Lower Duwamish Waterway Group

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

CRAB AND SHRIMP THIRD 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 third quarterly LDW crab and shrimp survey conducted in February 2004. Windward conducted the first two quarterly surveys in September and November 2003, and will conduct the fourth quarterly crab and shrimp survey in June 2004. The quarterly surveys will provide data needed to estimate seasonal variation of the potential ability to harvest 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.

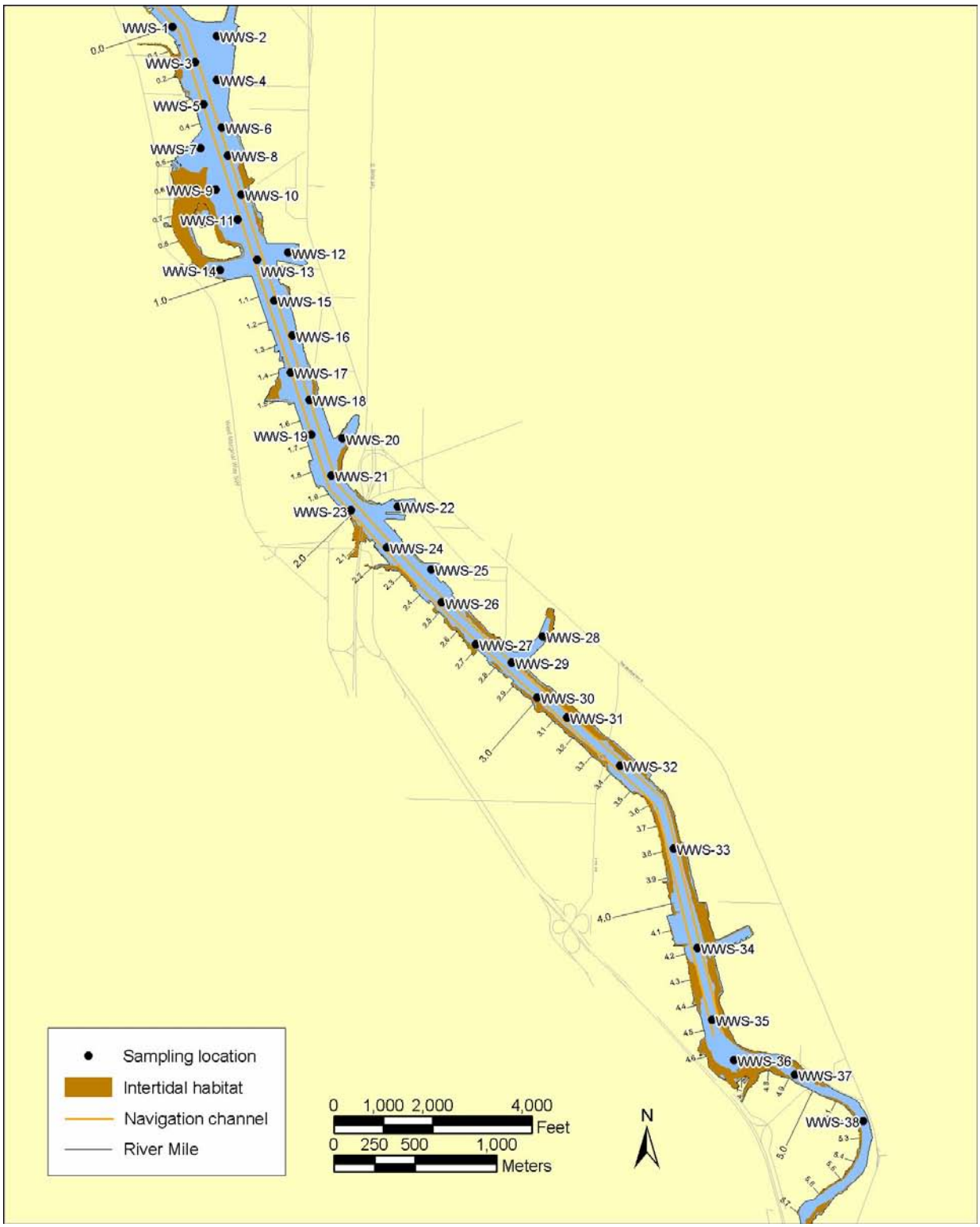

Figure 1. Intertidal habitat and crab and shrimp sampling locations in the Lower Duwamish Waterway

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 portion 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 traps and to avoid potentially underestimating crab and shrimp abundances 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), traps were allowed a 4-hour soak time for the quarterly survey.

Windward conducted the third quarterly crab and shrimp survey from February 16 to February 19, 2004. All 38 stations were sampled using the field procedures described in Section 3.2.1 of the QAPP. Crab and shrimp traps 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 third quarterly survey is shown in Table 1.

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

SAMPLING DATE	2.16.2004	2.17.2004	2.18.2004	2.19.2004
HIGH TIDE (TIME):	10.7 (03:05)	11.3 (03:59)	11.9 (04:42)	12.2 (05:18)
LOW TIDE (TIME):	8.2 (07:39)	7.8 (08:57)	7.1 (09:55)	6.3 (10:43)
HIGH TIDE (TIME):	10.4 (12:11)	10.3 (13:22)	10.3 (14:30)	10.3 (15:33)
LOW TIDE (TIME):	-1.4 (20:03)	-1.7 (20:59)	-1.8 (21:50)	-1.5 (22:35)

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 2004) (Table 2).

Table 2. Water depth (feet, below 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

Station	Water Depth		Station	Water Depth
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 traps were revisited and quickly pulled up at a constant speed to avoid potential crab or shrimp escape. All pertinent catch information was recorded, and the traps 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

Crabs and shrimp were collected using Ladner 30" SS rubber-wrapped crab traps and Ladner 30" nestable shrimp traps. 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 traps 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 (WAAS) 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. Crab and shrimp species were identified using a Pacific Northwest marine invertebrate key (Kozloff 1987).

2.4 DEVIATIONS FROM THE QAPP

During the third quarterly crab and shrimp survey, Windward sampled 8, 11, 10 and 9 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. Because of 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. The fourth quarterly survey will also 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 next quarterly survey.

The first and second quarterly crab and shrimp sampling efforts were conducted in September and November 2003, respectively, and the third survey was conducted in February 2004. The QAPP had indicated that the quarterly surveys would be conducted in August, October, January, and late April. Because of scheduling delays in August, the first-, second-, and third-quarterly sampling efforts were moved back one month.

3.0 Results

Catch-per-unit-effort (CPUE) was calculated for each trap to determine potential harvest rates by recreational and subsistence fishers. Crab and shrimp data collected during the third quarterly survey were summarized by number and mean length of each species per sampling trap. CPUE was calculated for each crab and shrimp species collected per trap by counting the number of individuals of each species for each pull of the trap. 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 the survey period was mostly clear with little wind and temperatures in the mid 40s (°F), but also included a light rain shower on the second survey day. River flow rates during the third quarterly survey were higher than flow rates during the first quarterly survey, but lower than during the second quarterly survey.

Mean streamflow rates at the US Geological Survey stream gage at river mile 32 (USGS 12113000 Green River near Auburn, WA) during the first three quarterly surveys are shown in Table 3.

Table 3. Mean streamflow in the Duwamish River at Auburn during quarterly crab and shrimp surveys

First quarterly survey		Second quarterly survey		Third quartlerly survey	
Date	Streamflow – m^3/sec (ft^3/sec)	Date	Streamflow – m^3/sec (ft^3/sec)	Date	Streamflow – m^3/sec (ft^3/sec)
9.8.2003	6.63 (234)	11.20.2003	96.3 (3400)	02.16.2004	36.6 (1290)
9.9.2003	5.95 (210)	11.21.2003	66.8 (2360)	02.17.2004	37.4 (1320)
9.10.2003	5.86 (207)	11.22.2003	47.6 (1680)	02.18.2004	36.8 (1300)
9.11.2003	6.46 (228)	11.23.2003	44.2 (1560)	02.19.2004	36.8 (1300)

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 third quarterly sampling results for each survey station. Slender crabs (*Cancer gracilis*) dominated the crab trap catch for the third quarterly survey with a total of 321 individuals, followed by Dungeness crabs (*Cancer magister*) with 66 individuals, and red rock crabs (*Cancer productus*) with 2 individuals. Slender crabs were the only crabs captured in the shrimp traps (84 individuals). Slender crabs were captured as far upstream as station WWS-28 (~RM 2.8), red rock crabs were only captured at station WWS-3 (~RM 0.2), and Dungeness crabs were captured as far upstream as station WWS-33 (~RM 3.8). Both of the red rock crabs captured were male and were of legal size (≥127 mm). Of the 66 Dungeness crabs captured (60 males and 6 females), 3 were of legal size (≥159 mm, males only). Only three dock shrimp (*Pandalus danae)* were captured, all at station WWS-5 (~RM 0.3), during this survey.

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 three quarterly surveys for the LDW. The number of slender crabs captured during the third (321 individuals) was slightly higher than the first (294 individuals) or the second (310 individuals) quarterly surveys. The number of red rock crabs caught decreased from 24 for the first quarterly survey, to 14 for the second quarterly survey, and to 2 for the third quarterly survey. However, the number of Dungeness crabs caught increased to 66 during the third quarterly survey, as compared to 56 and 39 caught for the first and second quarterly surveys, respectively. The number of dock shrimp caught was lower for the third quarterly survey (3 individuals) when compared to the second quarterly survey (60 individuals); only one was caught during the first quarterly survey.

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

Table 4. Third 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	0	na	na	0	na	na	0	na	na
WWS-1	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-2	crab	17	85-117	103.1	0	na	na	0	na	na	0	na	na
WWS-2	shrimp	16	82-108	94.5	0	na	na	0	na	na	0	na	na
WWS-3	crab	3	95-107	102.3	2	147-152	149.5	3	130-155	140.3	0	na	na
WWS-3	shrimp	5	74-96	86.4	0	na	na	0	na	na	0	na	na
WWS-4	crab	11	77-133	100.1	0	na	na	18	127-172	143.7	0	na	na
WWS-4	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-5	crab	10	64-104	84.0	0	na	na	0	na	na	0	na	na
WWS-5	shrimp	1	63	63	0	na	na	0	na	na	3	69-81	74.3
WWS-6	crab	4	76-98	83.3	0	na	na	1	148	148	0	na	na
WWS-6	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-7	crab	6	73-106	93.2	0	na	na	2	156	156.0	0	na	na
WWS-7	shrimp	2	69-99	84.0	0	na	na	0	na	na	0	na	na
WWS-8	crab	6	70-93	81.7	0	na	na	4	114-155	137.3	0	na	na
WWS-8	shrimp	2	88-95	91.5	0	na	na	0	na	na	0	na	na
WWS-9	crab	1	94	94	0	na	na	9	110-155	134.8	0	na	na
WWS-9	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-10	crab	5	70-101	88.5	0	na	na	3	124-158	142.3	0	na	na
WWS-10	shrimp	1	92	92	0	na	na	0	na	na	0	na	na
WWS-11	crab	7	63-110	81.9	0	na	na	1	132	132	0	na	na
WWS-11	shrimp	7	67-108	78.3	0	na	na	0	na	na	0	na	na
WWS-12	crab	16	69-101	84.4	0	na	na	0	na	na	0	na	na
WWS-12	shrimp	5	60-93	81.8	0	na	na	0	na	na	0	na	na
WWS-13	crab	12	63-99	75.8	0	na	na	1	155	155	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	4	61-89	74.5	0	na	na	0	na	na	0	na	na
WWS-14	crab	13	63-94	77.4	0	na	na	0	na	na	0	na	na
WWS-14	shrimp	11	58-92	77.4	0	na	na	0	na	na	0	na	na
WWS-15	crab	10	67-101	89.6	0	na	na	1	145	145	0	na	na
WWS-15	shrimp	1	64	64	0	na	na	0	na	na	0	na	na
WWS-16	crab	13	71-104	87.4	0	na	na	0	na	na	0	na	na
WWS-16	shrimp	7	78-108	92.7	0	na	na	0	na	na	0	na	na
WWS-17	crab	8	73-101	91.6	0	na	na	1	137	137	0	na	na
WWS-17	shrimp	1	101	101	0	na	na	0	na	na	0	na	na
WWS-18	crab	13	61-108	87.0	0	na	na	2	93-108	100.5	0	na	na
WWS-18	shrimp	3	75-91	84.7	0	na	na	0	na	na	0	na	na
WWS-19	crab	27	66-103	92.7	0	na	na	0	na	na	0	na	na
WWS-19	shrimp	2	89-98	93.5	0	na	na	0	na	na	0	na	na
WWS-20	crab	12	76-102	92.1	0	na	na	0	na	na	0	na	na
WWS-20	shrimp	3	83-85	84.3	0	na	na	0	na	na	0	na	na
WWS-21	crab	15	66-97	85.1	0	na	na	0	na	na	0	na	na
WWS-21	shrimp	4	67-92	78.5	0	na	na	0	na	na	0	na	na
WWS-22	crab	4	55-97	71.0	0	na	na	0	na	na	0	na	na
WWS-22	shrimp	1	98	98	0	na	na	0	na	na	0	na	na
WWS-23	crab	14	68-100	83.0	0	na	na	0	na	na	0	na	na
WWS-23	shrimp	3	68-107	88.7	0	na	na	0	na	na	0	na	na
WWS-24	crab	5	71-102	85.2	0	na	na	1	133	133	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	73-108	86.3	0	na	na	0	na	na	0	na	na
WWS-26	shrimp	5	68-104	92.8	0	na	na	0	na	na	0	na	na

Station	Trap type	Slender Crab (*Cancer gracilis*) # Individuals (CPUE)	Slender Crab (*Cancer gracilis*) Length range (mm)	Slender Crab (*Cancer gracilis*) Mean length (mm)	Red Rock Crab (*Cancer productus*) # Individuals (CPUE)	Red Rock Crab (*Cancer productus*) Length range (mm)	Red Rock Crab (*Cancer productus*) Mean length (mm)	Dungeness Crab (*Cancer magister*) # Individuals (CPUE)	Dungeness Crab (*Cancer magister*) Length range (mm)	Dungeness Crab (*Cancer magister*) Mean length (mm)	Dock Shrimp (*Pandalus danae*) # Individuals (CPUE)	Dock Shrimp (*Pandalus danae*) Length range (mm)	Dock Shrimp (*Pandalus danae*) Mean length (mm)
WWS-27	crab	0	na	na	0	na	na	1	153	153	0	na	na
WWS-27	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-28	crab	1	69	69	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	0	na	na	0	na	na	3	131-147	138.3	0	na	na
WWS-29	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-30	crab	0	na	na	0	na	na	1	154	154	0	na	na
WWS-30	shrimp	0	na	na	0	na	na	0	na	na	0	na	na
WWS-31	crab	0	na	na	0	na	na	3	138-156	145.3	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	7	142-161	152.3	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	4	123-157	144.0	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, second and third 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**

Third quarterly survey results (February 16-19, 2004)

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	237	55-133	88.1	2	147-152	149.5	66	93-172	141.8	0	na	na
Shrimp trap	84	58-108	85.7	0	na	na	0	na	na	3	69-81	74.3
All traps	**321**	**55-133**	**87.5**	**2**	**147-152**	**149.5**	**66**	**93-172**	**141.8**	**3**	**69-81**	**74.3**

na – not applicable

3.3 OBSERVATIONS OF OTHER SPECIES

Observations of other non-target species during the third quarterly crab and shrimp survey included: shiner surfperch (*Cymatogaster aggregata*), shore crab (*Hemigrapsus sp.*), 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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Appendix A. Survey forms and field notes from the third quarterly crab/shrimp survey (February 16-19, 2004)