

Lower Duwamish Waterway Group

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

CRAB AND SHRIMP PILOT STUDY AND FIRST QUARTERLY SURVEY DATA REPORT FINAL

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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 2003), and are also described briefly in Section 2.0 below.

This report summarizes the results of an initial pilot study and the first quarterly LDW crab and shrimp survey conducted in August and September, 2003, respectively. The initial pilot study was conducted to determine which of two soak times (4- versus 24-hour) produced the greatest numbers of crab and shrimp on a per pull basis. Twenty-four-hour zinc timers were also tested during the pilot study to determine their behavior in estuarine salinities. Windward will conduct the remaining three quarterly crab and shrimp surveys in November, February, and late April. 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, pots were allowed a 4-hour soak time for the quarterly survey.

Windward conducted an initial pilot study from August 19-20, 2003 to identify the difference in catch rates, on a per pull basis, associated with two different trap soak times (4-hour vs. 24-hour). The pilot study was conducted at several of the proposed sampling locations in the downstream end of the study area where crabs and shrimp are more likely to be found (Figure 1). Crab and shrimp pots were deployed at each location and retrieved after 4 hours. All pertinent catch information was recorded, and the pots were rebaited and redeployed for an additional 24 hours. Twenty-four-hour zinc timers were also tested at 4 of the pilot study locations during the 24-hour soak time to evaluate their behavior in estuarine salinities.

Windward conducted the first quarterly crab and shrimp survey from September 8 to September 11, 2003. All 38 stations were sampled utilizing the field procedures described in Section 3.2.1 of the QAPP. Ten different stations were sampled during each of the first 3 days of sampling and 8 stations were sampled on the fourth day. 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 pilot survey and first quarterly survey is shown in Table 1.

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

SAMPLING DATE	8.19.2003	8.20.2003	9.8.2003	9.9.2003	9.10.2003	9.11.2003
High tide (time):	2.1 (05:06)	1.7 (06:02)	9.4 (03:08)	9.6 (04:09)	9.7 (05:04)	3.7 (00:20)
Low tide (time):	8.1 (11:56)	8.3 (13:33)	-0.9 (10:13)	-0.6 (10:58)	-0.1 (11:38)	9.7 (05:53)
High tide (time):	5.6 (16:50)	6.6 (17:59)	11.3 (17:31)	11.3 (18:04)	11.2 (18:31)	0.7 (12:15)
Low tide (time):	9.4 (22:42)	9.1 (23:21)	5.2 (23:05)	4.5 (23:44)		11.0 (18:55)

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
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 plastic Scotty brand bait jars with numerous tiny perforations, allowing the scent of the bait to exit without allowing access to the bait itself.

Navigation to sample locations was achieved using a Magellan Color TRAK GPS unit.

2.3 CRAB AND SHRIMP SPECIES IDENTIFICATION AND SIZE MEASUREMENTS

The station location, species, sex, and carapace length were recorded for each crab. The one shrimp that was caught was identified to species and measured (total length). 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 first quarterly crab and shrimp survey, Windward sampled 10, 10, 10 and 8 stations per day over a period of 4 days. 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 follow the 13, 13, and 12 sampling design outlined in the QAPP as there is a possibility of storing the traps at an upland site on the LDW.

Windward used a mixture of fish and squid to bait the crab traps. The QAPP had 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 suffice. An attempt will be made to get clams for the future quarterly surveys.

The first quarterly crab and shrimp sampling effort was conducted in September 2003; with the remaining three surveys to be conducted in November, 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.

Prior to September 10th, 2003, entrance tunnels of the shrimp pots were deployed so as to create a 90-degree corner inside the pot. Although deployment methods were not specifically specified in the QAPP, this deployment method is not consistent with methods typically used by commercial shrimp fishermen. This deviation, combined with the relatively short soak times, could have affected the ability of these pots to catch shrimp. For all sampling efforts on September 10 and 11, 2003, the shrimp traps were set up to avoid the 90-degree corner inside the pot. This correction will also be used on all future surveys.

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 pilot and first quarterly surveys 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 PILOT STUDY

Initial analysis of existing commercial crab catch data (described in Section 2.4.2 of the QAPP) suggested a 24-hour soak time might be more appropriate for the quarterly LDW crab survey study. However, pilot survey results indicated greater catch rates for the 4-hour soak versus the 24-hour soak. Based on the pilot study results, a 4-hour soak time was agreed upon with the agencies for the quarterly crab and shrimp surveys.

Zinc timers were tested at 4 of the 6 pilot study locations, and all released within 24 hours (+/- 1 hour). Because the total catch was greater for the 4-hour versus the 24-hour soak time, zinc timers were not necessary for the first quarterly crab and shrimp survey and will not be used for the remainder of the study.

Table 3 summarizes the sampling results for both crab and shrimp traps at each of the six pilot study stations. Catch data were recorded for each station, soak time (4- versus 24-hour), and trap type. The CPUE for slender crabs (*Cancer gracilis*) was greater for the 4- versus 24-hour soak time at all six sample locations. The CPUE for red rock crabs (*Cancer productus*) was greater for the 4-hour soak time at 2 of the 4 stations where red rock crabs were captured. The CPUE for Dungeness crabs (*Cancer magister*) was greater for the 4-hour soak time at 4 of the 6 sample locations. No shrimp were captured during the pilot study.

Survey forms and field notes from the August 19-20 pilot survey are provided in Appendix A.

Table 3. Crab and shrimp pilot study results

STATION	TRAP TYPE	SOAK TIME	SLENDER CRAB (<i>CANCER GRACILIS</i>)			RED ROCK CRAB (<i>CANCER PRODUCTUS</i>)			DUNGENESS CRAB (<i>CANCER MAGISTER</i>)		
			# 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	~4 hr	5	98 - 105	101	9	127 - 160	149	6	154 - 160	157
WWS-1	crab	~24 hr	0	na	na	2	161 - 173	167	5	148 - 175	159
WWS-1	shrimp	~4 hr	1	107	107	0	na	na	0	na	na
WWS-1	shrimp	~24 hr	2	92 - 94	93	0	na	na	0	na	na
WWS-2	crab	~4 hr	10	93 - 103	98	1	133	133	1	151	151
WWS-2	crab	~24 hr	1	97	97	0	na	na	5	141 - 170	155
WWS-2	shrimp	~4 hr	0	na	na	0	na	na	0	na	na
WWS-2	shrimp	~24 hr	2	97 - 98	98	0	na	na	0	na	na
WWS-4	crab	~4 hr	12	92 - 108	100	2	106 - 127	117	7	134 - 177	155
WWS-4	crab	~24 hr	0	na	na	4	151 - 153	152	5	142 - 177	158
WWS-4	shrimp	~4 hr	1	100	100	0	na	na	0	na	na
WWS-4	shrimp	~24 hr	1	104	104	0	na	na	0	na	na
WWS-8	crab	~4 hr	14	65 - 109	94	0	na	na	1	146	146
WWS-8	crab	~24 hr	4	96 - 111	105	1	139	139	1	163	163
WWS-8	shrimp	~4 hr	4	80 - 100	91	0	na	na	0	na	na
WWS-8	shrimp	~24 hr	4	72 - 93	82	0	na	na	0	na	na
WWS-12	crab	~4 hr	11	79 - 109	101	0	na	na	1	125	125
WWS-12	crab	~24 hr	5	84 - 99	94	0	na	na	0	na	na
WWS-12	shrimp	~4 hr	1	80	80	0	na	na	0	na	na
WWS-12	shrimp	~24 hr	6	77 - 100	88	0	na	na	0	na	na
WWS-14	crab	~4 hr	10	70 - 103	89	0	na	na	1	145	145
WWS-14	crab	~24 hr	4	96 - 107	101	0	na	na	0	na	na
WWS-14	shrimp	~4 hr	1	86	86	0	na	na	0	na	na
WWS-14	shrimp	~24 hr	2	66 - 89	78	0	na	na	0	na	na

na – not applicable

3.2 FIRST QUARTERLY CRAB AND SHRIMP SURVEY

All 38 stations were sampled using both crab and shrimp traps. Catch data were recorded for each station and trap type, with the exception of the station WWS-1 shrimp trap which was missing during the retrieval phase. A new shrimp trap was redeployed on the second day of sampling at station WWS-1, and was again missing during the retrieval phase. No further attempts were made to sample station WWS-1 using a shrimp trap during this survey.

Tables 4 and 5 summarize the first quarterly sampling results for each survey station, and for the entire LDW, respectively. Slender crabs dominated the crab trap catch with a total of 228 individuals, followed by Dungeness crabs with 56, and finally red rock crabs with 24 total individuals. Slender crabs were the only crabs captured in the shrimp traps with a total of 66 individuals. Slender crabs were captured as far upstream as station WWS-35 (~RM 4.5), red rock crabs were captured as far upstream as station WWS-24 (~RM 2.2), and Dungeness crabs were captured as far upstream as station WWS-34 (~RM 4.2). Of the 24 total red rock crabs captured (13 females and 11 males), 19 were of legal size (≥ 127 mm, both sexes). Of the 56 total Dungeness crabs captured (53 males and 3 females), 23 were of legal size (≥ 159 mm, males only). One shrimp, a dock shrimp (*Pandalus danae*), was captured during this survey at station WWS-3.

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.

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

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

STATION	TRAP TYPE	SLENDER CRAB (<i>CANCER GRACILIS</i>)			RED ROCK CRAB (<i>CANCER PRODUCTUS</i>)			DUNGENESS CRAB (<i>CANCER MAGISTER</i>)			DOCK SHRIMP (<i>PANDALUS DANAÉ</i>)		
		# 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	7	92 - 111	105	6	113 - 170	139	13	125 - 174	151	0	na	na
WWS-1	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-2	crab	6	89 - 110	102	1	156	156	2	164 - 165	165	0	na	na
WWS-2	shrimp	1	99	99	0	na	na	0	na	na	0	na	na
WWS-3	crab	6	96 - 115	106	2	136 - 184	150	8	138 - 183	158	0	na	na
WWS-3	shrimp	0	na	na	0	na	na	0	na	na	1	92	92
WWS-4	crab	5	100 - 111	105	8	118 - 165	139	3	121 - 176	150	0	na	na
WWS-4	shrimp	1	96	96	0	na	na	0	na	na	0	na	na
WWS-5	crab	6	102 - 112	107	2	131 - 153	142	1	161	161	0	na	na
WWS-5	shrimp	2	88 - 98	93	0	na	na	0	na	na	0	na	na
WWS-6	crab	6	80 - 105	93	0	na	na	0	na	na	0	na	na
WWS-6	shrimp	1	80	80	0	na	na	0	na	na	0	na	na
WWS-7	crab	6	76 - 107	94	1	126	126	0	na	na	0	na	na
WWS-7	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-8	crab	10	80 - 105	94	0	na	na	0	na	na	0	na	na
WWS-8	shrimp	2	85	85	0	na	na	0	na	na	0	na	na
WWS-9	crab	10	80 - 104	94	0	na	na	2	133 - 163	148	0	na	na
WWS-9	shrimp	2	87 - 98	93	0	na	na	0	na	na	0	na	na
WWS-10	crab	6	87 - 104	97	0	na	na	2	160 - 165	163	0	na	na
WWS-10	shrimp	3	79 - 97	90	0	na	na	0	na	na	0	na	na
WWS-11	crab	7	92 - 107	99	0	na	na	5	115 - 175	145	0	na	na
WWS-11	shrimp	2	77 - 91	84	0	na	na	0	na	na	0	na	na
WWS-12	crab	5	76 - 100	87	0	na	na	0	na	na	0	na	na
WWS-12	shrimp	1	76	76	0	na	na	0	na	na	0	na	na
WWS-13	crab	14	77 - 103	95	0	na	na	0	na	na	0	na	na

STATION	TRAP TYPE	SLENDER CRAB (<i>CANCER GRACILIS</i>)			RED ROCK CRAB (<i>CANCER PRODUCTUS</i>)			DUNGENESS CRAB (<i>CANCER MAGISTER</i>)			DOCK SHRIMP (<i>PANDALUS DANA</i>)		
		# 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	4	64 - 104	81	0	na	na	0	na	na	0	na	na
WWS-14	crab	9	77 - 102	90	0	na	na	0	na	na	0	na	na
WWS-14	shrimp	3	84 - 97	88	0	na	na	0	na	na	0	na	na
WWS-15	crab	16	70 - 103	90	0	na	na	0	na	na	0	na	na
WWS-15	shrimp	6	70 - 95	80	0	na	na	0	na	na	0	na	na
WWS-16	crab	11	76 - 104	95	0	na	na	0	na	na	0	na	na
WWS-16	shrimp	4	71 - 89	79	0	na	na	0	na	na	0	na	na
WWS-17	crab	11	75 - 102	93	1	135	135	0	na	na	0	na	na
WWS-17	shrimp	3	73 - 102	84	0	na	na	0	na	na	0	na	na
WWS-18	crab	10	65 - 105	94	1	134	134	0	na	na	0	na	na
WWS-18	shrimp	4	90 - 101	96	0	na	na	0	na	na	0	na	na
WWS-19	crab	10	74 - 106	93	0	na	na	0	na	na	0	na	na
WWS-19	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-20	crab	10	71 - 93	85	0	na	na	0	na	na	0	na	na
WWS-20	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-21	crab	11	87 - 103	96	1	123	123	0	na	na	0	na	na
WWS-21	shrimp	1	80	80	0	na	na	0	na	na	0	na	na
WWS-22	crab	4	74 - 98	86	0	na	na	0	na	na	0	na	na
WWS-22	shrimp	2	60 - 74	67	0	na	na	0	na	na	0	na	na
WWS-23	crab	8	71 - 107	89	0	na	na	0	na	na	0	na	na
WWS-23	shrimp	4	71 - 88	76	0	na	na	0	na	na	0	na	na
WWS-24	crab	4	79 - 98	90	1	134	134	0	na	na	0	na	na
WWS-24	shrimp	2	75 - 79	77	0	na	na	0	na	na	0	na	na
WWS-25	crab	3	71 - 97	80	0	na	na	0	na	na	0	na	na
WWS-25	shrimp	2	67 - 86	77	0	na	na	0	na	na	0	na	na
WWS-26	crab	3	80 - 106	95	0	na	na	0	na	na	0	na	na
WWS-26	shrimp	3	73 - 95	86	0	na	na	0	na	na	0	na	na

STATION	TRAP TYPE	SLENDER CRAB (<i>CANCER GRACILIS</i>)			RED ROCK CRAB (<i>CANCER PRODUCTUS</i>)			DUNGENESS CRAB (<i>CANCER MAGISTER</i>)			DOCK SHRIMP (<i>PANDALUS DANA</i>)		
		# 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	6	73 - 99	91	0	na	na	0	na	na	0	na	na
WWS-27	shrimp	2	77 - 104	91	0	na	na	0	na	na	0	na	na
WWS-28	crab	0	na	na	0	na	na	2	87 - 100	94	0	na	na
WWS-28	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-29	crab	5	75 - 103	92	0	na	na	0	na	na	0	na	na
WWS-29	shrimp	1	81	81	0	na	na	0	na	na	0	na	na
WWS-30	crab	7	83 - 106	98	0	na	na	4	159 - 185	170	0	na	na
WWS-30	shrimp	5	74 - 96	84	0	na	na	0	na	na	0	na	na
WWS-31	crab	7	77 - 98	88	0	na	na	1	149	149	0	na	na
WWS-31	shrimp	2	87 - 106	95	0	na	na	0	na	na	0	na	na
WWS-32	crab	0	na	na	0	na	na	8	129 - 165	143	0	na	na
WWS-32	shrimp	2	100 - 102	101	0	na	na	0	na	na	0	na	na
WWS-33	crab	0	na	na	0	na	na	2	117 - 165	141	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	3	112 - 146	134	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	1	84	84	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. First quarterly crab and shrimp survey results for the LDW

METHOD	SLENDER CRAB (<i>CANCER GRACILIS</i>)			RED ROCK CRAB (<i>CANCER PRODUCTUS</i>)			DUNGENESS CRAB (<i>CANCER MAGISTER</i>)			DOCK SHRIMP (<i>PANDALUS DANAЕ</i>)		
	# 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

na – not applicable

3.3 OBSERVATIONS OF OTHER SPECIES

Observations of other non-target species during the pilot study and the first quarterly crab and shrimp survey included: staghorn sculpin (*Leptocottus armatus*), prickly sculpin (*Cottus asper*), shiner surfperch (*Cymatogaster aggregata*), an unidentified flatfish, an unidentified gunnel, sunflower star (*Pycnopodia helianthoides*), and an unidentified sea star. All fish caught were tallied by approximate size class, while seastars were only counted. All non-target species information is provided in Appendices A and B.

4.0 References

DEA. 2003. Lower Duwamish Waterway bathymetric survey. 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. David Evans and Associates, Inc., Portland, OR.

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

Windward. 2003. 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.

Appendix A. Survey forms and field notes from the crab/shrimp pilot survey (August 19-20, 2003)

**Appendix B. Survey forms and field notes from the first quarterly
crab/shrimp survey (September 8-11, 2003)**
