Lower Duwamish Waterway Group

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

CRAB AND SHRIMP SECOND QUARTERLY SURVEY DATA REPORT 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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1.0 Introduction

Data presented in this report were collected as part of the Phase 2 Remedial Investigation (RI) for the Lower Duwamish Waterway (LDW). These data will aid in estimating potential site-specific crab and shrimp harvest rates for the Phase 2 Human Health Risk Assessment. The field procedures used to conduct these surveys are described in detail in the Quality Assurance Project Plan (QAPP) for the clam, crab, and shrimp survey of the LDW (Windward 2003a), and are also described briefly in Section 2.0 below.

This report summarizes the results of the second quarterly LDW crab and shrimp survey conducted in November 2003. Windward conducted the first quarterly survey in September 2003, and will conduct the remaining two quarterly crab and shrimp surveys in February and late April 2004. The quarterly surveys will provide data needed to estimate seasonal variation of the potential harvestability of crabs and shrimp throughout the year.

2.0 Methods

The purpose of the quarterly crab and shrimp survey is to estimate the potential harvest rate of crabs and shrimp by subsistence and recreational fishers in the LDW. To meet the study objectives, crab and shrimp traps were deployed at 38 sampling locations throughout the LDW study area (Figure 1). All species caught were examined and measured, then released to the LDW.

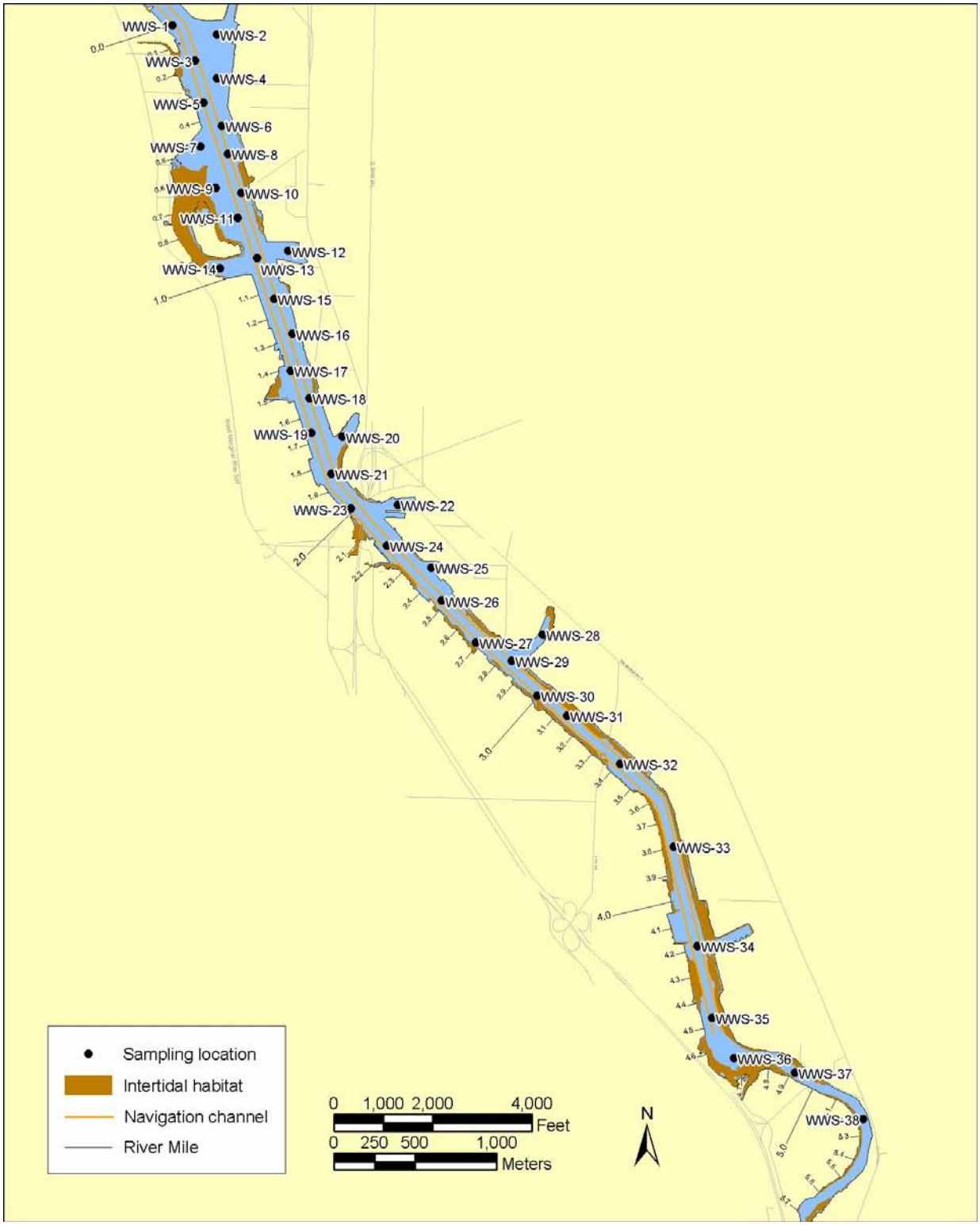

Figure 1. Intertidal habitat and crab and shrimp sampling locations in the Lower Duwamish Waterway

2.1 SAMPLING METHODS

Sampling locations were placed throughout the LDW study area with a relatively uniform sampling density by area. Consequently, there are more sampling locations in the northern portion of the study area because the river channel is wider there compared to the southern part of the study area. Sampling stations were placed more than 100 m apart, so as to provide adequate spatial coverage over the entire LDW with a reasonable number of pots and to avoid potentially underestimating crab and shrimp densities through trap competition. Based on the pilot study results described in Section 3.1 of the First Quarterly Crab and Shrimp Survey Data Report (Windward 2003b), pots were allowed a 4-hour soak time for the quarterly survey.

Windward conducted the second quarterly crab and shrimp survey from November 20 to November 23, 2003. All 38 stations were sampled utilizing the field procedures described in Section 3.2.1 of the QAPP. Crab and shrimp pots were deployed at each sampling location approximately 2 hours prior to the day's higher-high tide and retrieved after 4 hours. Tidal information for the second quarterly survey is shown in Table 1.

Table 1. Daily tidal heights (feet) for the LDW at 8th Ave South during the second quarterly crab and shrimp survey

SAMPLING DATE	11.20.2003	11.21.2003	11.22.2003	11.23.2003
HIGH TIDE (TIME):	8.3 (01:43)	9.4 (02:53)	10.5 (03:55)	11.4 (04:51)
LOW TIDE (TIME):	3.6 (07:22)	4.4 (08:19)	5.1 (09:13)	5.8 (10:06)
HIGH TIDE (TIME):	11.5 (13:41)	11.6 (14:12)	11.7 (14:45)	11.7 (15:20)
LOW TIDE (TIME):	1.3 (20:33)	-0.3 (21:11)	-1.7 (21:50)	-2.8 (22:32)

Water depths were not recorded at the time of deployment or retrieval, but the water depth at each target location was obtained from LDW bathymetric data collected in 2003 (DEA 2003) (Table 2).

Table 2. Water depth (feet, corrected to MLLW) at each target crab and shrimp sampling location

STATION	WATER DEPTH		STATION	WATER DEPTH
WWS-1	35.4		WWS-20	16.3
WWS-2	34.0		WWS-21	27.8
WWS-3	44.3		WWS-22	15.0
WWS-4	40.6		WWS-23	15.2
WWS-5	37.8		WWS-24	17.3
WWS-6	26.6		WWS-25	9.0
WWS-7	21.6		WWS-26	18.5
WWS-8	30.0		WWS-27	No data
WWS-9	13.7		WWS-28	9.9

Station	Water Depth		Station	Water Depth
WWS-10	28.6		WWS-29	18.2
WWS-11	20.3		WWS-30	12.7
WWS-12	24.9		WWS-31	17.4
WWS-13	35.4		WWS-32	17.1
WWS-14	18.7		WWS-33	14.6
WWS-15	34.2		WWS-34	13.3
WWS-16	20.2		WWS-35	12.2
WWS-17	31.7		WWS-36	9.0
WWS-18	29.4		WWS-37	No data
WWS-19	32.6		WWS-38	No data

Stations without depths were either obstructed during the bathymetric survey (WWS-27) or outside the surveyed area (WWS-37 and WWS-38)

After the designated soak time had elapsed, the pots were revisited and quickly pulled in at a constant speed to avoid potential crab or shrimp escape. All pertinent catch information was recorded, and the pots were stacked, cleaned of any debris, and prepared for the next day's sampling. Special care was taken to not dispose of any used bait to the LDW, as the addition of food to the system could negatively affect the subsequent day's catch.

2.2 Sampling Gear

Crab and shrimp were collected using Ladner 30" SS rubber-wrapped crab traps and Ladner 30" nestable shrimp pots. The crab and shrimp traps at a given station were deployed on separate floats approximately 10-15 feet apart. Crab traps were baited with a mixture of frozen salmon heads and whole squid, while the shrimp pots were baited with a mixture of slow- and fast-smolting (dissolving) shrimp pellet bait. The crab bait was placed in nylon mesh bait bags and hung from the center of the crab trap in such a manner that the bag could not be opened or moved by the crabs. The shrimp bait was placed in 1-quart plastic Scotty brand bait jars with approximately forty 8 mm-holes, thus allowing the scent of the bait to exit without allowing access to the bait itself.

Navigation to sample locations was achieved using a Magellan SporTrak GPS unit, upgraded to include the latest Wide Area Augmentation System (WASS) technology.

2.3 Crab and Shrimp Species Identification and Size Measurements

The station location, species, sex, and carapace length were recorded for each crab. The station location, species, and total length (rostrum to telson) were recorded for each shrimp. Crabs and shrimp were identified to the species level using a Pacific Northwest marine invertebrate key (Kozloff 1987).

2.4 DEVIATIONS FROM THE QAPP

During the second quarterly crab and shrimp survey, Windward sampled 12, 9, 10 and 7 stations, respectively, on each sampling day. The QAPP had indicated that the sampling would follow a 13, 13, and 12 station daily sampling effort over 3 days. Due to space limitations on the boat and the desire to maximize field crew safety, the Windward field team leader decided to sample fewer stations over 4 days. Future quarterly surveys will likely not follow the 13, 13, and 12 sampling design outlined in the QAPP.

Windward used a mixture of fish and squid to bait the crab traps. The QAPP indicated that crab traps would be baited with a mixture of fish, squid, and clams. Clams were not as readily available as fish and squid. The Windward project manager was informed, and it was decided that a mixture of fish and squid would be acceptable. An attempt will be made to get clams for the future quarterly surveys.

The first and second quarterly crab and shrimp sampling efforts were conducted in September and November 2003, respectively; with the remaining two surveys to be conducted in February and late April 2004. The QAPP had indicated that the quarterly surveys would be conducted in August, October, January, and late April. Due to scheduling delays in August, the first-, second-, and third-quarterly sampling efforts were moved forward one month.

3.0 Results

Catch-per-unit-effort (CPUE) was calculated for each pot to determine potential harvest rates by recreational and subsistence fishers. Crab and shrimp data collected during the second quarterly survey were summarized by number and mean length of each species per sampling pot. CPUE was calculated for each crab and shrimp species collected per pot by counting the number of individuals of each species for each pull of the pot. Potential crab and shrimp catch data were summarized per sampling pot and for the entire LDW and presented in tables in the following sections.

3.1 ENVIRONMENTAL CONDITIONS

Weather during survey was variable and included rain, intermittent showers, 5-10 mph wind (with gusts to 30 mph), and temperatures in the mid-30s (°F). Precipitation was heaviest on the first and final days of sampling, with consistent rain and some showers. There was minimal precipitation during the second sampling day, and no precipitation on the third sampling day.

River flow rates during the second quarterly survey were much higher than flow rates during the first quarterly survey. Mean stream flow at the US Geological Survey

stream gage at river mile 32 (USGS 12113000 Green River near Auburn, WA) during the first two quarterly surveys is shown in Table 3.

Table 3. Stream flow in the Duwamish River at Auburn during quarterly crab and shrimp surveys

First quarterly survey		Second quarterly survey	
Date	Stream flow – m^3/sec (ft^3/sec)	Date	Stream flow – m^3/sec (ft^3/sec)
9.8.2003	6.63 (234)	11.20.2003	96.3 (3400)
9.9.2003	5.95 (210)	11.21.2003	66.8 (2360)
9.10.2003	5.86 (207)	11.22.2003	47.6 (1680)
9.11.2003	6.46 (228)	11.23.2003	44.2 (1560)

3.2 Catch Results

All 38 stations were sampled using both crab and shrimp traps. Catch data were recorded for each station and trap type. Table 4 summarizes the second quarterly sampling results for each survey station. Slender crabs dominated the crab trap catch for the second quarterly survey with a total of 209 individuals, followed by Dungeness crabs with 39 individuals, and red rock crabs with 14 individuals. Slender crabs were the only crabs captured in the shrimp traps (101 individuals). Slender crabs were captured as far upstream as station WWS-31 (~RM 3.1), red rock crabs were captured as far upstream as station WWS-19 (~RM 1.7), and Dungeness crabs were captured as far upstream as station WWS-33 (~RM 3.8). Of the 14 red rock crabs captured (1 female and 13 males), 12 were of legal size (≥127 mm, both sexes). Of the 39 Dungeness crabs captured (29 males and 10 females), 3 were of legal size (≥159 mm, males only). Sixty dock shrimp (*Pandalus danae)*, were captured during this survey as far upstream as station WWS-20 (~RM 1.7).

Information regarding the number of legal size crabs captured during the survey is provided for comparison purposes only. It is recognized that subsistence fishers may catch and consume crabs smaller than legal size.

Table 5 compares the results of the first and second quarterly surveys for the LDW. The number of slender crabs captured varied slightly between the first and second quarterly surveys, with 294 and 310 individuals, respectively. The number of red rock and Dungeness crabs captured was greater for the first quarterly survey (24 red rock and 56 Dungeness) compared to the second quarterly survey (14 red rock and 39 Dungeness). The number of dock shrimp captured was greater for the second quarterly survey (60 individuals) versus the first quarterly survey (1 individual).

Survey forms and field notes from the second quarterly crab and shrimp survey are provided in Appendix A.

Table 4. Second quarterly crab and shrimp survey results by station

Station	Trap type	Slender Crab (*Cancer gracilis*)			Red Rock Crab (*Cancer productus*)			Dungeness Crab (*Cancer magister*)			Dock Shrimp (*Pandalus danae*)		
		# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)
WWS-1	crab	0	na	na	8	120 - 175	147.1	0	na	na	0	na	na
WWS-1	shrimp	2	79 - 81	80	0	na	na	0	na	na	0	na	na
WWS-2	crab	5	64 - 97	78.8	0	na	na	0	na	na	0	na	na
WWS-2	shrimp	10	66 - 95	77.7	0	na	na	0	na	na	14	80 - 110	100.1
WWS-3	crab	15	70 - 134	84.6	0	na	na	0	na	na	0	na	na
WWS-3	shrimp	7	69 - 81	74.3	0	na	na	0	na	na	17	86 - 112	102.5
WWS-4	crab	2	76 - 112	94	5	134 - 175	161.8	4	131 - 179	152.3	0	na	na
WWS-4	shrimp	9	71 - 97	84.1	0	na	na	0	na	na	7	91 - 106	99.9
WWS-5	crab	20	59 - 105	80.5	0	na	na	1	102	102	0	na	na
WWS-5	shrimp	4	75 - 82	77.3	0	na	na	0	na	na	4	90 - 109	100.8
WWS-6	crab	9	68 - 108	79.2	0	na	na	0	na	na	0	na	na
WWS-6	shrimp	1	55	55	0	na	na	0	na	na	2	84 - 89	86.5
WWS-7	crab	15	60 - 101	80.4	0	na	na	1	105	105	0	na	na
WWS-7	shrimp	4	71 - 97	81.5	0	na	na	0	na	na	2	74 - 112	93
WWS-8	crab	6	62 - 80	72.7	0	na	na	0	na	na	0	na	na
WWS-8	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-9	crab	11	64 - 131	89.7	0	na	na	2	111 - 124	117.5	0	na	na
WWS-9	shrimp	5	63 - 90	74.6	0	na	na	0	na	na	4	73 - 102	85.8
WWS-10	crab	6	61 - 90	74.7	0	na	na	0	na	na	0	na	na
WWS-10	shrimp	7	57 - 75	66.6	0	na	na	0	na	na	0	na	na
WWS-11	crab	16	61 - 103	83.1	0	na	na	0	na	na	0	na	na
WWS-11	shrimp	2	65 - 72	68.5	0	na	na	0	na	na	2	81 - 83	82
WWS-12	crab	5	89 - 105	96.4	0	na	na	0	na	na	0	na	na
WWS-12	shrimp	2	59 - 66	62.5	0	na	na	0	na	na	3	75 - 87	81.3
WWS-13	crab	3	82 - 101	93.7	0	na	na	0	na	na	0	na	na

Station	Trap type	Slender Crab (*Cancer gracilis*)			Red Rock Crab (*Cancer productus*)			Dungeness Crab (*Cancer magister*)			Dock Shrimp (*Pandalus danae*)		
		# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)
WWS-13	shrimp	7	57 - 76	66.7	0	na	na	0	na	na	1	66	66
WWS-14	crab	18	73 - 100	86.9	0	na	na	0	na	na	0	na	na
WWS-14	shrimp	3	62 - 87	76.7	0	na	na	0	na	na	0	na	na
WWS-15	crab	17	60 - 104	77.9	0	na	na	0	na	na	0	na	na
WWS-15	shrimp	2	67 - 74	70.5	0	na	na	0	na	na	0	na	na
WWS-16	crab	12	69 - 104	83.3	0	na	na	0	na	na	0	na	na
WWS-16	shrimp	10	61 - 108	79.3	0	na	na	0	na	na	0	na	na
WWS-17	crab	4	64 - 102	84.8	0	na	na	1	189	189	0	na	na
WWS-17	shrimp	4	66 - 90	83.8	0	na	na	0	na	na	0	na	na
WWS-18	crab	6	67 - 88	80	0	na	na	1	144	144	0	na	na
WWS-18	shrimp	4	63 - 89	76	0	na	na	0	na	na	1	68	68
WWS-19	crab	4	90 - 105	96.8	1	180	180	1	150	150	0	na	na
WWS-19	shrimp	2	71 - 77	74	0	na	na	0	na	na	2	72 - 79	75.5
WWS-20	crab	9	72 - 102	81.3	0	na	na	0	na	na	0	na	na
WWS-20	shrimp	7	66 - 86	73.9	0	na	na	0	na	na	1	91	91
WWS-21	crab	7	72 - 107	93.6	0	na	na	0	na	na	0	na	na
WWS-21	shrimp	1	83	83	0	na	na	0	na	na	0	na	na
WWS-22	crab	4	67 - 84	75.3	0	na	na	0	na	na	0	na	na
WWS-22	shrimp	2	63 - 68	65.5	0	na	na	0	na	na	0	na	na
WWS-23	crab	8	62 - 81	73.5	0	na	na	0	na	na	0	na	na
WWS-23	shrimp	3	65 - 75	70	0	na	na	0	na	na	0	na	na
WWS-24	crab	0	na	na	0	na	na	0	na	na	0	na	na
WWS-24	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-25	crab	0	na	na	0	na	na	0	na	na	0	na	na
WWS-25	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-26	crab	4	80 - 95	86	0	na	na	2	128 - 141	134.5	0	na	na
WWS-26	shrimp	1	72	72	0	na	na	0	na	na	0	na	na

Station	Trap type	Slender Crab (*Cancer gracilis*)			Red Rock Crab (*Cancer productus*)			Dungeness Crab (*Cancer magister*)			Dock Shrimp (*Pandalus danae*)		
		# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)
WWS-27	crab	1	89	89	0	na	na	2	126 - 142	134	0	na	na
WWS-27	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-28	crab	0	na	na	0	na	na	0	na	na	0	na	na
WWS-28	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-29	crab	1	79	79	0	na	na	0	na	na	0	na	na
WWS-29	shrimp	1	94	94	0	na	na	0	na	na	0	na	na
WWS-30	crab	0	na	na	0	na	na	5	126 - 157	140.8	0	na	na
WWS-30	shrimp	1	29	29	0	na	na	0	na	na	0	na	na
WWS-31	crab	1	97	97	0	na	na	5	131 - 167	143.6	0	na	na
WWS-31	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-32	crab	0	na	na	0	na	na	11	108 - 148	128.8	0	na	na
WWS-32	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-33	crab	0	na	na	0	na	na	3	129 - 140	135	0	na	na
WWS-33	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-34	crab	0	na	na	0	na	na	0	na	na	0	na	na
WWS-34	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-35	crab	0	na	na	0	na	na	0	na	na	0	na	na
WWS-35	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-36	crab	0	na	na	0	na	na	0	na	na	0	na	na
WWS-36	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-37	crab	0	na	na	0	na	na	0	na	na	0	na	na
WWS-37	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-38	crab	0	na	na	0	na	na	0	na	na	0	na	na
WWS-38	shrimp	0	na	na	0	na	na	0	na	na	0	na	na

na – not applicable

Table 5. Comparison of first and second quarterly crab and shrimp survey results for the LDW

First quarterly survey results (September 8-11, 2003)

Method	Slender Crab (*Cancer gracilis*)			Red Rock Crab (*Cancer productus*)			Dungeness Crab (*Cancer magister*)			Dock Shrimp (*Pandalus danae*)		
	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)
Crab trap	228	65 - 115	94	24	113 - 184	140	56	87 - 185	149	0	na	na
Shrimp trap	66	60 - 104	85	0	na	na	0	na	na	1	92	92
All traps	**294**	**60 - 115**	**92**	**24**	**113 - 184**	**140**	**56**	**87 - 185**	**149**	**1**	**92**	**92**

Second quarterly survey results (November 20-23, 2003)

Method	Slender Crab (*Cancer gracilis*)			Red Rock Crab (*Cancer productus*)			Dungeness Crab (*Cancer magister*)			Dock Shrimp (*Pandalus danae*)		
	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)	# Individuals (CPUE)	Length range (mm)	Mean length (mm)
Crab trap	209	59 - 134	83	14	120 - 180	155	39	102 - 189	136	0	na	na
Shrimp trap	101	29 - 108	75	0	na	na	0	na	na	60	66 - 112	96
All traps	**310**	**29 - 134**	**80**	**14**	**120 - 180**	**155**	**39**	**102 - 189**	**136**	**60**	**66 - 112**	**96**

na – not applicable

3.3 OBSERVATIONS OF OTHER SPECIES

Observations of other non-target species during the second quarterly crab and shrimp survey included: staghorn sculpin (*Leptocottus armatus*), prickly sculpin (*Cottus asper*), shiner surfperch (*Cymatogaster aggregata*), an unidentified juvenile flatfish, shore crab (*Hemigrapsus sp.*), graceful decorator crab (*Oregonia gracilis*), and sunflower star (*Pycnopodia helianthoides*). All fish caught were tallied by approximate size class, while seastars were only counted. All non-target species information is provided in Appendix A.

4.0 References

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Kozloff EN. 1987. Marine invertebrates of the Pacific Northwest. University of Washington Press, Seattle, WA.

Windward. 2003a. Quality assurance project plan: clam, crab, and shrimp survey of the Lower Duwamish Waterway. Prepared for Lower Duwamish Waterway Group for submittal to US Environmental Protection Agency, Region 10, Seattle, WA and Washington State Department of Ecology, Bellevue, WA. Windward Environmental LLC, Seattle, WA.

Windward. 2003b. Crab and shrimp pilot study and first quarterly survey data report. Prepared for Lower Duwamish Waterway Group for submittal to US Environmental Protection Agency, Region 10, Seattle, WA and Washington State Department of Ecology, Bellevue, WA. Windward Environmental LLC, Seattle, WA.

Appendix A. Survey forms and field notes from the second quarterly crab/shrimp survey (November 20-23, 2003)