Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

Lower Duwamish Waterway Remedial Investigation

DATA REPORT:
TAXONOMIC IDENTIFICATIONS OF BENTHIC INVERTEBRATE COMMUNITIES
FINAL

For submittal to

The US Environmental Protection Agency
Region 10
Seattle, WA

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, WA

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Acronyms

Acronym	Definition
COC	chain of custody
Ecology	Washington Department of Ecology
EPA	US Environmental Protection Agency
ERA	ecological risk assessment
GPS	global positioning system
LDW	Lower Duwamish Waterway
MHHW	mean higher high water
MLLW	mean lower low water
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
ROC	receptor of concern
RI	Remedial Investigation
SQS	Washington State Sediment Quality Standards
Windward	Windward Environmental LLC

1.0 Introduction

This data report presents the results of taxonomic analyses of benthic community samples collected as part of the Phase 2 Remedial Investigation for the Lower Duwamish Waterway (LDW). The sampling and analyses were conducted in accordance with the benthic invertebrate quality assurance project plan (QAPP) (Windward 2004).

The purpose of the benthic community study is to qualitatively characterize the benthic community in the LDW from a resource perspective (i.e., to provide qualitative information regarding the benthic communities present in various habitat types in the LDW). Results of this qualitative benthic community survey will be assumed to represent the likely taxonomic composition of the benthic invertebrate tissue samples[1] that were collected synoptically with the benthic community samples. Together, these data will be used in the Phase 2 ecological risk assessment (ERA) to assess the relationship between chemical concentrations in sediment and benthic invertebrate tissue.

This report is organized into sections addressing field and laboratory methods, taxonomic results, and references. The text is supported by the following appendices:

- Appendix A – taxonomic data tables
- Appendix B – quality assurance/quality control (QA/QC) data
- Appendix C – collection forms, field notes, and laboratory forms
- Appendix D – chain-of-custody (COC) forms

The text is also supported by a photo album documenting laboratory measurements: http://www.ldwg.org/Assets/BI/Taxonomy/BI_taxon_album.htm. The photo album is also available in compact disk format on request.

2.0 Benthic Invertebrate Collection and Sample Processing Methods

This section briefly describes the benthic invertebrate field collection and sample processing methods. The field procedures used to collect the benthic community samples are described in detail in the QAPP (Windward 2004). Field deviations from the QAPP are also presented in this section. Photocopies of field forms, notebooks, and laboratory forms are presented in Appendix C. Copies of completed COC forms used to track sample custody are presented in Appendix D.

[1] Chemical data for the co-located benthic invertebrate tissue and sediment samples were reported in the *Chemical Analyses of Benthic Invertebrate and Clam Tissue Samples and Co-located Sediment Samples* data report (Windward 2005)

2.1 BENTHIC INVERTEBRATE COLLECTION

Benthic community samples were collected at both intertidal and subtidal locations in accordance with the QAPP using standardized procedures developed for Puget Sound by the Puget Sound Estuary Program (PSEP 1987). This section briefly summarizes these methods.

2.1.1 Intertidal sampling

Benthic community samples were collected at 10 intertidal benthic invertebrate tissue sample locations and at two additional intertidal locations, as described in the QAPP (Windward 2004) (Figure 2-1; Table 2-1). At all 12 locations, a transect running perpendicular to the waterline between mean lower low water (MLLW) and mean higher high water (MHHW) was placed over the Global Positioning System (GPS) coordinates. Elevation above the water level at the time of sampling was estimated to the nearest foot using two staff gages, and the time was recorded on the field form (Table 2-2). Five sample locations were placed evenly along each transect and benthic community samples were collected using a 0.0024-m^2 polyvinyl chloride (PVC) core sampler coupled with a 0.1-m^2 transect frame. The core sampler was placed directly on the sediment just outside of the frame and driven into the sediment to a depth of 10 cm by hand before collecting the sample; the sample was sieved through a 0.5-mm mesh to collect benthic invertebrates. To collect larger organisms that may not have been sampled by the smaller core, the sample from within the 0.1-m^2 transect frame was also collected to a depth of 10 cm and sieved through a 2-mm sieve. The five replicate samples collected with the core sampler were combined into one composite sample, and the five replicates collected with the transect frame were combined into one composite sample. Both composite samples were preserved with 7-10% formalin.

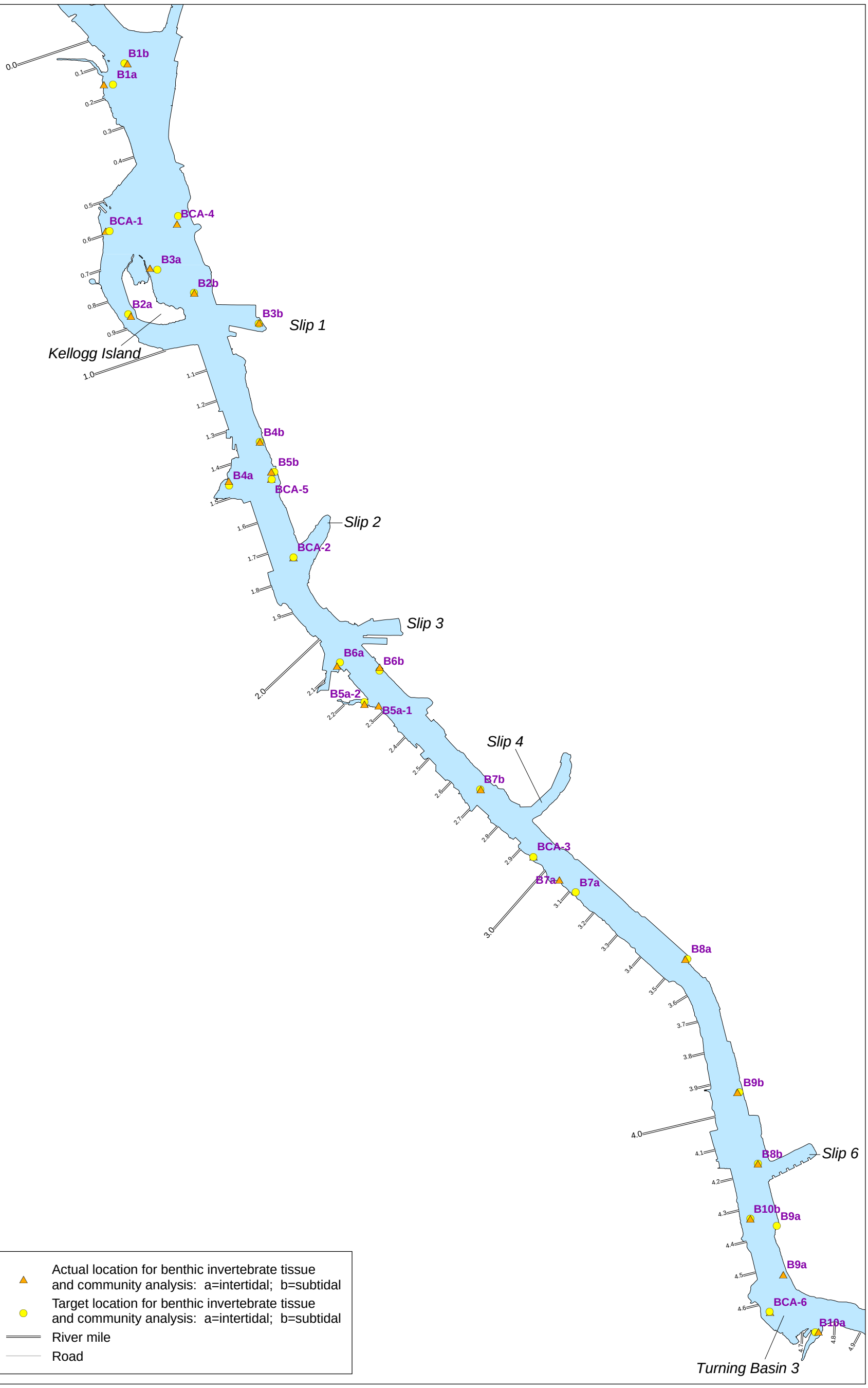

Figure 2-1. Target and actual locations for sampling benthic invertebrate tissue, communities, and co-located sediment

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Prepared by STS 05/20/05 Map 1778

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Table 2-1. Coordinates for intertidal benthic community sampling locations

Location[b]	Transect Location[a]							
	Waterline				Upland			
	Latitude	Longitude	X	Y	Latitude	Longitude	X	Y
B1a	47 34.013	122 21.021	1265931	210473	47 34.012	122 21.030	1265894	210468
B2a	47 33.384	122 20.905	1266333	206641	47 33.393	122 20.893	1266383	206694
B3a	47 33.521	122 20.820	1266699	207466	47 33.518	122 20.834	1266641	207449
B4a	47 32.948	122 20.495	1267968	203957	47 32.949	122 20.499	1267952	203964
B5a-2	47 32.360	122 19.940	1270182	200308	47 32.352	122 19.939	1270185	200290
B6a	47 32.467	122 20.048	1269750	200998	47 32.444	122 20.055	1269719	200858
B7a[c]	47 31.890	122 19.150	1273379	197419	47 31.890	122 19.150	1273379	197419
B8a	47 31.680	122 18.642	1275445	196102	47 31.683	122 18.644	1275437	196120
B9a	47 30.833	122 18.238	1277010	190922	47 30.839	122 18.221	1277081	190957
B10a	47 30.684	122 18.091	1277598	190005	47 30.683	122 18.077	1277656	189997
BCA-1	47 33.617	122 20.995	1265990	208064	47 33.617	122 21.017	1265900	208066
BCA-3	47 31.954	122 19.251	1272970	197816	47 31.948	122 19.259	1272937	197780

[a] Both geographic and state plane coordinates (WA State Plane N, US feet) based on NAD 83 horizontal datum

[b] At BCA-1 and BCA-3, only benthic invertebrate community samples were collected. At B1a-B10a, benthic invertebrate tissue samples were also collected for chemical analysis.

[C] The waterline and upland coordinates for this location were the same because the transect was less than 5 m in length

Table 2-2. Collection information for intertidal benthic community samples

Location	Collection Date	Time	Estimated Transect Elevation Range[a] (ft MLLW)	Estimated Length of Transect (m)
B1a	8/12/04	1045	0.0 to 6.5	11
B2a	8/13/04	1042	-0.5 to 4.5	19
B3a	8/26/04	0656	-1.0 to 4.0	20
B4a	8/14/04	1030	-1.0 to 3.0	10
B5a-2	9/24/04	0720	1.5 to 4.1	14
B6a	8/15/04	1105	0.5 to 5.5	44
B7a	8/30/04	1135	-1.0 to 2.5	6
B8a	8/17/04	1215	-0.4 to -0.4	10
B9a	8/27/04	0815	0.9 to 0.9	26
B10a	8/25/04	0645	-1.7 to 1.7	18
BCA-1	8/16/04	1250	0.0 to 3.0	28
BCA-3	8/17/04	1047	0.0 to 4.5	14

[a] Elevation of transect (waterline and upland) estimated either from x,y coordinates and bathymetric map or from elevation above the water level at the time of sampling, tide table, and sample time

2.1.2 Subtidal sampling

Benthic community samples were collected at 10 subtidal benthic invertebrate tissue sample locations and at four additional subtidal locations as described in the QAPP (Windward 2004) (Figure 2-1, Table 2-3). At the benthic invertebrate tissue sample locations, the benthic community samples were collected concurrently with the benthic invertebrate tissue samples from the first three casts where both grabs in the double van Veen grab sampler were acceptable[2]. Collection information is presented in Table 2-4. A 0.0024-m^2 PVC core sampler was placed directly on the sediment in each of the three grabs at a location, and driven into the sediment to a depth of 10 cm by hand; the sample was sieved through nested 1.0- and 0.5-mm mesh sieves. The material on the 0.5-mm mesh sieve was retained and kept separately. The remaining sediment in the three grabs at each location was collected to a depth of 10 cm and sieved through a 1.0-mm sieve. This sediment was then combined with the material from the core sampler retained on the 1.0-mm sieve. Three subsamples were collected at each location (one from each of the three acceptable grabs). The subsamples collected with the core sampler were combined into one composite sample per location, and the three subsamples collected with the van Veen grab sampler were combined into one composite sample per location. Both samples were preserved with 7-10% formalin. At the four additional subtidal locations where only benthic community samples were collected, samples were collected from one side of the van Veen grab sampler in three separate casts. The same methods were used to collect benthic invertebrates from these samples as those described above.

Table 2-3. Coordinates for subtidal benthic community sampling locations

Location [b]	Sampling Location [a]			
	Latitude	Longitude	X	Y
B1b	47 34.070	122 20.930	1266312	210812
	47 34.070	122 20.928	1266320	210812
	47 34.070	122 20.936	1266287	210813
B2b	47 33.456	122 20.647	1267403	207057
	47 33.454	122 20.649	1267395	207045
	47 33.455	122 20.649	1267395	207051
B3b	47 33.379	122 20.387	1268464	206568
	47 33.379	122 20.392	1268443	206569
	47 33.375	122 20.390	1268451	206544
B4b	47 33.056	122 20.375	1268475	204604
	47 33.056	122 20.376	1268470	204604
	47 33.057	122 20.376	1268471	204610

[2] One of the two grabs were used for community analyses and the other for benthic tissue analyses

Location [b]	Sampling Location [a]			
	Latitude	Longitude	X	Y
B5b	47 32.976	122 20.328	1268658	204114
	47 32.977	122 20.329	1268654	204120
	47 32.976	122 20.329	1268654	204114
B6b	47 32.455	122 19.882	1270432	200911
	47 32.453	122 19.882	1270432	200899
	47 32.453	122 19.882	1270432	200899
B7b	47 32.129	122 19.466	1272106	198897
	47 32.130	122 19.471	1272085	198903
	47 32.130	122 19.466	1272106	198903
B8b	47 31.134	122 18.339	1276629	192759
	47 31.134	122 18.338	1276633	192759
	47 31.135	122 18.337	1276638	192765
B9b	47 31.326	122 18.433	1276265	193934
	47 31.326	122 18.428	1276285	193933
	47 31.326	122 18.427	1276289	193933
B10b	47 30.984	122 18.364	1276509	191850
	47 30.984	122 18.364	1276509	191850
	47 30.984	122 18.365	1276505	191850
BCA-2	47 32.747	122 20.233	1269022	202714
	47 32.747	122 20.233	1269022	202714
	47 32.744	122 20.232	1269026	202696
BCA-4[c]	47 33.640	122 20.723	1267112	208182
	47 33.640	122 20.723	1267112	208182
	47 33.641	122 20.722	1267117	208188
BCA_5	47 32.956	122 20.329	1268652	203993
	47 32.957	122 20.327	1268660	203998
	47 32.957	122 20.327	1268660	203998
BCA-6	47 30.734	122 18.278	1276834	190323
	47 30.734	122 18.280	1276826	190323
	47 30.734	122 18.280	1276826	190323

[a] Both geographic and state plane coordinates (WA State Plane N, US feet) based on NAD 83 horizontal datum

[b] At BCA-2, BCA-4, BCA-5, and BCA-6, only benthic invertebrate community samples were collected. At B1b-B10b, benthic invertebrate tissue samples were also collected for chemical analysis.

[C] The sample location had to be moved from the target location in the QAPP to sample away from the recently capped area at the Duwamish/Diagonal outfall

Table 2-4. Collection information for subtidal benthic community samples

Location	Collection Date	Time	Depth MLLW [a] (m)	Penetration (cm)
B1b	9/27/04	0840-1230	-14.8 to -15.2	6-9
B2b	9/27/04	1330-1540	-10.9	6-9
B3b	8/10/04 8/17/04	1420-1540 1035-1245	-2.4 to -4.2	8-13
B4b	9/28/04	0830-1122	-3.0 to -3.3	14-18
B5b	9/28/04	1225-1425	-1.2 to -1.8	6-12
B6b	8/18/04	1315-1640	-3.3 to -4.2	12-15
B7b	8/13/04	1404-1650	-4.2 to -5.8	10-13
B8b	8/19/04	1245-1605	-1.2 to -1.5	14-15
B9b	8/13/04	0950-1300	-1.8 to -3.6	15-18
B10b	8/19/04	0835-1210	0.0 to -0.6	10-11
BCA-2	8/20/04	1005-1140	-9.4 to -9.7	13-17
BCA-4	8/20/04	1240-1400	-9.7 to -10.0	10-14
BCA-5	8/17/04	1700-1740	-2.1 to -2.4	9-13
BCA-6	8/20/04	0825-0940	0.0 to -0.1	8-14

[a] The depth was measured at each cast using the onboard depth sounder

Note that most of the grab samples achieved a 10 cm penetration depth, but the penetration depth of some of the grabs collected at locations B1b, B2b, B3b, B5b, BCA-5, BCA-6 was less than 10 cm (as allowed in the QAPP) because of coarse sediment at these locations (Table 2-4). At these locations, the results of the taxonomic identifications (Section 4.2) may under-represent the taxa richness and abundance of organisms that may have been present in the deeper portion of the 0-10 cm horizon.

2.2 Sample Identification Scheme

Each sampling location was assigned a unique alphanumeric location ID number. The first three characters of the location ID were "LDW" to identify the Lower Duwamish Waterway project area. The next characters indicated the type of samples collected (B or BCA), followed by a consecutive number identifying the specific location within the LDW area. The 20 locations designated with a B were sampled for benthic invertebrate tissue, benthic community, and sediment. The 20 locations consisted of ten intertidal locations and ten subtidal locations, numbered independently. The intertidal locations are numbered B1a (northernmost) to B10a (southernmost), and the subtidal locations were numbered B1b (northernmost) to B10b (southernmost). The type of sample was identified using a C suffix for community samples. Six other locations (two intertidal and four subtidal) designated with BCA were sampled only for benthic community analysis.

Two examples of sample IDs are provided below:

- The composite sample created for benthic community characterization at location B7a was called LDW-B7a-C
- The composite sample created for benthic community characterization at location BCA-2 was called LDW-BCA-2.

2.3 BENTHIC COMMUNITY HABITAT TYPES

The benthic community sampling design was based on a matrix table displaying combinations of primary habitat variables (salinity, sediment elevation, and grain size), and Phase 1 sediment chemical concentrations relative to the Washington State Sediment Quality Standards (SQS) (see Section 3.1.2 of the QAPP). Table 2-5 summarizes available Phase 2 information for the locations where taxonomy samples were collected. Salinity measurements were not specified in the QAPP and were therefore not measured during the field sampling effort. The salinity range included in the table are based on the assumptions presented in the QAPP (Windward 2004). Also, grain size and chemistry were not analyzed at the locations sampled for benthic community characterization only. Instead, descriptive sediment type information from the field notes is included for these locations. Table 2-6 presents the categorization of benthic community samples in the matrix table based on the information summarized in Table 2-5. Based on the data presented in Table 2-6, the benthic community characterization samples were taken from a wide variety of habitat types in the LDW.

Table 2-5. Summary information of primary habitat variables and Phase 2 sediment chemistry

LOCATION ID	DEPTH (ft MLLW)	SALINITY (% of time below 5 ppt)	GRAIN SIZE (% fines)	SQS EXCEEDANCE
B1a	0.0 to 6.5	0-30%	4.91	no
B2a	-0.5 to 4.5	30-70%	45.7	yes
B3a	-1.0 to 4.0	0-30%	30.5	no
B4a	-1.0 to 3.0	30-70%	34.2	yes
B5a-2	1.5 to 4.1	30-70%	23.2	yes
B6a	0.5 to 5.5	30-70%	16.1	yes
B7a	-1.0 to 2.5	30-70%	33.3	yes
B8a	-0.4 to -0.4	70-84%	27.5	yes
B9a	0.9 to 0.9	70-84%	39.7	yes
B10a	-1.7 to 1.7	70-84%	22.1	yes
BCA-1	0.0 to 3.0	0-30%	sand and silt	no information
BCA-3	0.0 to 4.5	30-70%	gravel and medium to fine sand	no information
B1b	-44.4 to -45.6	0-30%	5.41	yes
B2b	-32.7	0-30%	27.9	yes
B3b	-7.2 to -12.6	0-30%	34.6	yes
B4b	-9.0 to -9.9	0-30%	63.9	yes

LOCATION ID	DEPTH (ft MLLW)	SALINITY (% of time below 5 ppt)	GRAIN SIZE (% fines)	SQS EXCEEDANCE
B5b	-3.6 to -5.4	30-70%	29.6	yes
B6b	-9.9 to -12.6	0-30%	69.3	yes
B7b	-12.6 to -17.4	0-30%	31.7	yes
B8b	-3.6 to -4.5	30-70%	69.4	no
B9b	-5.4 to -10.8	30-70%	48.0	yes
B10b	0.0 to -1.8	70-84%	20.5	no
BCA-2	-28.2 to -29.1	0-30%	silt and clay	no information
BCA-4	-29.1 to -30.0	0-30%	coarse to medium sand	no information
BCA-5	-6.3 to -7.2	30-70%	silt and clay	no information
BCA-6	0.0 to -0.3	70-84%	medium sand	no information

Table 2-6. Phase 2 benthic community samples as a function of habitat type

ELEVATION (ft MLLW)	GRAIN SIZE (% fines)	SALINITY (% of time below 5 ppt)					
		0-30%		30-70%		70-84%	
		≤SQS	>SQS	≤SQS	>SQS	≤SQS	>SQS
≥ - 5	<40%	B1a, B3a	ns-c	BCA-3	B4a, B5a, B6a, B7a, B5b	B10b	B8a, B9a, B10a
≥ - 5	40-80%	BCA-1	ns-c	B8b	B2a	BCA-6	ns-c
≥ - 5	>80%[a]	ns	ns	ns	ns	ns	ns
< -5 to > -15	<40%	ns-c	B3b, B7b	ns	ns	na	na
< -5 to > -15	40-80%	ns	B4b, B6b	ns-c	B9b	na	na
< -5 to > -15	>80%	ns	ns	BCA-5	ns-c	na	na
≤ -15	<40%	ns-c	B1b, B2b	ns-a	na	na	na
≤ -15	40-80%	ns-c	BCA-4	ns-a	na	na	na
≤ -15	>80%	BCA-2	ns-c	ns-a	na	na	na

na – cell characteristics not present in LDW

ns – not sampled

ns-c – not sampled because there is either a historical (Phase 1) sample or a Phase 2 sample in the other SQS category for the same depth, salinity regime, and grain size range

ns-a – not sampled because this category (including both < SQS and >SQS) represented less than 1% of either the total intertidal area or total subtidal area within the LDW based on Phase 1 data

[a] sediment with > 80% fines was not collected at any of the intertidal invertebrate tissue and clam sampling locations

≤SQS – All chemicals analyzed were present at concentrations less than or equal to their respective SQS values

>SQS – At least one chemical analyzed was present at a concentration above its SQS value

2.4 FIELD DEVIATIONS FROM THE QAPP

Field deviations from the QAPP included modifications to collection methods, sampling dates, and locations. These field deviations did not affect the data quality and are discussed in detail below. The US Environmental Protection Agency (EPA) and Washington Department of Ecology (Ecology) were consulted on any significant deviations.

- Collection of intertidal and subtidal benthic community samples was extended beyond August 9–20, 2004, the target sampling dates identified in the QAPP. The intertidal benthic invertebrate tissue sampling effort, which occurred concurrently with the benthic community sampling effort, was time-consuming because of low invertebrate abundances and biomass at the ten intertidal sampling areas. The effort was extended into minus tides on August 25–30 and September 24, 2004.
- Two subtidal samples (B1b, B2b) were recollected on September 27, 2004 because Federal Express delivered the shipment of the original benthic invertebrate tissue and sediment samples from that location to the analytical chemistry laboratory 48 hours late. By that time, the temperature in the cooler was outside the acceptable temperature range. The taxonomic samples from those locations were also recollected at the same time.
- Two subtidal samples (B4b, B5b) were recollected on September 28, 2004 because the analytical chemistry laboratory kept the benthic invertebrate tissue and sediment samples from those locations in the refrigerator beyond the maximum analytical holding time rather than freezing them, as specified in the QAPP, to extend the holding time. The taxonomic samples from those locations were also recollected at the same time.
- Two intertidal sampling locations (B7a and B9a) were moved approximately 145 m north and 240 m south, respectively, because limited beach area was exposed at the intended locations during a minus tide (see Figure 2-1).
- Two sampling events occurred near or at intertidal location B5a. The first sampling event (B5a-1) was inadvertently conducted approximately 70 m from the target location presented in the QAPP. The second sampling event (B5a-2) was conducted at the target location. Only the benthic invertebrate community samples from B5a-2 were analyzed.
- As agreed to by EPA and Ecology, the sieve size for the subtidal benthic community samples was changed from 0.5-mm mesh to 1.0-mm mesh because of the large volume of material retained on the 0.5-mm sieve (up to 4 L per van Veen grab).
- As agreed to by EPA and Ecology, the number of replicate samples for the subtidal benthic community samples was changed from five to three because of the large volume retained on the 1.0-mm sieve at most of the locations. This modification will not affect the qualitative use of these data.
- To investigate the difference between the benthic communities retained on a 1.0-mm sieve and a 0.5-mm sieve at the subtidal locations, a 0.0024-m^2 core sampler was inserted into the sediment within the van Veen grab to a depth of 10 cm. The sediment from the core sampler was sieved through nested 1.0 and 0.5-mm sieves. The material retained on the 1.0-mm sieve was combined with

the remainder of the sediment in the van Veen grab which was also sieved through a 1.0-mm sieve. The material on the 0.5-mm sieve was retained as a core sample and both samples were preserved in 7-10% formalin.

3.0 Laboratory Methods

The methods and procedures used to enumerate the benthic community samples are described briefly in this section and in detail in the benthic invertebrate QAPP (Windward 2004). This section also summarizes any laboratory deviations from the QAPP.

3.1 Taxonomic Identification and Biomass Measurement

The benthic invertebrate samples collected for benthic community characterization were processed in the taxonomic laboratory in accordance with standardized procedures for the Puget Sound area that have been developed by PSEP (1987). The samples were sorted into five major taxonomic groups (i.e., Annelida [Polychaeta and Oligochaeta], Arthropoda [Crustacea and Insecta], Mollusca, Echinodermata, and miscellaneous taxa) by Allan Fukuyama, the project lead taxonomist. The subsamples of each major taxonomic group were identified to the lowest practical level by the taxonomists presented in Table 3-1 using keys based on their personal collections of literature. The voucher collections created from the subsamples by each taxonomist were verified by the second taxonomists presented in Table 3-1. For further details on taxonomic QA/QC procedures, see Section 4.3.

After identification, the sorted samples were returned to the Windward laboratory where the major taxonomic groups from each sample were weighed to the nearest 0.1 g (wet weight, ww) and photographed. These data were collected to describe the community and also for direct comparison with weights of these major groups in the co-located tissue samples that were chemically analyzed (Windward 2005). The weight data are presented in full in Appendix C and the photographs can be viewed at http://www.ldwg.org/Assets/BI/Taxonomy/BI_taxon_album.htm.

Table 3-1. Taxonomic identifications of benthic community samples collected in the LDW

PHYLUM	CLASS	ORDER	COMMON NAME	PRIMARY TAXONOMIST	VERIFICATION TAXONOMIST
Annelida	Polychaeta		segmented worms	Kathy Welch	Howard Jones
	Oligochaeta		segmented worms	Kathy Welch	Howard Jones
Arthropoda (subphylum Crustacea)	Cirripedia		barnacles	Jeff Cordell	Kevin Li
	Copepoda		no common name		
	Ostracoda		seed shrimps		
	Malacostraca	Amphipoda	scuds		
		Cumacea	no common name		
		Decapoda	shrimps, crabs		
		Isopoda	sea slaters, sow bugs		
		Tanaidacea	no common name		
Arthropoda	Insecta		insects	Jeff Cordell	Kevin Li Allan Fukuyama
Mollusca	Gastropoda		snails	Allan Fukuyama	Susan Weeks
	Bivalvia		clams, mussels		
Echinodermata			sea urchins, brittle stars	Scott McEuen	Steve Hulsman
Cnidaria[a]			sea anemones, sea pens	Scott McEuen	Steve Hulsman Allan Fukuyama Valerie Hironaka
Platyhelminthes[a]			flatworms		
Nemertea[a]			ribbon worms		
Nematoda[a]			roundworms		

[a] Phylum or class included in miscellaneous taxa

3.2 LABORATORY DEVIATIONS FROM THE QAPP

The taxonomic identification was conducted according to the QAPP, with the following exception approved by EPA. At three locations (B8b, B10b, and BCA-6), a complete identification of all crustaceans in the composite van Veen grab samples was not performed because the number of crustaceans was very high (> 3,500 individuals). Instead, each sample was visually inspected for larger crustaceans, and if present, these crustaceans were picked out for identification. A one-eighth subsample was randomly collected from the remaining organisms and the crustaceans within that subsample were identified to the lowest practical taxonomic level. A total of 672, 505, and 481 crustaceans were identified in the subsamples from locations B8b, B10b, and BCA-6, respectively.

4.0 Taxonomic Results

Results of the taxonomic identifications and the QA/QC procedures are summarized in this section. The taxonomic results for both intertidal and subtidal samples are presented in full in Appendix A, and the results from the QA/QC procedures performed on the voucher collections are presented in full in Appendix B.

4.1 INTERTIDAL COMMUNITY RESULTS

The description of benthic communities present at the 12 intertidal locations is based primarily on the samples collected with the core sampler. Samples collected with the transect frame and sieved on a 2-mm sieve are used to augment the data by enumerating larger benthic invertebrates from a larger area that may have been missed by the smaller core. However, because of algae, wood chips, and other organic materials that created a layer in the 2-mm sieve, numerous smaller benthic invertebrates, similar to those collected with the core sampler, were also retained in the transect frame samples. The taxonomic results of the core and transect frame samples are presented in Sections 4.1.1 and 4.1.2, respectively. The organism abundances in each sample are reported as is, based on the total area of the composite sample, and on the more standard unit basis of 0.1 m^2. Intertidal biomass measurements are presented in Section 4.1.3.

4.1.1 Taxonomic results for the intertidal core samples

The total number of organisms in the composite intertidal samples collected with the core sampler ranged from 60 at B5a-2 to 1,948 at B2a (Table 4-1). The five core samples that were composited into one sample covered a total area of 0.012 m^2 (5 x 0.0024 m^2) at each intertidal location. On a standard 0.1-m^2 basis, the total number of organisms ranged from 500 to 16,233. In general, annelids and crustaceans were the most abundant organisms in the intertidal samples. Annelids were the most abundant organisms at 11 of the 12 locations, while at the remaining location (B2a), crustaceans were the most abundant organisms. Insects and mollusks were observed at some of the intertidal sampling locations, together constituting 1.1% or less of all observed organisms. No echinoderms were observed in any of the intertidal core samples. Organisms other than those in the major taxonomic groups were present at all locations except B3a, with abundances[3] ranging from 0.1% to 9.6% of all identified organisms (see miscellaneous taxa in Table 4-1).

[3] Abundance is defined as the total number of organisms or type of organisms in a sample.

Table 4-1. Organism abundances in composite core samples collected at intertidal locations

Location	Total Organism Abundance[a]		Major Taxonomic Group Abundance[b]														
			Annelida			Crustacea			Insecta			Mollusca			Misc. Taxa[c]		
	0.012 m^2	0.1 m^2	0.012 m^2	0.1 m^2	%	0.012 m^2	0.1 m^2	%	0.012 m^2	0.1 m^2	%	0.012 m^2	0.1 m^2	%	0.012 m^2	0.1 m^2	%
B1a	581	4842	474	3,950	82	80	667	14	1	8	0.2	0	0	0.0	26	217	4.5
B2a	1,948	16,233	927	7,725	48	982	8,183	50	3	25	0.2	5	42	0.3	31	258	1.6
B3a	1,435	11,958	1101	9,175	77	332	2,767	23	0	0	0.0	2	17	0.1	0	0	0.0
B4a	1,063	8,858	832	6,933	78	220	1,833	21	3	25	0.3	0	0	0.0	8	67	0.8
B5a-2	60	500	57	475	95	2	17	3.3	0	0	0.0	0	0	0.0	1	8	1.7
B6a	177	1,475	146	1,217	82	12	100	6.8	0	0	0.0	2	17	1.1	17	142	9.6
B7a	1,032	8,600	718	5,983	70	311	2,592	30	1	8	0.1	0	0	0.0	2	17	0.2
B8a	1,692	14,100	886	7,383	52	790	6,583	47	0	0	0.0	0	0	0.0	16	133	1.0
B9a	705	5,875	479	3,992	68	224	1,867	32	1	8	0.1	0	0	0.0	1	8	0.1
B10a	792	6,600	395	3,292	50	332	2,767	42	0	0	0.0	0	0	0.0	65	542	8.2
BCA-1	1,400	11,667	730	6,083	52	650	5,417	46	2	17	0.1	1	8	0.1	17	142	1.2
BCA-3	1,086	9,050	919	7,658	85	152	1,267	14	0	0	0.0	0	0	0.0	15	125	1.4

[a] Total number of individual organisms in a composite of five core samples (representing a total area of 0.012 m^2) and total number of individual organisms in a standard 0.1-m^2 area (by extrapolating what was enumerated in the composite sample to a larger area)

[b] Total number of individual organisms in each major taxonomic group at each location in a composite of five core samples (representing a total area of 0.012 m^2) and in a standard 0.1-m^2 area (by extrapolating what was enumerated in the composite sample to a larger area). No echinoderms were observed in any of the intertidal core samples.

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes

The total number of taxa (taxa richness[4]) identified in the composite intertidal core samples representing a total area of 0.012 m^2 ranged from 10 at B5a-2 to 30 at B2a (Table 4-2). The majority of taxa present at all intertidal locations belonged to two major taxonomic groups, Annelida and Crustacea. Crustaceans were the most common taxa at 9 of the 12 locations, where they ranged from 40% to 57% of all identified taxa. Annelids were the most abundant taxa at the remaining three locations (B5a-2, B6a, and BCA-3), where they ranged from 47% to 70% of all identified taxa. At least one insect or mollusk taxon was present at 8 of the 12 intertidal sampling locations (Table 4-2). No echinoderms were observed in any of the intertidal core samples. Low numbers of miscellaneous taxa were present at all intertidal locations except B3a, ranging from 4.2% to 16% of all identified taxa.

Table 4-2. Taxa richness in composite core samples collected at intertidal locations

Location	Total Taxa Richness[a]	Major Taxonomic Group Richness[b]									
		Annelida		Crustacea		Insecta		Mollusca		Misc. Taxa[c]	
		No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
B1a	13	5	39	6	46	1	7.7	0	0	1	7.7
B2a	30	9	30	12	40	2	6.7	3	10	4	13
B3a	25	10	40	13	52	0	0	2	8	0	0
B4a	23	7	30	13	57	2	8.7	0	0	1	4.3
B5a-2	10	7	70	2	20	0	0	0	0	1	10
B6a	19	9	47	5	26	0	0	2	11	3	16
B7a	20	7	35	11	55	1	5	0	0	1	5.0
B8a	21	8	38	11	52	0	0	0	0	2	9.5
B9a	24	9	38	13	54	1	4.2	0	0	1	4.2
B10a	20	8	40	10	50	0	0	0	0	2	10
BCA-1	22	8	36	9	41	2	9.1	1	4.5	2	9.1
BCA-3	16	9	56	6	38	0	0	0	0	1	6.3

[a] Total number of taxa in a composite of five core samples, representing a total area of 0.012 m^2, at each location

[b] Total number of taxa in each major taxonomic group in a composite of five core samples (representing a total area of 0.012 m^2) at each location

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes

4.1.2 Taxonomic results for the intertidal transect frame samples

The total number of organisms retained on a 2.0-mm sieve from the composite intertidal transect frame samples (representing a total area of 0.5 m^2) ranged from 23 at B1a to 259 at B3a (Table 4-3). On a 0.1-m^2 basis, the total number of organisms

[4] Taxon (plural taxa) represents an identifiable taxonomic unit (i.e., any group of organisms, populations, or taxa considered to be sufficiently distinct from other such groups to be treated as a separate unit). Taxa richness is defined as the total number of taxa within a sample.

enumerated ranged from 5 to 52 organisms. In general, crustaceans and annelids were the most abundant organisms in these samples. Crustaceans were most abundant at 9 of 12 locations, where they ranged from 60% to 85% of all identified organisms in the composite samples. At the remaining three locations (B5a-2, B6a, and B9a), annelids were the most abundant organisms, ranging from 52% to 90% of all identified organisms. Mollusks were present at all locations except B1a; abundances ranged from 0.7% to 10% of all identified organisms. Insects and other miscellaneous taxa were present at a few of the intertidal sampling locations, constituting 1.2% or less of all identified organisms. No echinoderms were observed in the transect frame samples.

Table 4-3. Organism abundances in composite transect frame samples collected at intertidal locations

Location	Total Organism Abundance[a]		Major Taxonomic Group Abundance[b]															
			Annelida			Crustacea			Insecta			Mollusca			Misc. Taxa[c]				
	0.5 m^2	0.1 m^2	0.5 m^2	0.1 m^2	%	0.5 m^2	0.1 m^2	%	0.5 m^2	0.1 m^2	%	0.5 m^2	0.1 m^2	%	0.5 m^2	0.1 m^2	%
B1a	23	5	5	1	22	18	4	78	0	0	0	0	0	0	0	0	0
B2a	215	43	40	8	19	157	31	73	0	0	0	18	4	8.3	0	0	0
B3a	259	52	50	10	19	194	39	75	0	0	0	13	3	5.0	2	<1	0.77
B4a	168	34	15	3	8.9	143	29	85	2	<1	1.2	8	2	4.8	0	0	0
B5a-2	39	8	35	7	90	0	0	0	0	0	0	4	1	10	0	0	0
B6a	95	19	84	17	88	4	1	4.2	0	0	0	7	1	7.4	0	0	0
B7a	49	10	10	2	20	35	7	71	0	0	0	4	1	8.1	0	0	0
B8a	205	41	45	9	22	154	31	75	0	0	0	6	1	2.9	0	0	0
B9a	200	40	103	21	52	87	17	44	0	0	0	10	2	5.0	0	0	0
B10a	144	29	56	11	39	87	17	60	0	0	0	1	<1	0.7	0	0	0
BCA-1	154	31	30	6	20	111	22	72	0	0	0	13	3	8.4	0	0	0
BCA-3	151	30	26	5	17	124	25	82	0	0	0	1	<1	0.7	0	0	0

[a] Total number of individual organisms retained on a 2-mm sieve in a composite of five frame samples (representing a total area of 0.5 m^2) and in a standard 0.1-m^2 area (by extrapolating what was enumerated in the composite sample to a smaller area).

[b] Total number of individual organisms in each major taxonomic group at each location in a composite of five frame samples (representing a total area of 0.5 m^2) and in a standard 0.1-m^2 area (by extrapolating what was enumerated in the composite sample to a smaller area). No echinoderms were observed in any of the intertidal transect frame samples

[c] Miscellaneous taxa include Nemertea and Cnidaria. No nematodes or platyhelminths were observed in any of the intertidal frame samples.

Taxa richness in the composite intertidal transect frame samples representing a total area of 0.5 m^2 ranged from 4 at B5a-2 to 20 at B3a (Table 4-4). The majority of taxa present in the transect frame samples were annelid worms or crustaceans. In combination, these groups made up between 79% and 100% of all identified organisms, except at location B5a-2, where no crustaceans were present. Low numbers of mollusk taxa were present at all intertidal locations, constituting between 7.1% and 25% of all identified taxa, except at location B1a, where no mollusks were present. Insects or other miscellaneous taxa were present in two of the transect frame samples collected at intertidal locations. No echinoderms were present in the intertidal transect frame samples.

Table 4-4. Taxa richness in composite transect frame samples collected at intertidal locations

Location	Total Taxa Richness[a]	Major Taxonomic Group Richness[b]									
		Annelida		Crustacea		Insecta		Mollusca		Misc. Taxa[c]	
		No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
B1a	5	2	40	3	60	0	0	0	0	0	0
B2a	15	5	33	8	53	0	0	2	13	0	0
B3a	20	8	40	8	40	0	0	2	10	2	10
B4a	14	5	36	6	43	2	14	1	7.1	0	0
B5a-2	4	3	75	0	0	0	0	1	25	0	0
B6a	12	10	83	1	8.3	0	0	1	8.3	0	0
B7a	9	4	44	4	44	0	0	1	11	0	0
B8a	10	4	40	5	50	0	0	1	10	0	0
B9a	12	5	42	6	50	0	0	1	8.3	0	0
B10a	8	4	50	3	38	0	0	1	13	0	0
BCA-1	16	8	50	6	38	0	0	2	13	0	0
BCA-3	8	3	38	4	50	0	0	1	13	0	0

[a] Total number of taxa in a composite of five transect frame samples, representing a total area of 0.5 m^2, at each location

[b] Total number of taxa in each major taxonomic group in a composite of five transect frame samples (representing a total area of 0.5 m^2) at each location. No echinoderms were present in the transect frame samples.

[c] Miscellaneous taxa include Nemertea and Cnidaria. No nematodes or platyhelminths were observed in any of the intertidal transect frame samples.

A few taxa were observed in the frame samples that were not in the core samples from the same locations. These taxa included:

- Two crustaceans, the amphipod *Ampithoe lacertosa* and the shrimp *Crangon franciscorum*, which were present only in transect frame samples from B2a, B3a, and B9a

- Four polychaete species, *Abarenicola pacifica*, *Barantolla* nr *americana*, *Glycera nana*, and *Glycinde polygnatha*, which were present in relatively low abundances in transect frame samples from B2a, B3a,B4a, B6a, and/or BCA-1
- One mollusk, *Mya arenaria*, which was observed in the transect frame samples from B3a and BCA-1
- One nemertean, *Paranemertes peregrina*, which was observed only in the transect frame sample from B3a

These organisms, missed by the core sampler, are among the larger invertebrates in benthic communities. The taxonomic data from the intertidal transect frame samples are presented in full in Appendix A, Table A-2.

4.1.3 Intertidal biomass measurements

The major taxonomic groups (Annelida, Crustacea, Mollusca, and miscellaneous taxa) identified in the intertidal composite core and transect frame samples were weighed to the nearest 0.1 g (note: all biomass weight measurements are on a wet weight [ww] basis and mollusks were weighed with shells[5]). No echinoderms were present in the intertidal samples. The weight data were collected to describe the community and also for comparison with weights of these major groups in the co-located tissue samples that were chemically analyzed (Windward 2005). These comparisons and associated uncertainties will be discussed in the ERA.

Annelids (polychaetes and oligochaetes) constituted the largest portion of the biomass in the core samples at 7 of 12 locations, ranging from 0.1 g to 1.0 g (Table 4-5). At four other locations (B2a, B7a, B8a, and BCA-1), crustaceans constituted the largest portion of the biomass, ranging from 0.9 g to 1.4 g. Mollusks constituted the largest portion of the biomass at location B6a with 2.5 g, and a relatively large portion of the biomass at location B2a with 0.8 g. The biomass of miscellaneous taxa was <0.1 g at all locations, except at B3a, where no miscellaneous taxa were present.

Table 4-5. Weight (g ww) of major taxa in composite core samples collected at intertidal locations

Location	Annelida		Crustacea[a]		Mollusca[b]		Misc. Taxa[c]		Total Weight[d]
	Weight	Percent	Weight	Percent	Weight	Percent	Weight	Percent	
B1a	0.3	60	0.2	40	0.0	0	<0.1	nc	0.5
B2a	0.6	24	1.1	44	0.8	32	<0.1	nc	2.5
B3a	0.9	50	0.6	33	0.3	17	0.0	nc	1.8
B4a	0.5	63	0.3	38	0.0	0	<0.1	nc	0.8
B5a-2	0.1	100	<0.1	nc	0.0	0	<0.1	nc	0.1
B6a	0.2	7.4	<0.1	nc	2.5	93	<0.1	nc	2.7

[5] Bivalves, in the co-located samples analyzed for chemicals, were weighed without shells. Shell weight can comprise at least half of the total bivalve weight.

Location	Annelida		Crustacea[a]		Mollusca[b]		Misc. Taxa[c]		Total Weight[d]
	Weight	Percent	Weight	Percent	Weight	Percent	Weight	Percent	
B7a	0.3	25	0.9	75	0.0	0	<0.1	nc	1.2
B8a	1.0	45	1.2	55	0.0	0	<0.1	nc	2.2
B9a	1.0	67	0.5	33	0.0	0	<0.1	nc	1.5
B10a	0.5	56	0.4	44	0.0	0	<0.1	nc	0.9
BCA-1	0.3	17	1.4	78	0.1	5.6	<0.1	nc	1.8
BCA-3	0.9	75	0.3	25	0.0	0	<0.1	nc	1.2

nc - not calculated

[a] The relatively few insects present were weighed with the crustaceans because it is difficult to separate insects from crustaceans without microscopic examination

[b] Mollusks were weighed with the shell because the taxonomic identifications are based on the shell and many of the organisms were so small that breaking the shell and retrieving the tissue would have been very difficult and time-consuming

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes. No echinoderms were present in the intertidal core samples

[d] Weights are total weights for the composite of five core samples, representing a total area of 0.012 m^2, at each location

Mollusks constituted the largest portion of the biomass in the transect frame samples at all locations except B1a, ranging from 1.2 to 13.3 g (Table 4-6). At B1a, crustaceans constituted the largest portion of the biomass with a weight of 0.1 g. At the other locations, crustacean biomass ranged from 0.0 g to 1.6 g. Annelids were present at all locations, with biomass ranging from <0.1 g to 5.2 g. Miscellaneous taxa were only present at location B3a, with a biomass of <0.1 g.

Table 4-6. Weight (g ww) of major taxa in composite transect frame samples collected at intertidal locations

Location	Annelida		Crustacea[a]		Mollusca[b]		Misc. Taxa[c]		Total Weight[d]
	Weight	Percent	Weight	Percent	Weight	Percent	Weight	Percent	
B1a	<0.1	nc	0.1	100	0.0	0	0	0	0.1
B2a	1.6	13	1.3	11	9.1	76	0	0	12.0
B3a	3.3	26	1.6	13	7.8	61	<0.1	nc	12.7
B4a	0.9	14	1.6	25	3.8	60	0	0	6.3
B5a-2	1.9	24	0	0	5.9	76	0	0	7.8
B6a	5.2	34	<0.1	nc	9.9	66	0	0	15.1
B7a	0.5	9	0.3	5.5	4.7	85	0	0	5.5
B8a	1.6	19	1.4	17	5.4	64	0	0	8.4
B9a	2.7	16	1.4	8.1	13.3	76	0	0	17.4
B10a	0.8	20	0.6	15	2.7	66	0	0	4.1
BCA-1	1.1	14	0.9	11	6.0	75	0	0	8.0
BCA-3	1.0	30	1.1	33	1.2	36	0	0	3.3

nc - not calculated

[a] The relatively few insects present were weighed with the crustaceans because it is difficult to separate insects from crustaceans without microscopic examination

[b] Mollusks were weighed with the shell because the taxonomic identifications are based on the shell and many of the organisms were so small that breaking the shell and retrieving the tissue would have been very difficult and time-consuming

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes. No echinoderms were present in the intertidal transect frame samples

[d] Weights are total weights for the composite of five transect frame samples, representing a total area of 0.5 m^2 at each location, and representing organisms retained on a 2.0-mm sieve.

4.2 SUBTIDAL COMMUNITY RESULTS

Data describing benthic communities at the 14 subtidal locations are based primarily on samples collected with the van Veen grab sampler and sieved with a 1.0-mm sieve. Core samples were also collected from within the van Veen grab sampler and sieved with nested 1.0- and 0.5-mm sieves to identify benthic invertebrates potentially lost by increasing the sieve size from 0.5 mm to 1 mm for the more voluminous van Veen grab samples. The taxonomic results from the van Veen grab and core samples are presented in Sections 4.2.1 and 4.2.2, respectively. Subtidal biomass measurements are presented in Section 4.2.3.

4.2.1 Taxonomic results for the van Veen grab samples

The total number of organisms in the subtidal composite samples collected with the van Veen grab sampler ranged from 217 at BCA-5 to 6,899 at B8b (Table 4-7). The three van Veen grab samples[6] that were composited into one composite sample covered a total area of 0.3 m^2 (i.e., three 0.1-m^2 van Veen grab samples were composited at each subtidal location). Abundances are also presented in Table 4-7 on a standard 0.1-m^2 basis to facilitate comparison with the intertidal samples. On a 0.1-m^2 basis, the total number of organisms ranged from 72 to 2,300.

[6] The samples included material retained on a 1-mm sieve from both the van Veen grab and the core sampler

Table 4-7. Organism abundances in composite van Veen grab samples collected at subtidal locations

Location	Total Organism Abundance [a]		Major Taxonomic Group Abundance [b]														
			Annelida			Crustacea			Mollusca			Echinodermata			Misc. Taxa [c]		
	0.3 m^2	0.1 m^2	0.3 m^2	0.1 m^2	%	0.3 m^2	0.1 m^2	%	0.3 m^2	0.1 m^2	%	0.3 m^2	0.1 m^2	%	0.3 m^2	0.1 m^2	%
B1b	977	326	528	176	54	232	77	24	198	66	20	9	3	0.9	10	3	1.0
B2b	1,611	537	372	124	23	256	85	16	968	323	60	2	<1	0.1	13	4	0.8
B3b	1,678	559	1,191	397	71	127	42	7.6	254	85	15	2	<1	0.1	104	35	6.2
B4b	1,562	521	623	208	40	83	28	5.3	828	276	53	21	7	1.3	7	2	0.5
B5b	1,930	643	1,403	468	73	314	105	16	131	44	6.8	0	0	0	82	27	4.3
B6b	3,412	1,137	3,124	1,041	92	51	17	1.5	231	77	6.8	0	0	0	6	2	0.2
B7b	1,492	497	1,172	391	79	34	11	2.3	283	94	19	1	<1	0.1	2	<1	0.1
B8b	6,899	2,300	1,505	502	22	5,379[d]	1,793	78	15	5	0.2	0	0	0	0	0	0
B9b	2,806	935	1,304	435	47	1,478	493	53	23	8	0.8	0	0	0	1	<1	0
B10b	4,624	1,541	584	195	13	4,040[d]	1,347	87	0	0	0	0	0	0	0	0	0
BCA-2	984	328	846	282	86	52	17	5.3	82	27	8.3	2	<1	0.2	2	<1	0.2
BCA-4	2,811	937	1,497	499	53	179	60	6.4	1,100	367	39	2	<1	0.1	33	11	1.2
BCA-5	217	72	155	52	71	18[e]	6	8.3[e]	39	13	18	0	0	0	5	2	2.3
BCA-6	5,067	1,689	1,215	405	24	3,852[d]	1284	76	0	0	0	0	0	0	0	0	0

[a] Total number of individual organisms retained on a 1-mm sieve in a composite of three van Veen grab samples (representing a total area of 0.3 m^2) and in a standard 0.1-m^2 area (by extrapolating what was enumerated in the composite sample to a smaller area).

[b] Total number of individual organisms in each major taxonomic group at each location in a composite of three van Veen grab samples (representing a total area of 0.3 m^2) and in a standard 0.1-m^2 area (by extrapolating what was enumerated in the composite sample to a smaller area)

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes

[d] Because of high abundance of crustaceans, one-eighth of the crustaceans were sub-sampled, enumerated, and identified. The total abundance is the enumerated crustaceans multiplied by 8.

[e] Crustacea at location BCA-5 include the only insect observed in the subtidal van Veen grab samples

In general, annelids, crustaceans, and mollusks were the most abundant organisms in the subtidal samples (Table 4-7). Annelids were the most abundant organisms at 8 of the 14 locations. At four of the other locations (B8b, B9b, B10b, and BCA-6), crustaceans were the most abundant organisms, and at the remaining two locations (B2b and B4b), mollusks were the most abundant organisms. Insects were only present at one of the subtidal sampling locations (BCA-5), constituting 0.5% of all identified organisms. Echinoderms were present at locations B1b, B2b, B3b, B4b, B7b, BCA-2, and BCA-4, with abundances ranging from 0.1% to 1.3% of all identified organisms. Miscellaneous taxa were present at all locations except B8b, B10b, and BCA-6, with abundances ranging between 0.1% and 6.2% of all identified organisms. In addition, though not shown in Table 4-7, colonies of Bryozoa and Entoprocta were present at locations B1b, B2b, BCA-4, and BCA-5. These colonies were not included in the enumeration of organisms because of difficulties in identifying what constituted one organism or colony. Instead, these organisms were simply noted as present.

The total number of taxa identified in the composite subtidal van Veen grab samples, representing a total area of 0.3 m^2, ranged from 14 at BCA-6 to 107 at B1b and BCA-4 (Table 4-8). Annelids were the most common taxa at 13 of the 14 locations, where they ranged from 40% to 58% of all identified taxa. Annelids and crustaceans were the most common taxa at the remaining location (BCA-6), each representing 50% of all identified taxa. Mollusks were present at all locations except B10b and BCA-6, ranging from 4% to 26% of all identified taxa. One insect taxon was present at location BCA-5. Echinoderms were present at locations B1b, B2b, B3b, B4b, B7b, BCA-2, and BCA-4, ranging from 1.1 to 3.9% of all identified taxa. Low numbers of miscellaneous taxa were present at all subtidal locations except B8b, B10b, and BCA-6, ranging from 1.1% to 9.3% of all identified taxa.

Table 4-8. Taxa richness in composite van Veen grab samples collected at subtidal locations

Location	Total Richness[a]	Major Taxa Richness[b]									
		Annelida		Crustacea		Mollusca		Echinodermata		Misc. Taxa[c]	
		No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
B1b	107	43	40	22	21	28	26	4	3.7	10	9.4
B2b	92	43	47	17	18	23	25	1	1.1	8	8.7
B3b	93	54	58	14	15	22	24	2	2.2	1	1.1
B4b	78	39	50	11	14	19	24	3	3.9	6	7.7
B5b	60	34	57	11	18	11	18	0	0	4	6.7
B6b	83	41	49	17	20	21	25	0	0	4	4.8
B7b	75	38	51	16	21	18	24	1	1.3	2	2.7
B8b	27	14	52	12	44	1	4	0	0	0	0
B9b	36	17	47	12	33	6	17	0	0	1	2.8
B10b	16	9	56	7	44	0	0	0	0	0	0
BCA-2	54	29	54	12	22	11	20	1	1.9	1	1.9

Location	Total Richness[a]	Major Taxa Richness[b]									
		Annelida		Crustacea		Mollusca		Echinodermata		Misc. Taxa[c]	
		No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
BCA-4	107	62	58	12	11	25	23	2	1.9	6	5.6
BCA-5	50	27	54	8[d]	16[d]	12	24	0	0	3	6.0
BCA-6	14	7	50	7	50	0	0	0	0	0	0

[a] Total number of taxa in a composite of three van Veen grab samples, representing a total area of 0.3 m^2, at each location

[b] Total number of taxa in each major taxonomic group in a composite of three van Veen grab samples (representing a total area of 0.3 m^2) at each location

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes

[d] Crustacea at location BCA-5 include the only insect observed at a subtidal location

4.2.2 Taxonomic results for the subtidal core samples

Three core samples[7] that were collected from within the van Veen grabs and composited into one sample covered a total area of 0.0072 m^2 at each subtidal location. The total number of organisms present in these composite subtidal core samples ranged from 1 at BCA-5 to 534 at BCA-6 (Table 4-9). On a standard 0.1 m^2 basis, the total number of organisms ranged from 14 to 7,417. Annelids were the most abundant organisms at 11 out of 14 locations, where they ranged from 53% to 97% of all identified organisms. At one location (B10b), crustaceans were most abundant, constituting 65% of all identified organisms. Mollusks were the most abundant organisms at location B2b. Only one insect was collected in any of the core samples, at subtidal location B6b. Miscellaneous taxa were present at all locations except B1b and BCA-4, ranging from 0.6 to 100% of all identified organisms. At BCA-5, only one identifiable organism (a nematode) was collected in the composite core sample. No echinoderms were present in any of the subtidal core samples.

[7] The samples included the material retained on a 0.5-mm sieve

Table 4-9. Organism abundances in composite core samples collected at subtidal locations

Location	Total Organism Abundance [a]		Major Taxonomic Group Abundance [b]														
			Annelida			Crustacea			Insecta			Mollusca			Misc. Taxa [c]		
	0.0072 m^2	0.1 m^2	0.0072 m^2	0.1 m^2	%	0.0072 m^2	0.1 m^2	%	0.0072 m^2	0.1 m^2	%	0.0072 m^2	0.1 m^2	%	0.0072 m^2	0.1 m^2	%
B1b	39	542	29	403	74	5	69	13	0	0	0	5	69	13	0	0	0.0
B2b	134	1,861	51	708	38	19	264	14	0	0	0	63	875	47	1	14	0.8
B3b	60	833	54	750	90	3	42	5.0	0	0	0	0	0	0	3	42	5.0
B4b	99	1,375	67	931	68	1	14	1.0	0	0	0	30	417	30	1	14	1.0
B5b	221	3,069	183	2,542	83	32	444	14	0	0	0	3	42	1.4	3	42	1.4
B6b	164	2,278	159	2,208	97	0	0	0	1	14	0.6	3	42	1.8	1	14	0.6
B7b	33	458	24	333	73	1	14	3.0	0	0	0	5	69	15	3	42	9.1
B8b	261	3,625	149	2,069	57	110	1,528	42	0	0	0	0	0	0	2	28	0.8
B9b	128	1,778	80	1,111	63	41	569	32	0	0	0	0	0	0	7	97	5.5
B10b	148	2,056	51	708	34	96	1,333	65	0	0	0	0	0	0	1	14	0.7
BCA-2	66	917	59	819	89	2	28	3.0	0	0	0	3	42	4.6	2	28	3.0
BCA-4	61	847	53	736	87	5	69	8.2	0	0	0	3	42	4.9	0	0	0
BCA-5	1	14	0	0	0	0	0	0	0	0	0	0	0	0	1	14	100
BCA-6	534	7,417	284	3,944	53	173	2,403	32	0	0	0	0	0	0	77	1,069	14

[a] Total number of individual organisms in a composite of three core samples (representing a total area of 0.0072 m^2) and in a standard 0.1 m^2 area (by extrapolating what was enumerated in the composite sample to a larger area)

[b] Total number of individual organisms in each major taxonomic group at each location in a composite of three core samples (0.0072 m^2) and in a standard 0.1-m^2 area (by extrapolating what was enumerated in the composite sample to a larger area). No echinoderms were present in any of the subtidal core samples.

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes

The total number of taxa present in the composite subtidal core samples (representing a total area of 0.0072 m^2) ranged from 1 at BCA-5 to 26 at B2b and B4b (Table 4-10). Annelids were the most common taxa at 11 of the 14 locations, where they represented 42% to 79% of all identified taxa. Crustaceans were the most common taxa B10b, where they represented 53% of all identified taxa. At one location (B8b), crustaceans and annelids were equally common, each representing 47% of all identified taxa. Mollusks were present at eight of the subtidal sampling locations, representing 7.1% to 31% of all identified taxa. Only one insect taxon (Collembola) was collected in any of the subtidal core samples, at location B6b. Miscellaneous taxa were present at all locations except B1b and BCA-4, ranging from 3.9% to 100% of all identified taxa. At BCA-5, only one identifiable taxon (a nematode) was identified in the composite core sample. No echinoderms were present in any of the subtidal core samples.

Table 4-10. Taxa richness in composite core samples collected at subtidal locations

Location	Total Taxa Richness[a]	Major Taxonomic Group Richness[b]									
		Annelida		Crustacea		Insecta		Mollusca		Misc. Taxa[c]	
		No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
B1b	20	12	60	4	20	0	0	4	20	0	0
B2b	26	11	42	6	23	0	0	8	31	1	3.9
B3b	13	10	77	2	15	0	0	0	0	1	7.7
B4b	26	16	62	1	3.9	0	0	8	31	1	3.9
B5b	23	15	65	5	22	0	0	2	8.7	1	4.4
B6b	18	13	72	0	0	1	5.6	3	17	1	5.6
B7b	15	9	60	1	6.7	0	0	4	27	1	6.7
B8b	15	7	47	7	47	0	0	0	0	1	6.7
B9b	14	7	50	6	43	0	0	0	0	1	7.1
B10b	15	6	40	8	53	0	0	0	0	1	6.7
BCA-2	14	11	79	1	7.1	0	0	1	7.1	1	7.1
BCA-4	20	14	70	3	15	0	0	3	15	0	0
BCA-5	1	0	0	0	0	0	0	0	0	1	100
BCA-6	17	8	47	7	41	0	0	0	0	2	12

[a] Total number of taxa in a composite of three core samples, representing a total area of 0.0072 m^2, at each location

[b] Total number of taxa in each major taxonomic group in a composite of three core samples (representing a total area of 0.0072 m^2) at each location

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes. No echinoderms were observed in any of the subtidal core samples

Organisms retained only in the core samples represented those retained on a 0.5-mm sieve, but not on a 1.0-mm sieve. Thus, they represent organisms that are present in subtidal samples, but may have been under-represented in grab samples sieved

through a 1.0-mm sieve. A total of seven taxa were present only in the core samples (i.e., never in the 1.0 mm sieved samples). Three polychaete species, *Exogone molesta, Micropodarke dubia,* and *Sphaerosyllis ranunculus*, were present at relatively low abundances (1-4 per sample) in a few of the core samples. One amphipod, *Americhelidium variabilum*, and two copepods, *Coullana canadensis* and *Eurytemora americana*, were present in some of the core samples with abundances ranging from 1 to 48 per sample. One insect (a Collembola) was present in the core sample from B6b. One small flatworm, *Rhabdocoela sp.*, was present in the core samples from B9b and BCA-6 with 7 and 30 individuals per sample, respectively. The taxonomic data from the subtidal core samples are presented in full in Appendix A, Table A-4.

4.2.3 Subtidal biomass measurements

Organisms of the taxonomic groups Annelida, Crustacea, Mollusca, Echinodermata, and miscellaneous taxa present in the subtidal composite van Veen grab[8] and core[9] samples were weighed to the nearest 0.1 g (note: all biomass weight measurements are on a wet weight [ww] basis and mollusks were weighed with shells[10]). The weight data were collected to describe the community and also for comparison with weights of these major groups in the co-located tissue samples that were chemically analyzed (Windward 2005). These comparisons and associated uncertainties will be discussed in the ERA.

The major biomass components in the van Veen grab samples were annelids, crustaceans, and mollusks. Annelids (polychaetes and oligochaetes) constituted the largest portion of the biomass at 7 of 14 locations, ranging from 5.8 g to 18.8 g (Table 4-11). Crustaceans constituted the largest portion of the biomass at locations B10b (20.7 g) and BCA-6 (19.7 g). Mollusks constituted the largest portion of the biomass at the remaining five locations (B2b, B7b, B8b, B9b, and BCA-5), ranging from 1.8 g to 23.0 g. Echinoderms were present at seven locations (B1b, B2b, B3b, B4b, B7b, BCA-2, and BCA-4) with the only measurable biomass at location B4b (0.1 g). Miscellaneous taxa were present at eleven locations, with measurable biomass at B1b, B2b, B6b, BCA-4, and BCA-5.

Table 4-11. Weight (g ww) of major taxa in composite van Veen grab samples collected at subtidal locations

Location	Annelida		Crustacea[a]		Mollusca[b]		Echinodermata		Misc. Taxa[c]		Total Weight[d]
	Weight	Percent	Weight	Percent	Weight	Percent	Weight	Percent	Weight	Percent	
B1b	5.8	50	2.5	22	2.8	24	<0.1	nc	0.4	3.5	11.5
B2b	3.4	21	3.5	22	8.9	56	<0.1	nc	0.1	0.6	15.9
B3b	10.4	60	0.3	1.7	6.5	38	<0.1	nc	<0.1	nc	17.2

[8] Organisms retained on a 1.0-mm sieve

[9] Organisms retained on a 0.5–mm sieve after being sieved through 1.0-mm sieve

[10] Bivalves, in the co-located samples analyzed for chemicals, were weighed without shells. Shell weight can comprise at least half of the total bivalve weight.

Location	Annelida		Crustacea[a]		Mollusca[b]		Echinodermata		Misc. Taxa[c]		Total Weight[d]
	Weight	Percent	Weight	Percent	Weight	Percent	Weight	Percent	Weight	Percent	
B4b	11.4	60	<0.1	nc	7.5	39	0.1	0.5	<0.1	nc	19.0
B5b	10.5	58	1.3	7.2	6.2	34	0.0	0.0	<0.1	nc	18.0
B6b	15.6	83	0.5	2.7	2.5	13	0.0	0.0	0.1	0.5	18.7
B7b	5.5	19	0.5	1.7	23.0	79	<0.1	nc	<0.1	nc	29.0
B8b	7.2	15	19.7	42	20.5	43	0.0	0.0	0.0	0.0	47.4
B9b	3.0	11	7.5	27	17.4	62	0.0	0.0	<0.1	nc	27.9
B10b	3.0	13	20.7	87	0.0	0.0	0.0	0.0	0.0	0.0	23.7
BCA-2	12.4	91	0.6	4.4	0.6	4.4	<0.1	nc	<0.1	nc	13.6
BCA-4	18.8	51	1.7	4.6	15.1	41	<0.1	nc	1.1	3.0	36.7
BCA-5	1.0	22	1.6	35	1.8	39	0.0	0.0	0.2	4.4	4.6
BCA-6	11.8	37	19.7	63	0.0	0.0	0.0	0.0	0.0	0.0	31.5

nc - not calculated

[a] The relatively few insects present were weighed with the crustaceans because it is difficult to separate insects from crustaceans without microscopic examination

[b] Mollusks were weighed with the shell because the taxonomic identifications are based on the shell and many of the organisms were so small that breaking the shell and retrieving the tissue would have been very difficult and time-consuming

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes

[d] Weights are total weights for a composite of three van Veen grab samples, representing a total area of 0.3 m^2, at each location

Annelids constituted the largest portion of the biomass in the subtidal core samples at 6 of 14 locations, ranging from 0.1 g to 0.6 g (Table 4-12). Mollusks constituted the largest portion of the biomass at B2b (0.5 g) and B4b (1.2 g). Crustaceans and/or miscellaneous taxa were present at most of the locations, but with a biomass of 0.1 g or less. No echinoderms were observed in any of the subtidal core samples.

Table 4-12. Weight (g ww) of major taxa in composite core samples collected at subtidal locations

Location	Annelida		Crustacea[a]		Mollusca[b]		Misc. Taxa[c]		Total Weight[d]
	Weight	Percent	Weight	Percent	Weight	Percent	Weight	Percent	
B1b	0.1	100	<0.1	nc	<0.1	nc	0.0	0.0	0.1
B2b	0.2	29	<0.1	nc	0.5	71	<0.1	nc	0.7
B3b	0.2	100	<0.1	nc	0.0	0.0	<0.1	nc	0.2
B4b	0.5	29	<0.1	nc	1.2	71	<0.1	nc	1.7
B5b	0.4	80	<0.1	nc	0.1	20	<0.1	nc	0.5
B6b	0.6	100	<0.1	nc	<0.1	nc	<0.1	nc	0.6
B7b	<0.1	nc	<0.1	nc	<0.1	nc	<0.1	nc	<0.1
B8b	0.1	50	0.1	50	0.0	0.0	<0.1	nc	0.2
B9b	0.1	100	<0.1	nc	0.0	0.0	<0.1	nc	0.1
B10b	<0.1	nc	0.1	100	0.0	0.0	<0.1	nc	0.1
BCA-2	0.2	100	<0.1	nc	<0.1	nc	<0.1	nc	0.2
BCA-4	<0.1	nc	<0.1	nc	<0.1	nc	0.0	0.0	<0.1
BCA-5	<0.1[e]	nc	0.0	nc	0.0	0.0	<0.1	nc	<0.1
BCA-6	0.1	50	0.1	50	<0.1	nc	<0.1	nc	0.2

nc - not calculated

[a] The relatively few insects present were weighed with the crustaceans because it is difficult to separate insects from crustaceans without microscopic examination

[b] Mollusks were weighed with the shell because the taxonomic identifications are based on the shell and many of the organisms were so small that breaking the shell and retrieving the tissue would have been very difficult and time-consuming

[c] Miscellaneous taxa include Nemertea, Nematoda, Cnidaria, and Platyhelminthes. No echinoderms were observed in any of the subtidal core samples.

[d] Weights are total weights for a composite of three core samples, representing a total area of 0.0072 m^2, at each location

[e] Polychaete fragments only

4.3 QA/QC of Taxonomic Identifications

The QA/QC process of the taxonomic identifications consisted of three steps, as described in the QAPP (Sections 3.4.1.2 and 3.5.2) (Windward 2004):

1. A 20% resorting of each sample, which involved the examination of a sample that had been sorted once and was considered free of organisms. If a removal criterion of 95% was not met, the whole sample was resorted.
2. Verification of voucher collections by a second group of taxonomists. At least 95% of the two species identifications were confirmed to be in agreement. Disagreement was resolved by re-examination of the species in question by the two taxonomists followed by a discussion until agreement was reached.
3. Re-identifications of all organisms in 5% of the total number of samples by a second group of taxonomists.

4.3.1 Resorting process results

The resorting process met the 95% removal criterion for all samples except the core sample collected at subtidal location B1b. In this sample, two organisms were found in the QA sorting that were missed during the first sorting. The total number of organisms was 39, resulting in a removal rate just under 95% (94.9%). A 100% resort was performed on this sample. Tables 4-13, 4-14, and 4-15 present the resorting data for the intertidal core samples and the subtidal core and van Veen grab samples.

The intertidal transect frame samples were not resorted for the following reasons:

- These samples were collected to capture larger organisms potentially missed by the smaller core sampler.
- The transect frame samples contained large amounts of debris and algae, which created a layer in the 2-mm sieve that retained organisms much smaller than the sampling design intended. Because of this, the transect frame samples were sorted using the naked eye only (i.e., without the use of a microscope).
- Low abundances of organisms (14-259) were present in the transect frame samples, which meant that a relatively low number of missed organisms (1-13), including the small organisms unintentionally retained in the samples, would necessitate a complete resort of the large transect frame samples (up to 6 L).

It was therefore assumed that none of the larger organisms targeted by the sampling design were missed in the primary sorting process and a 20% resort of the samples was not performed.

Table 4-13. Number of organisms found during resorting of intertidal core samples

	B1a	B2a	B3a	B4a	B5a-2	B6a	B7a	B8a	B9a	B10a	BCA-1	BCA-3
Annelida	frag[a]	1	0	1	frag[a]	0	1	frag[a]	1	frag[a]	1	1
Crustacea	0	0	1	0	0	0	0	0	0	0	0	0
Mollusca	0	6	0	1	0	0	1	0	0	0	1	0
Echinodermata	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous taxa	0	0	0	0	0	0	0	0	0	0	0	0
Total number of organisms missed	0	7	1	2	0	0	2	0	1	0	2	1
Total number of organisms in sample	581	1,948	1,435	1,063	60	177	1,032	1,692	705	792	1,399	1,086
% missed [b]	0.0	0.36	0.07	0.19	0.0	0.0	0.19	0.0	0.14	0.0	0.14	0.09

[a] Fragments of annelids were observed in the sample during resorting

[b] Percent missed was calculated as follows: (number of missed organisms/total number of organisms)*100

Table 4-14. Number of organisms found during resorting of subtidal van Veen grab samples

	B1b	B2b	B3b	B4b	B5b	B6b	B7b	B8b	B9b	B10b	BCA-2	BCA-4	BCA-5	BCA-6
Annelida	3	2	frag[a]	2	1	3	frag[a]	2	5	0	1	2	frag[a]	2
Crustacea	0	0	1	5	2	2	1	0	0	3	1	9	0	0
Mollusca	0	1	0	0	1	0	0	12	6	0	3	0	0	8
Echinodermata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous taxa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total number of organisms missed	3	3	1	7	4	5	1	14	11	3	5	11	0	10
Total number of organisms in sample	978	1,611	1,678	1,562	1,932	3,411	1,492	2,192	2,806	1,089	985	2,811	206	1,704
% missed [b]	0.31	0.19	0.06	0.45	0.21	0.15	0.07	0.64	0.39	0.28	0.51	0.39	0.0	0.59

[a] Fragments of annelids were observed in the sample during resorting

[b] Percent missed was calculated as follows: (number of missed organisms/total number of organisms)*100

Table 4-15. Number of organisms found during resorting of subtidal core samples

TAXA[a]	B1b	B2b	B3b	B4b	B5b	B6b	B7b	B8b	B9b	B10b	BCA-2	BCA-4	BCA-5	BCA-6
Annelida	0	0	frag[a]	0	frag[a]	1	frag[a]	frag[a]	0	0	frag[a]	frag[a]	0	0
Crustacea	1	0	0	2	0	0	0	0	0	0	0	0	0	0
Mollusca	1	0	0	0	1	0	0	0	0	0	0	0	0	1
Miscellaneous taxa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total number of organisms missed	2	0	0	2	1	1	0	0	0	0	0	0	0	1
Total number of organisms in sample	39	134	60	99	221	164	33	261	128	148	66	61	1	534
% missed [b]	5.1[c]	0.0	0.0	2.0	0.45	0.61	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2

[a] Fragments of annelids were observed in the sample during resorting

[b] Percent missed was calculated as follows: (number of missed organisms/total number of organisms)*100

[c] A 100% resort was performed on this sample

4.3.2 Verification of voucher collections

The voucher collections included a total of 249 taxa distributed among five major taxonomic groups as follows: 108 annelids, 65 crustaceans, 44 mollusks, 9 echinoderms, and 23 miscellaneous taxa. In general, few disagreements occurred between the primary and secondary groups of taxonomists. The two annelid taxonomists agreed on the identification of all specimens in the voucher collection. The second crustacean taxonomist preferred to leave two taxa in the voucher collection at a higher taxonomic level (family instead of subfamily and genus instead of species) than the primary taxonomist. The primary taxonomist re-examined the specimens and the original identifications were included in the data. The second mollusk taxonomist disagreed with the identification of two of the species in the voucher collection. Upon re-examination, the primary mollusk taxonomist agreed with the new identifications and changes were applied to the data. In addition, one gastropod identified to genus (*Onchidella* sp.) could not be confirmed by the second taxonomist because the only specimen, found in a van Veen grab sample from location B2b, was in poor condition. However, the primary taxonomist felt comfortable with the identification and it was included in the data.

The second taxonomist identifying miscellaneous taxa disagreed with the identification of four taxa (three nemerteans and one bryozoan). The primary taxonomist re-examined the specimens, agreed with the second taxonomist, and the identifications were changed and applied to the data. Another nemertean was identified by the primary taxonomist as belonging to the species complex of *Tubulanus pellucidus/polymorphus*, whereas the second taxonomist identified the specimen as *Tubulanus polymorphus*. Because of great variability in specimens, the identification was retained as *Tubulanus pellucidus/polymorphus*. Three specimens (one nemertean, one bryozoan, and one echinoderm) were identified to different taxonomic levels by the two taxonomists. The higher taxonomic levels were retained and applied to the data. The voucher collections and the verification information, including comments and resolutions to disagreements, are presented in full in Appendix B.

4.3.3 Re-identification and re-enumeration of invertebrate samples

As part of the QA/QC performed by Allan Fukuyama's laboratory, 2 out of the 52 samples were sent out to a second group of taxonomists for re-identification and re-enumeration of all organisms. Tables 4-16, 4-17, 4-18, and 4-19 present the re-identification and re-enumeration of benthic invertebrate samples by major taxonomic group. In general, the identifications by the second group of taxonomists agreed with those of the primary taxonomists. In instances where the organism counts differed, the counts of the primary taxonomist were included, based on the assumption that some of the relatively small organisms had been lost. In the intertidal core sample from B6a, the two polychaete taxonomists disagreed over the

counts of *Capitella capitata* complex and oligochaetes. These two worms look very similar and the combined counts are close (62 versus 66). The primary taxonomist re-examined the sample and deemed the original identifications and counts correct. In the subtidal van Veen grab sample from BCA-5, the primary taxonomist identified 11 polychaetes to species whereas the second taxonomist left them at family level. The primary taxonomist re-examined the specimens and felt comfortable with the original identifications, which were retained. The two crustacean taxonomists disagreed on the identification of two small crustaceans in the subtidal core sample from BCA-4. The identifications were elevated to families and included in the data. In addition, two taxa (a total of three organisms) identified by the primary taxonomist, but not by the second crustacean taxonomist, were included in the data from this location. The two mollusk taxonomists disagreed on the counts of three *Macoma* taxa in the subtidal van Veen grab sample from BCA-2. The combined counts of all three taxa are very similar (45 versus 49). Because many of the specimens were juveniles in poor condition, the primary taxonomist identifications (leaving many at genus level) and counts were retained in the data. In addition, one bivalve in this sample was identified to different taxonomic levels (species and genus) by the two taxonomists. The primary taxonomist re-examined the specimen and felt comfortable with the original identification to species, which was retained. The two taxonomists identifying miscellaneous taxa agreed on all identifications and counts in the two samples.

Table 4-16. Re-identification and re-enumeration of polychaete samples

K WELCH IDENTIFICATION	#	H JONES IDENTIFICATION	#	COMMENTS/RESOLUTION
B6a (core)				
Capitella capitata complex	25	*Capitella capitata* complex	14	re-examined and original count accepted (3 specimens to voucher collection)
Eteone californica	1	*Eteone californica*	0	no animal found
Hobsonia florida	6	*Hobsonia florida*	5	original count accepted (1 specimen to voucher collection)
Manayunkia aestuarina	19	*Manayunkia aestuarina*	15	re-examined and original count accepted (3 specimens to voucher collection)
Neanthes limnicola	5	*Neanthes limnicola*	4	original count accepted (1 specimen to voucher collection)
Oligochaeta	37	Oligochaeta	50	2 to vouchers; re-examined and some were *Capitella capitata* complex (3 specimens to voucher collection)
Polydora cornuta	3	*Polydora cornuta*	2	original count accepted (1 specimen to voucher collection)
Pseudopolydora kempi	7	*Pseudopolydora kempi*	3	2 specimens to voucher collection
Pygospio elegans	43	*Pygospio elegans*	33	budding juveniles counted; original count accepted (2 specimens to voucher collection)

K WELCH IDENTIFICATION	#	H JONES IDENTIFICATION	#	COMMENTS/RESOLUTION
BCA-5 (van Veen grab)				
Abarenicola pacifica	1	*Abarenicola pacifica*	1	
Aphelochaeta glandaria	4	*Aphelochaeta glandaria*	4	
Armandia brevis	8	*Armandia brevis*	8	
Capitella capitata complex	30	*Capitella capitata* complex	30	also known as *C. capitata* 'hyperspecies' in this area
Cossura pygodactylata	1	*Cossura pygodactylata*	1	
Dipolydora caulleryi	3	*Dipolydora caulleryi*	3	
Eteone spilotus	1	*Eteone spilotus*	0	original count accepted (1 specimen to voucher collection)
Eteone sp.	1	*Eteone* sp.	1	
Euchone limnicola	2	*Euchone limnicola*	2	
Euclymeninae	1	Euclymeninae	0	original count accepted (1 specimen to voucher collection)
Heteromastus filobranchus	1	*Heteromastus filobranchus*	1	
Leitoscoloplos pugettensis	1	*Leitoscoloplos pugettensis*	1	
Lumbrineridae	1	Lumbrineridae	1	
Malmgreniella macginitiei	1	*Malmgreniella macginitiei*	0	original count accepted (1 specimen to voucher collection)
Mediomastus sp.	12	*Mediomastus* sp.	12	
Monticellina serratiseta	3	*Monticellina serratiseta*	2	original count accepted (1 specimen to voucher collection)
Nereis procera	1	*Nereis procera*	1	
Nereis vexillosa	1	*Nereis vexillosa*	0	original count accepted (1 specimen to voucher collection)
Oligochaeta	26	Oligochaeta	28	re-examined and original count accepted
Platynereis bicanaliculata	1	*Platynereis bicanaliculata*	1	
Podarkeopsis glabrus	2	*Podarkeopsis glabrus*	2	
Polycirrus sp.	3	*Polycirrus* sp.	3	
Polydora cornuta	27	*Polydora cornuta*	29	re-examined and original count accepted
Prionospio lighti	4	*Prionospio lighti*	4	
Pseudopolydora kempi	4	*Pseudopolydora kempi*	3	original count accepted
Scoletoma luti	4	*Scoletoma luti*	4	
Monticellina secunda	11	Cirratulidae	11	re-examined and original identification accepted

Table 4-17. Re-identification and re-enumeration of crustacean samples

J CORDELL IDENTIFICATION	#	K LI IDENTIFICATION	#	COMMENTS/RESOLUTION
BCA-4 (core)				
Eudorella pacifica	3	*Eudorella pacifica*	2	re-examined and original count accepted
Bathyleberis sp.	1	*Cylindroleberis* sp.	1	changed to Cylindroleberididae
Nippoleucon hinumensis	1	*Leucon* sp.	1	changed to Leuconidae (small juvenile)
B6b (van Veen grab)				
Not identified		*Balanus* sp.	1	re-examined and count accepted
Cancer gracilis	1	*Cancer gracilis*	1	
Diastylis santamariensis	1	*Diastylis santamariensis*	1	
Grandidierella japonica	4	*Grandidierella japonica*	3	original count accepted
Anisogammarus pugettensis	1	*Anisogammarus pugettensis*	1	
Eochelidium sp.	6	*Eochelidium* sp.	6	
Crangon sp.	2	*Crangon* sp.	2	
Crangon alaskensis	4	*Crangon alaskensis*	4	
Euphilomedes carcharodonta	3	*Euphilomedes carcharodonta*	3	
Aoroides inermis	3	*Aoroides inermis*	3	
Photis brevipes	2	*Photis brevipes*	3	original count accepted
Monocorophium acherusicum	7	*Monocorophium acherusicum*	6	original count accepted
Americorophium spinicorne	1	*Americorophium spinicorne*	1	
Americorophium salmonis	1	*Americorophium salmonis*	1	
Dyopedos sp.	2			included in data
Munnogonium sp.	1			included in data

Table 4-18. Re-identification and re-enumeration of mollusk samples

A FUKUYAMA IDENTIFICATION	#	S WEEKS IDENTIFICATION	#	COMMENTS/RESOLUTION
LDW-B9b (van Veen grab)				
Axinopsida serricata	1		1	
Macoma baltica	13		14	re-examined and original count accepted
Macoma nasuta	5		4	re-examined and original count accepted
Mytilus sp. juvenile	1		1	
Nutricola lordi	2		2	
Tellina modesta	1	*Tellina* sp.	1	re-examined and original identification accepted
BCA-2 (van Veen grab)				
Ennucula tenuis	1	*Acila castrensis*	1	re-examined juvenile specimen left as *E. tenuis* as no chevron markings present
Alvania compacta	13		12	one specimen in poor condition, left as *A. compacta*
Axinopsida serricata	3		3	
Clinocardium nuttallii	9		9	
		Gastropoda sp.	1	Identified as *Alvania compacta* by A. Fukuyama

A Fukuyama Identification	#	S Weeks Identification	#	Comments/Resolution
Lyonsia californica	5		5	
Macoma carlottensis	2		14	*Macoma* specimens in very poor condition and many juveniles present so most left as *Macoma* sp. Original count accepted
Macoma nasuta	1		3	
Macoma sp. juvenile	41		23	
Mytilus sp. juvenile	3		3	
Parvilucina tenuisculpta	2		2	

Table 4-19. Re-identification and re-enumeration of miscellaneous taxa samples

S McEuen Identification	#	S Hulsman & V Hironaka Identification	#	Comments/Resolution
BCA-1 (core)				
Nynantheae spp.	2	Nynantheae spp.	2	
Acarina sp.	1	Acarina sp.	1	
B7b (van Veen grab				
Edwardsia sipunculoides	1	*Edwardsia sipunculoides*	1	
Tubulanus pellucidus/polymorphus	1	*Tubulanus pellucidus/polymorphus*	1	
Amphiodia sp.	1	*Amphiodia* sp.	1	

5.0 References

PSEP. 1987. Recommended protocols for sampling and analyzing subtidal benthic macroinvertebrate assemblages in Puget Sound. Final Report. Prepared for the Puget Sound Estuary Program. US Environmental Protection Agency, Region 10, Seattle, WA.

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