



SEACOLOGY



Biophysical Survey of Subtidal Habitat at Royal Vancouver Yacht Club's, Coal Harbour Proposed Marina Reconfiguration

Submitted to:

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Table of Contents

Executive Summary.....	2
Qualifications and Background.....	2
Safety and Field Operations.....	2
Work Plan.....	2
Transect Biophysical Survey.....	3
Assessment of Existing Biophysical Values.....	3
Water Quality.....	4
Species List.....	4
Staff and Tasks.....	5
Results.....	6
Site Physical Description.....	6
Substrate	6
Table 1. Substrate quadrat percent cover observations by transect.....	6
Water Quality Profiles; Dissolved Oxygen.....	8
Specific Conductance (salinity).....	8
Temperature.....	9
Biota.....	9
Table 2. Summary of biota observations.....	10
Fish.....	10
Invertebrates.....	10
Plants Phaeophyta.....	12
Plants Rhodophyta.....	12
Plants Chlorophyta.....	12
Plants Tracheophyta.....	13
Diatoms and Bacteria.....	13
Summary of Quadrat Survey Data.....	14
Incidental Observations.....	15
Location Waypoints.....	16
Quadrat Survey Selected Photos.....	17
Photo 1. T3: Juvenile dungeness crab. Mar. 6, 2018.	17
Photo 2. T4: Gaper clam siphon and juvenile dungeness crab. Mar. 6, 2018.....	18
Photo 3. T6: Muddy substrate with bottles and small woody debris. Mar. 6, 2018.....	19
Photo 4. T6: Abundant shell hash, and a few bivalve siphons and holes. Mar. 6, 2018.....	20
Photo 5. T7: Area of abundant bivalve shells. Mar. 6, 2018.....	21
Photo 6. T1: Typical substrate (mud) and biota (dominated by diatoms). Mar. 7, 2018.....	22
Photo 7. T1: Boulder colonized by taxa including red algae, hydroids and chitons. Mar. 7, 2018.....	23
Photo 8. T1: Creosote preserved wooden pile. Mar. 7, 2018.....	24
Photo 9. T5: Clam siphons partially withdrawn. Mar. 7, 2018.....	25
Photo 10: Eelgrass and concentrated bivalve shells observations.....	26
Subtidal Taxa Observations.....	27
Biota Density Table Summary by Transect.....	32

Executive Summary

Seacology conducted a subtidal biophysical survey of the area in and around the Royal Vancouver Yacht Club, Coal Harbour Marina in Vancouver Harbour, Burrard inlet, BC, Canada between March 6th and 7th 2018. Work was completed in anticipation of a proposed dock re-alignment. Seven transects were positioned and deployed to best survey sites that are proposed to be covered with the newly positioned docks, boat houses and floats. Two meandering transects were completed at depths where eelgrass was discovered adjacent to the RVYC property lease. One eelgrass shoot was observed during the survey within the RVYC property lease. Marine biota observed was typical of the primarily soft bottom habitat expected at the time of year the survey was conducted. No red listed, endangered marine biota were observed during the survey. Macro algae growth was limited by season of the survey and lack of suitable substrate. Diatoms as evident by the brown colouration of substrate was observed covering seventy-three percent of the substrate. An invasive tunicate was observed on piles supporting the existing dock and float emplacements. Commercial recreational and ceremonial biota observed included flounders, a green urchin, California sea cucumbers, dungeness and red rock crabs, bivalves, chitons, and anemones. Anthropogenic debris observed included: glass jars, glass bottles and a porcelain toilet; plastics including plastic containers and pipes; tires; small metal objects; corrugated aluminum; steel I beam and creosote preserved wooden piles.

Qualifications and Background

Seacology has successfully completed more than 40 subtidal biophysical surveys throughout the southern Strait of Georgia. Our professional staff and associates have worked with all levels of government including first nations, the private sector and non-government organizations. The personnel chosen for this survey have an excellent knowledge of the survey methods employed and are familiar with a wide range of habitat values and features in the marine environment. Seacology's staff and associates are independent of the project proponent.

Seacology's dive team members meet or exceed CSA Z275.4-97 'Competency Standard for Diving Operations,' carry Unrestricted Occupational Diver's Certificates and have current Diver Medical Certifications issued by Work Safe BC.

Safety and Field Operations

Seacology has an unblemished diver safety record. Seacology's three person self-contained underwater breathing apparatus (SCUBA) dive team has accumulated more than 60 years of diving experience. Seacology adopts a safety first attitude in all its activities.

Work Plan

Seacology conducted a subtidal biophysical survey around the existing Royal Vancouver Yacht Club's Coal Harbour Marina Docks. Transect locations were selected to provide information on areas currently not covered by dock or boat house structures and were proposed for coverage or closely related to the proposed new alignment of docks and boat houses. Seacology divers use SCUBA equipment and are

not able to swim into space with a restricted overhead condition that might prevent direct access to the surface by the SCUBA diver. The dock reconfiguration outlined in Typlan's drawing CV-102 Revision P1 was used to establish these transects, see illustration 1. The Seacology survey utilized a SCUBA dive team of marine biologists and support staff well practiced in the identification of the marine biota and habitats encountered in the Strait of Georgia. The team employed transects, quadrats, underwater high definition video, underwater still camera and diver observations to complete the survey. Transects and quadrats were used to quantitatively assess biological and physical features within and adjacent to the proposed area of dock reconfiguration. A two part meandering survey, EG1 and EG2 was used to detect the presence of Eelgrass *Zostera* sp. along the shoreline close to the Stanley Park seawall adjacent to the proposed works.

Transect Biophysical Survey

HD digital video was recorded along each transect. Species and substrate description was recorded using digital video and diver observation recorded on dive slates. GPS obtained endpoints were used to plot transects on a plan view illustration of the site, see illustration 2.

Assessment of Existing Biophysical Values

Habitat was assessed along each transect and incidental observations were made during an overlapping meandering survey following the completion of each transect. Two SCUBA divers carried the transect deploying a metered tape and surveying for fish and other highly mobile fauna. On the return swim along the metered transect one of the divers, carrying a one meter squared quadrat, conducted a quantitative survey taking notes of substrate, flora, fauna, depth and recording a digital image of each quadrat. The second diver taking a meandering course, within 2 to 5 meters of the transect, used a camera with strobe to photograph and record incidental observations on biota and substrate. Both divers made note of sensitive marine habitat, for example eelgrass, macro algae, shellfish concentrations, forage fish and accumulations of anthropogenic debris, see illustration 10.

Transects were deployed using a compass bearing obtained on the surface before each transect deployment and underwater using marina features like visible piles and shadows of boat houses. This worked well for all transects except T2. The initial deployment of T2 resulted in the transect being deployed outside of the lease boundaries and intersecting with a patch of eelgrass (T2W). This eelgrass patch is noted within this report and assisted in the establishment of a known depth of eelgrass for the remainder of the survey including the search for eelgrass during the meandering transect swims, see illustration 2.



Illustration 1: Red transects used to assess habitat within the area of interest. Orange meandering transects were completed at depths where eelgrass was known to occur.

Water Quality

A YSI Inc. Pro2030 with dissolved Oxygen, conductivity and temperature sensors was used to assess water quality at three locations around the site, see WC#1, WC#2, and WC#3 in illustration 2. Profiles were obtained at 0.5 m intervals starting at complete sensor immersion (zero meters below the water's surface) to a maximum length of the sensor cable near four meters below the water's surface.

Water Quality parameters measured were obtained on March 7th between 16:00 and 17:00 hrs following the transect survey. Tide height levels for Vancouver Harbour during the measurements ranged between 1.57 m and 1.76 m elevation. Salinity calculations were obtained using Conductance and temperature readings from the YSI Inc. Pro2030 and a web based conversion calculator accessed April 06, 2018 (<http://www.fivecreeks.org/monitor/sal.shtml>).

Species List

Images and diver observations obtained during the transect surveys and a meandering survey of the

area were used to generate an inventory of species observed. Data was geo-referenced by the position along the transect. Species densities were determined using quadrats (at least 8) randomly placed along each transect.

Time line

The survey occurred on March 6th and 7th of 2018.

Administration Requirements

Seacology contacted the Port Authority's Marine Events web page to obtain permission to conduct a marine event as required to complete a dive survey in areas covered under jurisdiction of the Port Authority.

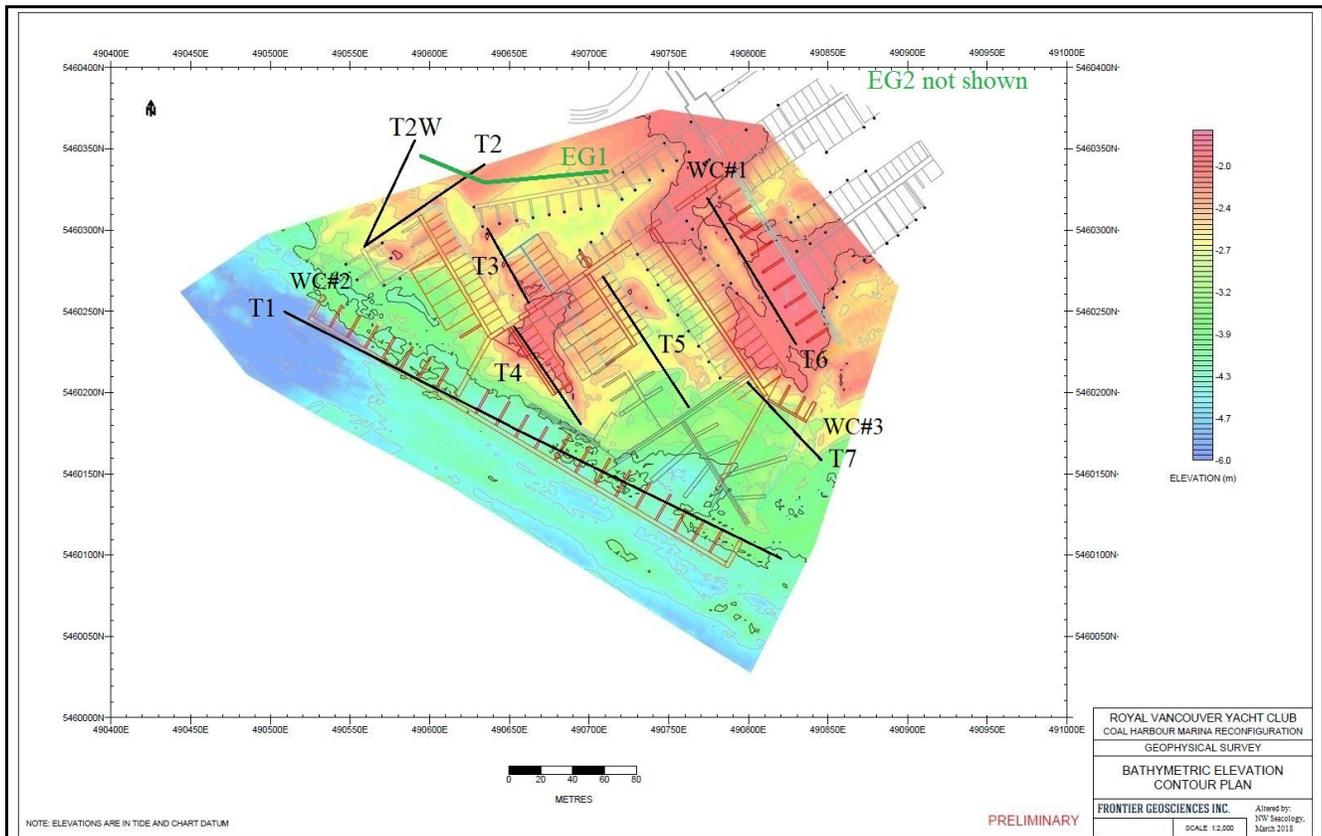


Illustration 2: Transects located over proposed dock realignment with depths indicated by colour and contours. Eelgrass meandering transect EG2 (see also illustration 1) is not shown in this illustration.

Staff and Tasks

Douglas Swanston (DS) Seacology's project liaison, Worksafe BC unrestricted SCUBA Diver, under water photographer, report coauthor, SVOP licensed boat operator;

Neil McDaniel (NM) dive supervisor, biologist, photographer, boat operator;

Erika Paradis, RPBio.(EP) Biologist, Worksafe BC unrestricted SCUBA Diver, boat operator, quadrat data summary and report coauthor.

Results

Visibility underwater during the survey dates ranged from two to three meters horizontally. Weather was clear with occasional clouds to overcast. Winds were light ranging from calm to 15 km/hr.

Site Physical Description

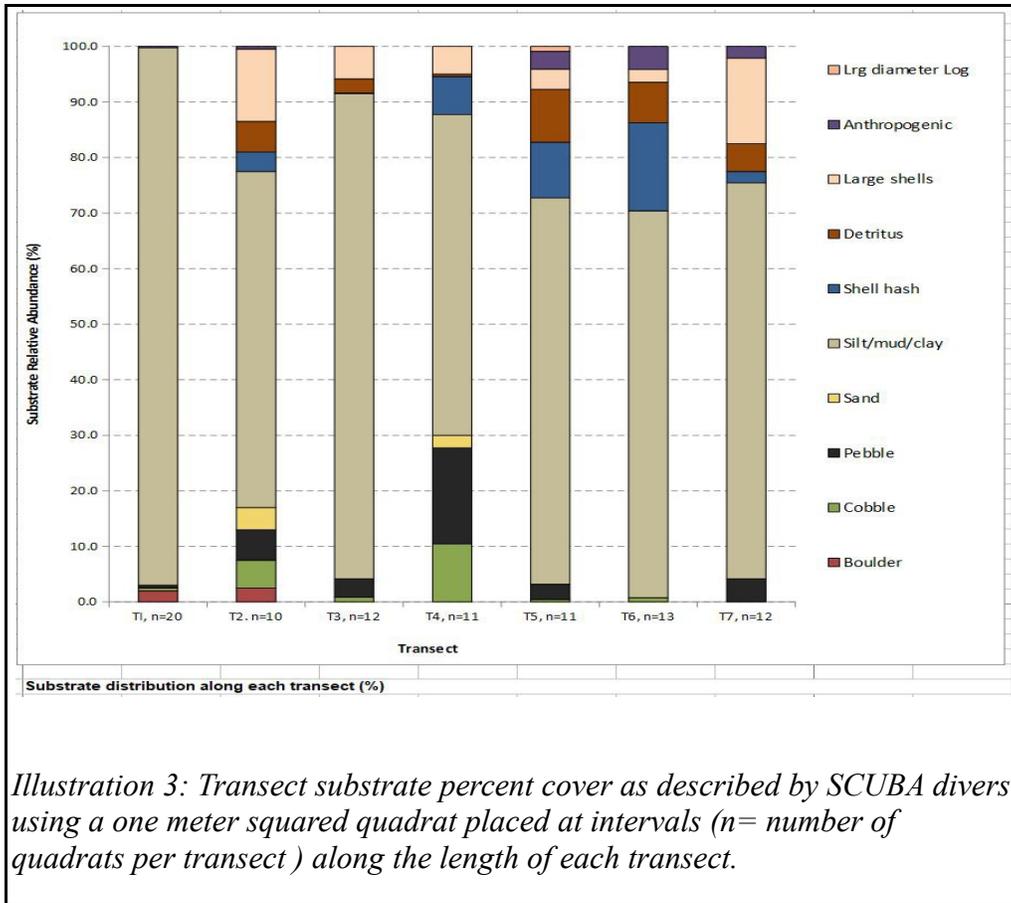
Substrate

Substrate Distribution (%) Along Transects, RVYC Coal Harbour, March 2018

Substrate Type	Transect ID							TOTAL
	T1, n=20	T2, n=10	T3, n=12	T4, n=11	T5, n=11	T6, n=13	T7, n=12	
Lrg diameter Log	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.1
Woody debris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthropogenic	0.3	0.5	0.0	0.0	3.2	4.2	2.1	1.5
Large shells	0.0	13.0	5.8	5.0	3.6	2.3	15.4	6.5
Detritus	0.0	5.5	2.6	0.5	9.5	7.3	5.0	4.3
Shell hash	0.0	3.5	0.1	6.8	10.0	15.8	2.1	5.5
Silt/mud/clay	96.8	60.5	87.3	57.7	69.5	69.6	71.3	73.2
Sand	0.0	4.0	0.0	2.3	0.0	0.0	0.0	0.9
Gravel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pebble	0.5	5.5	3.3	17.3	2.7	0.0	4.2	4.8
Cobble	0.5	5.0	0.8	10.5	0.5	0.8	0.0	2.6
Boulder	2.0	2.5	0.0	0.0	0.0	0.0	0.0	0.6
Total % Cover	100	100						

Table 1. Substrate quadrat percent cover observations by transect

Substrate was mostly unconsolidated fine grained sediments with surface layer that obscure visibility when disturbed by diver activity like quadrat placement and fin kicks made too close to the substrate. Locations of larger boulders; areas of boulder and cobble; large anthropogenic items (creosote preserved wood piles and steel I beam piles laying on the benthos) observed during the transect survey are depicted in illustration 10.



A modified Wentworth Scale was used to classify sediment grain size quantified during the quadrat survey. Boulders occurred occasionally, 0.6 percent cover averaged over all transects, but only on T1 T2 and T3 during the quadrat survey. Cobble, 2.6 percent cover averaged over all transects, was observed on each transect but T7. Substrate, smaller than cobble, including pebble, gravel, sand, silt, mud, clay, shell hash*, shells and detritus made up 95.2 percent of the substrate cover in the survey. Anthropogenic items covered 1.6 percent of the area surveyed and included creosote preserved wood piles, steel I beam piles, corrugated Aluminum sheets, smaller metal objects, rope, cable, wire, glass jars, glass bottles and plastic items observed as scattered debris throughout the survey.

* Note: shell hash is defined as finely broken up shell fragments with a maximum dimension less than 10 mm. Shell hash is usually composed of barnacle fragments and bivalve shell fragments.

Water Quality Profiles; Dissolved Oxygen

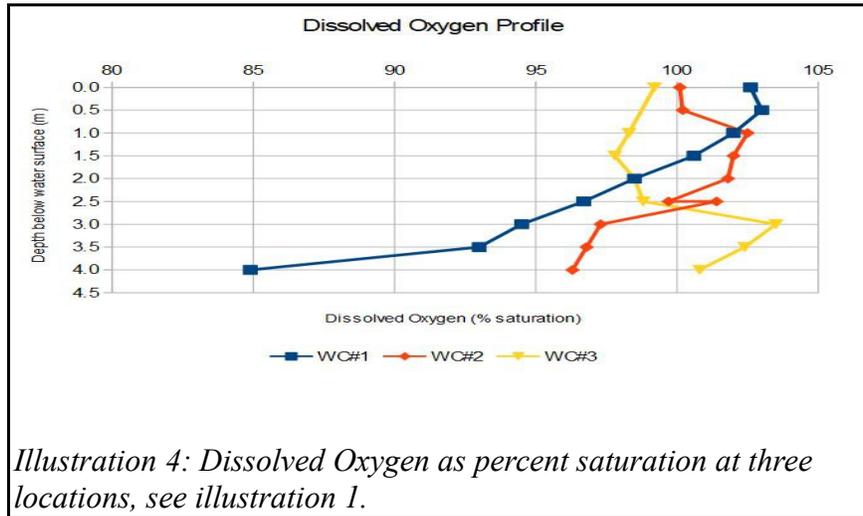


Illustration 4: Dissolved Oxygen as percent saturation at three locations, see illustration 1.

Dissolved Oxygen (DO) values were obtained at three locations in the lease area, at WC#1 (located centrally in the site), WC#2 (south western corner of the site), and WC#3 (eastern end of the site). WC#1 DO value at the 4 m depth measure indicates the probe may have impacted the bottom and disturbed the sediment surface resulting in a dramatic alteration in DO values.

Specific Conductance (salinity)

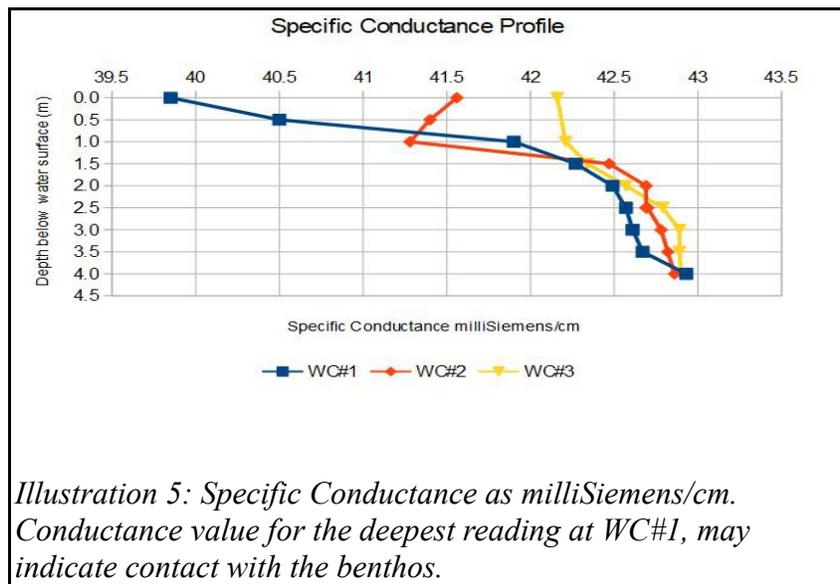
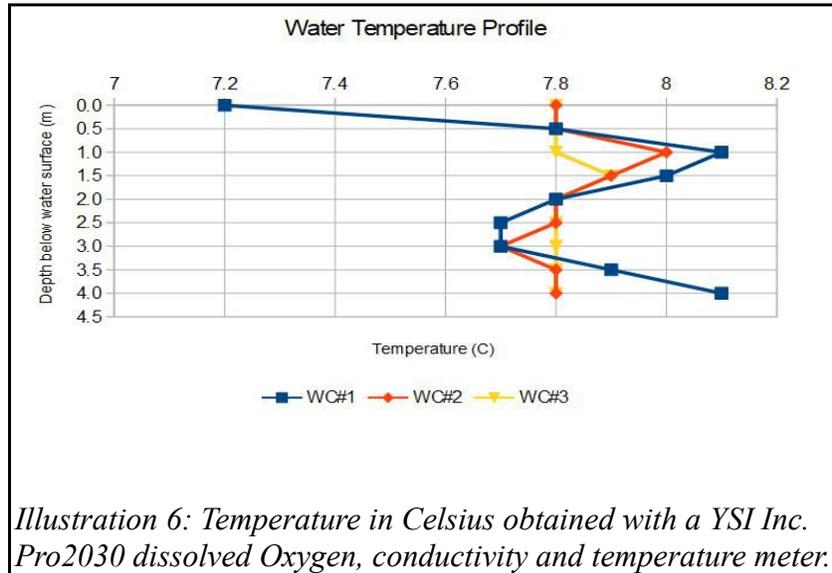


Illustration 5: Specific Conductance as milliSiemens/cm. Conductance value for the deepest reading at WC#1, may indicate contact with the benthos.

Salinity calculated using conductivity values ranged from 25 parts per thousand near the waters surface to 27 parts per thousand four meters below the waters surface.

Temperature



Biota

Biota observed is representative of late winter seasons expectations for a soft bottom substrate with occasional rocky outcrops, in an estuarine embayment within the southern Strait of Georgia. Fish diversity is lower than expected with only a few fish observed throughout the two day survey. Macro algae observations indicated that substrates suitable for secure holdfast attachments with the exception of a few boulders and cobbles is limited. A fine layer of silts covered most horizontally oriented surfaces observed in the survey which may act to periodically smother embryonic forms of macro flora and macro fauna. Accumulations of drift macro algae were not observed. Invertebrate observations of epifauna and evidence of infauna revealed the following:

1. Invasive tunicate taxa;
2. Evidence of sea star wasting syndrome;
3. Occasional dense accumulations of bivalve shells, see photo 5 and 10 and the bivalve shells and cockle shell categories in the Biota Density Table Summary by Transect;
4. Low densities of commercial, recreational and ceremonial harvested species including crabs and bivalves (as evident from siphon show including gaper clams, *Tresus* sp. and butter clams, *Saxidomus gigantea* and cockles *Clinocardium* sp.).

Otter Street Taxa Observed During All Survey Activities	Total of all Taxa and Taxa Signs Observed in the Survey	T1	T2	T2W *	T3	T4	T5	T6	T7
Total Taxa observed including signs	98	34	43	19	46	53	49	47	45
Diatoms and Bacteria	3	2	2	2	2	2	2	3	2
Marine Flora	18	4	11	4	8	8	6	10	8
Marine Fauna	77	28	30	13	36	43	41	34	35
Marine Invertebrates	73	26	29	13	35	42	40	34	35
Marine Fishes	4	2	1	0	1	1	1	0	0
	Length of Transect (m):	355	90	75	55	75	100	100	55

Notes: * Transect TW2 only incidental biota observations from the fish survey video were collected. Transect T2W was re-positioned to T2 for data collection within RVYC lease area.

Table 2. Summary of biota observations

Fish

No fish were observed during the quantitative fish surveys conducted along each transect during either the the initial deployment of each transect or during the quadrat survey. All fish were observed incidentally during meandering surveys following each transect swim and therefore quantitative data on fish is made strictly from incidental observations. Three species of fish were observed in the survey: *Citharichthys* sp., Bothidae a juvenile left eyed flounder); an adult flounder, Pleuronectiforme; two sculpins probably *Artedius fenestralis*, padded sculpin; and two clusters of fish eggs (probably deposited by *Artedius fenestralis*, padded sculpin). The unidentified adult flatfish, Pleuronectiforme was observed swimming away from the divers at the south end of Transect One in low visibility conditions.

Invertebrates

An invasive tunicate, harbour star ascidian, *Botryllus schlosseri* was observed incidentally on piles. The echinoderm sunflower sea star, *Pycnopodia helianthoides* was not observed in the survey and a few examples of mottled star, *Evasterias troschelii* were observed as having recent dismemberment possibly due to ongoing exposure to Sea Star Wasting Syndrome.

Commercial, recreational and ceremonially important motile invertebrates observed included one green urchin; a few California sea cucumbers, *Parastichopus californicus*; dungeness crabs, *Metacarcinus (Cancer) magister* density of 0.2 juveniles per meter squared (S.D.=0.4, n=89); and red rock crab, *Cancer productus* density of 0.01 per meter squared (S.D.=0.1, n=89). Chitons densities of 0.06 per meter squared (S.D. =0.4, n=89) and limpet densities of 0.05 per meter squared (S.D.=0.3, n=89) were frequently observed on boulders but at low densities due to the low relative abundance of this substrate in the survey.

Commercial, recreational and ceremonially important and relatively non motile bivalve molluscs were observed including fat gaper, *Tresus capax*; Pacific gaper, *Tresus nuttallii*; butter clam, *Saxidomus gigantea*; soft shell clam, *Mya* sp.; pacific blue mussel, *Mytilus edulis* complex (dislodged from dock and pile structures); Macoma clam, *Macoma* sp.; and cockle, *Clinocardium nuttallii*. Bivalve density for the entire site determined by siphon counts in the quadrat survey is 0.5 siphons per meter squared (S.D.=1.3, n=89). Horse clams, *Tresus* sp. density was 0.06 per square meter (S.D.=0.3, n=89), see illustration 7.

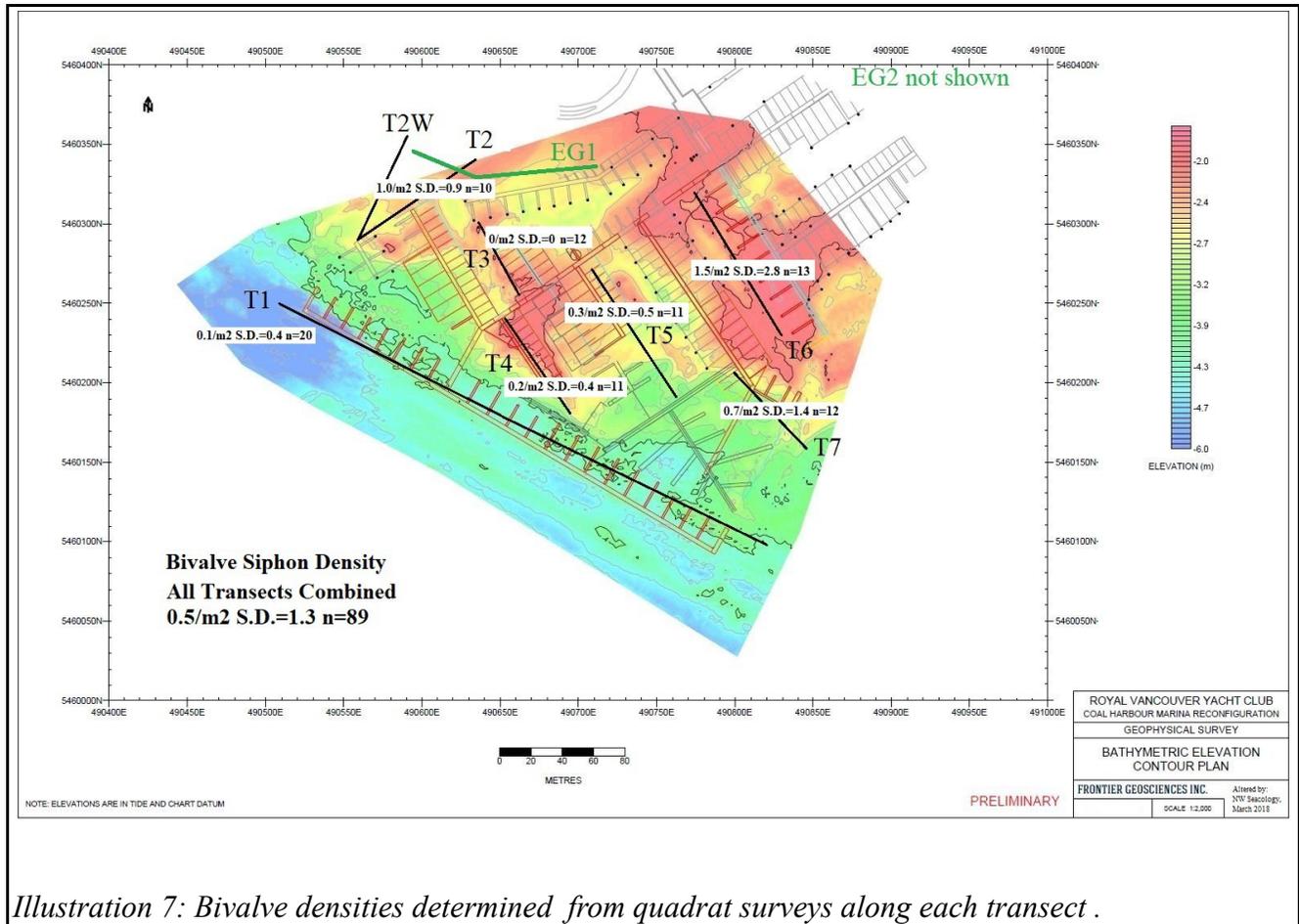


Illustration 7: Bivalve densities determined from quadrat surveys along each transect.

Plants Phaeophyta

Brown macro algae density of 0.4 percent cover (S.D.=1.8, n=89) was observed on the limited suitable substrate of cobble and boulders. Brown macro algae drift density was 0.4 percent cover (S.D.=1.2, n=89). Five taxa of brown algae and three taxa of drift were observed in the survey, see illustration 8 and 9.

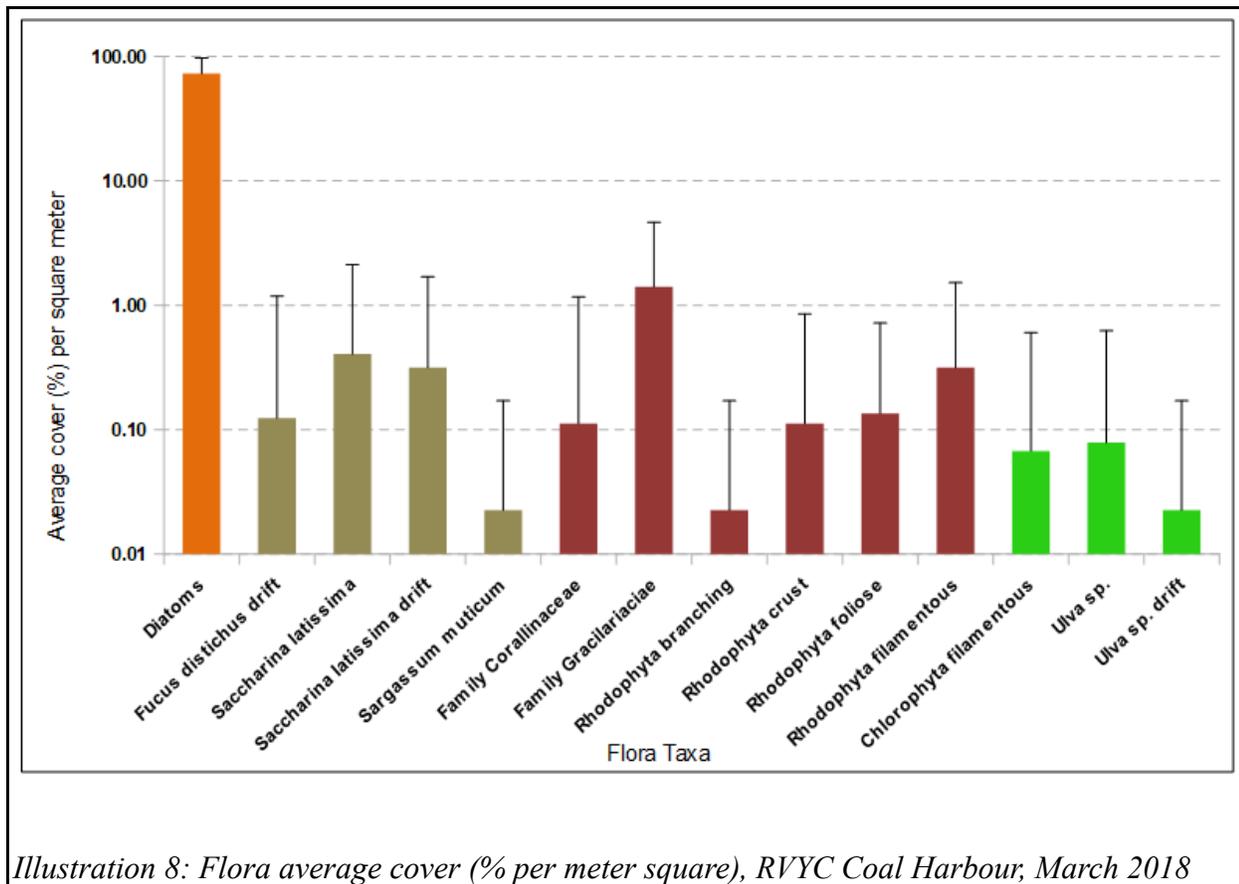


Illustration 8: Flora average cover (% per meter square), RVYC Coal Harbour, March 2018

Plants Rhodophyta

Red macro algae had the highest percent cover of any algae taxa with succulent filamentous taxa in the family Gracilariaceae with a 1.4 percent cover (S.D.=3.3, n=89) combined for all transects. Other fine filamentous algae observed had a 0.3 percent cover (S.D.=1.2, n=89). Red blade (foliose) algae taxa was present with a 1.3 percent cover (S.D.=0.6, n=89). Red Crust algae and crustose coralline algae made up 0.1 percent cover with (S.D.=0.7, n=89) and (S.D.=1.1, n=89) respectively. At least six taxa of red macro algae were observed, see illustration 8 and 9.

Plants Chlorophyta

Green foliose algae, *Ulva* sp. was present with 0.08 percent cover (S.D.=0.5, n=89). Filamentous green algae was also present as a green turf, 0.07 percent cover (S.D.=0.5, n=89). *Ulva* drift was observed on

every transect but T3 and T5, see illustration 8 and 9.

Plants Tracheophyta

Eelgrass, *Zostera marina* was observed at the north end of Transect T2W in a patch with estimated dimensions 5 x 5 m with a density range between 2 and 10 shoots per square meter, UTM coordinates 10U 490595.67 m east 5460347.08 m north. A single shoot of eelgrass was observed on Transect Five, T5, UTM coordinates approximately 10 U 490735 m east 5460230 m north, see illustration 10 and photo 10.

Diatoms and Bacteria

Diatoms and filament forming diatoms were present on all transects as recognized by the brown discolouration of the unconsolidated fine sediment throughout the survey, 72.8 percent cover (S.D.=25.0,5, n=89).

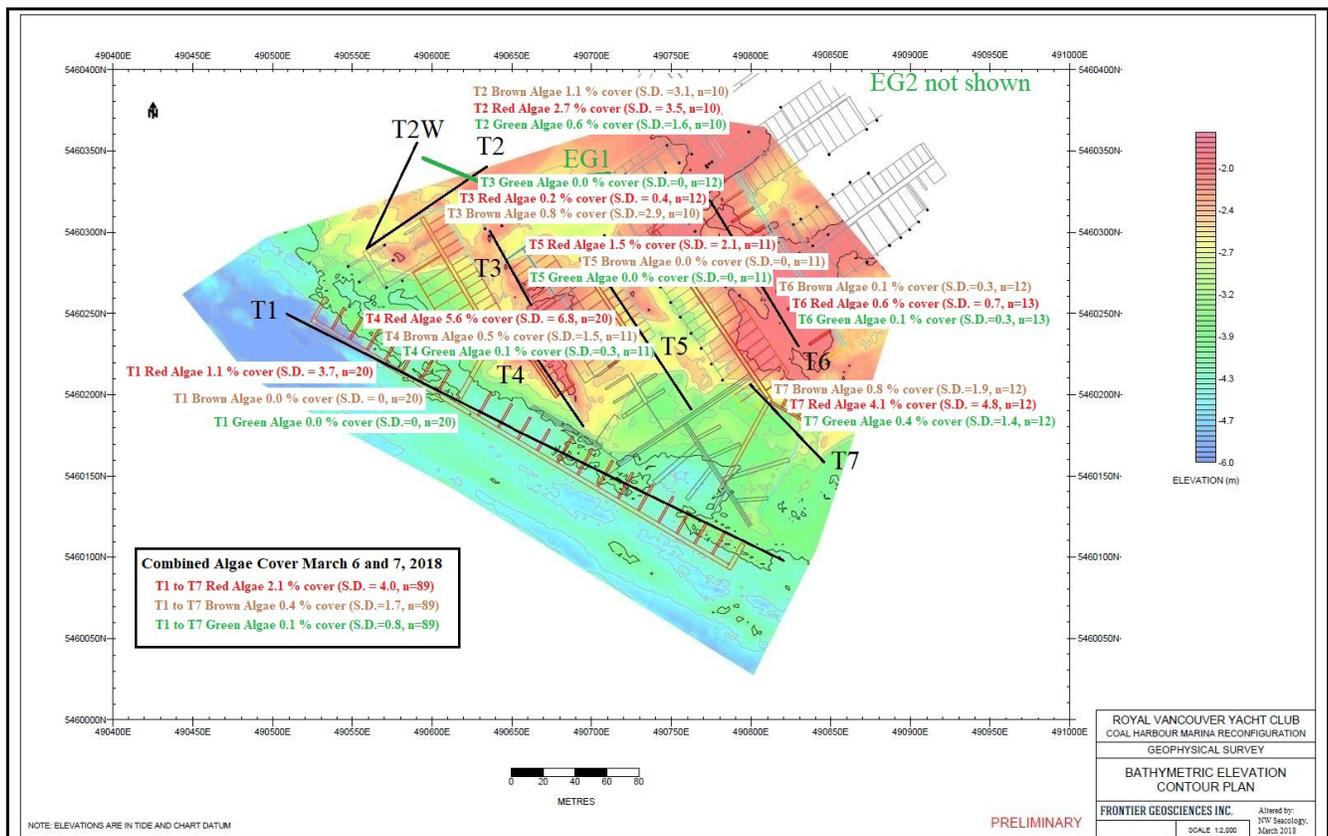


Illustration 9: Percent cover for attached brown, red and green macro algae obtained from the quadrat survey for each transect and combined as an averaged over all transects.

Summary of Quadrat Survey Data

Transect ID	Average Depth (m)*	Dominant Substrate	Overview of Biota
1	-3.4	Mud	Abundant diatoms. Trace abundance of various red algae. Limited bivalve shells, two bivalve siphons, over 30 small (~1 cm diameter) holes, and numerous smaller (<1 cm) holes. One mottled star. Homogeneous biophysical characteristics along transect (Photo 6), with occasional increase in species diversity provided by anthropogenic debris (including riprap; Photo 7). Three plumose anemones on a creosote preserved wooden pile (Photo 8),
2	-1.1	Mud	Abundant diatoms. Limited red spaghetti algae, and trace abundance of other red algae, green algae and sugar kelp. abundant bivalve shells (mainly clams, with cockles and mussels). Ten bivalve siphons, a few infaunal hole (~1 cm) and several smaller ones.
3	-1.8	Mud	Abundant diatoms. Trace abundance of sugar kelp and red spaghetti algae. Some bivalve shells (mainly clam species and cockles). Two juvenile dungeness crabs (Photo 1) and one red rock crab.
4	-1.2	Mud	Abundant diatoms. Limited abundance of various red algae, trace sugar kelp. Some bivalve shells and sabellid worms, one leather star, chitons cockles and nudibranchs. Five dungeness crabs and seven bivalve siphons (Photo 2), including rough piddocks. Boulders and hard clay outcrops.
5	-1.6	Mud	Abundant diatoms. Limited red spaghetti algae and other red algae. Some bivalve shells, three bivalve siphons (shows), and evidence of several withdrawn siphons (Photo 9). Five juvenile dungeness crabs and one adult. Invasive tunicate on creosote preserved wood piles.
6	-1.0	Mud	Numerous bottles (Photo 3). Abundant diatoms. Trace filamentous red algae and sugar wrack kelp. Numerous bivalve siphons (>20, plus abundant holes; Photo 4), including gaper clams and cockles. Three juvenile dungeness crabs and a few molts. Sea stars with evidence of sea star wasting syndrome. Nudibranchs and invasive tunicate on creosote preserved wood piles.
7	-2.4	Mud	Abundant diatoms. Limited red spaghetti algae, and trace sugar kelp. Areas of abundant bivalve shells (mainly clams; Photo 5), eight bivalve siphons, and over 30 infaunal holes. Two juvenile dungeness crabs, crangon shrimps and sea stars

* Adjusted to Chart Datum, based on DFO Observed Water Levels for Vancouver (Station #7735), PST (Z+8). www.pac.dfo-mpo.gc.ca/science/charts-cartes/obs-app/observed-eng.aspx?StationID=07735. Accessed 20 March 2018.

Incidental Observations

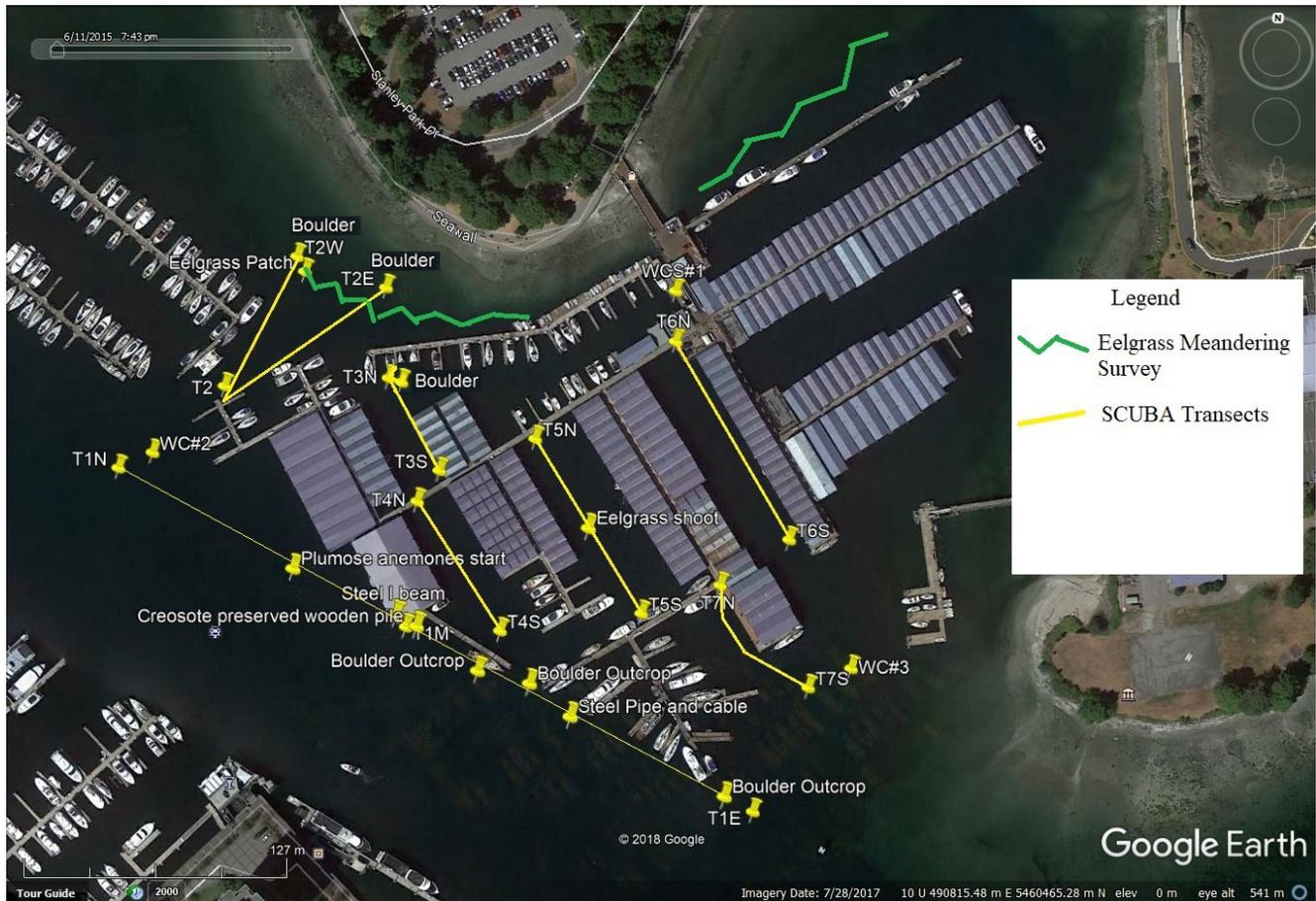


Illustration 10: Incidental observations of large boulders eelgrass, piles (steel and creosote preserved wood),

Coal Harbour Royal Vancouver Yacht Club - Incidental Observations

Common Name	Scientific Name	Number Observed
gulls		several
bufflehead	<i>Bucephala albeola</i>	a few
goldeneye	<i>Bucephala sp.</i>	several
double-crested comorant	<i>Phalacrocorax auritus</i>	a few
great blue heron	<i>Ardea herodias</i>	1
mallard	<i>Anas platyrhynchos</i>	several

Note: No marine mammals observed in the project area or adjacent areas during the assessment.

Location Waypoints

Label	Latitude	Longitude	y_proj	x_proj
T1N	49.294923	-123.130519	5460250	490510
T1Mid	49.294295	-123.128592	5460180	490650
T1S	49.293572	-123.126253	5460099	490820
T2	49.295292	-123.129846	5460291	490559
T2W	49.295868	-123.129403	5460355	490591
T2E	49.295750	-123.128813	5460342	490634
T3N	49.295357	-123.128773	5460298	490637
T3S	49.294970	-123.128415	5460255	490663
T4N	49.294808	-123.128593	5460238	490650
T4S	49.294296	-123.127973	5460180	490695
T5N	49.295117	-123.127875	5460271	490702
T5S	49.294396	-123.127052	5460191	490762
T6N	49.295532	-123.126785	5460316	490783
T6S	49.294765	-123.126035	5460232	490836
T7N	49.294478	-123.126543	5460200	490799
T7S	49.294111	-123.125926	5460159	490844
Bivalve shell bed end	49.294190	-123.126171	5460168	490826
Bivalve shell bed start	49.294316	-123.126364	5460182	490812
Eelgrass shoot	49.294728	-123.127424	5460229	490735
Eelgrass patch	49.295797	-123.129343	5460347	490596
WC#1	49.295786	-123.126917	5460346	490772
WC#2	49.295001	-123.130297	5460259	490526
WC#3	49.294205	-123.125659	5460170	490863

Illustration 11: Location waypoints labels refer to locations depicted in illustration 10 and photo 10.

Quadrat Survey Selected Photos



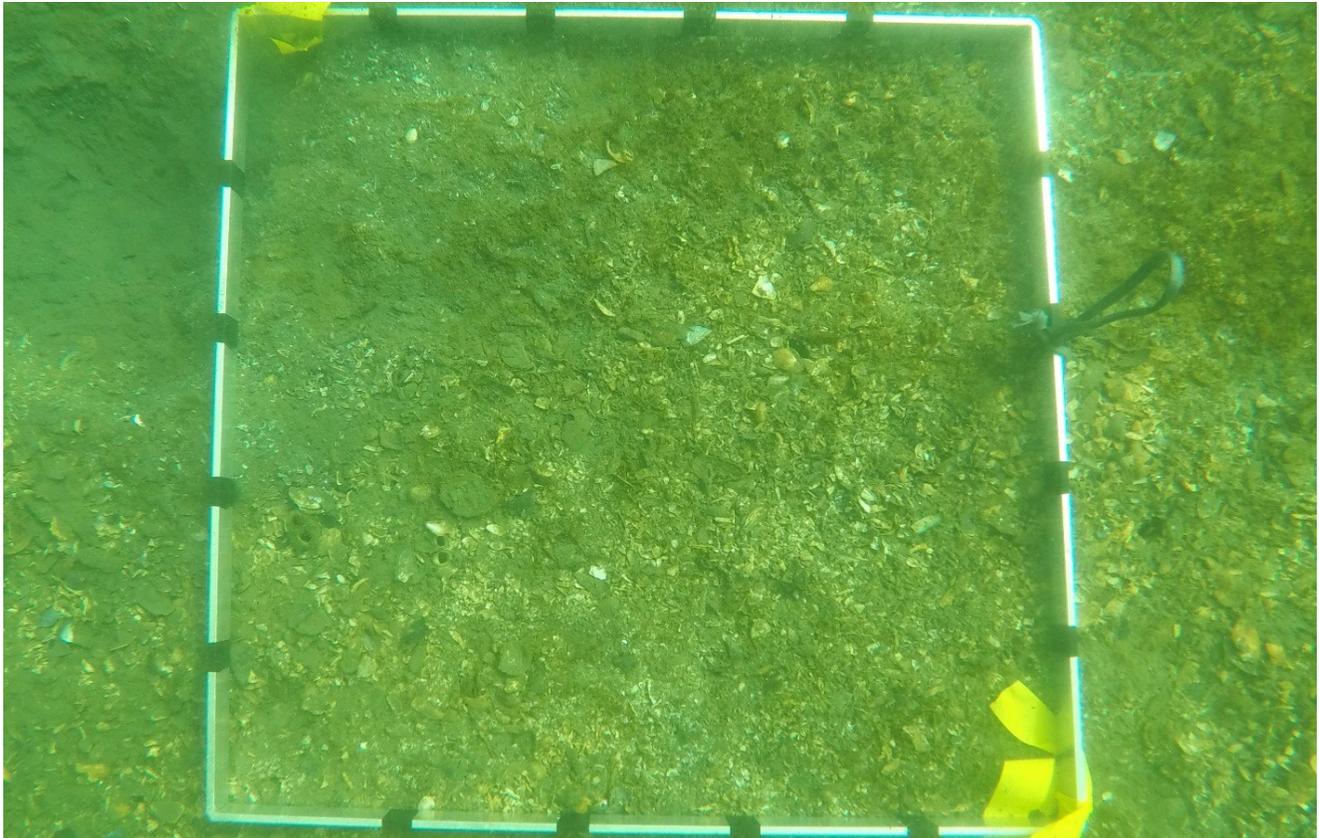
Photo 1. T3: Juvenile dungeness crab. Mar. 6, 2018.



Photo 2. T4: Gaper clam siphon and juvenile dungeness crab. Mar. 6, 2018.



Photo 3. T6: Muddy substrate with bottles and small woody debris. Mar. 6, 2018.



***Photo 4. T6: Abundant shell hash, and a few bivalve siphons and holes.
Mar. 6, 2018.***

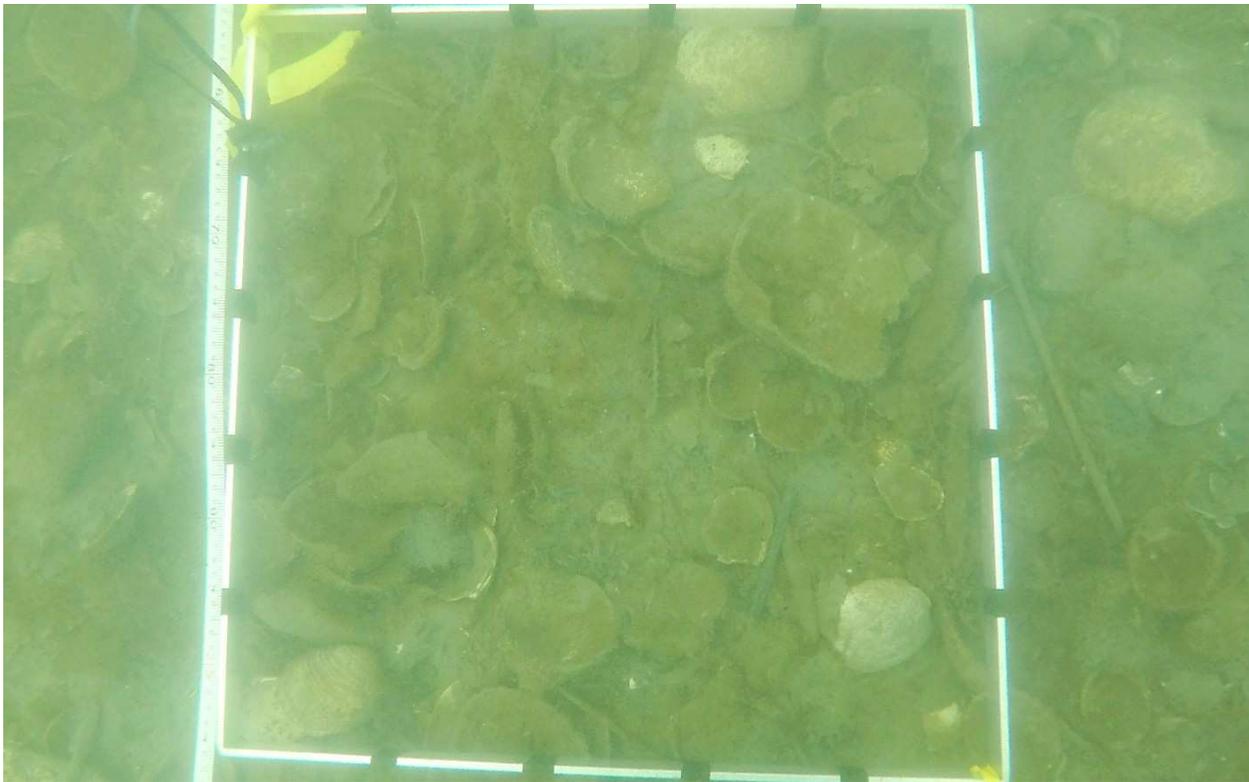
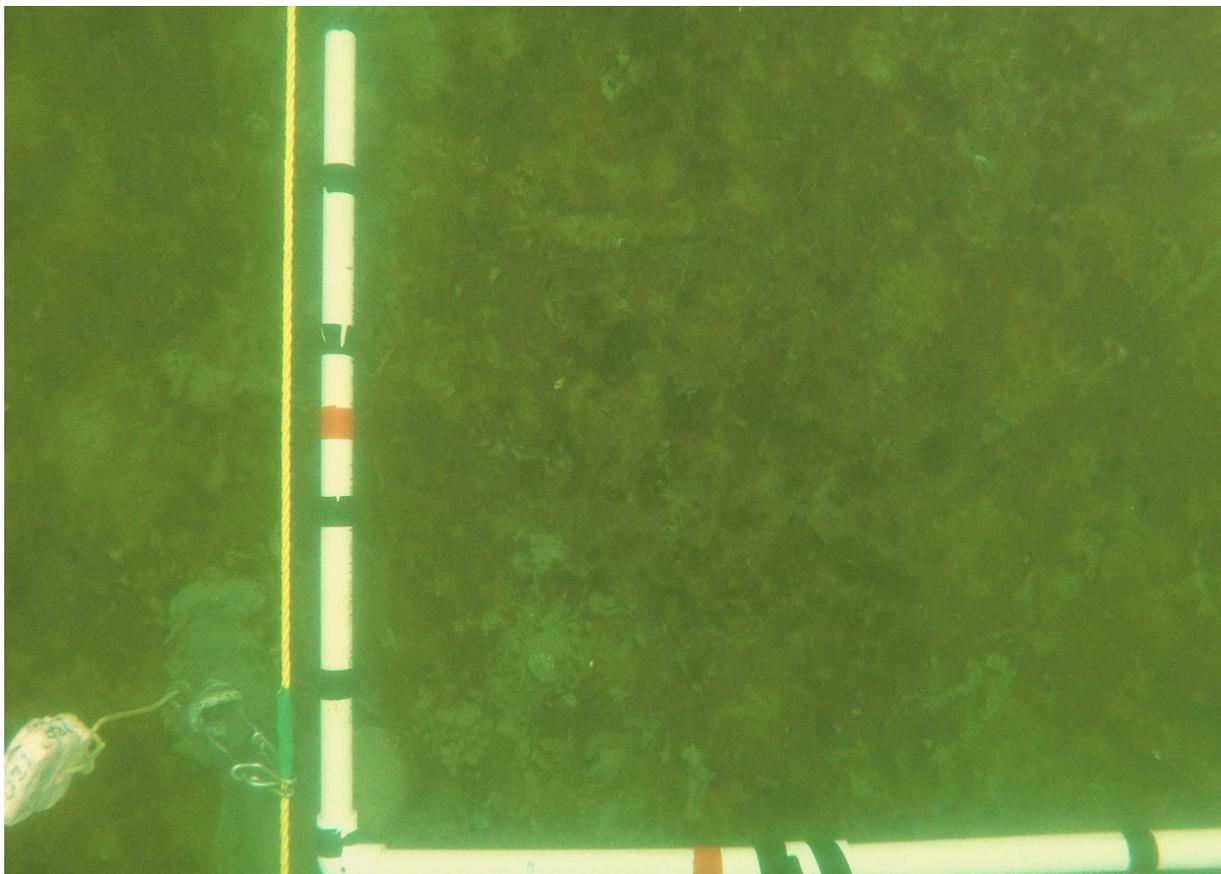


Photo 5. T7: Area of abundant bivalve shells. Mar. 6, 2018.



***Photo 6. T1: Typical substrate (mud) and biota (dominated by diatoms).
Mar. 7, 2018.***



Photo 7. T1: Boulder colonized by taxa including red algae, hydroids and chitons. Mar. 7, 2018.

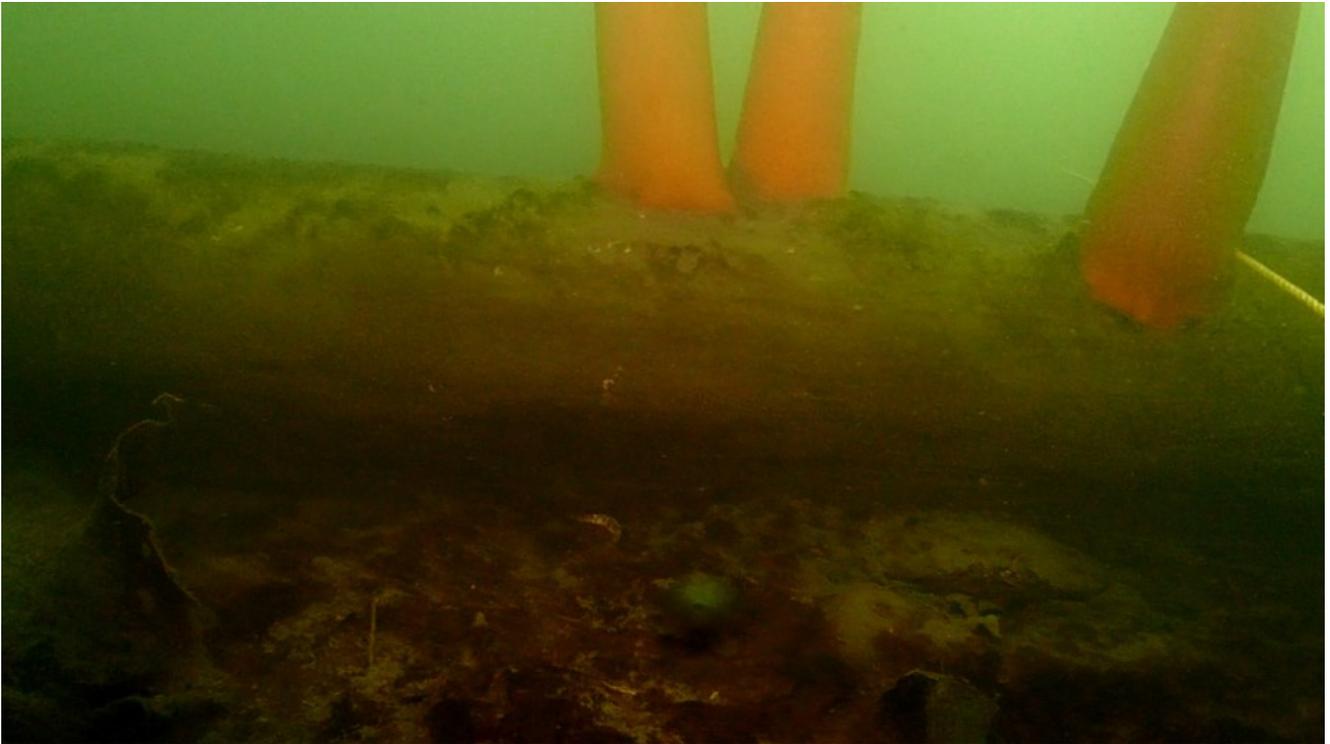


Photo 8. T1: Creosote preserved wooden pile. Mar. 7, 2018.



Photo 9. T5: Clam siphons partially withdrawn. Mar. 7, 2018.

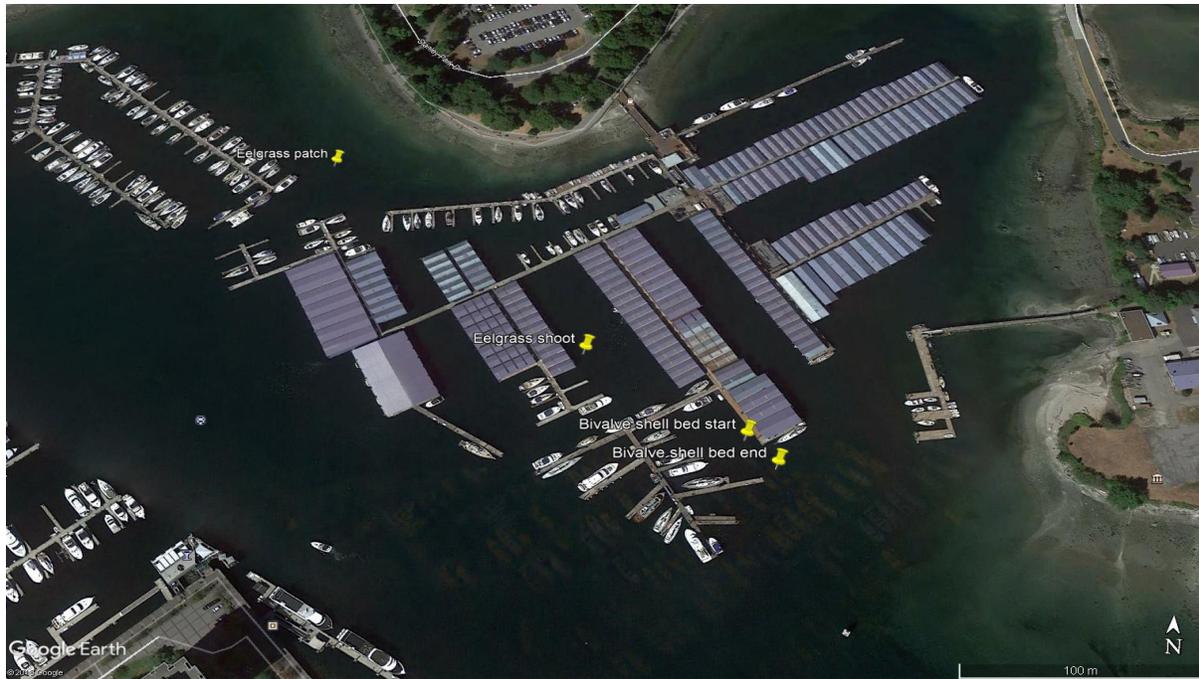


Photo 10: Eelgrass and concentrated bivalve shells observations.

Subtidal Taxa Observations

Marine Taxa Presence (P) Observations	Transect	T1	T2	T2W	T3	T4	T5	T6	T7
Common name	Taxa or Related Observation								
Bacteria									
wood decomposing filamentous bacteria	<i>Beggiatoa</i> sp.							P	
Algae									
diatoms epiflora	diatoms	P	P	P	P	P	P	P	P
filamentous algae	filamentous diatoms	P	P	P	P	P	P	P	P
Phaeophyta Brown Macroalgae									
Acid kelp	<i>Desmarestia</i> sp.								P
stringy acid weed	<i>Desmarestia viridis</i>						P	P	
rockweed drift	<i>Fucus distichus</i> drift		P						
blade algae smaller than 50 mm	Phaeophyta small blade algae				P				
sugar kelp	<i>Saccharina latissima</i>		P	P	P	P	P	P	P
sugar kelp drift	<i>Saccharina latissima</i> drift		P					P	P
sargassum	<i>Sargassum muticum</i>		P			P			
brown algae drift	Phaeophyta drift		P		P			P	P
Rhodophyta Red Algae									
red filamentous algae	Family Gracilariaceae	P	P	P	P	P	P	P	P
Turkish washcloth	<i>Mastocarpus</i> sp.				P	P			
red blade algae	Rhodophyta foliose aglae	P	P		P	P	P	P	P
filamentous red algae	Rhodophyta branching aglae		P			P	P	P	P
red coralline crustose algae	Family Corallinaceae	P			P	P		P	
Red crustose algae on shells	Red crustose algae on shells				P				
Chlorophyta Green Algae									
filamentous green algae	Chlorophyta filamentous algae		P					P	
sea lettuce	<i>Ulva</i> sp.		P	P		P		P	P
sea lettuce drift	drift <i>Ulva</i> sp.	P	P						
Tracheophyta Vascular Plants									
eelgrass	<i>Zostera marina</i>			P			P		
Length of Transect (m):		355	90	75	55	75	100	100	55

Subtidal Flora Observations for all survey methods

Marine Taxa Presence (P) Observations	Transect	T1	T2	T2W	T3	T4	T5	T6	T7
Common name	Taxa or Related Observation								
Porifera Sponges									
orange encrusting sponge	Demospongia						P		P
Tan to lavender coloured incrusting sponge	Demospongia				P				
yellow encrusting sponge thin	Demospongia						P	P	
Cnidaria Anemones, Corals, Sea Pens Jellyfish, Hydroids									
Hydroid colony	Hydroid colony	P	P		P	P	P	P	P
juvenile anemone	Actinaria juvenile				P				
plumose anemone	<i>Metridium farcimen</i>	P	P		P	P	P	P	P
plumose anemone	<i>Metridium</i> spp.	P	P		P	P	P	P	P
painted tealial	<i>Urticina crassicornis</i>	P							P
Nemertean									
Annelida Segmented Worms									
fragile ruffled scaleworm	c.f <i>Arctonoe fragilis</i>		P	P			P		P
feather duster	<i>Eudystilia vancouveri</i>				P		P		P
slime tube feather-duster	<i>Myxicola infundibulum</i>					P			
scaleworms	Polynoidae						P		P
Western calcareous tubeworm	<i>Pseudochitinopoma occidentalis</i>	P							
feather-duster	Family Sabellidae	P	P	P	P	P	P	P	P
red trumpet calcareous tubeworm	<i>Serpula columbiana</i>					P	P		
split-branch feather-duster	<i>Schizobranchia insignis</i>	P	P	P	P	P		P	P
Spaghetti-worm	Terebellidae family	P			P	P		P	
Phoronida Horseshoe Worms									
Length of Transect (m):		355	90	75	55	75	100	100	55

Subtidal Taxa continued, fauna observations for all survey methods part 1 of 4. P = present.

Marine Taxa Presence (P) Observations	Transect	T1	T2	T2W	T3	T4	T5	T6	T7
Common name	Taxa or Related Observation								
Mollusca Chitons, Snails, Limpets, Clams, Nudibranchs, Octopus									
shag rug nudibranch	<i>Aeolidia papillosa</i>						P		
yellow tipped ancula	<i>Ancula gibbosa</i>					P			P
bivalve shell	bivalve shell	P	P	P	P	P	P	P	P
bivalve siphon	Class Bivalvia	P	P		P	P	P	P	P
cockle	<i>Clinocardium nuttallii</i>		P			P	P	P	
cockle shell	<i>Clinocardium nuttallii</i> shell	P	P	P	P	P	P	P	P
amphissa or dove shells	Columbellidae family					P			
Fine-sculptured Odostome	<i>Evalea tenuisculpta</i>							P	
red gilled nudibranch	<i>Flabellina</i> sp					P		P	P
opalescent nudibranch	<i>Hermisenda crassicornis</i>		P		P		P	P	P
white and orange tipped nudibranch	<i>Janolus fuscus</i>								P
Macoma clam siphon	<i>Macoma</i> sp. siphon				P				
hooded nudibranch	<i>Melibe leonina</i>		P	P	P				
chiton	<i>Mopalia</i> sp.	P	P		P	P	P	P	P
soft shell clam	<i>Mya</i> sp.		P		P			P	
pacific blue mussel	<i>Mytilus edulis</i> complex						P		
pacific blue mussel shells	<i>Mytilus edulis</i> complex shells		P	P	P	P	P	P	P
chiton	polyplacophera	P			P	P	P		P
green false-jingle shell	<i>Pododesmus macrochisma</i>								P
butter clam shell	<i>Saxidomus gigantea</i> shell				P	P	P		P
butter clam siphon	<i>Saxidomus gigantea</i> siphon							P	
limpet	<i>Tectura</i> sp.		P			P			
lined chiton	<i>Tonicella</i> sp.						P		
fat gaper	<i>Tresus capax</i>	P			P	P	P		P
Pacific gaper	<i>Tresus nuttallii</i>		P			P		P	
gaper clam shell	<i>Tresus</i> sp. shell	P							
gaper clam siphon	<i>Tresus</i> sp. siphon	P	P			P	P	P	P
rough piddock	Zirfaea pilsbryi					P			
Bryozoa Mossy Animal									
bryozoan colony, encrusting	Bryozoan (Ectoprocta)					P			
orange encrusting bryozoan	<i>Schizoporella</i> sp.					P			
Length of Transect (m):		355	90	75	55	75	100	100	55

Subtidal Taxa continued, fauna observations for all survey methods part 2 of 4. P = present.

Marine Taxa Presence (P) Observations	Transect	T1	T2	T2W	T3	T4	T5	T6	T7
Common name	Taxa or Related Observation								
Arthropods Sea Spiders, Crustacea, Lobsters, Crabs, Shrimp, Krill, Amphipods, Isopods									
graceful crab	<i>Cancer gracilis</i>		P						
dungeness crab	<i>Metacarcinus (Cancer) magister</i>	P	P	P	P	P	P	P	P
red rock crab	<i>Cancer productus</i>	P	P		P	P		P	
red rock crab signs - shell	<i>Cancer productus</i> signs carapace							P	
Cancer crab	Cancer sp.								P
barnacle shells	Cirripidea barnacles shells	P	P		P	P	P	P	P
barnacles	Cirripidea barnacles live				P	P	P		
spinyhead or tank shrimp	Crangonidae shrimp family						P		P
green shore crab	<i>Hemigrapsus oregonensis</i>						P		
heptacarpus shrimp	<i>Heptacarpus</i> sp.		P		P	P			P
graceful decorated crab	<i>Oregonia gracilis</i>					P	P		P
greenmark hermit	<i>Pagurus caurinus</i>						P		
hairy hermit	<i>Pagurus hirsutiusculus</i>				P			P	
Alaskan hermit	<i>Pagurus ochotensis</i>				P				
hermit crab	<i>Pagurus</i> sp.	P			P	P	P	P	
Echinoderms Sea Stars, Sea Urchins, Sea Cucumbers, Brittle Stars, Crinoids									
leather star	<i>Dermasterias imbricata</i>	P		P		P	P		
white sea cucumber	<i>Eupentacta pseudoquinqueesemita</i>					P		P	
mottled star	<i>Evasterias troschelii</i>	P	P	P	P	P	P	P	P
California sea cucumber	<i>Parastichopus californicus</i>	P	P			P	P	P	
ochre star	<i>Pisaster ochraceus</i>				P	P	P	P	
green sea urchin	<i>Strongylocentrotus droebachiensis</i>		P						
Tunicates									
harbour star ascidian	<i>Botryllus schlosseri</i>						P	P	P
broadbase tunicate	<i>Cnemidocarpa finmarkiensis</i>					P		P	
transparent tunicate	<i>Corella willmeriana</i>	P	P	P	P	P	P	P	P
Infauna Signs									
Infaunal hole	Infaunal hole	P	P	P	P	P	P	P	P
Infaunal mounds	Infaunal mounds	P	P	P	P	P	P		P
mud tube	mud tube				P				
Length of Transect (m):		355	90	75	55	75	100	100	55

Subtidal Taxa continued, fauna observations for all survey methods, part 3 of 4. P = present.

Marine Taxa Presence (P) Observations	Transect	T1	T2	T2W	T3	T4	T5	T6	T7
Common name	Taxa or Related Observation								
Vertebrates Fishes									
left eyed flounder Bothidae	<i>Citharichthys</i> sp.	P							
flatfish	order Pleuronectiformes	P							
unidentified sculpin	Sculpin					P	P		
unidentified sculpin eggs	Sculpin eggs		P		P				
Length of Transect (m):									
		355	90	75	55	75	100	100	55

Subtidal Taxa continued, fauna observations (fish) for all survey methods, part 4 of 4. P = present.

Biota Density Table Summary by Transect

Quadrat by Transect Observations

Transect T#, N= number of quadrats		Unit	T1, n=20		T2, n=10		T3, n=12		T4, n=11	
Common name	Taxa or Related Observation		AVG	SD	AVG	SD	AVG	SD	AVG	SD
Bacteria										
		%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Algae										
diatoms epiflora	diatoms	%	89.500	2.236	58.000	30.386	46.667	33.934	71.364	30.008
Phaeophyta Brown Macroalgae										
rockweed drift	<i>Fucus distichus</i> drift	%	0.000	0.000	1.100	3.143	0.000	0.000	0.000	0.000
sugar kelp	<i>Saccharina latissima</i>	%	0.000	0.000	1.000	3.162	0.833	2.887	0.455	1.508
sugar kelp drift	<i>Saccharina latissima</i> drift	%	0.000	0.000	0.500	1.581	0.000	0.000	0.000	0.000
sargassum	<i>Sargassum muticum</i>	%	0.000	0.000	0.100	0.316	0.000	0.000	0.091	0.302
attached macroalgae		%	0.000	0.000	1.100	3.143	0.833	2.887	0.545	1.508
Phaeophyta drift		%	0.000	0.000	1.600	3.340	0.000	0.000	0.000	0.000
Rhodophyta Red Algae										
crustose corallines	Family Corallinaceae	%	0.500	2.236	0.000	0.000	0.000	0.000	0.000	0.000
red spaghetti	Family Gracilariaceae	%	0.300	1.129	2.200	3.393	0.167	0.389	3.182	5.862
red branching algae	Rhodophyta branching aglae	%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
red crust algae	Rhodophyta crust algae	%	0.250	1.118	0.000	0.000	0.000	0.000	0.455	1.508
red foliose algae	Rhodophyta foliose aglae	%	0.050	0.224	0.100	0.316	0.000	0.000	0.545	1.508
filamentous red algae	Rhodophyta filamentous algae	%	0.000	0.000	0.400	0.516	0.000	0.000	1.455	3.205
red upright		%	0.350	1.137	2.700	3.466	0.167	0.389	5.182	6.524
red encrusting		%	0.750	3.354	0.000	0.000	0.000	0.000	0.455	1.508
red algae		%	1.100	3.684	2.700	3.466	0.167	0.389	5.636	6.757
Chlorophyta Green Algae										
filamentous green algae	Chlorophyta filamentous algae	%	0.000	0.000	0.500	1.581	0.000	0.000	0.000	0.000
sea lettuce	<i>Ulva</i> sp.	%	0.000	0.000	0.100	0.316	0.000	0.000	0.091	0.302
sea lettuce drift	<i>Ulva</i> sp. drift	%	0.000	0.000	0.100	0.316	0.000	0.000	0.000	0.000
green attached algae		%	0.000	0.000	0.600	1.578	0.000	0.000	0.091	0.302
Tracheophyta Vascular Plants										
		%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Porifera Sponges										
orange sponge	Demospongia	%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cnidaria Anemones, Corals, Sea Pens, Jellyfish, Hydroids										
hydroid colony	Hydroid colony	%	0.100	0.308	0.200	0.422	0.000	0.000	0.000	0.000
plumose anemone	<i>Metridium</i> spp.	num	0.000	0.000	0.300	0.483	0.000	0.000	0.000	0.000
Nemerteans										
			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Annelida Segmented Worms										
scaleworm	Family Polynoidae	num	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
feather-duster	Family Sabellidae	num	0.000	0.000	0.200	0.632	0.000	0.000	0.818	1.601
Western calcareous tubeworm	<i>Pseudochitinopoma occidentalis</i>	%	0.250	1.118	0.000	0.000	0.000	0.000	0.000	0.000

Part 1, Transects T1 to T4

Biota Density Table, Part 1 Transect T1 to T4 continued

Quadrat by Transect Observations continued

Transect T#, N= number of quadrats		Unit	T1, n=20		T2, n=10		T3, n=12		T4, n=11	
Common name	Taxa or Related Observation		AVG	SD	AVG	SD	AVG	SD	AVG	SD
Mollusca Chitons, Snails, Limpets, Clams, Nudibranchs, Octopus										
bivalve shell	bivalve shell	%	1.750	1.682	17.500	21.890	10.000	19.259	8.182	9.714
cockle shell	<i>Clinocardium</i> sp. shell	%	0.150	0.366	1.800	2.251	0.833	1.946	1.136	1.951
opalescent nudibranch	<i>Hermisenda crassicornis</i>	num	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
chiton	<i>Mopalia</i> sp.	num	0.200	0.894	0.100	0.316	0.000	0.000	0.000	0.000
pacific blue mussel shell	<i>Mytilus</i> complex shell	%	0.000	0.000	4.100	12.618	2.500	8.660	0.455	1.508
butter clam shell	<i>Saxidomus gigantea</i> shell	%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
limpet	<i>Tectura</i> sp.	num	0.000	0.000	0.200	0.632	0.000	0.000	0.182	0.603
gaper clam	<i>Tresus</i> sp.	num	0.000	0.000	0.000	0.000	0.000	0.000	0.091	0.302
rough piddock	<i>Zirfaea pilsbryi</i>	num	0.000	0.000	0.000	0.000	0.000	0.000	0.364	1.206
bivalve siphon	Class Bivalvia	num	0.100	0.447	1.000	0.943	0.000	0.000	0.182	0.405
Lampshells Brachiopoda										
			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bryozoa Mossy Animal										
		%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dungeness crab - juvenile										
	<i>Cancer magister</i>	num	0.000	0.000	0.000	0.000	0.167	0.389	0.364	0.674
red rock crab	<i>Cancer productus</i>	num	0.000	0.000	0.000	0.000	0.083	0.289	0.000	0.000
barnacle shells	Cirripidea barnacles shells	%	0.400	1.142	1.200	1.398	0.000	0.000	0.455	0.522
crangon shrimp	<i>Crangon</i> sp.	num	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
greenmark hermit	<i>Pagurus caurinus</i>	num	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
hermit crab	<i>Pagurus</i> sp.	num	0.000	0.000	0.000	0.000	0.000	0.000	0.091	0.302
Echinoderms										
leather star	<i>Dermasterias imbricata</i>	num	0.000	0.000	0.000	0.000	0.000	0.000	0.091	0.302
mottled star	<i>Evasterias troschelii</i>	num	0.050	0.224	0.000	0.000	0.000	0.000	0.000	0.000
Tunicates										
broadbase tunicate	<i>Cnemidocarpa finmarkiensis</i>	num	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
transparent tunicate	<i>Corella willmeriana</i>	num	0.000	0.000	0.300	0.675	0.500	1.732	0.455	1.508
Vertebrates Fishes										
			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Infauna Signs										
infaunal hole	Infaunal hole/ burrow	num	1.600	4.309	1.200	2.044	0.250	0.866	0.273	0.647
infaunal mound	Infaunal mound	num	0.050	0.224	0.000	0.000	0.000	0.000	0.000	0.000

Biota Density Table Part 2, Transects T5 to T7 and Averaged for all Transects (T1 to T7)

Quadrat by Transect Observations

Transect T#, N= number of quadrats			T5, n=11		T6, n=13		T7, n=12		T1 to T7, N=89	
Common name	Taxa or Related Observation	Unit	AVG	SD	AVG	SD	AVG	SD	AVG	SD
Bacteria										
		%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Algae										
diatoms epiflora	diatoms	%	89.091	3.015	76.154	13.868	65.833	13.790	72.753	24.818
Phaeophyta Brown Macroalgae										
rockweed drift	<i>Fucus distichus</i> drift	%	0.000	0.000	0.000	0.000	0.000	0.000	0.124	1.064
sugar kelp	<i>Saccharina latissima</i>	%	0.000	0.000	0.077	0.277	0.833	1.946	0.404	1.724
sugar kelp drift	<i>Saccharina latissima</i> drift	%	0.000	0.000	0.538	1.391	1.333	3.085	0.315	1.387
sargassum	<i>Sargassum muticum</i>	%	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.149
attached macroalgae		%	0.000	0.000	0.077	0.277	0.833	1.946	0.427	1.725
Phaeophyta drift		%	0.000	0.000	0.538	1.391	1.333	3.085	0.438	1.725
Rhodophyta Red Algae										
crustose corallines	Family Corallinaceae	%	0.000	0.000	0.000	0.000	0.000	0.000	0.112	1.060
red spaghetti	Family Gracilariaceae	%	1.091	1.973	0.000	0.000	4.000	4.632	1.404	3.267
red branching algae	Rhodophyta branching aglae	%	0.000	0.000	0.154	0.376	0.000	0.000	0.022	0.149
red crust algae	Rhodophyta crust algae	%	0.000	0.000	0.000	0.000	0.000	0.000	0.112	0.745
red foliose algae	Rhodophyta foliose aglae	%	0.273	0.467	0.000	0.000	0.083	0.289	0.135	0.588
filamentous red algae	Rhodophyta filamentous algae	%	0.182	0.405	0.462	0.519	0.000	0.000	0.315	1.212
red upright		%	1.545	2.067	0.615	0.650	4.083	4.757	1.876	3.608
red encrusting		%	0.000	0.000	0.000	0.000	0.000	0.000	0.225	1.670
red algae		%	1.545	2.067	0.615	0.650	4.083	4.757	2.101	3.997
Chlorophyta Green Algae										
filamentous green algae	Chlorophyta filamentous algae	%	0.000	0.000	0.077	0.277	0.000	0.000	0.067	0.539
sea lettuce	<i>Ulva</i> sp.	%	0.000	0.000	0.000	0.000	0.417	1.443	0.079	0.548
sea lettuce drift	<i>Ulva</i> sp. drift	%	0.000	0.000	0.000	0.000	0.083	0.289	0.022	0.149
green attached algae		%	0.000	0.000	0.077	0.277	0.417	1.443	0.146	0.762
Tracheophyta Vascular Plants										
		%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Porifera Sponges										
orange sponge	Demospongia	%	0.000	0.000	0.000	0.000	0.083	0.289	0.011	0.106
Cnidaria Anemones, Corals, Sea Pens, Jellyfish, Hydroids										
hydroid colony	Hydroid colony	%	0.182	0.405	0.462	1.391	0.250	0.452	0.169	0.607
plumose anemone	<i>Metridium</i> spp.	num	0.091	0.302	0.000	0.000	0.000	0.000	0.045	0.208
Nemertean										
			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Annelida Segmented Worms										
scaleworm	Family Polynoidae	num	0.000	0.000	0.000	0.000	0.083	0.289	0.011	0.106
feather-duster	Family Sabellidae	num	0.000	0.000	0.000	0.000	0.000	0.000	0.124	0.636
Western calcareous tubeworm	<i>Pseudochitinopoma occidentalis</i>	%	0.000	0.000	0.000	0.000	0.000	0.000	0.056	0.530

Biota Density Table Part 2 continued, Transects T5 to T7 and Averaged for Transects (T1 to T7)

Quadrat by Transect Observations Continued

Transect T#, N= number of quadrats		Unit	T5, n=11		T6, n=13		T7, n=12		T1 to T7, N=89	
Common name	Taxa or Related Observation		AVG	SD	AVG	SD	AVG	SD	AVG	SD
Mollusca Chitons, Snails, Limpets, Clams, Nudibranchs, Octopus										
bivalve shell	bivalve shell	%	5.636	8.594	7.385	5.140	18.917	25.731	9.045	15.396
cockle shell	<i>Clinocardium</i> sp. shell	%	0.909	1.446	1.000	1.291	0.500	1.446	0.815	1.556
opalescent nudibranch	<i>Herrissenda crassicornis</i>	num	0.000	0.000	0.000	0.000	0.083	0.289	0.011	0.106
chiton	<i>Mopalia</i> sp.	num	0.000	0.000	0.000	0.000	0.000	0.000	0.056	0.436
pacific blue mussel shell	<i>Mytilus</i> complex shell	%	0.727	1.489	0.077	0.277	0.417	1.443	1.011	5.318
butter clam shell	<i>Saxidomus gigantea</i> shell	%	0.000	0.000	0.000	0.000	0.417	1.443	0.056	0.530
limpet	<i>Tectura</i> sp.	num	0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.298
gaper clam	<i>Tresus</i> sp.	num	0.000	0.000	0.308	0.751	0.000	0.000	0.056	0.315
rough piddock	<i>Zirfaea pilsbryi</i>	num	0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.424
bivalve siphon	Class Bivalvia	num	0.273	0.467	1.462	2.787	0.667	1.371	0.494	1.315
Lampshells Brachiopoda										
			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bryozoa Mossy Animal										
		%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dungeness crab - juvenile										
	<i>Cancer magister</i>	num	0.455	0.522	0.231	0.439	0.167	0.389	0.180	0.415
red rock crab	<i>Cancer productus</i>	num	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.106
barnacle shells	Cirripidea barnacles shells	%	0.364	0.505	0.769	1.363	0.167	0.389	0.461	0.966
crangon shrimp	<i>Crangon</i> sp.	num	0.091	0.302	0.000	0.000	0.000	0.000	0.011	0.106
greenmark hermit	<i>Pagurus caurinus</i>	num	0.091	0.302	0.000	0.000	0.000	0.000	0.011	0.106
hermit crab	<i>Pagurus</i> sp.	num	0.000	0.000	0.000	0.000	0.083	0.289	0.022	0.149
Echinoderms										
leather star	<i>Dermasterias imbricata</i>	num	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.106
mottled star	<i>Evasterias troschellii</i>	num	0.000	0.000	0.077	0.277	0.000	0.000	0.022	0.149
Tunicates										
broadbase tunicate	<i>Cnemidocarpa finmarkiensis</i>	num	0.000	0.000	0.154	0.555	0.000	0.000	0.022	0.212
transparent tunicate	<i>Corella willmeriana</i>	num	0.364	0.924	0.154	0.376	0.083	0.289	0.236	0.917
Vertebrates Fishes										
			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Infauna Signs										
infaunal hole	Infaunal hole/ burrow	num	1.636	2.942	2.308	6.033	2.833	6.408	1.483	4.051
infaunal mound	Infaunal mound	num	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.106