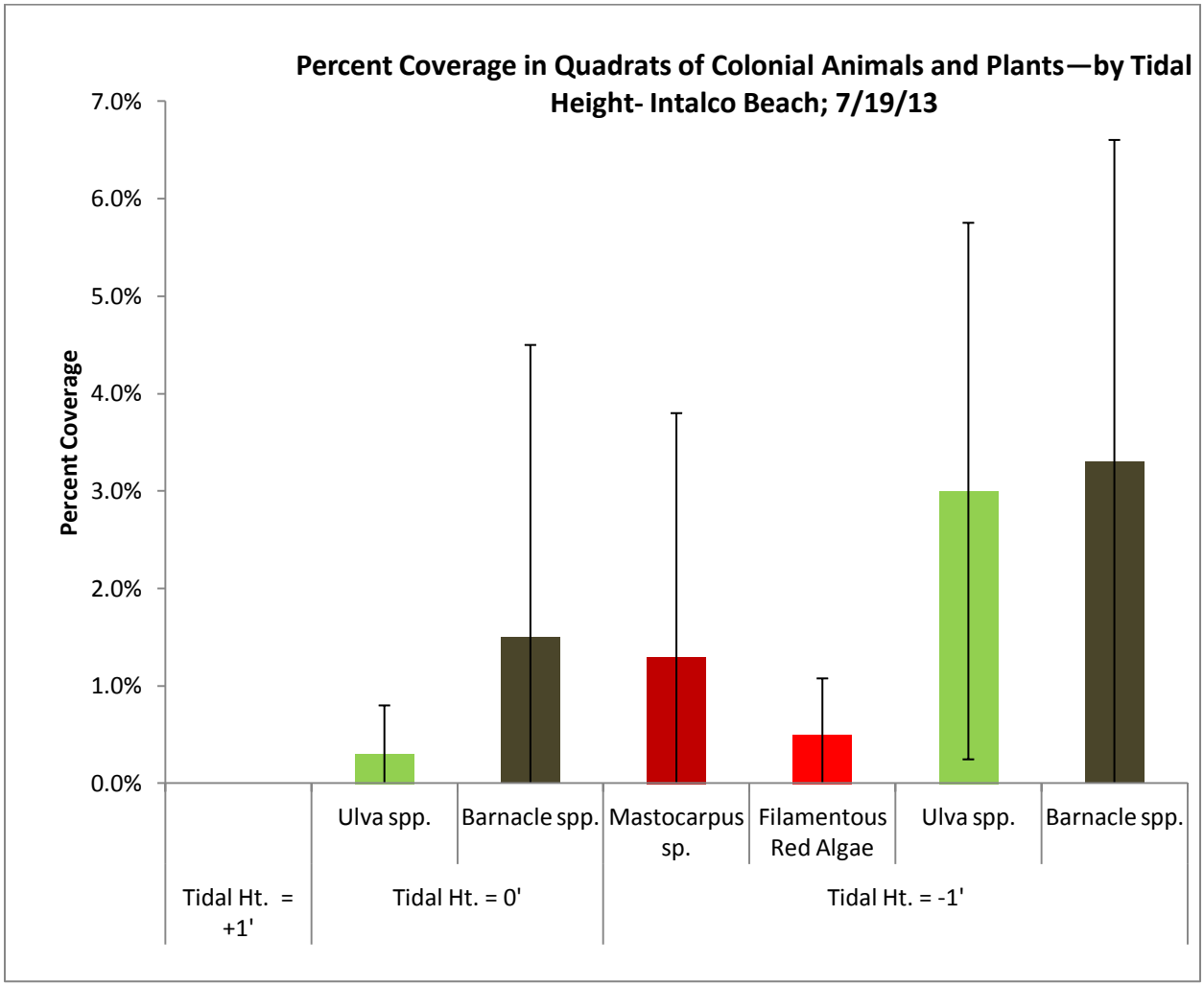


Figure 13: Percent Coverage in Quadrats of Colonial Plants and Animals at Intalco Beach

Table 9: Intalco Beach Percent Coverage Data

Transect Elevation	**Species**	**Quadrat (Q)**				**Average percent**
		1	2	3	4	
+1'						
	Substrate in quadrat:	G	G	S, G	G	
0'		1	2	3	4	
	Ulva spp.	0%	1%	0%	0%	0.3%
	Barnacle spp.	0%	0%	0%	6%	1.5%
	Substrate in quadrat:	G	G	G	G, C	
-1'		1	2	3	4	
	Mastocarpus sp.	5%	0%	0%	0%	1.3%
	Filament. Red Algae	0%	0%	1%	1%	0.5%
	Ulva spp.	1%	0%	5%	6%	3.0%
	Ulva intestinalis	***1%***	0%	0%	0%	0.3%
	Ulva spp. (SUM)	2%	0%	5%	6%	3.3%
	Balanus crenatus	8%	0%	0%	0%	2.0%
	Balanus glandula	0%	0%	1%	3%	1.0%
	Barnacle spp.	0%	***1%***	0%	0%	0.3%
	Barnacle spp. (SUM)	8%	***1%***	1%	3%	3.3%
	Substrate in quadrat:	G	G	S, G	S, G	
1% (bold, italicized): denotes less than 1% S= Sand, G= Gravel, C= cobble						

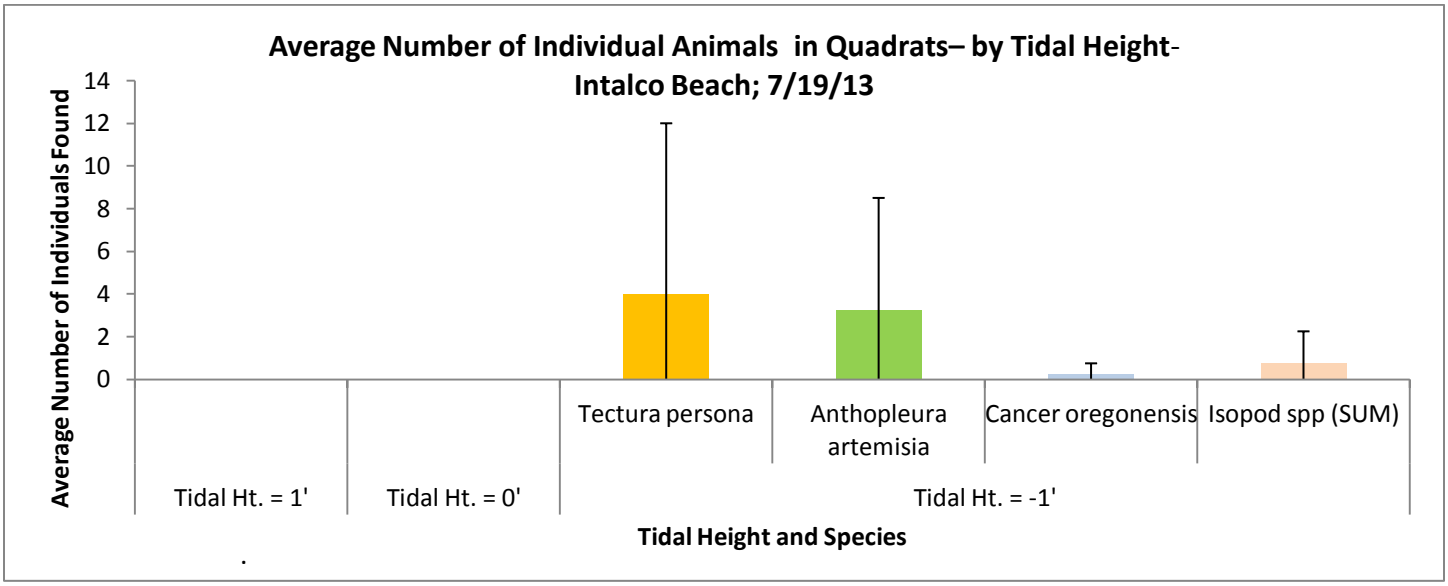


Figure 14: Average Number of Individual Animals in Quadrats at Intalco Beach

Table 10: Intalco Beach Individual Organisms Data

Transect Elevation	**Species**	**Quadrat**				**Average Count**
		1	2	3	4	
Tidal Ht. = +1’	none					
Tidal Ht. = 0’	none					
Tidal Ht. = -1’	*Tectura persona*	16	0	0	0	4.0
	Anthopleura artemisia	0	0	2	11	3.0
	Cancer oregonensis	0	0	0	1	0.3
	Pentidotea wosnesenskii	1	0	0	0	0.3
	Isopod (unidentified)	2	0	0	0	0.5
	Isopod spp (SUM)	3	0	0	0	0.8

Figure 15: Group of surveyors at Intalco. Photo credit: Raina Clark

Table 11: Intalco Beach Profile Data: Elevation, Substrate, and Species Groups

INTALCO				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	-0.9			x	x	x																												
2	10'	20	-0.2			x	x				x																									
3	10'	30	-1.6			x	x				x							x																		
4	10'	40	-1.3			x	x				x							x														x		x		
5	10'	50	-1.6			x	x		x									x																x		
6	10'	60	-1.1			x	x	x		x			x							x	x					x					x					
7	10'	70	-1.4			x	x	x										x														x	x			
8	10'	80	-1.2			x	x	x					x							x											x	x				
9	10'	90	-1.3				x	x	x				x					x		x											x	x				
10	10'	100	-1.0				x	x	x				x	x		x			x							x					x	x				

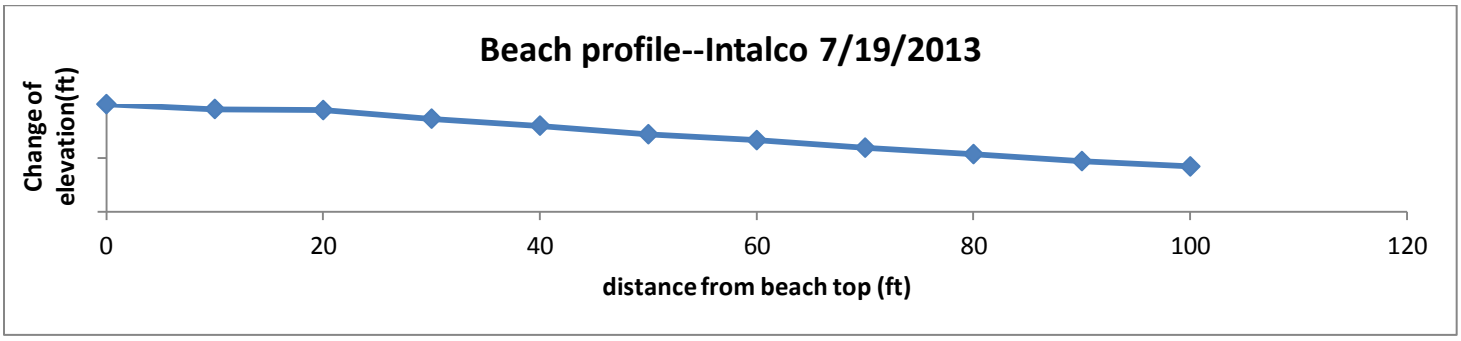


Figure 16: Beach profile elevation from backshore for Intalco

At the Intalco Beach survey site, the surface substrate was almost entirely gravel. Areal coverage was again low, with no organisms at +1', and minimal coverage at 0' and -1', consisting mainly of *Ulva* and barnacle species. Individual species were also few in numbers and only found at the -1' tidal elevation.

Neptune Beach results

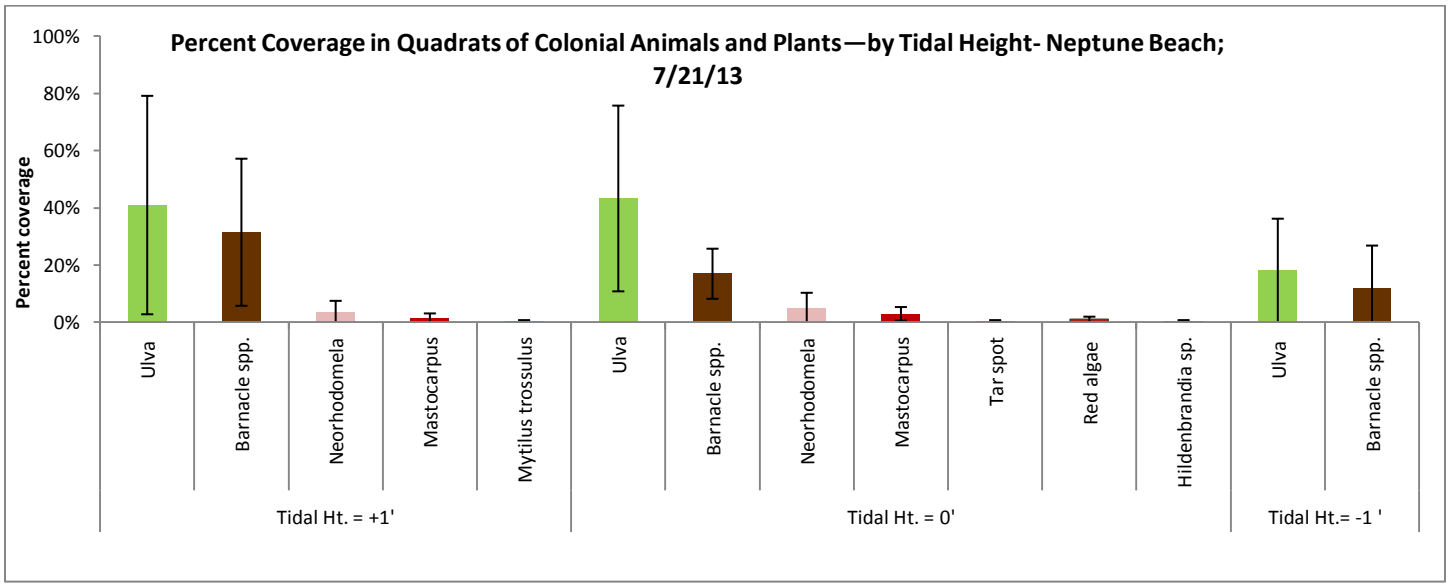


Figure 17: Percent Coverage in Quadrats of Colonial Animals and Plants at Neptune Beach

Figure 18: Profile at Neptune Beach. Photo credit: RE Sources

Figure 19: Monica Tonty and Kathy Willis estimating percent coverage. Photo Credit: RE Sources

Table 12: Neptune Beach Percent Coverage Data

Neptune Beach

Date: 7/21/2014

Transect	Species	Quadrat				Average
Elevation		1	2	3	4	percent
1'	Ulva sp.	83%	63%	15%	3%	41%
	Chthamalus dalli	0%	8%	25%	0%	8%
	Semibalanus cariosus	0%	14%	0%	0%	4%
	Balanus glandula	2%	0%	10%	65%	19%
	Balanus crenatus	2%	0%	0%	0%	1%
	Barnacle spp. (SUM)	4%	22%	35%	65%	32%
	Neorhodomela sp.	0%	9%	4%	1%	4%
	Mastocarpus sp.	0%	0%	4%	1%	1%
	Mytilus trossulus	0%	0%	0%	***1%***	0.3%
	Substrate in quadrat:	S, B	C	S, C, B shell,	S,C, B	
		1	2	3	4	
0'	Ulva sp.	80%	56%	33%	4%	43%
	Chthamalus dalli	6%	6%	5%	0%	4.3%
	Balanus glandula	0%	0%	18%	0%	4.5%
	Semibalanus cariosus	0%	8%	0%	0%	2.0%
	Barnacle spp.	0%	0%	0%	25%	6.3%
	Barnacle spp. (SUM)	6%	14%	23%	25%	17.0%
	Neorhodomela sp.	1%	0%	8%	11%	5%
	Mastocarpus sp.	3%	6%	1%	***1%***	3%
	Tar spot (Mastocarpus sp. or Ralfsia pacifica)*	0%	0%	0%	***1%***	0.3%
	Filamentous red algae	0%	0%	0%	***1%***	0.3%
	Foliose red algae	0%	0%	0%	1%	0.3%
	Red alage (SUM)	0%	0%	0%	2%	1%
	Hildenbrandia sp.	0%	0%	0%	1%	0.3%
	Substrate in quadrat:	S,C	S,C	S,C	S,G,C, B	
		1	2	3	4	
-1'	Ulva	41%	6%	1%	24%	18%
	Chthamalus dalli	5%	0%	0%	0%	1%
	Balanus glandula	0%	***1%***	7%	34%	11%
	Barnacles spp. (SUM)	5%	***1%***	7%	34%	12%
	Neorhodomela	19%	0%	0%	0%	5%
	Mastocarpus	4%	0%	***1%***	1%	2%
	filamentous red algae	0%	0%	0%	1%	0.3%
	Substrate in quadrat:	S,G	S, silt	S, G, C	S, B	

1% (bold, italicized): denotes less than 1%
S= Sand, G= Gravel, C= cobble, B= Boulder

*This is unclear; both "sea fingers" and "tar spot" are written down as if the volunteer could not decide between the two. However, these organisms are very different. Expert Michael Kyte states that Codium fragile is not found in this area and he did see tar spot. (Ralfsia pacifica or Mastocarpus sp.)

Figure 20: Average Number of Individual Animals in Quadrats at Neptune Beach

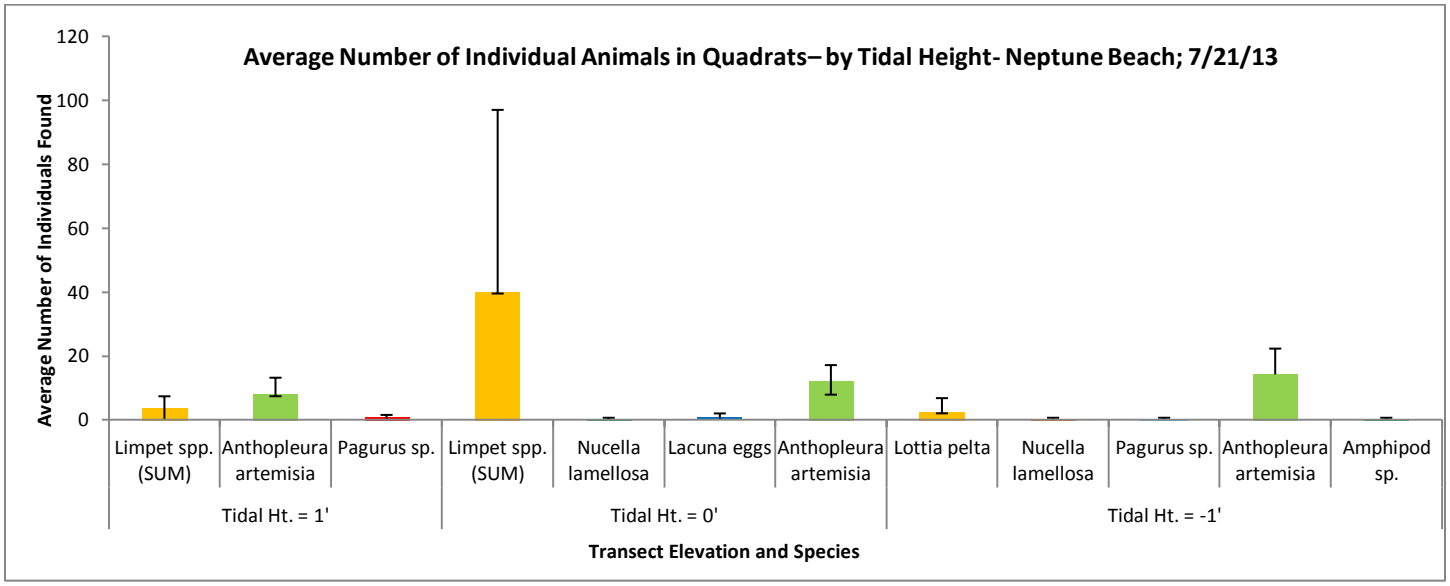


Table 13: Neptune Beach Individual Organisms Data

Neptune Beach			7/21/2013			
Transect	Species	Quadrat				Average Count
Elevation		1	2t	3	4	
1'	*Tectura persona*	0	10	1	0	2.7
	Lottia pelta	0	0	0	3	0.7
	Limpet spp. (SUM)	0	10	1	3	3.5
	Anthopleura artemisia	3	4	15	11	8.3
	Pagurus sp.	0	2	1	0	0.8
		1	2	3	4	
0'	*Tectura persona*	0	19	3	102	31.0
	Lottia pelta	0	0	0	29	7.3
	Lottia digitalis	0	0	0	2	0.5
	Tectura scutum	0	0	0	5	1.3
	Limpet spp. (SUM)	0	19	3	138	40
	Nucella lamellosa	0	0	0	1	0.3
	Lacuna eggs	3	0	0	0	0.8
	Anthopleura artemisia	16	4	16	13	12.3
		1	2	3	4	
-1'	*Lottia pelta*	0	0	0	10	2.5
	Nucella lamellosa	0	0	0	1	0.3
	Pagurus sp.	0	1	0	0	0.3
	Anthopleura artemisia	4	9	20	24	14.3
	Amphipod sp.	0	1	0	0	0.3

Table 14: Neptune Beach Profile Data: Elevation, Substrate, and Species Groups

Neptune				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	-0.85			x	x																													
2	10'	20	-0.35			x	x				x							x																		
3	10'	30	-1.25			x	x				x							x																		
4	10'	40	-1.25					x													da															
5	10'	50	-1.45					x			x							x													da					
6	10'	60	-1.20					x	x		x		x					x		x	x					x					x	x				
7	10'	70	-1.10					x	x		x		x			x			x	x	x					x				x	x	x				
8	10'	80	-0.8			x			x		x		x			x			x	x	x					x				x	x	x				
9	10'	90	-0.75			x		x	x		x	x	x			x	x		x	x	x					x				x	x	x	x			
10	10'	100	-0.55			x					x	x	x	x		x	x		x	x	x					x				x	x	x	x			
11	10'	110	-0.65			x					x	x	x			x			x	x	x				x	x				x	x	x	x			
12	10'	120	-0.90	x		x	x				x	x	x			x	x		x	x	x				x	x			x		x	x	x			
13	10'	130	-0.35	x		x	x	x	x		x	x	x		x		x		x	x					x	x				x	x	x	x			
da= drift-associated																																				

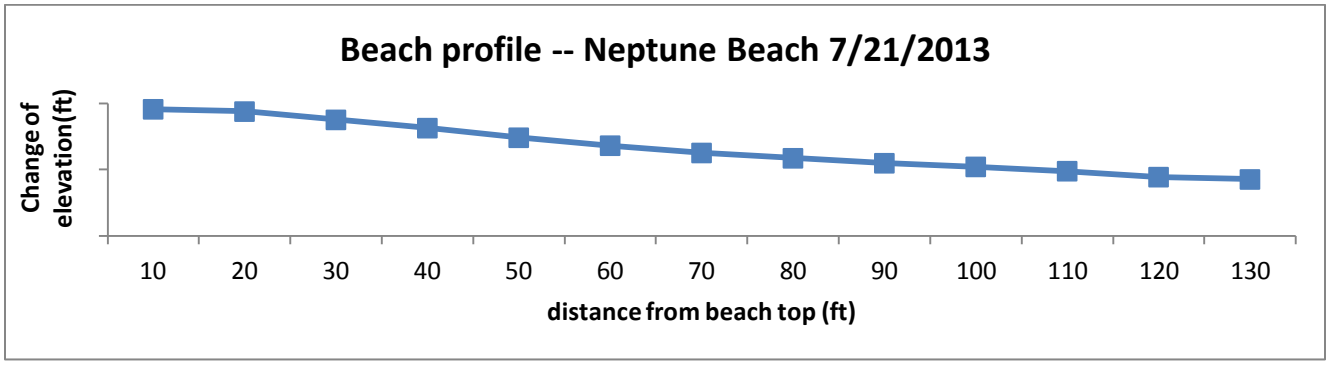


Figure 21: Beach profile elevation from backshore for Neptune Beach

At the Neptune Beach survey site, the substrate consisted of a mixture of silt, sand, shell hash, gravel, cobble, and boulders that were all present throughout the site at differing tidal transect heights. Species represented as percent coverage were diverse, with *Ulva* spp. and barnacles having the highest percent coverage values throughout all tidal-height transects. The number of countable animals at Neptune Beach was the largest and most diverse collection of all those seen at the four study sites. *Anthopleura artemisia*, *Tectura persona*, and *Lottia pelta* were the dominant species at the site.

One invasive species was recorded at the 60-70' level, *Battilaria attramentaria*, the Asian mud snail.

Comparison across all four sites

Across all four sites, the percent coverage and number of animals was highest at Neptune Beach. This is consistent with the idea that substrate composition is one of the primary determining factors influencing intertidal habitat, flora, fauna, and ecology. According to Dethier and Schoch (2005), "In areas where cobbles (>~ 4" or 10 cm diam.) are abundant on the low shore, the substrate is stabilized into a complex mix of cobbles, pebbles, and sand; these habitats harbor a rich flora (on the cobbles) and fauna (both on the cobbles and infauna)."

Discussion

The goal of this project is to provide a baseline for the detection of any changes over time and the objective is to collect baseline data on beach slope, substrate, and intertidal biodiversity at four monitoring sites. The project was completed as intended.

Thirty-nine volunteers were trained and participated in the survey. The first data-gathering effort produced a complete set of data, but one that required substantial checking due to both inexperienced volunteers and our inexperience with the protocol. The group learned several important lessons about the importance of careful training and practice in organism identification and the protocol itself. A core party of experienced volunteers now exists that will be able to expand and improve future monitoring events. The project promoted many goals of the citizen-science program within the CPAR including environmental education, community outreach, and stewardship development.

Quality control (QC) protocols described in the QAPP were satisfactory, given the parameters and limitations of the study. There were several instances where data were not completely recorded or survey sheets were not filled out correctly. For example, substrate composition was not recorded on the data sheets for several quadrats. This had limited impact on the overall results because of the similarity in substrate composition between quadrats on the same transect (checked photographically).

Possible observer bias may have contributed to inaccurate data collection in some cases. For example, QC protocols corrected several apparent overestimations by survey teams of substrate cover by algae, plant, and colonial species. These tended to occur in areas of no or very low floral and faunal abundance, and may have been the result of a desire to see and record "everything there" to collect the largest amount of data possible. More experienced researchers double-checking photographs of each survey quadrat were able to correct the field coverage overestimates.

See the Planned Procedure and Program Improvements section below for how we anticipate dealing with these issues in future surveys.

Attempts to compare the data in this survey with two others, covering the reach of the Cherry Point Aquatic Reserve and conducted in 1969 (Schneider and Dube, 1969) and 1982 (Geiger, 1982) were not possible for the following reasons. In the 1969 study, the data was semi-quantitative and not linked to tidal height. In the 1982 study, only two survey locations were in similar locations to the ones of the current study. In addition, the methods in the 1982 study used to present data were quite different from the present study. Quite often, the 1982 data emphasized numbers of species or taxa rather than numbers of organisms within a species, or a group of related species. Direct comparisons will be possible with the 2014 and future surveys, which will be done at the same sites and with the same (or improved) methodology. This first year baseline data are not a comprehensive look at the intertidal zone. Additional years of data will be necessary to capture year to year and quadrat variability. We hope that our committee and volunteers will collect data in the coming years, which can be used to establish a more robust baseline.

Feasibility of continuing this study

Many enthusiastic volunteers participated in this first year, partly due to the draw of the CPAR, a place that is relatively close to urban centers but not very familiar to urban residents, and one in which environmental and industrial interests overlap. We anticipate that participants' enthusiasm and interest will remain high given the beauty and natural resources many have learned to appreciate. We believe that continuing the annual surveys will expand a cadre of experts, including people who can effectively implement the QC protocols. In addition to the data, this trained cadre of surveyors is more engaged with the reserve and intertidal habitats, in general.

Data processing and QC were relatively cumbersome this first year. We have identified ways to streamline data processing (discussed below) that will eliminate errors and speed up the work. We do expect that continued funding for the project will be needed as the coordination and quality assurance workload is quite heavy during the survey preparation and implementation season. An unsupported volunteer-led effort could probably not be sustained indefinitely.

Planned Program and Procedure Improvements

Training

In the coming year we plan to emphasize identification of the organisms that were most commonly found at CPAR. This will help ensure correct identification of common organisms and free the field experts to focus on organisms that are difficult to identify or uncommon.

Additionally, we will place a greater training emphasis on identifying invasive species. Previous training included this, but it needs to be stressed. Volunteers on the beach may be able to detect invasive species before others, since they will be closely observing and identifying species. With early warning, agencies can move quickly to address an infestation while it is still small.

Survey Procedures

Photographing quadrats: Currently, photos are taken at the start of the survey, usually before volunteers start their work. During QC procedures, which sometimes rely on photos, questions can arise as to whether some of the material present in the photo represents debris or unattached algae (not counted in the survey). To eliminate this question, we will have the photographer take photos after volunteers have removed debris and unattached algae.

Station identification: Some GPS and compass readings did not include all of the units. We will ensure that GPS information includes units (decimal degrees or degrees, minutes, seconds) and that compass readings include declination, by adding those specific instructions and choices to the worksheet (Appendix B).

Ensure that *each quadrat corresponds to one data sheet*. Some volunteers tried to save paper by placing multiple quadrats on one piece of paper; this confused data entry and QC.

For the *profile list of species,* volunteers systematically categorized species in each 10' profile segment from start to waterline. This herculean effort became uneven as the survey went on. In addition, volunteers had difficulty consistently determining where they were related to the profile line.

One piece of information found wanting in data analysis will be remedied with a new entry on the quadrat data sheet. We will ask what longitudinal distance each quadrat corresponds to.

Quality Control

Some mistakes found in the QC review could have been avoided if there had been a more thorough assessment of the data while on the beach. Therefore, we will institute a more rigorous on-the-beach QC check. This will include:

- Ensure that all blanks are filled out
- Ensure that animals and plants are placed in correct category (% coverage vs countable species)
- Ask that participants total the entire % coverage for each quadrat (Some estimates were greater than 100%)
- Have a QC specialist review and validate each data sheet before quadrats are removed

Some mistakes found in QC were due to poor data-entry procedures. To prevent this, data entry will be standardized, including naming conventions and number of significant figures for each measure or calculation.

Overall Program

Additional Transect at -2':

Volunteers are interested in adding a survey transect at -2' to document organisms present below -1', especially where much richer species diversity exists. For example, at Point Whitehorn, a band of sand with very few plants and animals was present between -1' and +1', whereas higher and lower elevations were obviously rockier and more diverse. For these surveys to be valuable, the -2'survey must occur in all years. Ideally, it should be done at all sites.

Surveys of fauna in sediments:

Future surveys may allow for the possibility of surveying fauna located within intertidal sediments (i.e., below the surface) to provide a greater representation of the ecological communities present at the CPAR. This undertaking will depend on overall interest from the community, as it does entail significantly more work. The tools would likely be available from the Fidalgo Bay Aquatic Reserve group.

Possible future uses of this data:

Ongoing annual surveys will allow comparisons from year to year. In this way, changes in overall species diversity may be detected. After detection, causes may be able to be elucidated and potentially 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 and attend to invasive species presence.

References

Dethier, M.N. and G.C. Schoch. 2005. The consequence of scale: assessing the distribution of benthic populations in a complex estuarine fjord. Estuarine, Coastal, and Shelf Science. 62:253-270.

Geiger, N.S. 1982. 1982 Survey of the Intertidal Zone from Sandy Point to Birch Bay, Whatcom County, Washington.

Schneider, D. F. and M. A. Dube. 1969. Survey of the Intertidal Zone from Sandy Point to Birch Park Marina, Whatcom County, Washington.

Steffensen, W, and J. Joyce, 2013. Quality Assurance Project Plan for Intertidal Biota Monitoring in the Cherry Point and Fidalgo Bay Aquatic Reserves. Available at: https://sites.google.com/a/re-sources.org/main-2/programs/baykeeper/whatcom-and-skagit-county-aquatic-reserves

Steffensen, W, 2014. Cherry Point Aquatic Reserve 2013 Intertidal Species Lists at Four Locations. Available at: https://sites.google.com/a/re-sources.org/main-2/programs/baykeeper/whatcom-and-skagit-county-aquatic-reserves

WDNR, 2010. Cherry Point Environmental Aquatic Reserve Management Plan. http://www.dnr.wa.gov/Publications/aqr_cp_mgmt_plan_2010.pdf (accessed December 12, 2013)

WSU BW, 2003. Beach Monitoring Procedures, Training Manual for Island County/ Washington State University Beach Watchers. Available at: http://www.beachwatchers.wsu.edu/island/monitoring/data/manual03.htm (accessed March 26, 2014).

Acknowledgments

Most of the sampling protocol and procedures is 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. Finally, 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 would also like to thank Megan Dethier, Betty Bookheim, Michael Kyte, and Bob Lemon for their review and comments on this report.

We extend gratitude to RE Sources interns, Monica Tonty, Marissa McBride, and Taylor Garrod for data entry and assistance with graphics, and to WEC Project coordinator Maddie Foutch for assistance with formatting and much support throughout the project.

We also would like to extend a heartfelt thank you to all of the committee members and volunteers who helped plan the surveys and who took part in the surveys. This work would not have happened without your interest and dedication.

Appendix A: Data Forms

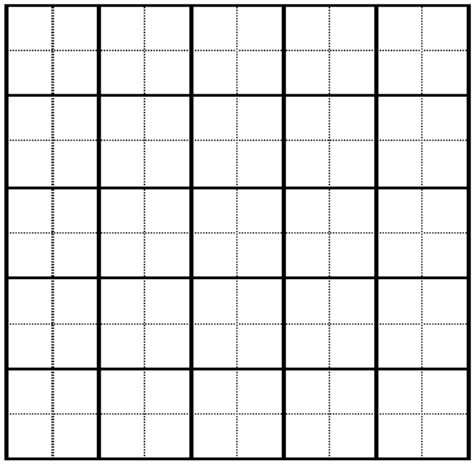
The following data forms were used in this project:

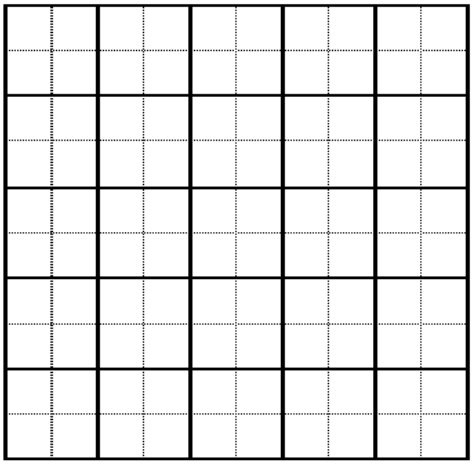
Form	Purpose
Quadrat Estimation Worksheet, rev1	Assess percentage coverage
Whatcom Quadrat Sheet, rev 1	Quadrat analysis, Cherry Point AR
Beach Watcher Field data sheet	Profile elevation, substrate type and species type
Species Checklist_scientific nomenclature, rev1	Species identification
Profile Start Point Form, rev1	Record start point with multiple readings
Beach Watcher, Vertical Height Form	Record presence and dimensions of structure on or near the profile line
Beach Watcher, Directions to Beach Form	Identifies general location of beach and then provides specific information to locate start point

Quadrat Estimation Worksheet

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

Organism: _____ Row Totals Organism: _ Row Totals

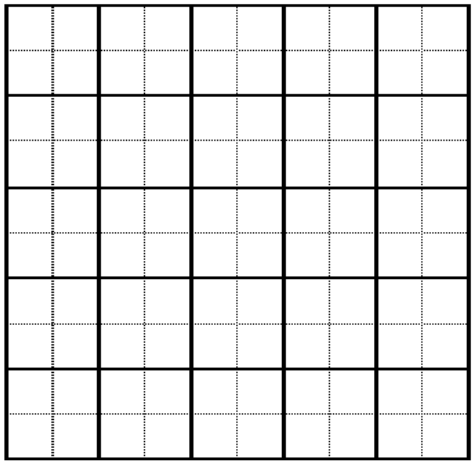


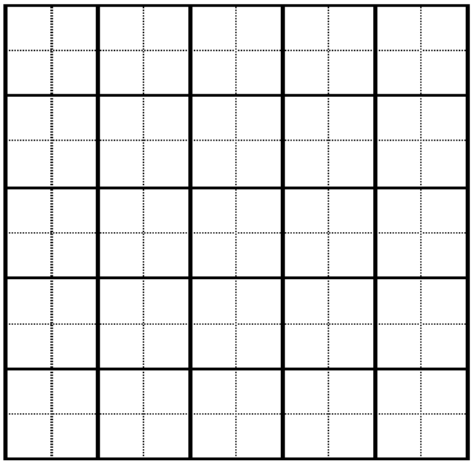


Grand Total:

Grand Total:

Organism: _____ Row Totals Organism: __ Row Totals





Whatcom Quadrat Sheet

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)

Pg. 1/1

Beach Watcher, Field Data Sheet

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

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

	A	B	C	Substrate (check all that apply)							Seaweeds and Invertebrates (check all that apply)																													
Entry (1,2,3, etc.)	Length of survey section	Cumulative Distance (optional) + or -	Survey Reading	Ground shell debris	Clay/Silt	Sand (.002" - .08")	Gravel (.08" - 2")	Cobbles (2" - 10")	Boulders (>10")	Erratics (BIG ROCKS!)	Amphipods	Anemones	Barnacles	Chitons	Clams	Crabs	Fish	Insects	Isopods	Limpets	Mussels	Nudibranchs	Sand Dollars	Sea Cucumbers	Seastars	Snails	Urchins	W Flat Worms	W Nemerteans	W Polychaetes	Green Seaweeds	Red Seaweeds	Brown Seaweeds	Seagrass	Arachnid	Shrimp	Other	
1																																						
2																																						
3																																						
4																																						
5																																						
6																																						
7																																						
8																																						
9																																						
10																																						
11																																						
12																																						
13																																						
14																																						
15																																						
16																																						
17																																						
18																																						
19																																						
20																																						
21																																						

Species Checklist – scientific nomenclature

LEAD:_____

Team names: _____and _____

Identifier:_____Recorder:_____

Site: _____

Date & Time of sampling: _____

		Elevation Distances					
Genus/Species name	Common Name						
Hemigraspus oregonesis	Hairy Shore rab						
Cancer productus	Red Rock crab						
Tectura persona	Mask limpet						
Lottia digitalis	Finger limpet						
Lottia pelta	Shield limpet						
Tectura scutum	Plate limpet						
Lottia alveus paralella	Eelgrass limpet						
Pisaster brevispinus	Giant pink sea star						
Pisaster ochraceus	Purple star						
Evasterias troschelli	Mottled sea star						
Anthopleura artemisia	Moonglow anemone						
Anthopleura elegantissima	Aggregating anemone						
Urticina coriacea	Stubby rose anemone						
Urticina crassicornis	Christmas anemone						
Fucus distichus	Rockweed						
Saragassum muticum	Wireweed						
Zostera marina	Native eelgrass						
Zostera japonica	Japanese eelgrass						
Ulva lactuca	Sea lettuce						
	Filamentous red						

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 _____

Beach Watcher 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.

Beach Watcher 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

Do NOT walk below +1 before quadrats are set AND do Not walk in quadrats!

Placement of Profile Line: A member of the CPARCS committee will do this

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, and -1 area of the profile, do not mark the area of the swath until a'er 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 (if back is to water) 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', 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 le' corner of the quadrat placed on the random number. For example:

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 Types of Organisms 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 li' 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'.

Recording Species 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'.

Recording Organisms in Quadrat:

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.

All blanks should be filled out on the data sheet.

- Remove any debris, shells, unattached seaweeds or miscellaneous drift that might hinder analysis. ONLY IDENTIFY THE TOP VISIBLE LAYER. 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, sea grasses or colonial organisms, such as barnacles or 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.