Toxic Contaminants in Dungeness crab (*Metacarcinus magister*) and Spot Prawn (*Pandalus platyceros*) from Puget Sound, Washington, USA

By Andrea J. Carey, Laurie A. Niewolny, Jennifer A. Lanksbury and James E. West.

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Author and Contact Information

Andrea J. Carey
Andrea.carey@dfw.wa.gov
360.902.2710

Laurie A. Niewolny
Laurie.niewolny@dfw.wa.gov
360.902.2687

Jennifer A. Lanksbury
Jennifer.lanksbury@dfw.wa.gov
360.902.2820

James E. West (corresponding author)
James.west@dfw.wa.gov
360.902.2842

Marine Resources Division
Washington Department of Fish and Wildlife
600 Capital Way N
Olympia, WA 98501-1051

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GLOSSARY OF SPECIALIZED TERMS

Bioaccumulation: The buildup of contaminants in an organism's tissues over time via ingestion of prey

Bioconcentration: An increase in contaminant concentration in organisms relative to their environment

Biomagnification: An increase in contaminant level concentration in predators relative to their prey

Persistent Organic Pollutants (POPs): Organic compounds resistant to degradation that persist in the environment, are capable of long-range transport, and often bioaccumulate in living tissue

Resection: Surgical removal of all or part of an organ, tissue, or structure.

Toxicant: A toxic agent (chemical compound or mixture) that presents a risk of death, disease, injury, or birth defects in organisms that ingest or absorb it. Toxicants are typically introduced into the environment by human activity

ACRONYMS, ABBREVIATIONS, AND UNITS

Acronyms and abbreviations used frequently in this report are listed below, those used infrequently are excluded.

$\delta^{15}N$	"delta" N (nitrogen), or the ratio of the isotopes ^{15}N to ^{14}N
$\delta^{13}C$	"delta" C (carbon) or the ratio of the isotopes ^{13}C to ^{12}C
C	carbon
DDT	1,1,1-trichloro-2,2-di(4-chlorophenyl)ethane
DOH	Washington Department of Health
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
GC/MS	gas chromatography/mass spectrometry
GPS	global positioning system
HPLC	high performance liquid chromatography
HRGC/MS	high resolution gas chromatography/mass spectrometry
LOQ	limit of quantitation
MA(s)	Marine Area(s)
MDL	method detection limit
N	nitrogen
NOAA	National Oceanic & Atmospheric Administration
OCP	organo-chlorinated pesticides
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PBT	persistent, bioaccumulative, and toxic chemical
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
POP	persistent organic pollutant
PSEMP	Puget Sound Ecosystem Monitoring Program (formerly PSAMP)
QA/QC	quality assurance/quality control
SRM	standard reference materials
WDFW	Washington Department of Fish and Wildlife
ww	wet weight

UNITS OF MEASUREMENT

cm	centimeter
m	meter
ft	feet
gm	gram
km	kilometer
mL	milliliters
mm	millimeters
mg/kg	milligrams per kilogram (parts per million)
ng/g	nanograms per gram (parts per billion)
‰	permille (parts per thousand)

ABSTRACT

In 2011-2012 the Washington Department of Fish and Wildlife (WDFW) conducted a Puget Sound-wide assessment of toxic contaminants in Dungeness crab (*Metacarcinus magister*) and spot prawn (*Pandalus platyceros*); its purpose was to (a) evaluate the geographic extent and magnitude of toxic contaminants in these two crustacean species in Puget Sound and (b) to provide contaminant data to Washington State Department of Health (DOH) to conduct a human health risk assessment. The study was designed to sample animals typically taken in fisheries, across areas typically fished, and using typical sport-fishery gear. In addition, within each species, we sought to hold potentially confounding biological covariates (such as size and sex) constant across sampling areas. Data summaries herein are focused on a comparison of contaminant concentrations in crustacean tissues across sampling areas in Puget Sound. Evaluation of the significance of contaminant levels on human health will be conducted by DOH. Raw data are included in Appendix C of this document.

Two hundred forty Dungeness crab specimens were collected at 54 stations, from which we generated 56 crab muscle and 19 crab hepatopancreas composites. Seven hundred seventy-seven spot prawn specimens were collected at 42 stations, from which we generated 43 spot prawn muscle and 16 spot prawn head-tissue composites. Study specimens were collected with the help of various tribal test fishery biologists, WDFW crab and prawn test fishery staff, and the WDFW Puget Sound Ecosystem Monitoring Program (PSEMP) team. Sampling occurred in nine WDFW Marine Areas (fishery management areas for marine recreational fishing per WAC 220-56-185) and three urbanized embayments, which were sub-divisions of Marine Areas. The WDFW Marine Areas (MAs) were MA 6, 7, 8.1, 8.2, 9, 10, 11, 12, and 13, with three urban embayments in in MA 10 (Elliott Bay and Sinclair Inlet) and MA 11 (Commencement Bay). Persistent organic pollutants (POPs) including polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides and six metals (mercury, arsenic, cadmium, copper, lead and zinc) were analyzed in crab and prawn tissues.

Of the POPs, PCBs were detected most frequently in Dungeness crab and spot prawn and were highest in specimens taken from urban areas. DDTs and PAHs in both species, and PBDEs in crab, were detected frequently at lower concentrations, with highest levels in samples from urban areas. PBDEs were rarely detected in spot prawn from any area. Mercury, arsenic, copper and zinc were the most frequently detected metals in Dungeness crab, while those metals plus cadmium were most frequently detected in spot prawn. Unlike the POPs, metal concentrations in Dungeness crab and spot prawn muscle were relatively evenly distributed throughout all Marine Areas and urban embayments of Puget Sound. Mercury was the only metal that occurred in significantly greater levels in urban than non-urban areas.

With the exception of a few metals, all contaminant concentrations in the hepatopancreas of Dungeness crab and head tissue of spot prawn were greater (as much as 36 times) than their corresponding muscle tissue. In addition, nearly all of the analytes detected in the hepatopancreas of Dungeness crab and the head tissue of spot prawn were positively correlated with their muscle concentrations. Because variability in these relationships was moderate to high, our confidence in predicting contaminant concentrations in the head of spot prawn or the hepatopancreas of Dungeness crab based on their muscle tissue ranges widely.

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All organic contaminants in this study were analyzed by the Environmental Chemistry program of NOAA's Northwest Fisheries Science Center in Seattle, WA.
http://www.nwfsc.noaa.gov/research/divisions/efs/envchem/index.cfm

All metals were analyzed by the King County Environmental Laboratory in Seattle, WA.
http://www.kingcounty.gov/environment/wlr/sections-programs/environmental-lab.aspx

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Jamestown S'Klallam Tribe:	Kelly Toy – Shellfish Program Manager Chris Kaplan – Shellfish Biologist Tribal fishers
Lummi Nation:	Ben Starkhouse – Harvest Manager Tribal Fishers
Muckleshoot Tribe:	Andy Dalton – Shellfish Biologist
Port Gamble S'Klallam Tribe:	Rory O'Rourke – Environmental Scientist
Puyallup Tribe:	David Winfrey – Shellfish Biologist
Swinomish Tribal Community:	Jim Gibson – Shellfish Biologist Casey Ruff (Salmon Biologist that transported samples) Tribal Fishers - Tandy Grossglass, Wayne Cayou, and Joe McDonald
Skokomish Tribe:	Margaret Homerding – former Skokomish Shellfish Biologist (now the Shellfish Biologist for the Nisqually Tribe) Tribal Fishers - Kevin Cagey, Bobby Blacketra, Jeff Johns, Tim LeClair, and Ron Twiddy Sr.
Suquamish Tribe:	Paul Williams- Shellfish Biologist
Tulalip Tribes:	Michael McHugh – Shellfish Program Manager Cathy Stanley – Shellfish Biologist

INTRODUCTION

The Washington State Department of Fish and Wildlife (WDFW) is a member of the Puget Sound Ecosystem Monitoring Program (PSEMP, formerly PSAMP), which is a multi-agency effort aimed at monitoring the health of Puget Sound. The WDFW-PSEMP team conducts regular contaminant surveys on select fish and invertebrate species to assess the status and trends of toxic contaminants in the Puget Sound food web. The study presented here was a one-time Puget Sound-wide assessment of selected organic contaminants and metals in Dungeness crab (*Metacarcinus magister*) and spot prawn (*Pandalus platyceros*). The purpose of the study was to (a) evaluate the geographic extent and magnitude of toxic chemical contaminants in these two shellfish species in Puget Sound and (b) provide contaminant data to the Washington Department of Health (DOH) for a human health risk assessment.

Contaminants in Dungeness crab and spot prawn are of particular interest in Puget Sound because of the high importance of these species in commercial, subsistence, and recreational fisheries. In 2009, the recreational fishery alone landed an estimated 125,000 pounds of spot prawn and almost 1.5 million pounds of Dungeness crab, while the commercial fleet collected just over 3 million pounds of crab throughout Puget Sound (WDFW 2011; Kraig 2013).

Dungeness crab range from the Pribilof Islands, Alaska to Santa Barbara, California and inhabit sandy bottoms and eelgrass beds at depths ranging from the intertidal zone to about 230 m (Jensen 1995). They are opportunistic carnivores, eating a wide variety of benthic organisms such as bivalves, fish and small crustaceans, and they are preyed upon by a variety of animals, including their own species, large fish and octopi (Stevens et al. 1982; Jensen 1995).

Spot prawn range from Unalaska Island, Alaska to southern California and are found in rocky habitats along the seafloor from the intertidal zone to about 490 m (Jensen 1995). Spot prawns are protandric hermaphrodites, beginning their lives as males and eventually changing to females upon reaching a particular size, which varies depending on location within their range (Jensen 1995; Lowry 2007). They are omnivorous and make daily vertical migrations throughout the water column in search of food, which includes other crustaceans, polychaetes, siliceous sponges, and dead fish and molluscs (Butler 1970; Lowry 2007). Though reports are somewhat lacking on spot prawn predators, it is thought they are eaten by lingcod (*Ophiodon elongates*), dogfish (*Squalus acanthias*), Pacific cod (*Gadus macrocephalus*), and octopi (Butler 1970; Lowry 2007).

Studies have shown that crustaceans are able to accumulate metals and contaminants through their food or by absorbing them directly from their surrounding environment (Bryan 1971; Bryan et al. 1979; Reichmuth et al. 2010). Although some organic pollutants, including polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs), have been measured in Dungeness crab from British Columbian or northeastern Pacific waters (Ikonomou et al. 2002, Ikonomou et al. 2006, Eickhoff et al. 2003), little effort has been made to elucidate contaminant patterns in Puget Sound populations. Limited PSEMP studies have shown elevated PAHs in Dungeness crab hepatopancreas (PSAT 2007, Figure 4-27) and PCBs in spot prawn muscle tissue (WDFW/PSEMP unpublished data) from urban areas.

METHODS

Sampling and analytical methods in this study followed standard operating procedures detailed in the Quality Assurance Project Plan written for this work (West et al. 2012). The primary goal of the sampling effort was to collect Dungeness crab and spot prawn across Marine Areas (MAs - fishery management areas for marine recreational fishing per WAC 220-56-185) used by WDFW to track and manage fisheries for these species. Sampling effort was distributed to cover as wide a geographic area as possible, while focused on areas typically fished by sport and tribal fishers. Only animals that met conditions prescribed by WDFW fishing regulations were used in this study. Specifically, hard-shelled male Dungeness crab measuring greater than 158 mm in carapace width and adult-sized spot prawn, measuring greater than 28 mm in carapace length were used. Although the spot prawn were not sexed, based on a study in the Strait of Juan de Fuca and Hood Canal their

carapace length measurements suggest 7% were males, 44% were in the transitional stage and 49% were females (using size:sex ratios predicted by Lowry 2007). The primary target tissue was muscle, which was taken from all specimens. Hepatopancreas (crab) or head tissue (prawn) was taken from a subset of samples to provide data for a model to predict POP or metal concentrations in one tissue type from the other for each species.

Dungeness crab and spot prawn were sampled primarily using standard fishing gear (baited pots). Most were taken during pre-season fishery assessments by WDFW or tribal biologists. The study area comprised nine WDFW Marine Catch Areas and three urbanized embayments. WDFW Marine Catch Areas were MA 6, 7, 8.1, 8.2, 9, 10, 11, 12, and 13, with subdivisions in MA 10 and MA 11 to represent three urban embayments; Elliott Bay in Seattle (MA 10), Sinclair Inlet near the Puget Sound Naval Shipyard in Bremerton (MA 10), and Commencement Bay in Tacoma (MA 11 – see Figures 1 and 2). We targeted at least five sampling stations within each sampling area, distributing them as broadly as possible within the area. Not all sampling areas were expected to produce sufficient samples based on typical distribution and abundance patterns for these species. In addition to this directed fishing some samples were obtained from other PSEMP sampling efforts including bycatch from biennial bottom trawling for English sole.

Crab and prawn specimens taken by field staff were placed into individual plastic bags (crab) or grouped by sampling station into bags (prawns), and held on ice until they were frozen at -20° Celsius (C). Thawed samples were processed in the laboratory according to standard operation procedures detailed below.

Sample Size and Station Location

A total of 134 composite samples of crab and spot prawn were created for this study (Table 1). Dungeness crab specimens were collected at 54 stations generating 56 crab muscle and 19 crab hepatopancreas composites. Spot prawn specimens were collected at 42 stations generating 43 spot prawn muscle and 16 spot prawn head-tissue composites. Sampling success at each location was proportional to organism abundance, with low sampling numbers reflecting a probability of low fisheries harvest. Stations selected for making the 19 crab hepatopancreas and 16 spot prawn head-tissue composites were distributed across a broad geographic area and represented a wide range of expected contaminant conditions.

Dungeness Crabs

There were 12 sample areas in total for this study (Table 1). At least five crab muscle composites were made from each of seven sampling areas, however in the following five sampling areas the target of five composites was not reached: MA 6 (one sample), Sinclair Inlet, Commencement Bay and MA 11 (three samples each), MA 13 (four samples; Table 1). Overall, Dungeness crabs were more broadly distributed than spot prawn, hence the greater numbers of stations (54 versus 42; Figure 1). As noted in Table 1 Dungeness crabs were obtained from at least five stations in all sample areas except MA 6 (one station), Sinclair Inlet (one station), MA 11 (three stations), Commencement Bay (three stations), and MA 13 (four stations). Eight of the 54 Dungeness crab composites contained three or four crabs each because of limited catch for those stations (Table A1).

Spot Prawn

Of the 12 sample areas in the study, no spot prawn specimens were collected from Commencement Bay or Sinclair Inlet (Table 1). Of the remaining 10 sample areas, five spot prawn composites were collected in each of five areas, while between two and four composites were collected in each of the remaining five sampling areas. Spot prawn were less broadly distributed than Dungeness crab, resulting in fewer stations overall (42 versus 54; Figure 2) and four of the sampling areas are represented by one, two, or three stations. All composites contained a maximum of 20 individual spot prawns (Table A2). While it was not possible to obtain more than one station in MA 13, where spot prawn are relatively rare, PSEMP was able to create two composites at one station in MA 13 (NISQUALLY), using spot prawn bycatch taken during the 2011 English Sole Survey.

Figure 1 (Dungeness crab) and Figure 2 (spot prawn) indicate sampling locations for each station, within sampling areas. Numbers that denote each station correspond to information in Table A3 and Table A4 in addition to station name, marine catch area, basin, collection, effort ID and data, and GPS coordinates.

Table 1. Total number of tissue composites created for Dungeness crab and spot prawn by sampling area. NS = not sampled.

	Dungeness crab			Spot prawn		
Location	Stations	Muscle	Hepato-pancreas	Stations	Muscle	Head-tissue
MA 6	1	1	1	2	2	1
MA 7	5	5	2	5	5	2
MA 8.1	6	6	1	6	6	1
MA 8.2	6	6	1	6	6	2
MA 9	7	7	2	3	3	0
MA 10	7	7	2	4	4	1
Elliott Bay	5	5	4	6	6	6
Sinclair Inlet	1	3	0	0	NS	NS
MA 11	3	3	1	3	3	0
Commencement Bay	3	3	2	0	NS	NS
MA 12	6	6	1	6	6	1
MA 13	4	4	2	1	2	2
TOTALS	**54**	**56**	**19**	**42**	**43**	**16**

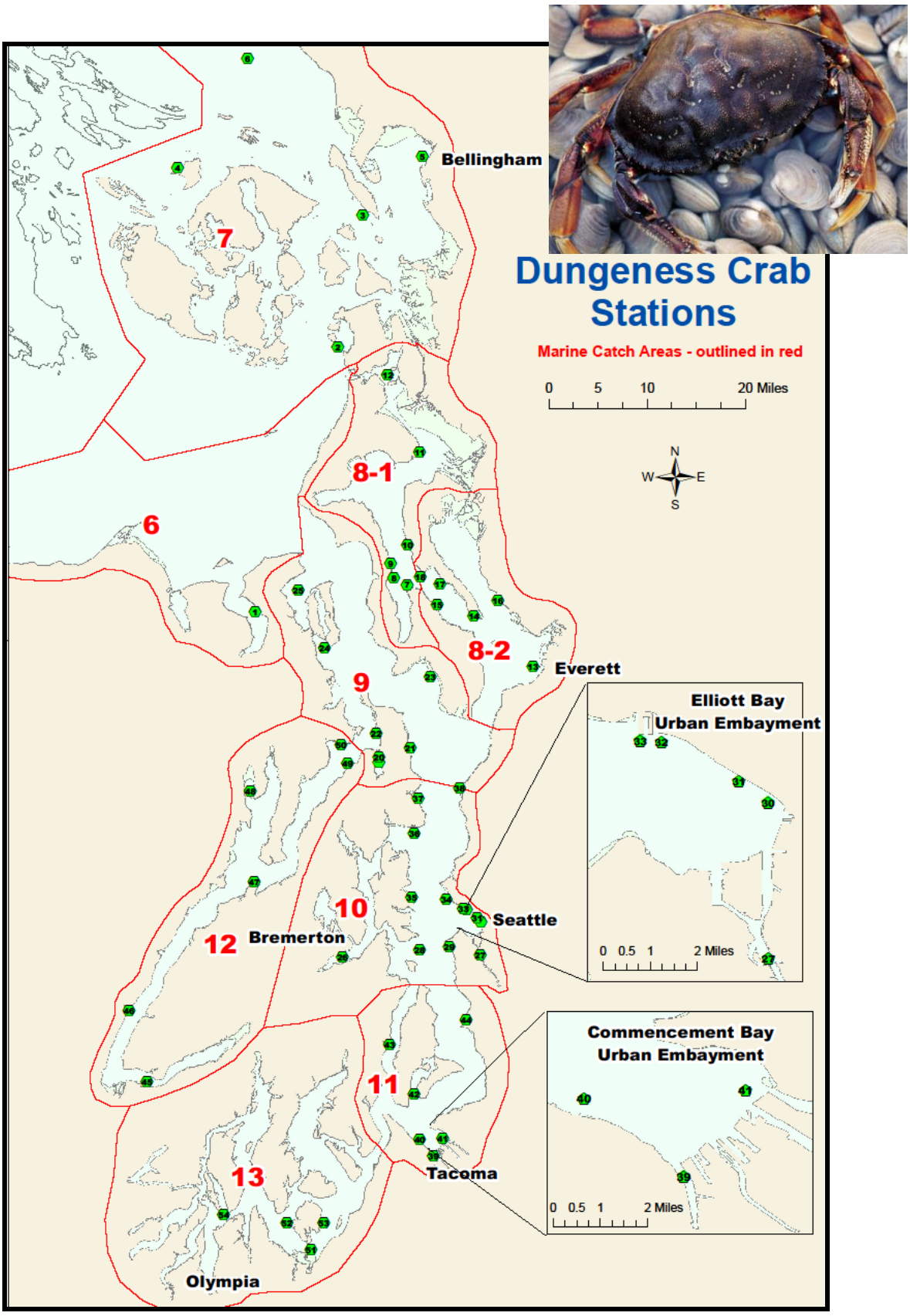

Figure 1. Map of Dungeness crab collection station locations

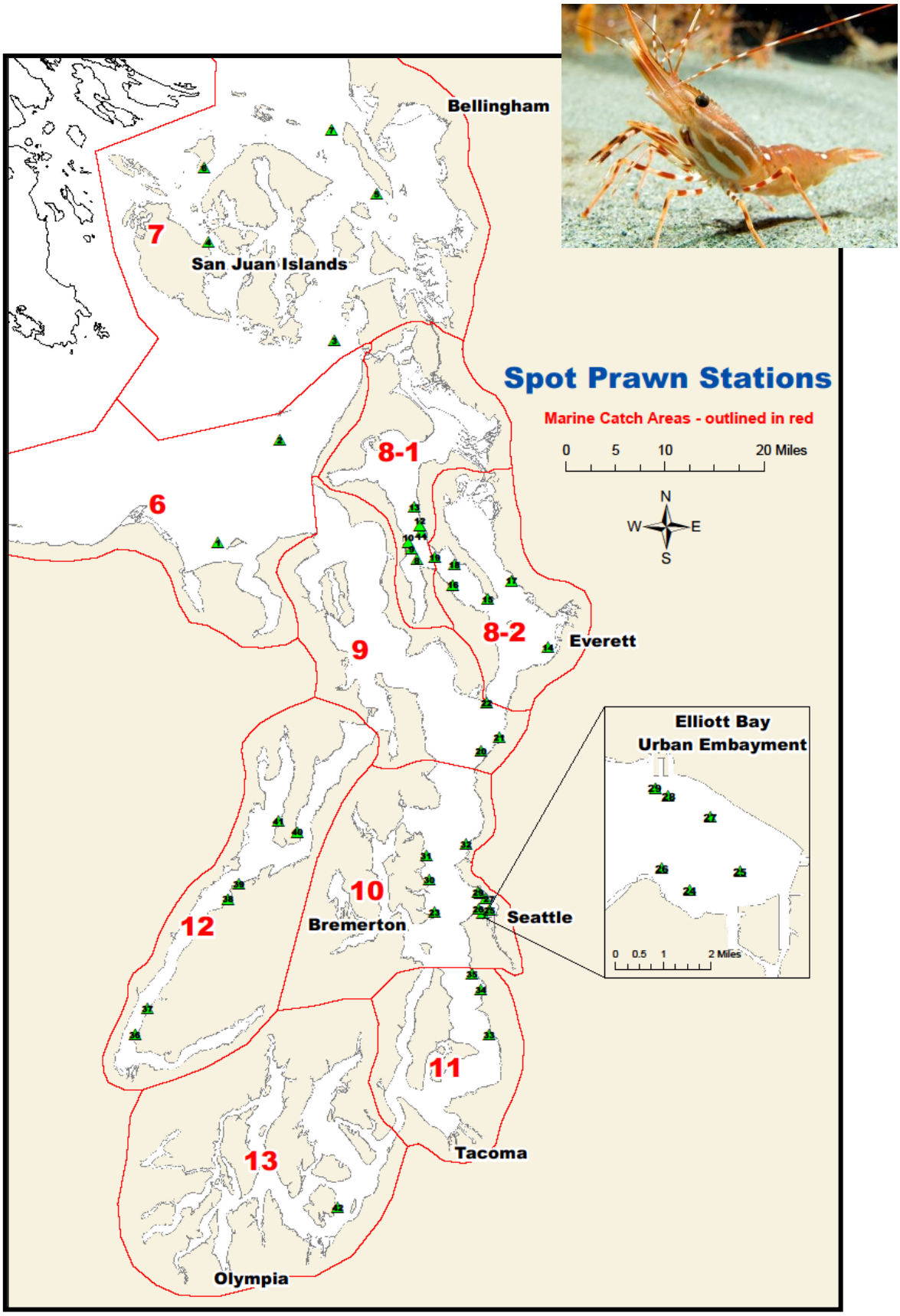

Figure 2. Map of spot prawn collection station locations

Specimen Collection Efforts

Dungeness crab and spot prawn were collected with the help of various tribal test fishery biologists, WDFW crab and prawn test fishery staff, and the PSEMP team (Table A5 and Table A6). Crab and prawn specimens were collected from April to May in 2011 and from late March to early August in 2012 (Table A3 and Table A4). Forty-four crab and 39 prawn composites were created from 2012 survey samples, while 10 and three composites, respectively, were created from sampling in 2011.

Dungeness crab and spot prawn were sometimes collected simultaneously as was the case with the 2012 WDFW Groundfish Survey and the 2011 PSEMP English Sole Survey because bottom trawl gear sampled the station indiscriminately. All other specimens were collected using selective gear (i.e., crab and prawn pots). PSEMP staff coordinated with all the above mentioned organizations to obtain adequate station coverage per MA. This was done in concert with Tribal and WDFW test fishery biologists who selected sites based on historical fishing patterns and species abundance. Upon acquisition, station and specimen data was recorded on a chain-of-custody form and location information was later transferred to haul forms, to identify specific station locations. Finally, station location information was entered into the PSEMP database and specimen processing forms were created. Upon receipt, specimens were stored at -20° C in WDFW Marine Laboratory freezers.

2011 PSEMP Biennial English Sole Survey Trawl (April and May 2011)

English Sole are surveyed at 10 predetermined stations biennially as part of a long-term status and trends contaminant monitoring program run by PSEMP. In 2011, PSEMP retained Dungeness crab and spot prawn bycatch during that year's effort in anticipation of, and support for, the current study. Crabs were collected at eight stations and spot prawns were collected at three stations through this effort. Collection was conducted aboard the F/V Chasina using bottom trawl gear and one or more tows were made at each station. Station latitude and longitude were calculated at the mid-line of the trawl transect. If two tows were conducted, station latitude and longitude were calculated by averaging the two mid-lines of each of the trawl transects. Dungeness crabs and spot prawn were subsequently identified, isolated, rinsed, and frozen. Specimens were then brought to the WDFW Marine Lab and held in the freezer until processed.

2012 Annual WDFW Groundfish Abundance Survey Trawl (May 2012)

Dungeness crabs were collected at seven stations and spot prawns were collected at nine stations during the WDFW Groundfish Trawl Survey in May 2012. Groundfish surveys occur at predetermined stations annually during ongoing WDFW fisheries management studies. In 2012, the Groundfish survey team collected crab and spot prawn during that year's effort to supplement this study.

Collection was also conducted aboard the F/V Chasina using bottom trawl gear (Eastern 400 Otter Trawl) in 2012. As in 2011, one or more tows were made at each station, station coordinates were calculated at the mid-line of the trawl transect, and if two tows were conducted, coordinates were calculated by averaging the two midlines of each of the trawl transects. Dungeness crabs and spot prawn were subsequently identified, isolated, rinsed, and frozen and specimens were brought to the WDFW Marine Lab and held in the freezer until processed.

WDFW Test Fishery Sampling (March –June 2012)

Dungeness crabs were collected at 16 stations through the WDFW test fishery sampling program. Test fishery staff provided PSEMP with crabs from preselected, historical test fishery sites and crab specimens were collected throughout several test fishing events. Field biologists set crab pots along pre-determined tracks according to standard test fishery protocols. Each string of pots (traps) comprised a group of up to five pots attached along a line, and crabs were sampled from all pots from a string. Crab collected from pots were identified and sorted, shell hardness, size, and sex were recorded, and individuals were then bagged, tagged, and frozen. Study

specimens were brought to the WDFW Marine Lab and stored in the freezer until processed. Spot prawns were collected at 12 stations through the WDFW test fishery sampling program. Test fishery staff provided PSEMP with spot prawn from preselected, historical test fishery sites and prawn specimens were collected throughout several test fishing events. As with the crab test fishery, WDFW staff used prawn pots in strings and specimens were collected from throughout the string. Spot prawn were identified, sorted, bagged, tagged, and frozen. Study specimens were then brought to the WDFW Marine Lab and stored in the freezer until processed.

Tribal Test Fishery Sampling (May –August 2012)

Dungeness crab and spot prawn specimens were collected during several test fishing events by a number of tribal test fishery staff using individual crab and prawn pots. In four cases, tribal subsistence fishers were asked to assist. In total, crabs were collected from 20 stations and prawns were collected from 18 stations during this set of collection efforts. Together they provided PSEMP with crabs and prawns from preselected, historical test fishery sites. Upon collection, specimens were identified, bagged, tagged, and frozen. Study specimens were then brought to the WDFW Marine Lab and stored in the freezer until processed.

PSEMP Sampling (July 2012)

Crabs were also collected at three stations in a separate PSEMP effort (Figure 3). Staff mobilized a crab collection effort in MA 13 using crab pots and associated gear provided by the Dungeness crab test fishery staff. Upon collection, individuals were identified, bagged, tagged, and frozen. Study specimens were then brought to the WDFW Marine Lab and stored in the freezer until processed.

Figure 3. PSEMP group collecting Dungeness crab with (left) Steve Quinnell hauling a crab pot onboard the boat and (right) a crab pot containing both Dungeness crab (lower right) and red rock crab

Sample Preparation and Laboratory Analysis.

A detailed description of the laboratory methods to resect tissues, create composites, homogenize tissues, and measure analytes is provided in Appendix B: Materials and Methods Details

Data Analysis

Analyte data are presented as summed values for analyte groups, except in cases with fewer than two analytes per group. All raw data for summed values and some individual analytes are included in Appendix C: POPs and

Metals Raw Data for All Samples Analyzed. Summed analytes (e.g., Σ_6DDTs) are the sum of all detected values with each group. In cases where all analytes in a group were not detected the greatest limit of quantitation (LOQ) for any analyte in the group was used as the summation value, and the value was censored as "not detected" with a "U" qualifier. An estimated total PCB (eTPCB) concentration was calculated by summing the detected values for 18 commonly detected congeners and multiplying the result by two, according to Laurenstein and Cantillo (1993). Summary statistics were calculated for each location as arithmetic means, geometric means, medians, and 10^{th} and 90^{th} percentiles. All analyses were performed using wet weight (ww) POP concentrations. An alpha of 0.05 was used for all statistical analyses.

Comparisons of POP concentrations among locations for both Dungeness crab and spot prawn muscle tissue were performed with parametric analysis of variance using a General Linear Model (GLM, SYSTAT 13) on natural log-transformed POP analytes, with the location (Marine Areas and urban embayments) as the categorical variable. Lipid percent, δ_{15}Nitrogen, and carapace width or length were included as covariates. Geometric mean POP concentrations and 95% confidence intervals were back-calculated from the least squares means generated by the GLM and plotted in figures. If a covariate contributed significantly to explaining variability in the analyte concentration, least squares mean values were adjusted to the predicted value for the grand mean covariate. In cases where covariates were significant, but contributed trivial additional explanation of analyte variance (e.g., r^2 less than 5%), they were not included in the final GLM model for simplicity. Tukey's Honestly-Significant Difference (THSD) *post hoc* test was used for pairwise location comparisons of least square means generated by the GLM.

The metals data for both species first underwent a GLM analysis as described above with the exception that carapace width (for crab) and carapace length (for prawn) were the only covariate. Once it was determined that carapace width and length were not a contributing factor to metal contamination in either species, data were analyzed using an analysis of variance (ANOVA, SigmaPlot 11.0) test by location. For the crab analyses, MA 6 was excluded because there was only one collection site for the entire area. If data did not pass the Shapiro-Wilk Normality test or the Equal Variance test, they were natural-log-transformed and analyzed again. Geometric mean metals concentrations and 95% confidence intervals were back-calculated from the least squared means generated by the GLM and plotted in figures. The THSD *post hoc* test was run to examine pairwise comparisons between locations. If data did not pass the parametric assumptions, the non-parametric ANOVA equivalent, Kruskal-Wallis test, was performed. For the non-parametric multiple comparisons, Dunn's *post hoc* test was used to determine pairwise differences between locations.

Linear regression analysis was used to examine the relationship between Dungeness crab muscle and hepatopancreas and spot prawn muscle and head tissue, and to produce predictive models. The analyses were performed in SigmaPlot using an alpha of 0.05. In order to simplify the regression equation, the constant (y-intercept) was removed if determined to not be significant ($p > 0.05$).

RESULTS

Dungeness crab ranged in size from 150 to 239 mm (carapace width) and their muscle lipid concentrations ranged narrowly from 0.21% to 0.46% wet weight. Additionally, the δ^{13}Carbon in crab muscle ranged from -17.32‰ to -12.97‰, while the crab muscle δ^{15}Nitrogen ranged from 11.37‰ to 14.76‰ (Table 2). For crab hepatopancreas, lipid concentrations ranged from 2.26% to 7.86% (Table D1). Spot prawn ranged in size from 28 to 50.4 mm (carapace length) and the lipid concentrations in their muscle ranged narrowly from 0.32% to 0.66% ww. In addition, δ^{13}Carbon ranged from -16.79‰ to -12.99‰ and δ^{15}Nitrogen ranged from 11.62‰ to 14.45‰ in spot prawn muscle (Table 3). The lipid concentrations in spot prawn head tissue ranged from 2.88% to 11.48% (Table D2).

Persistent Organic Pollutants Analysis Overview

POPs were detected in 51 Dungeness crab muscle and 19 corresponding crab hepatopancreas samples. POPs were detected in 39 spot prawn muscle and 16 corresponding spot prawn head tissue samples. Overall, POPs were detected more frequently in Dungeness crab muscle than spot prawn muscle. Estimated TPCBs were found

in all 51 crab muscle samples, $\sum_6$DDTs from 44 samples, $\sum_{37}$PAHs from 31 samples, $\sum_{11}$PBDEs from 28 samples, $\sum_3$HCHs from 16 samples, $\sum_8$Chlordanes from 8 samples and HCB from 1 sample (Table D3). Estimated TPCBs were also found in all 39 spot prawn muscle samples, $\sum_{37}$PAHs from 38 samples, $\sum_{11}$PBDEs from 22 samples, and $\sum_6$DDTs from 1 sample. HCB, $\sum_8$Chlordanes, and $\sum_3$HCHs were not reported in any spot prawn muscle samples (Table D4). Also, the organochlorine pesticides aldrin, dieldrin, mirex, and α-endosulfan were not reported in any crab or prawn muscle samples. The average limit of quantitation (LOQ) for all POPs ranged from 0.25 to 0.31 ng/g (part per billion) ww in crab muscle and from 0.20 to 0.23 ng/g ww for prawn muscle (Table 4).

Table 2. Biometric data and trophic status (mean values) of Dungeness crab from nine Marine Areas and three urban embayment (EB = Elliott Bay, SI = Sinclair Inlet, and CB = Commencement Bay)

Location	n	Total Solids (%)	Total Lipids (%)	Carapace Width (mm)	δ^{13}C (‰)	δ^{15}N (‰)
6	1	18.5	0.36	175.2	-15.48	11.57
7	5	17.3	0.25	176.6	-15.43	12.21
8.1	5	19.7	0.22	167.3	-14.50	12.62
8.2	5	18.1	0.22	173.7	-15.22	12.65
9	7	17.8	0.21	173.1	-14.84	12.10
10	5	18.7	0.25	178.8	-14.13	13.02
EB	5	18.4	0.25	176.5	-15.36	12.95
SI	3	21.9	0.46	192.9	-13.84	14.04
11	3	19.4	0.23	174.8	-13.45	13.14
CB	3	18.4	0.26	178.3	-15.71	12.27
12	5	19.0	0.25	173.0	-16.56	12.95
13	4	19.4	0.27	191.8	-13.73	14.32

Table 3. Biometric data and trophic status (mean values) of spot prawn from nine Marine Areas and one urban embayment (EB = Elliott Bay).

Location	n	Total Solids (%)	Total Lipids (%)	Carapace Length (mm)	δ^{13}C (‰)	δ^{15}N (‰)
6	2	22.6	0.48	37.3	-14.67	12.12
7	5	21.9	0.49	39.0	-14.98	12.43
8.1	5	23.3	0.66	41.8	-15.16[a]	13.18[a]
8.2	5	22.0	0.43	42.7	-14.87[b]	13.35[b]
9	3	21.7	0.32	37.3	-14.23	12.46
10	4	21.7	0.66	39.0	-14.00	13.04
EB	5	22.6	0.65	43.3	-14.72	12.81
11	3	22.1	0.47	39.5	-13.25	13.47
12	5	21.2	0.61	38.4	-16.22	12.81
13	2	22.5	0.36	39.3	-13.62	14.29

[a]missing data from BABYISLAND

[b]missing data from PTGARDNR and PTSUSAN

Table 4. Average limit of quantitation (LOQ) for 25 analytes or congener groups (ng/g ww) reported in Dungeness crab and spot prawn muscle

Analyte	Dungeness crab	Spot prawn
Hexachlorobenzene	-	0.21
α-hexachlorocyclohexane	-	0.20
β-hexachlorocyclohexane	-	0.21
γ-hexachlorocyclohexane	0.25	0.21
α-chlordane	0.25	0.21
cis-nonachlor	0.25	0.21
β-chlordane	0.25	0.21
Heptachlor	0.25	0.21
heptachlor epoxide	0.25	0.21
nonachlor III	0.25	0.21
Oxychlordane	-	0.21
trans-nonachlor	-	0.21
Aldrin	0.25	0.21
Dieldrin	0.25	0.21
Mirex	0.25	0.21
α-endosulfan	0.25	0.21
o,p'-DDD	0.25	0.21
o,p'-DDE	0.25	0.21
o,p'-DDT	0.25	0.21
p,p'-DDD	0.25	0.20
p,p'-DDE	0.25	-
p,p'-DDT	-	0.21
$\sum_{11}$PBDEs	0.25	0.21
eTPCBs	-	0.21
$\sum_{37}$PAHs	0.31	0.23

Estimated Total PCBs

Estimated Total PCB (eTPCB) concentrations ranged from 1 ng/g ww in MA 12 to 180 ng/g ww in Elliott Bay for crab muscle (Table D3) and from 0.85 ng/g ww in MA 7 to 27 ng/g ww in Elliott Bay for prawn muscle (Table D4).

Of the 46 PCB congeners tested in this study, 36 were measured as individual congeners, and four groups were measured as coeluters. Four congeners and two coeluters (PCB 101/90[1] and PCB 153/132) were detected > 50% in crab muscle samples while one congener and three coeluters (PCB 101/90, PCB 138/163/164, and PCB 153/132) were detected > 50% in prawn muscle samples. Nine congeners and one coeluter (PCB 187/159/182) were detected in 25-49% of the crab muscle samples, while five congeners were detected in 25-49% of the prawn muscle samples. Twenty congeners and one coeluter (PCB 138/163/164) were detected in 1-24% of crab muscle samples while 14 congeners were detected in 1-24% of prawn muscle samples. Finally, three congeners were not detected in any crab muscle samples while 16 congeners and one coeluter (PCB 187/159/182) were not detected in any prawn muscle samples (Table 5).

In Dungeness crab muscle the variability in eTPCB concentration was explained by location alone; no covariate was a significant contributor (GLM, natural log-transformed eTPCB by location, $F_{(10, 50)} = 20.99$, $p < 0.001$; $p>0.05$ for all other factors). Elliott Bay and Sinclair Inlet had the highest significant geometric mean concentration of eTPCBs with 110 ng/g ww and 27 ng/g ww, respectively (THSD, $p < 0.001$).

[1]Coeluting congeners are expressed as congener numbers separated by a slash mark. The leftmost congener is dominant and concentration decreases as the coeluters are listed from left to right.

Commencement Bay (geometric mean 24.1 ng/g ww) and MA 10 (geometric mean 12.4 ng/g ww) were not significantly different from Sinclair Inlet but were significantly lower than Elliott Bay (THSD, $p < 0.04$). Although crab collected in Sinclair Inlet, Commencement Bay and MA 10 had some of the highest eTPCBs concentrations in all the areas, they were still 5-10 times lower than the Dungeness crab collected in Elliott Bay. MAs 13, 8.2, and 11 had the mid-range eTPCBs concentrations ranging from 4.59 ng/g wet weight in MA 11 to 5.19 ng/g ww in MA 13, and they were not significantly different than MA 10 or the four areas with the lowest eTPCB concentrations but they were significantly different from the three urban areas (THSD, $p < 0.05$). The areas with the lowest significant eTPCB concentrations were MAs 8.1, 7, 9, and 12. Their geometric mean concentrations ranged from 3.19 ng/g ww in MA 8.1 to 2.15 ng/g ww in MA 12, 34 to 53 times lower than the Dungeness crab collected in Elliott Bay (THSD, $p < 0.03$; Figure 4, Table 6). Of the non-urban MA10 sampling locations, one sample area, the Four-mile Rock location had particularly high eTPCB (55 ng/g ww). This location is situated just outside the line demarcating Elliott Bay. Had this location been included in the Elliott Bay area (rather than MA 10), the eTPCB in MA 10 would have been substantially lower.

In spot prawn muscle, as with Dungeness crab, location was the only significant factor that explained eTPCBs concentration (GLM of natural log- transformed eTPCB by location, $F_{(9,39)} = 33.77$, $p < 0.001$; $p>0.05$ for all other factors). As with Dungeness crab muscle, Elliott Bay was found to have the highest significant eTPCB concentration in spot prawn muscle, with a geometric mean of 17.7 ng/g ww (THSD, $p < 0.009$). MA 9 had the second highest eTPCB concentration with a geometric mean of 9.57 ng/g ww (THSD, $p < 0.04$) and was not significantly different from Elliott Bay ($p = 0.213$) or from MAs 10 and 11. MAs 10 and 11 also contained spot prawn with relatively high eTPCB muscle concentrations (geometric means of 7.39 and 6.96 ng/g ww, respectively). From there eTPCBs in spot prawn muscle gradually tapered down from a geometric mean of 4.1 ng/g ww in MA 8.2 to the lowest significant concentration in spot prawn muscle of 1.3 ng/g ww in MA 6, which was 14 times lower than spot prawn collected in Elliott Bay. Spot prawn muscle with the lowest eTPCBs were taken in MAs 12, 7 and 6 (Table 7, Figure 5).

Estimated total PCBs in Dungeness crab muscle were positively correlated with eTPCBs concentration reported in the hepatopancreas (linear regression of natural log-transformed analytes, $p < 0.001$, $r^2 = 0.933$; Table 8, Figure 6A), and eTPCBs concentrations were roughly 20 times greater in crab hepatopancreas than muscle tissue (Table D1). Estimated total PCB concentration in spot prawn muscle was positively correlated with eTPCBs in head tissue (regression, $p < 0.001$, $r^2 = 0.959$; Table 9, Figure 6B), and eTPCB concentrations were roughly 31 times greater in head tissue than muscle (Table D2). For the spot prawn, the regression equation was simplified due to the y-intercept not being significant ($p = 0.834$). These results give us the ability to predict eTPCBs in prawn head tissue or crab hepatopancreas based on eTPCBs concentration in the muscle of either species. In both cases log-transformation was required to reduce heteroscedasticity in the data; variability in the data increased with increasing eTPCB concentration for crab.

Table 5. Detection frequency of the 46 congeners found in 51 Dungeness crab and 39 spot prawn samples. Bolded congeners contributed to the eTPCBs calculation. Numbers in parentheses indicate coeluting congeners.

PCB congener	Homolog group	Dungeness crab	Spot prawn
PCB 17	Tri	5.9	5.13
PCB 18	Tri	23.5	25.6
PCB 28	Tri	51	33.3
PCB 31	Tri	43.1	30.8
PCB 33	Tri	17.6	20.5
PCB 44	Tetra	9.8	0
PCB 49	Tetra	13.7	0
PCB 52	Tetra	35.3	5.13
PCB 66	Tetra	25.5	2.56
PCB 70	Tetra	25.5	2.56
PCB 74	Tetra	17.6	2.56
PCB 82	Penta	0	0
PCB 87	Penta	13.7	0
PCB 95	Penta	27.5	2.56
PCB 99	Penta	43.1	23.1
PCB 101 (90)	Penta	66.7	74.4
PCB 105	Penta	29.4	18
PCB 110	Penta	60.8	20.5
PCB 118	Penta	62.7	92.3
PCB 128	Hexa	23.5	7.69
PCB 138 (163, 164)	Hexa	98	97.4
PCB 149	Hexa	54.9	15.4
PCB 151	Hexa	19.6	0
PCB 153 (132)	Hexa	98	97.4
PCB 156	Hexa	13.7	0
PCB 158	Hexa	13.7	0
PCB 170	Hepta	19.6	15.4
PCB 171	Hepta	13.7	0
PCB 177	Hepta	19.6	0
PCB 180	Hepta	35.3	38.5
PCB 183	Hepta	19.6	15.4
PCB 187 (159, 182)	Hepta	45.1	0
PCB 191	Hepta	0	0
PCB 194	Octa	17.6	0
PCB 195	Octa	3.9	0
PCB 199	Octa	15.7	5.13
PCB 205	Octa	13.7	0
PCB 206	Nona	3.9	0
PCB 208	Nona	0	0
PCB 209	Deca	2	0

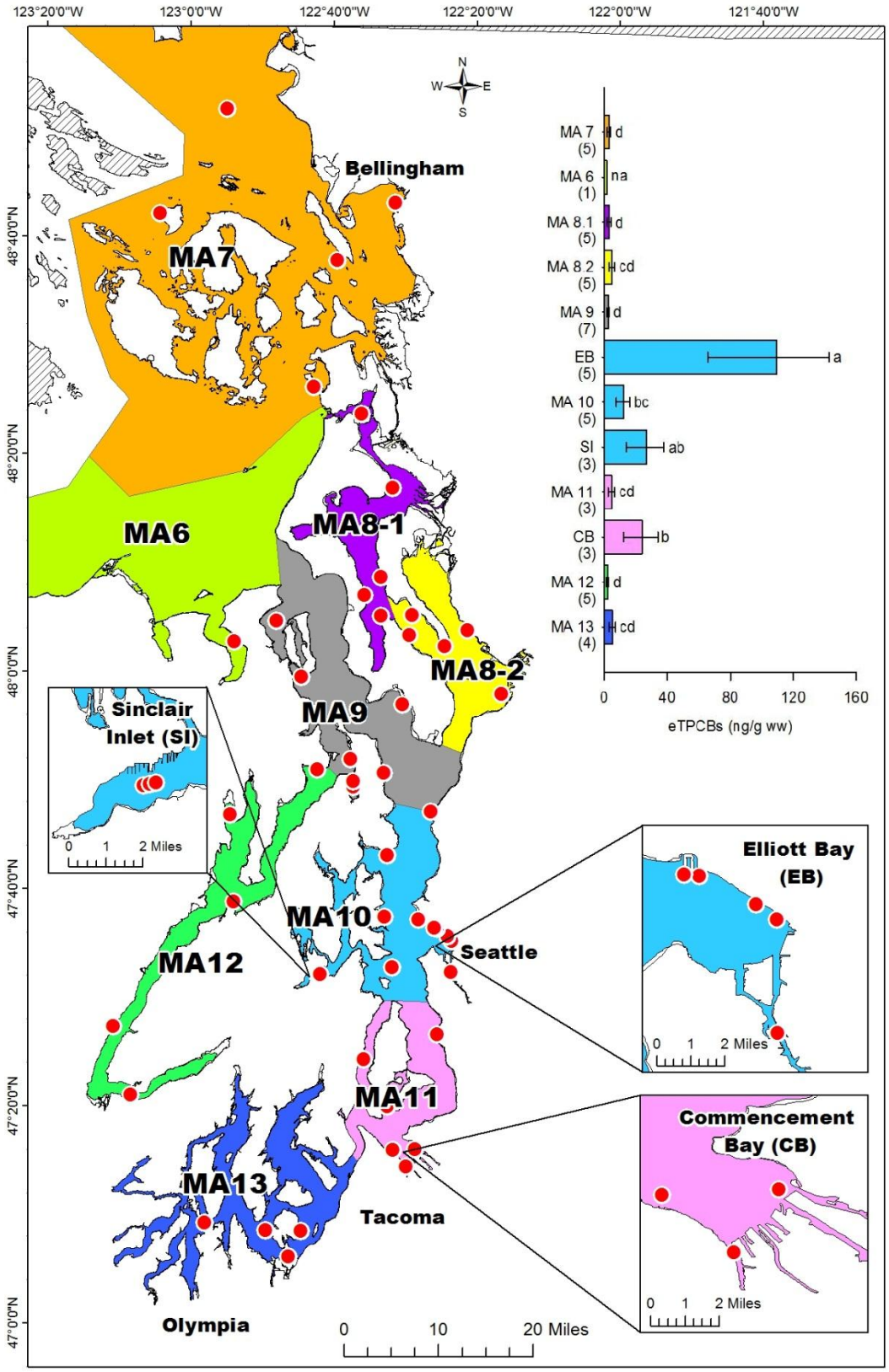

Figure 4. Geometric mean concentrations of eTPCBs (ng/g ww) in Dungeness crab muscle ± 95% CI by WDFW Marine Area and three urban areas (EB = Elliott Bay, SI = Sinclair Inlet and CB = Commencement Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$, na = not analyzed) and sample size is in parentheses.

Table 6. Dungeness crab muscle General Linear Model (GLM) results

		eTPCBs	$\sum_{11}$PBDEs	$\sum_{6}$DDTs	$\sum_{37}$PAHs
	n	50	50	50	50
	r^2	0.843	0.874	0.734	0.515
	Overall p-value	< 0.001	< 0.001	< 0.001	0.001
	F-ratio	21.0	27.1	10.8	4.14
	AIC (corrected)	108.5	74.06	74.14	111.3
Location	p-value	< 0.001	< 0.001	< 0.001	< 0.001
Lipids (%)	p-value	0.008[a]	0.111	0.10	0.983
Carapace Width (mm)	p-value	0.505	0.933	0.311	0.404
δ^{15}Nitrogen	p-value	0.780	0.472	0.971	0.181

[a] dropped variable because it explained only a small amount of variation

Table 7. Spot prawn muscle General Linear Model (GLM) results

Parameter		eTPCBs	$\sum_{37}$PAHs
	n	39	39
	r^2	0.91	0.42
	Overall p-value	< 0.001	0.043
	F-ratio	33.77	2.305
	AIC (corrected)	39.55	57.57
Location	p-value	< 0.001[a]	0.035[a]
Lipids (%)	p-value	0.056[a]	0.028[ab]
Carapace Length (mm)	p-value	0.281[a]	0.972[a]
δ^{15}Nitrogen	p-value	0.718[a]	0.772[a]

[a] n = 36 due to three sites with missing δ^{15}Nitrogen data
[b] dropped variable because it explained only a small amount of variation

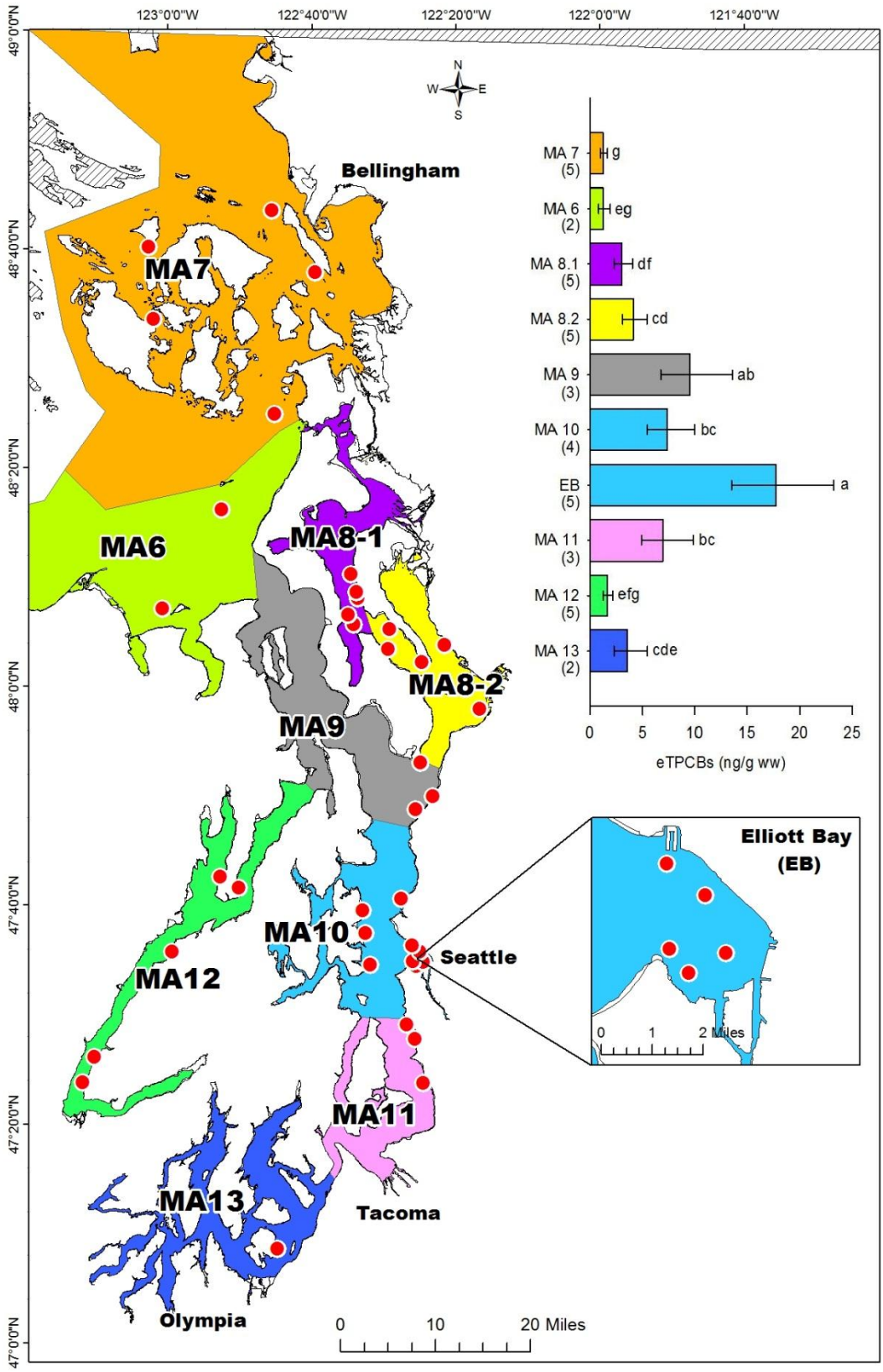

Figure 5. Geometric mean concentrations of eTPCBs (ng/g ww) in spot prawn muscle tissue ± 95% CI by WDFW Marine Area and one urban area (EB = Elliott Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$) and sample size is in parentheses.

Table 8. Results of the POPs regression analysis between Dungeness crab muscle and hepatopancreas

POP	n	y-intercept	slope	p-value	r^2	Test Assumptions: Log-transformed (Yes/No)	Test Assumptions: Normality (Pass/Fail)	Test Assumptions: Variance (Pass/Fail)	Constant p-value	Re-run stats (Yes/No)
eTPCBs	19	1.588	0.832	< 0.001	0.933	Y	P	P	< 0.001	N
$\sum_{15}$PBDEs	19	1.426	0.93	< 0.001	0.883	Y	P	P	< 0.001	N
$\sum_{6}$DDTs	19	1.468	0.692	< 0.001	0.604	Y	P	P	< 0.001	N
$\sum_{8}$Chlordanes	19	NS	15.13	< 0.001	0.85	N	P	P	0.802	Y
$\sum_{3}$HCHs	19	0.978	0.778	< 0.001	0.512	Y	P	P	< 0.001	N
HCB[a]	19	-	-	-	-	-	-	-	-	-
$\sum_{37}$PAHs	19	0.85	0.72	0.045	0.216	Y	P	P	< 0.001	N

[a] not analyzed due to large amount of non-detected values

Table 9. Results of the POPs regression analysis between spot prawn muscle and head tissue

POP	n	y-intercept	slope	p-value	r^2	Test Assumptions: Log-transformed (Yes/No)	Test Assumptions: Normality (Pass/Fail)	Test Assumptions: Variance (Pass/Fail)	Constant p-value	Re-run stats (Yes/No)
eTPCBs	19	NS	31.15	< 0.001	0.959	N	P	P	0.834	Y
$\sum_{15}$PBDEs	19	NS	36.29	< 0.001	0.839	N	P	P	0.971	Y
$\sum_{6}$DDTs[a]	19	-	-	-	-	-	-	-	-	-
$\sum_{8}$Chlordanes[a]	19	-	-	-	-	-	-	-	-	-
$\sum_{3}$HCHs[a]	19	-	-	-	-	-	-	-	-	-
HCB[a]	19	-	-	-	-	-	-	-	-	-
$\sum_{37}$PAHs	19	0.914	0.993	0.036	0.295	Y	P	P	< 0.001	N

[a] not analyzed due to large amount of non-detected values

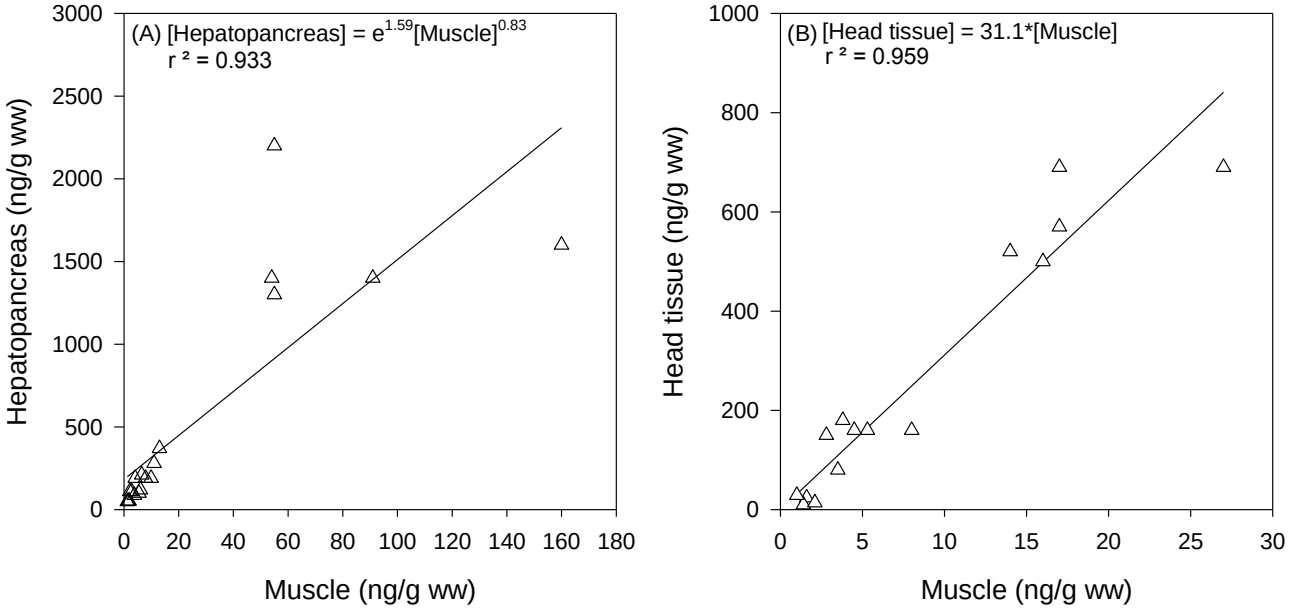

Figure 6. Regression analyses of eTPCBs (ng/g ww) reported in (A) Dungeness crab muscle in relation to hepatopancreas tissue, and (B) spot prawn muscle in relation to head tissue

$\sum_{11}$*PBDEs*

$\sum_{11}$PBDE concentrations in crab muscle ranged from 0.20 ng/g ww in MA 7 (LOQ) to 7.3 ng/g ww in Commencement Bay (Table D3). $\sum_{11}$PBDEs in spot prawn muscle ranged from 0.11 ng/g ww in MA 7 (LOQ) to 0.68 ng/g ww in MA 9 (Table D4).

Five PBDE congeners were detected in crab muscle (PBDE-28, -47, -49, -99 and -100) and six were detected in prawn muscle (PBDE-47, -49, -99, -100, -153, and -154). PBDE congeners 47 and 49 were the most abundant in both crab and prawn muscle, with a frequency of detection of 53% and 47% respectively in crab, and 44% and 23% respectively in prawn. PBDE congeners -66, -85, -153, -154, -155, and -183 were not detected in any crab muscle and PBDE congeners -28, -66, -85, -155, and -183 were not detected in any prawn muscle (Table 10). At 20 sites all of the PBDE values fell below the LOQ. Therefore, for those sites the greatest LOQ value for any single non-detected PBDE congener (within a site) was used as the summation ($\sum_{11}$PBDE) for that site when making comparisons.

Of the four factors tested, location was the only variable found to be correlated with $\sum_{11}$PBDEs in crab muscle (GLM, log-transformed, $F_{(10,50)} = 27.16$, $p < 0.001$). Further analysis revealed Dungeness crab collected in Commencement Bay had the highest significant $\sum_{11}$PBDE concentration (THSD, $p < 0.03$), with a geometric mean of 2.82 ng/g ww. Elliott Bay, the site with the second highest $\sum_{11}$PBDE concentration in crab (2.14 ng/g ww) was not significantly different from Commencement Bay, MA 11, or Sinclair Inlet. The crabs from the top six sites, including MAs 10 and 8.2, were found to have concentrations above detection limits. The MAs with the least amount of $\sum_{11}$PBDEs in crabs were 13, 12, 8.1, 9 and 7 (descending order of concentration), with the majority or all of their sites reported as below detection limits. These sites were all significantly different from Commencement Bay and Elliott Bay (THSD, $p < 0.03$). Generally, $\sum_{11}$PBDEs in crab were highest in the three urban areas (Table 6, Figure 7).

No GLM analysis was performed with $\sum_{11}$PBDEs data for spot prawn muscle because 17 of the total 39 samples were reported as non-detects. In addition, a site from MA 11 (SEAHURST) was removed from the analysis as an outlier because its $\sum_{11}$PBDE value of 8.2 ng/g ww was 12 times greater than the second highest concentration of

0.68 ng/g from crab collected at a station in MA 9 (POSSEPT). Marine Areas 9, 8.2 and 10 had the highest $\sum_{11}$PBDEs concentrations in spot prawn muscle ranging from 0.51 ng/g ww in MA 9 to 0.39 ng/g ww in MA 10, with all of their values reported above detection limits. The remaining MAs (13, 12, 8.1, 6, and 7) and Elliott Bay had a majority, or the entirety, of their $\sum_{11}$PBDEs values below the detection limits, with the lowest $\sum_{11}$PBDE concentration of 0.14 ng/g ww in MA 7 (Table D4).

$\sum_{11}$PBDEs in Dungeness crab muscle were positively correlated with $\sum_{11}$PBDEs found in the hepatopancreas (linear regression of log-transformed analytes, $p < 0.001$, $r^2 = 0.88$; Table 8, Figure 8A), and $\sum_{11}$PBDEs in crab hepatopancreas were roughly 25 times greater than muscle concentrations (Table D3). In addition, $\sum_{11}$PBDEs in spot prawn muscle exhibited a significant relationship with the $\sum_{11}$PBDEs in the head tissue ($p < 0.001$, $r^2 = 0.839$, Table 9, Figure 8B), and $\sum_{11}$PBDEs in prawn head tissues were roughly 36 times greater than muscle concentrations (Table D2). The y-intercept was not significant ($p = 0.971$) and was therefore removed from the spot prawn regression equation. These results give us the ability to predict $\sum_{11}$PBDE concentrations in Dungeness crab hepatopancreas or spot prawn head tissue based on the $\sum_{11}$PBDEs found in their muscle.

Table 10. Frequency of detection (%) for 11 PBDE congeners in 51 Dungeness crab muscle samples and 39 spot prawn muscle samples

PBDE congener	Dungeness crab	Spot Prawn
BDE 28	2	0
BDE 47	52.9	43.6
BDE 49	47.1	23.1
BDE 66	0	0
BDE 85	0	0
BDE 99	11.8	2.56
BDE 100	3.9	2.56
BDE 153	0	2.56
BDE 154	0	2.56
BDE 155	0	0
BDE 183	0	0

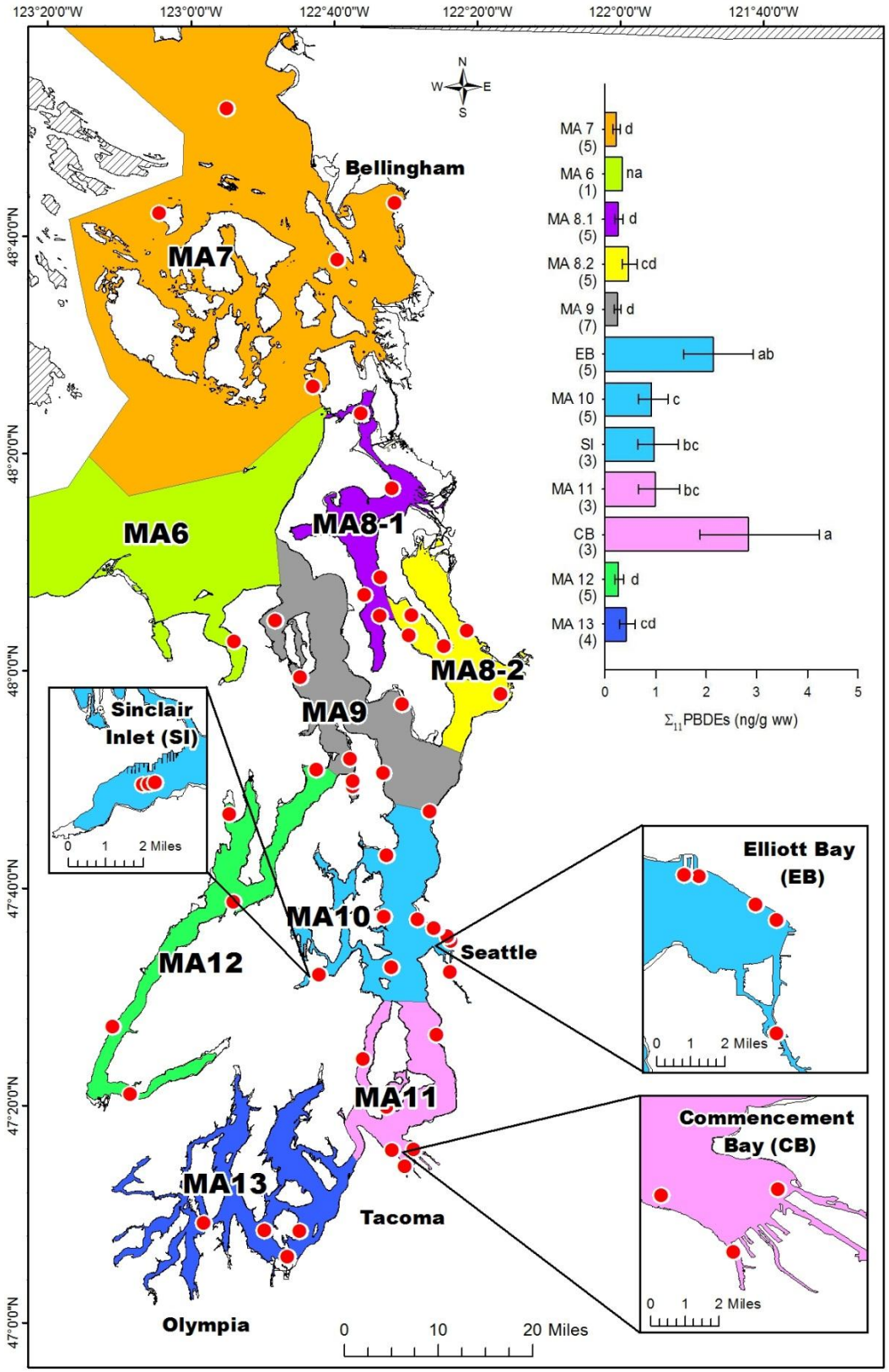

Figure 7. Geometric mean concentrations of $\sum_{11}$PBDEs (ng/g ww) in Dungeness crab muscle tissue ± 95% CI by WDFW Marine Area and three urban areas (EB = Elliott Bay, SI = Sinclair Inlet and CB = Commencement Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$, na = not analyzed) and sample size is in parentheses.

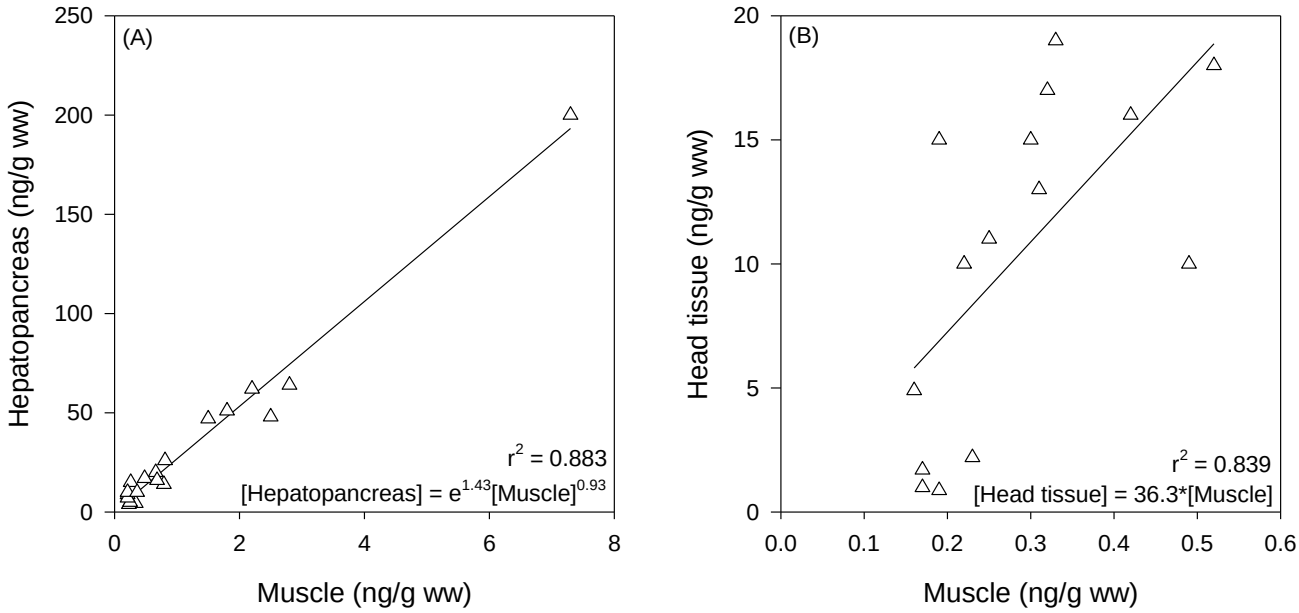

Figure 8. Regression analyses of $\sum_{11}$PBDEs (ng/g ww) reported in (A) Dungeness crab muscle in relation to hepatopancreas and (B) spot prawn muscle vs. head tissue

$\sum_6$*DDTs*

Of the 51 crab muscle samples, 44 had $\sum_6$DDTs values above the detection limits. The $\sum_6$DDTs values ranged from 0.21 ng/g ww in MA 7 (LOQ) to 4.8 ng/g ww in Elliott Bay (Table D3). Of the 39 prawn muscle samples analyzed, only one sample contained $\sum_6$DDTs levels above the detection limit, which was 0.24 ng/g ww in MA 9 (Table D4). Prawn muscle data was not included in any further comparisons, since only one sample was reported above detection limits. Of the six DDT isomers, only *p,p'*-DDE was detected in both crab and prawn muscle at 86.3% and 2.56%, respectively. The five other isomers were not detected in either tissue type (Table 11).

Location was the only significant factor in explaining $\sum_6$DDTs variation in Dungeness crab muscle (GLM analysis, natural log-transformed, $F_{(10,50)} = 10.78$, $p < 0.001$; $p>0.05$ for all other factors). A similar pattern to eTPCBs in crab muscle was observed for $\sum_6$DDTs across the areas of Puget Sound. The urban areas of Elliott Bay and Commencement Bay had the two highest concentrations of all the areas analyzed, with geometric means of 2.18 ng/g wet weigh and 1.27 ng/g ww, respectively. The mid-range concentrations of $\sum_6$DDTs in crab muscle were found in MA 10, Sinclair Inlet, and MAs 11, 8.2, 13, 12 and 9 (descending order of concentration) with a range from 0.75 ng/g ww in MA 10 to 0.35 ng/g ww in MA area 9. All MAs with samples in the mid-range of $\sum_6$DDT concentrations were not significantly different from Commencement Bay, each other, or the two areas with the lowest concentrations. MAs 8.1 and 7 had the lowest $\sum_6$DDT concentrations in crab muscle of all the areas and they were significantly lower than Elliott Bay (THSD, $p < 0.001$) and Commencement Bay (THSD, $p < 0.003$; Table 6, Figure 10).

$\sum_6$DDTs in Dungeness crab muscle were positively correlated with $\sum_6$DDTs in the hepatopancreas (linear regression of log transformed analytes, $p < 0.001$, $r^2 = 0.604$; Table 8, Figure 9), and concentrations were roughly 30 times greater in hepatopancreas than in muscle (Table D3). As with PCBs, variability in $\sum_6$DDTs increased with concentration.

Table 11. Frequency of detection (%) for six DDT isomers in 51 Dungeness crab muscle samples and 39 spot prawn samples

DDT isomer	Dungeness crab	Spot prawn
o,p'-DDD	0	0
o,p'-DDE	0	0
o,p'-DDT	0	0
p,p'-DDD	0	0
p,p'-DDE	86.3	2.56
p,p'-DDT	0	0

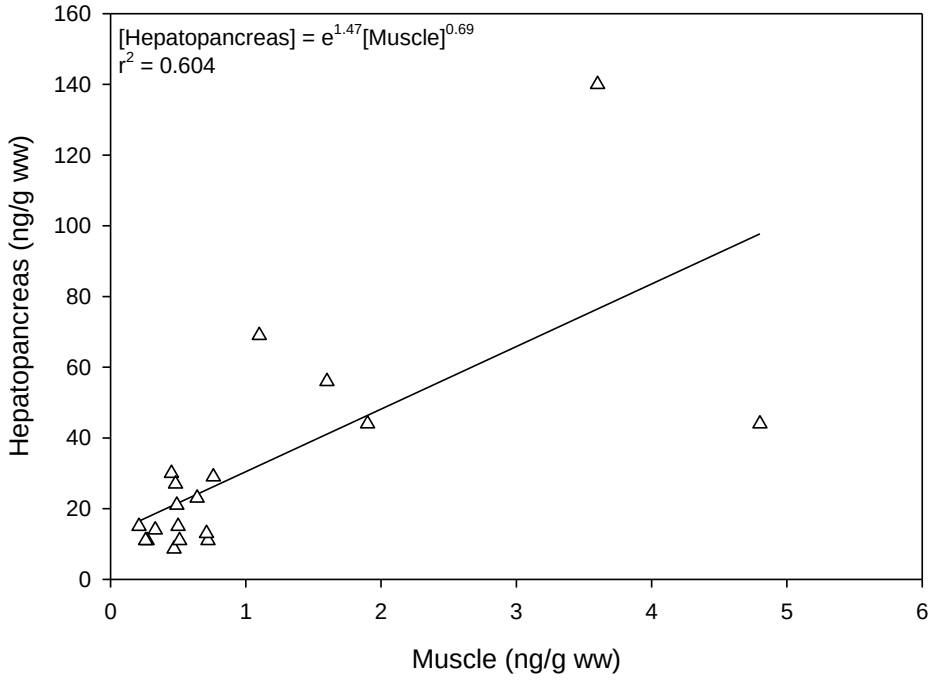

Figure 9. Regression analysis of $\sum_6$DDTs (ng/g ww) reported in Dungeness crab muscle in relation to hepatopancreas tissue

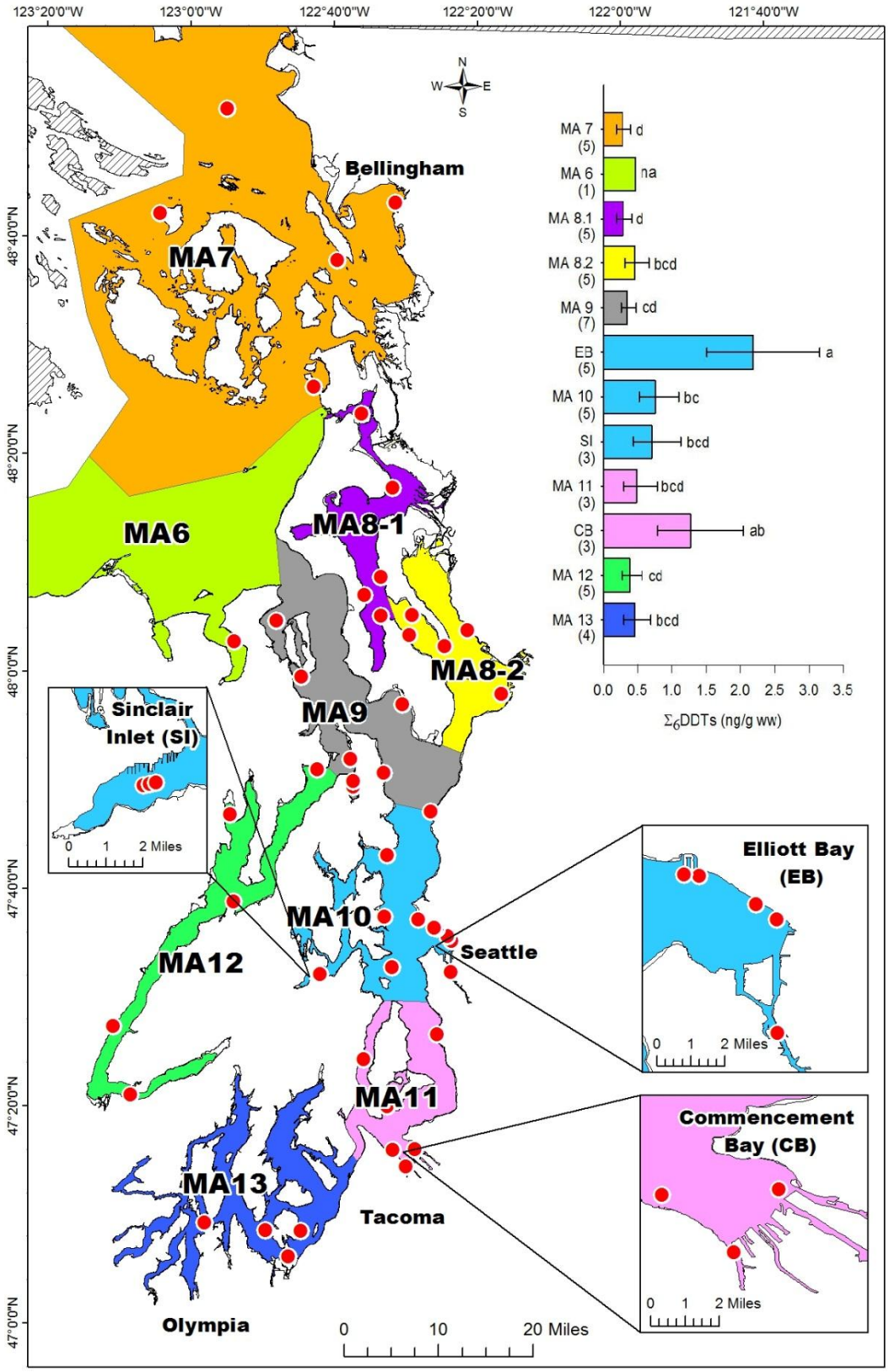

Figure 10. Geometric mean concentrations of $\sum_6$DDTs (ng/g ww) in Dungeness crab muscle tissue ± 95% CI by WDFW Marine Area and three urban areas (EB = Elliott Bay, SI = Sinclair Inlet and CB = Commencement Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$, na = not analyzed) and sample size is in parentheses.

$\sum_3$*HCHs*

Of the three HCH isomers, α-HCH and β-HCH were detected in 31.4% and 11.8% of crab muscle samples, respectively (Table 12). No HCHs were detected in prawn muscle samples, which were therefore not included in further comparisons. $\sum_3$HCHs in crab muscle ranged from 0.15 ng/g ww in Commencement Bay (LOQ) to 1.8 ng/g ww in MA 11. $\sum_3$HCHs in crab muscle were only detected in five (MA 9, 10, Elliott Bay, 11, and 13) of the 12 locations sampled. It is important to note that only one crab sample from Elliott Bay (n = 5) contained detectable levels of $\sum_3$HCHs and neither Sinclair Inlet nor Commencement Bay samples contained levels of $\sum_3$HCHs above detection limits (Table D3).

GLM analysis was not performed for Dungeness crab due to the high number of non-detect values reported in the samples. The only discernible pattern of $\sum_3$HCHs in crab muscle was that they were generally found in the central Puget Sound region (MAs 9, 10, Elliott Bay, and 11).

$\sum_3$HCHs were found above detection limits in all crab hepatopancreas samples, so a regression analysis was performed. It is important to note that 11 of the 19 samples had $\sum_3$HCH values below the LOQ. As a result the maximum reported LOQ was used in place of zero for the analysis. $\sum_3$HCHs in crab muscle were positively correlated with $\sum_3$HCHs in the hepatopancreas (linear regression, $p < 0.001$, $r^2 = 0.512$; Table 8, Figure 11), and hepatopancreas concentrations were roughly 12 times greater than those found in muscle tissue (Table D1). These results may give us the ability to predict $\sum_3$HCHs in Dungeness crab hepatopancreas based on $\sum_3$HCHs in their muscle, but additional samples should be analyzed to better understand this relationship.

Table 12. Frequency of detection (%) for three HCH isomers in 51 Dungeness crab muscle samples and 39 spot prawn samples

HCH isomer	Dungeness crab	Spot Prawn
α-hexachlorocyclohexane	31.4	0
β-hexachlorocyclohexane	11.8	0
γ-hexachlorocyclohexane	0	0

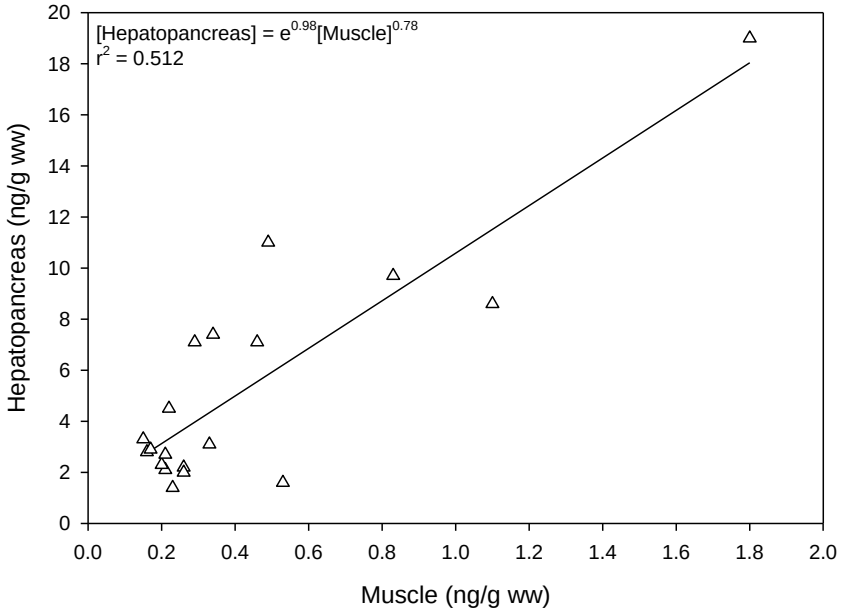

Figure 11. Regression analysis of $\sum_3$HCHs (ng/g ww) reported in Dungeness crab muscle in relation to hepatopancreas tissue

$\sum_8$*Chlordanes*

The $\sum_8$Chlordanes in crab muscle ranged from 0.18 ng/g ww in MA 7 (LOQ) to 1.8 ng/g ww in Commencement Bay (Table D3). A GLM analysis was not performed for Dungeness crab due to the high number of non-detected values reported in the samples. No chlordane chemicals were detected in spot prawn muscle, so they did not undergo further analysis.

Eight out of 51 Dungeness crab samples had detected $\sum_8$Chlordane levels. Those were from MA 10, Elliott Bay and Commencement Bay. Of the eight chlordane chemicals, only oxychlordane and trans-nonachlor were detected in Dungeness crab muscle, and those were in only 13.7% of the samples, for each (Table 13).

$\sum_8$Chlordanes were detected in all the Dungeness crab hepatopancreas samples. However, only six out of the 19 corresponding muscle samples had chemical residue levels above the detection limit, therefore the maximum LOQ was used in place of zeros from the remaining 13 samples. $\sum_8$Chlordanes in crab muscle were significantly related to the $\sum_8$Chlordanes in the hepatopancreas (linear regression, $p < 0.001$, $r^2 = 0.85$; Table 8, Figure 12), and the y-intercept was removed from the equation as not significant ($p = 0.802$). The concentrations of $\sum_8$Chlordanes in the hepatopancreas were roughly 15 times greater than in muscle tissue (Table D1). Although we can predict $\sum_8$Chlordanes in Dungeness crab hepatopancreas based on the $\sum_8$Chlordanes in their muscle, additional samples/analyses are needed to better understand this relationship.

Table 13. Frequency of detection (%) for eight chlordane and chlordane-related isomers in 51 Dungeness crab muscle samples and 39 spot prawn samples

Chlordane analyte	Dungeness crab	Spot prawn
α-chlordane	0	0
cis-nonachlor	0	0
β-chlordane	0	0
heptachlor	0	0
heptachlor epoxide	0	0
nonachlor III	0	0
oxychlordane	13.7	0
trans-nonachlor	13.7	0

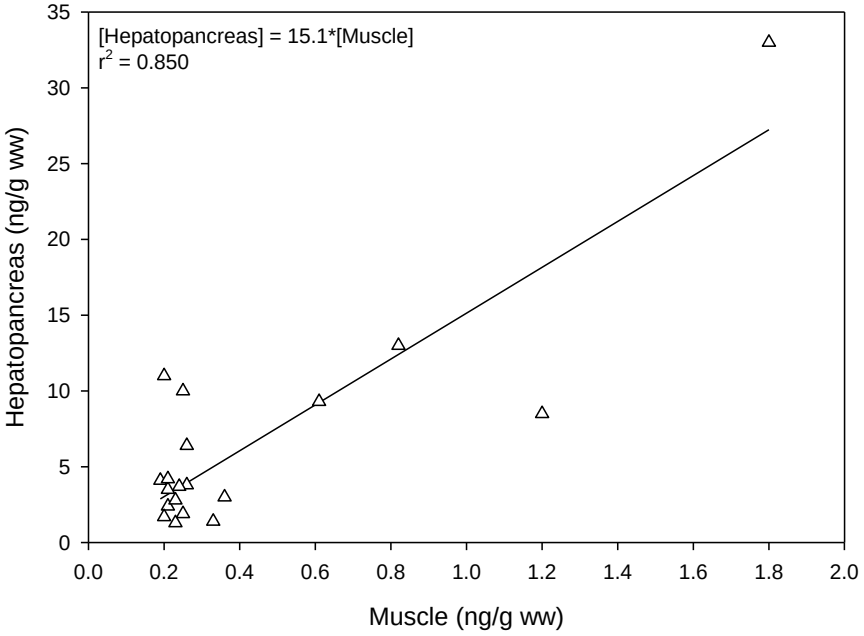

Figure 12. Regression analysis of $\sum_8$Chlordanes (ng/g ww) reported in Dungeness crab muscle in relation to the hepatopancreas

Hexachlorobenzene

Hexachlorobenzene was not detected in any of the Dungeness crab or spot prawn samples. Therefore no comparisons were made between locations with the two tissues of each species.

Other Organochlorine Pesticides (OCPs)

Aldrin, dieldrin, mirex and α-endosulfan were not detected in any of the Dungeness crab or spot prawn samples. Therefore no comparisons were made between locations with the two tissues of each species.

$\sum_{37}$PAHs

The $\sum_{37}$PAHs in Dungeness crab muscle samples ranged from 0.27 ng/g ww in MA 8.2 to 6.0 ng/g ww in Commencement Bay (Table D3). Similarly, the mean detected $\sum_{37}$PAHs in prawn muscle ranged from 0.30 ng/g ww in MA 8.2 to 3.7 ng/g ww in Elliott Bay (Table D4). Naphthalene and its alkylated homologs were not included in the summation because these compounds appeared in method blanks, suggesting intrusion from external sources during lab processing. Detected concentrations in samples may be adjusted by data users for concentrations observed in method blanks.

Overall, $\sum_{37}$PAHs were detected in 61% of Dungeness crab muscle samples and 97% of spot prawn muscle samples. While the Dungeness crab muscle samples had a lower $\sum_{37}$PAHs detection frequency, they had a wider variety of low molecular weight PAHs (LMWPAHs) compared to spot prawn. Thirteen out of 17 LMWPAHs were detected in crab muscle; phenanthrene had the highest frequency of detection at 51%, while C_3-Fluroene (C3FLU), C_3-dibenzothiophene (C3DBT), C_4-dibenzothiophene (C4DBT), C_2-phenanthrenes/anthracenes (C2PHN), C_3-phenanthrenes/anthracenes (C3PHN) and C_4-phenanthrenes/anthracenes (C4PHN) were the lowest at 2% each. Five of the 17 LMWPAHs were detected in prawn muscle with phenanthrene and C_1-phenanthrenes/anthracenes (C1PHN) having the highest frequency of detection at 85%, while C_2-phenanthrenes/anthracenes had the lowest at 2.6%. Only two (perylene and naphthalene) out of 20 high molecular weight PAHs (HMWPAHs) were detected in both the crab and prawn muscle samples. Perylene was

the most frequently detected HMWPAH, found in 14% of crab muscle samples and 31% of prawn muscle samples (Table 14).

Location was the only significant factor contributing to the variability of $\sum_{37}$PAHs in Dungeness crab muscle samples (GLM analysis, natural log-transformed, $F_{(10,50)} = 4.14$, $p = 0.001$; $p>0.05$ for all other factors). Crab muscle from Elliott Bay had highest significant concentration of $\sum_{37}$PAHs, with a geometric mean of 2.2 ng/g ww (THSD, $p < 0.02$). But Elliott Bay crabs were not significantly different from crab collected in Commencement Bay, MA 7, Sinclair Inlet or MA 13, with geometric means of 0.99, 0.88, 0.76 and 0.74 ng/g ww, respectively. The only discernible pattern in crab muscle with respect to $\sum_{37}$PAHs across the MAs was that crab from the three urban areas had three of the four highest $\sum_{37}$PAH concentrations. Geometric mean $\sum_{37}$PAHs of crab muscle from the remaining six MAs ranged from 0.34 ng/g ww in MA 8.2 to 0.52 ng/g ww in MA 12. Crab from Commencement Bay, MA 7, Sinclair Inlet and MA 13 were not significantly different from crab collected in the seven other MAs. Crab from MA 8.2 had the lowest $\sum_{37}$PAHs concentration (0.34 ng/g ww) and was six times lower than crab collected from Elliott Bay (Table 6, Figure 13).

Location was the only significant factor that contributed to the variability of Σ_{37}PAH concentration (GLM analysis, natural log-transformed Σ_{37}PAH, $F_{(9,39)} = 2.31$, $p = 0.043$) in spot prawn muscle. However, further pairwise comparisons revealed no significant difference between locations ($p > 0.05$). Marine Area 13 had the highest concentration of Σ_{37}PAH among all the locations, while MA 6 had the lowest. The overall range of $\sum_{37}$PAH concentrations in prawn were quite small (0.14 ng/g ww), suggesting $\sum_{37}$PAHs were low throughout Puget Sound (Table 7, Figure 14).

The Σ_{37}PAHs in crab muscle were positively correlated with Σ_{37}PAHs in crab hepatopancreas (linear regression, log-transformed analytes, $p = 0.045$, $r^2 = 0.216$; Table 8, Figure 15A), and Σ_{37}PAH concentrations in hepatopancreas were roughly 12 times greater than in muscle tissue (Table D1). However, $\sum_{37}$PAHs in spot prawn were highly variable and weakly correlated with $\sum_{37}$PAHs in head tissue (regression, log-transformed, $p = 0.036$, $r^2 = 0.295$; Table 9, Figure 15B), with Σ_{37}PAHs roughly 10 times greater in head tissue than in muscle tissue (Table D2). It appears that there could be two different relationships between the tissue types, but because of the small sample size no definitive conclusions were made. Because of the weak correlations, these results do not provide the ability to confidently predict $\sum_{37}$PAHs in Dungeness crab hepatopancreas or spot prawn head tissue based on $\sum_{37}$PAHs in muscle tissues for either.

Table 14. Frequency of detection (%) of Low Molecular Weight (LMW) and High Molecular Weight (HMW) polycyclic aromatic hydrocarbon compounds (PAHs) in 51 Dungeness crab and 39 spot prawn muscle samples. Naphthalenes not included here because of intrusion by extrinsic sources during processing, as identified by detections in method blanks.

LMW Compounds	Crab	Prawn	HMW Compounds	Crab	Prawn
acenaphthylene (ACY)	0	0	fluoranthene (FLA)	0	2.6
acenaphthene (ACE)	9.8	33	pyrene (PYR)	0	0
fluorene (FLU)	12	7.7	C_1-F/P	2.0	0
C_1-Flourene	3.9	0	C_1-F/P	0	0
C_2-Fluorene	5.9	0	C_1-F/P	0	0
C_3-Fluorene	2.0	0	C_1-F/P	0	0
dibenzothiophene (DBT)	0	0	benz[*a*]anthracene (BAA)	0	0
C_1-dibenzothiophene	0	0	chrysene (CHR)[d]	0	0
C_2-dibenzothiophene	0	0	C_1-chrysene	0	0
C_3-dibenzothiophene	2.0	0	C_2-chrysene	0	0
C_4-dibenzothiophene	2.0	0	C_3-chrysene	0	0
phenanthrene (PHN)	51	85	C_4-chrysene	0	0
anthracene (ANT)	5.9	0	benzo[*b*]fluoranthene (BBF)	0	0
C_1-P/A	28	85	benzo[*k*]fluoranthene (BKF)[e]	0	0
C_2-P/A	2.0	2.6	benzo[*e*]pyrene (BEP)	0	0
C_3-P/A	2.0	0	benzo[*a*]pyrene (BAP)	0	0
C_4-P/A	2.0	0	perylene (PER)	14	31
1-methylphenanthrene (MP1)[a]	0	0	indeno[*1,2,3-cd*]pyrene (IDP)	0	0
3-methylphenanthrene (MP3)[a]	0	0	dibenz[*a,h*]anthracene (DBA)[f]	0	0
9-methylphenanthrene (MP9)[a]	0	0	benzo[*z*]pyrene (BZP)	0	0
1,7-dimethylphenanthrene (DMP)[b]	0	0			
retene[c]	0	0			

[a]Individual analytes, included in C_1-P/A

[b]Individual analyte, included in C_2-P/A

[c]1-methyl-7-isopropyl phenanthrene, individual analyte, included in C_4-P/A

[d]coelutes with triphenylene

[e]coelutes with benzo[*j*]fluoranthene

[f]coelutes with dibenz[*a,c*]anthracene

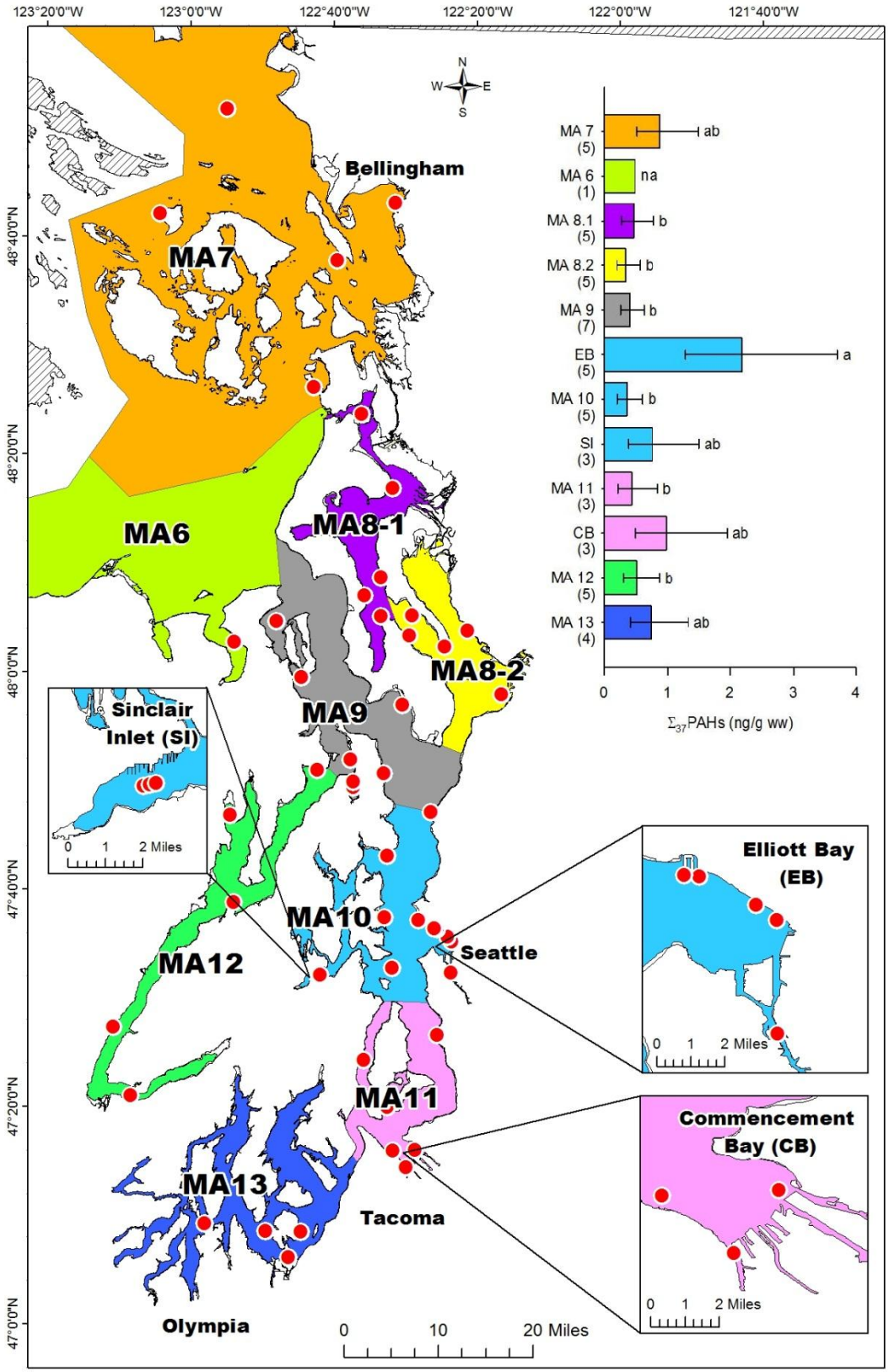

Figure 13. Geometric mean concentrations of $\sum_{37}$PAHs (ng/g ww) in Dungeness crab muscle tissue ± 95% CI by WDFW Marine Area and three urban areas (EB = Elliott Bay, SI = Sinclair Inlet and CB = Commencement Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$, na = not analyzed) and samples size is in parentheses.

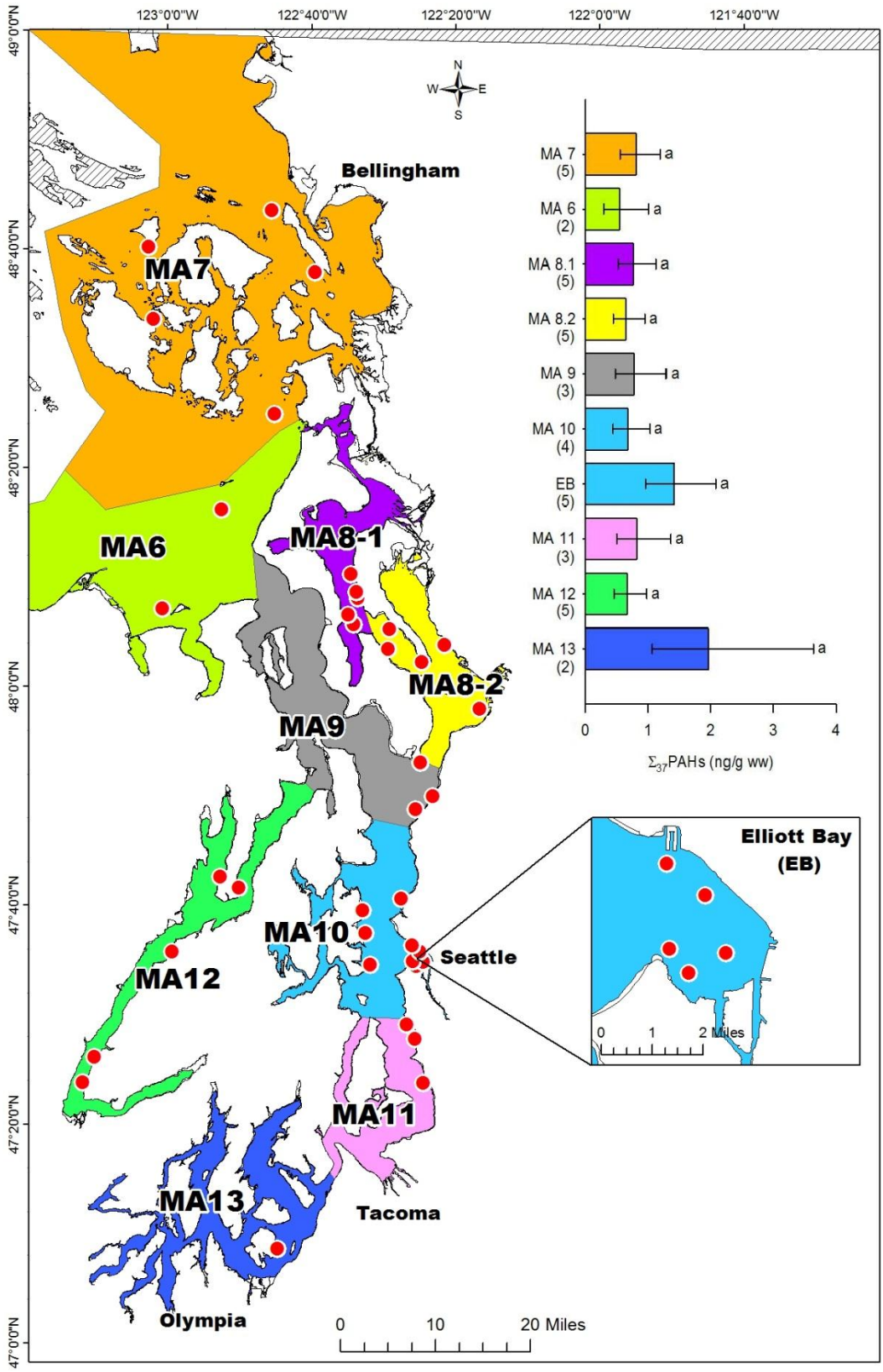

Figure 14. Geometric mean concentrations of $\sum_{37}$PAHs (ng/g ww) in spot prawn muscle tissue ± 95% CI by WDFW Marine Area and one urban area (EB = Elliott Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$) and sample size is in parentheses.

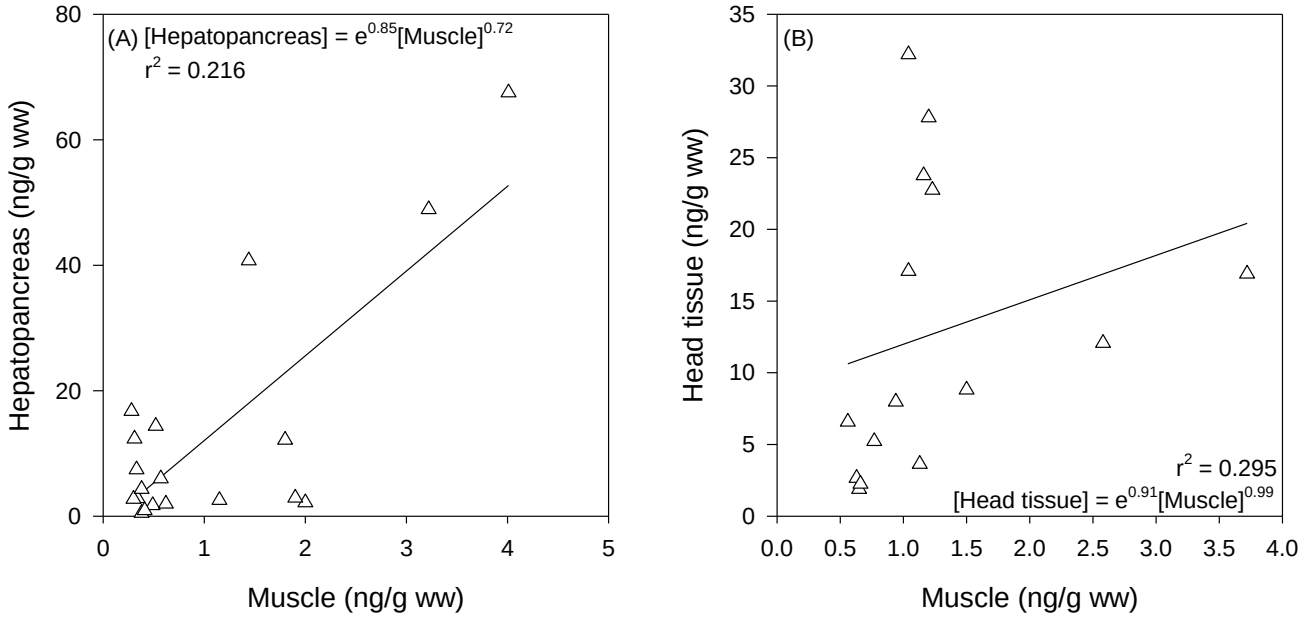

Figure 15. Regression analyses of $\sum_{37}$PAHs (ng/g ww) reported in (A) Dungeness crab muscle in relation to hepatopancreas and (B) spot prawn muscle in relation to head tissue

Metals Analysis Overview

Of the metals analyzed in this study, mercury, arsenic, copper, and zinc were reported in all 51 crab muscle samples, cadmium from 41 samples, and lead from 20 samples. Mercury, arsenic, cadmium, copper, and zinc were reported in all 39 prawn muscle samples and lead from one sample.

The following results are reported by each metal. Note we report metals analysis results from ANOVA tests here, rather than from GLMs. Initial GLM analyses revealed that crab carapace width and prawn carapace length were not correlated with the concentration of metal in the muscle of Dungeness crab or spot prawn (no interactions, $p > 0.05$). Therefore differences in metal concentrations in the two species' tissues were tested among locations using either an ANOVA test or its non-parametric counterpart, the Kruskal-Wallis rank test. Results of the location comparisons are presented in bar graphs with geometric means and 95% confidence intervals, where bars labeled with the same letter are not significantly different. In addition, results of regression analyses comparing Dungeness crab muscle to hepatopancreas and spot prawn muscle to head tissue are given for each metal, along with a corresponding figure.

Mercury

Mercury was detected in all samples of Dungeness crab and spot prawn muscle (Table 15). In crab muscle, mercury ranged from 0.018 mg/kg (parts per million) ww in MA 7 to 0.25 mg/kg ww in Sinclair Inlet (Table E1). In prawn muscle, mercury ranged from 0.027 mg/kg ww in MA 12 to 0.12 mg/kg ww in MA 8.2. Interestingly, the second highest level of mercury in spot prawn (0.11 mg/kg ww; Table E2) was in MA 7, the same area that had the lowest mercury level in crab muscle (0.018 mg/kg;).

The variability in mercury concentration reported in Dungeness crab muscle was explained by location (ANOVA, natural log-transformed mercury by location, $F_{(10,50)} = 7.27$, $p < 0.001$; Table 16). Crabs collected in Sinclair Inlet had the highest level of mercury with a geometric mean of 0.21 mg/kg ww, which was significantly different from most of the other locations (THSD, $p < 0.009$), except for Elliott Bay (THSD, $p = 0.22$). Crabs collected in Elliott Bay had the second highest concentration of mercury with a geometric mean of 0.10 mg/kg ww, but they were not

significantly different from MA 10, Commencement Bay, MAs 11, 13, 8.2, 12, and 8.1 (descending order of mercury levels). Marine Area 7 and MA 9 had the two lowest mercury concentrations, compared to Sinclair Inlet and Elliott Bay, with geometric means of 0.039 and 0.036 mg/kg ww, respectively (Figure 16).

Location also explained the variability in mercury concentrations reported in spot prawn muscle (ANOVA, natural log-transformed mercury by location, $F_{(9,39)} = 6.84$, $p < 0.001$; Table 17). However, the concentration of mercury in prawn muscle did not vary greatly across Puget Sound; the lowest geometric mean concentration (0.037 mg/kg ww) was found in MA 12, while the highest concentration (0.085 mg/kg ww) was found in MA 8.1, which was significantly higher than Elliott Bay, MAs 9, 10, 11 and 12 (THSD, $p < 0.03$). Interestingly, prawn collected in Elliott Bay only contained a mid-range geometric mean concentration of 0.050 mg/kg ww (Figure 17).

Mercury in Dungeness crab muscle was positively correlated with mercury reported in the hepatopancreas (linear regression, $p < 0.001$, $r^2 = 0.750$; Table 18, Figure 18A) and mercury concentration in the muscle was roughly 1.4 times greater than in the hepatopancreas (Table E3). Because it failed the assumptions of variance and normality and had abnormally high mercury levels in the hepatopancreas (1.5 times higher than the second highest reported value), Elliott Bay Pier 69 (station ID 12EB_P69) was deemed an outlier and removed from further analysis. Mercury in spot prawn muscle was positively correlated with mercury in head tissue (linear regression, $p < 0.001$, $r^2 = 0.775$; Table 19, Figure 18B) and mercury concentration in the muscle was roughly 1.8 times greater than in the head tissue (Table E4). These results give us the ability to predict mercury in Dungeness crab hepatopancreas and spot prawn head tissue based on mercury levels in their muscle tissue.

Table 15. Frequency of detection (%) of the six metals analyzed in 51 Dungeness crab samples and 39 spot prawn samples

Metal	Dungeness crab	Spot prawn
Mercury	100	100
Arsenic	100	100
Cadmium	80.4	100
Copper	100	100
Lead	39.2	2.6
Zinc	100	100

Table 16. Results comparing metal concentrations in Dungeness crab muscle across nine Marine Areas and three urban embayments

			Test Assumptions				
Metal	n	Natural log transformed (Yes/No)	Normality (Pass/Fail)	Variance (Pass/Fail)	Test used	F-statistic	p-value
Mercury	51	Y	P	P	ANOVA	7.266	< 0.001
Arsenic	51	N	P	P	ANOVA	1.195	0.324
Cadmium	51	Y	P	P	ANOVA	3.476	0.002
Copper	51	N	P	P	ANOVA	1.339	0.245
Lead	51	-	-	-	-	-	-
Zinc	51	N	P	F	Kruskal-Wallis	NA	0.538

Table 17. Results comparing metal concentrations in spot prawn muscle across nine Marine Areas and one urban embayment

			Test Assumptions				
Metal	n	Natural log transformed (Yes/No)	Normality (Pass/Fail)	Variance (Pass/Fail)	Test used	F-statistic	p-value
Mercury	39	Y	P	P	ANOVA	6.838	< 0.001
Arsenic	39	N	F	F	Kruskal-Wallis	NA	0.002
Cadmium	39	N	P	P	ANOVA	3.879	0.003
Copper	39	N	P	P	ANOVA	3.755	0.003
Lead	39	-	-	-	-	-	-
Zinc	39	N	P	P	ANOVA	5.953	< 0.001

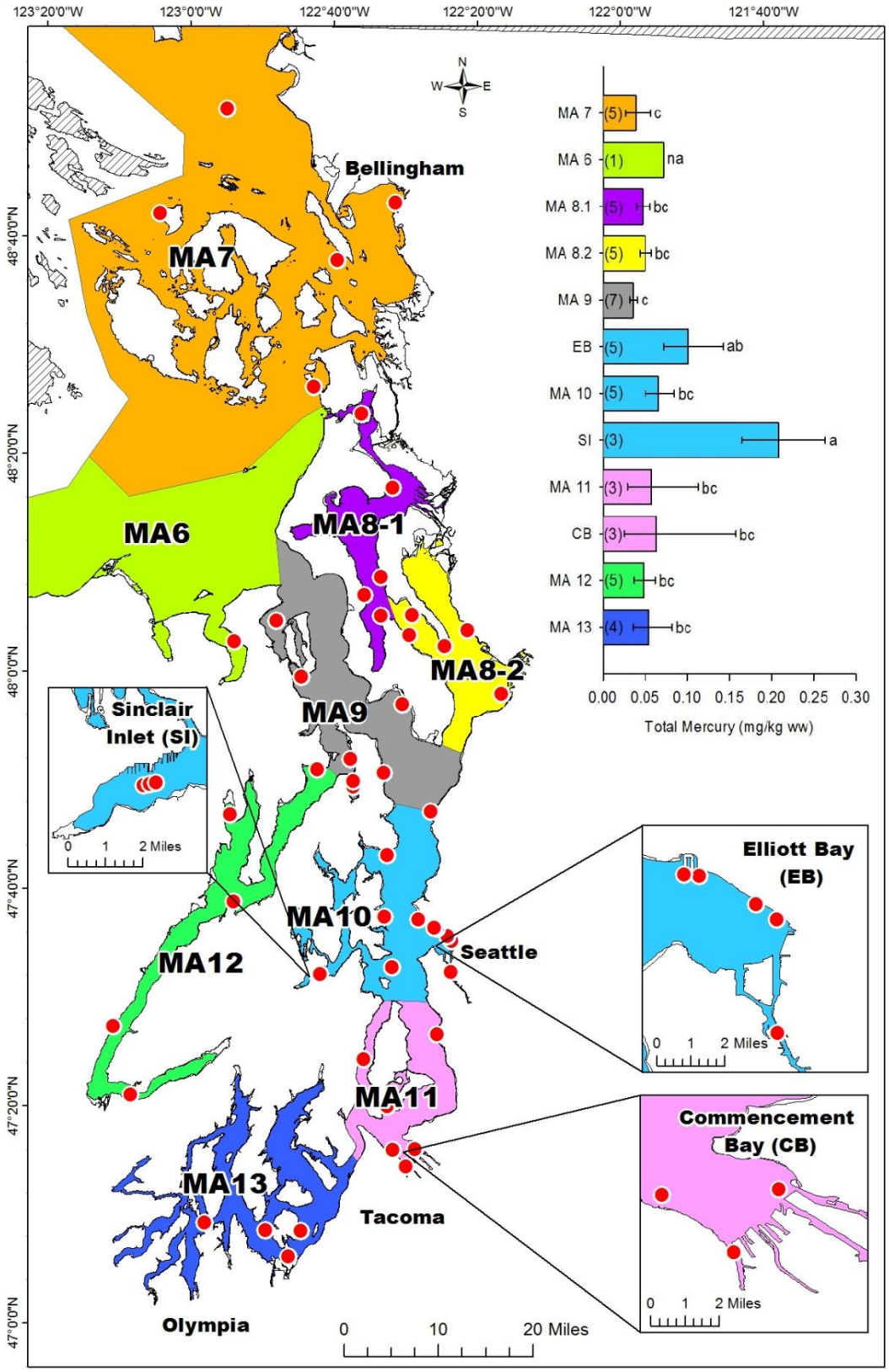

Figure 16. Geometric mean concentrations of total mercury (mg/kg ww) in Dungeness crab muscle tissue ± 95% CI by WDFW Marine Area and three urban areas (EB = Elliott Bay, SI = Sinclair Inlet and CB = Commencement Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$, na = not analyzed) and sample size is in parentheses.

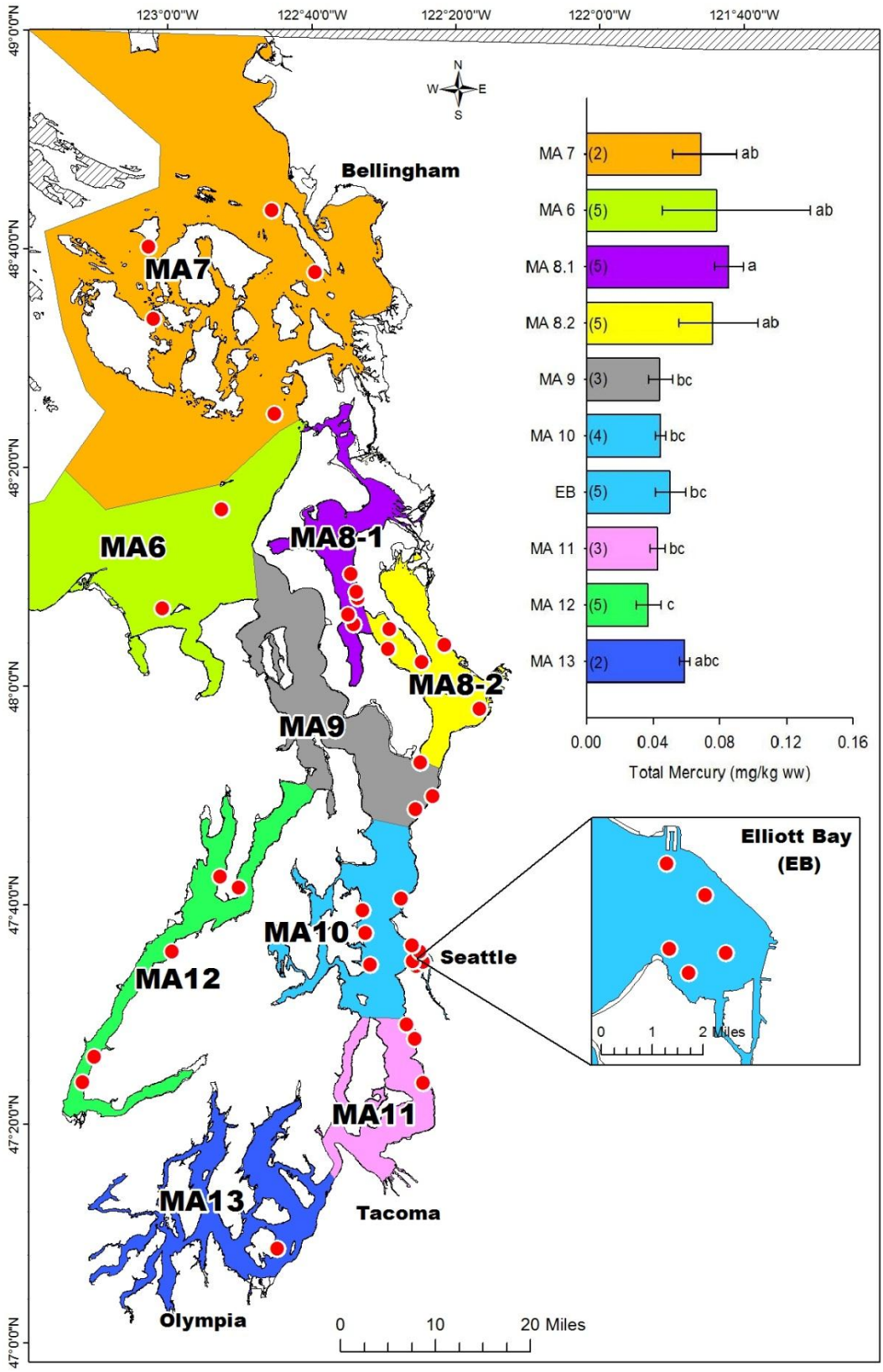

Figure 17. Geometric mean concentrations of total mercury (mg/kg ww) in spot prawn muscle ± 95% CI by WDFW Marine Area and one urban area (EB = Elliott Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$) and sample size is in parentheses.

Table 18. Results of the metals regression analysis between Dungeness crab muscle and hepatopancreas (NS = not significant)

Metal	n	y-intercept	slope	p-value	r^2	Log-transformed (Yes/No)	Test Assumptions: Normality (Pass/Fail)	Test Assumptions: Variance (Pass/Fail)	Constant p-value	Re-run stats (Yes/No)
Mercury	18[a]	0.0215	0.347	< 0.001	0.750	N	P	P	< 0.001	N
Arsenic	19	NS	0.753	< 0.001	0.932	N	P	P	0.218	Y
Cadmium	19	2.386	1.11	0.004	0.387	Y	P	P	0.007	N
Copper	19	NS	2.58	< 0001	0.836	N	P	P	0.168	Y
Lead	18[a]	NS	11.2	< 0.001	0.632	N	P	P	0.213	Y
Zinc	19	NS	0.331	< 0.001	0.974	N	P	P	0.768	Y

[a] ELLTBAY_P69 removed as an outlier after failing normality and variance tests

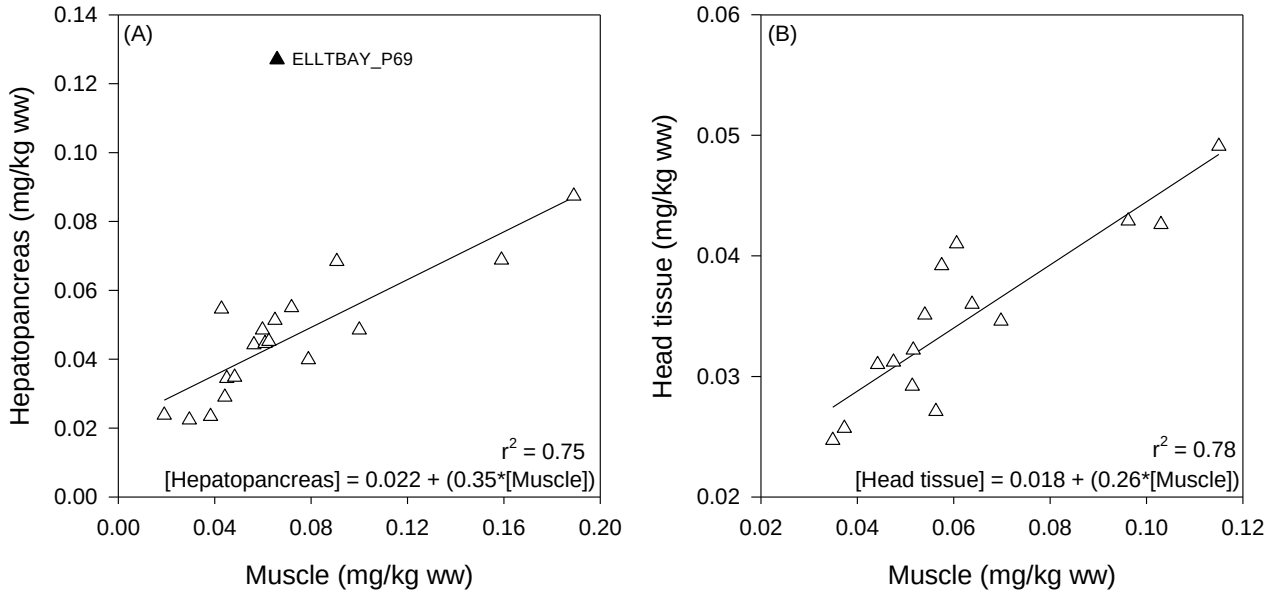

Figure 18. Regression analyses of total mercury (mg/kg ww) reported in (A) Dungeness crab muscle in relation to hepatopancreas and (B) spot prawn muscle in relation to head tissue. Station ELLTBAY_P69 was removed from the crab analysis as an outlier.

Table 19. Results of the regression analysis between spot prawn muscle and head tissue (NS = not significant)

Metal	n	y-intercept	slope	p-value	r^2	Test Assumptions: Log-transformed (Yes/No)	Test Assumptions: Normality (Pass/Fail)	Test Assumptions: Variance (Pass/Fail)	Constant p-value	Re-run stats (Yes/No)
Mercury	15	0.0183	0.262	< 0.001	0.775	N	P	P	< 0.001	N
Arsenic	15	NS	0.811	< 0.001	0.980	N	P	P	0.549	Y
Cadmium	15	NS	45.3	< 0.001	0.936	N	P	P	0.067	Y
Copper	15	59.3	0.720	0.727	0.010	N	P	P	0.002	N
Lead	15	NS	17.7	<0.001	0.868	N	P	P	0.326	Y
Zinc	15	NS	1.98	< 0.001	0.989	N	P	P	0.123	Y

Arsenic

Arsenic was detected in all samples of Dungeness crab and spot prawn muscle (Table 15). In crab muscle, arsenic ranged from 3.44 mg/kg ww in Commencement Bay to 20.5 mg/kg ww in MA 8.2 (Table E1). Spot prawn muscle arsenic residues ranged higher and wider than crab, with 8.0 mg/kg ww in MA 8.2 to 31 mg/kg ww in MA 8.2 (Table E2).

Arsenic levels in Dungeness crab muscle did not vary significantly across MAs in Puget Sound (ANOVA, $F_{(10,50)} = 1.20$, $p = 0.324$; Table 16, Figure 19). Arsenic concentrations in prawn muscle failed the parametric assumptions for ANOVA, therefore the non-parametric Kruskal-Wallis test was used. Unlike the crab muscle, variability of arsenic in spot prawn muscle was explained by location (Kruskal-Wallis, $p = 0.002$; Table 17). *Post hoc* pairwise comparison revealed that spot prawn collected in MA 8.1 had the highest levels of arsenic, with a median concentration of 25 mg/kg ww compared to prawn from MA 9, which had a median concentration of 9.6 mg/kg ww (Dunn's, $p < 0.05$). The prawns from the remaining seven Marine Areas and Elliott Bay did not vary significantly and had a median arsenic concentration range of 22 mg/kg ww in MA 13 to 13 mg/kg ww in Elliott Bay (Figure 20,Table E2).

Arsenic in Dungeness crab muscle was positively correlated with arsenic in the hepatopancreas (linear regression, $p < 0.001$, $r^2 = 0.932$; Table 18, Figure 21A) and arsenic in muscle was roughly 1.3 times greater than in hepatopancreas (Table E3). The y-intercept was not significant and the regression equation was simplified as a result ($p = 0.218$). In addition, arsenic in spot prawn muscle was positively correlated with arsenic in head tissue (linear regression, $p < 0.001$, $r^2 = 0.980$; Table 18, Figure 21B) and arsenic in muscle was roughly 1.2 times greater than in head tissue (Table E4). As with crab, the y-intercept was not significant and the regression equation was simplified as a result ($p = 0.549$). These results give us the ability to predict arsenic concentration in Dungeness crab hepatopancreas and spot prawn head tissue based on arsenic found in the muscle of either species.

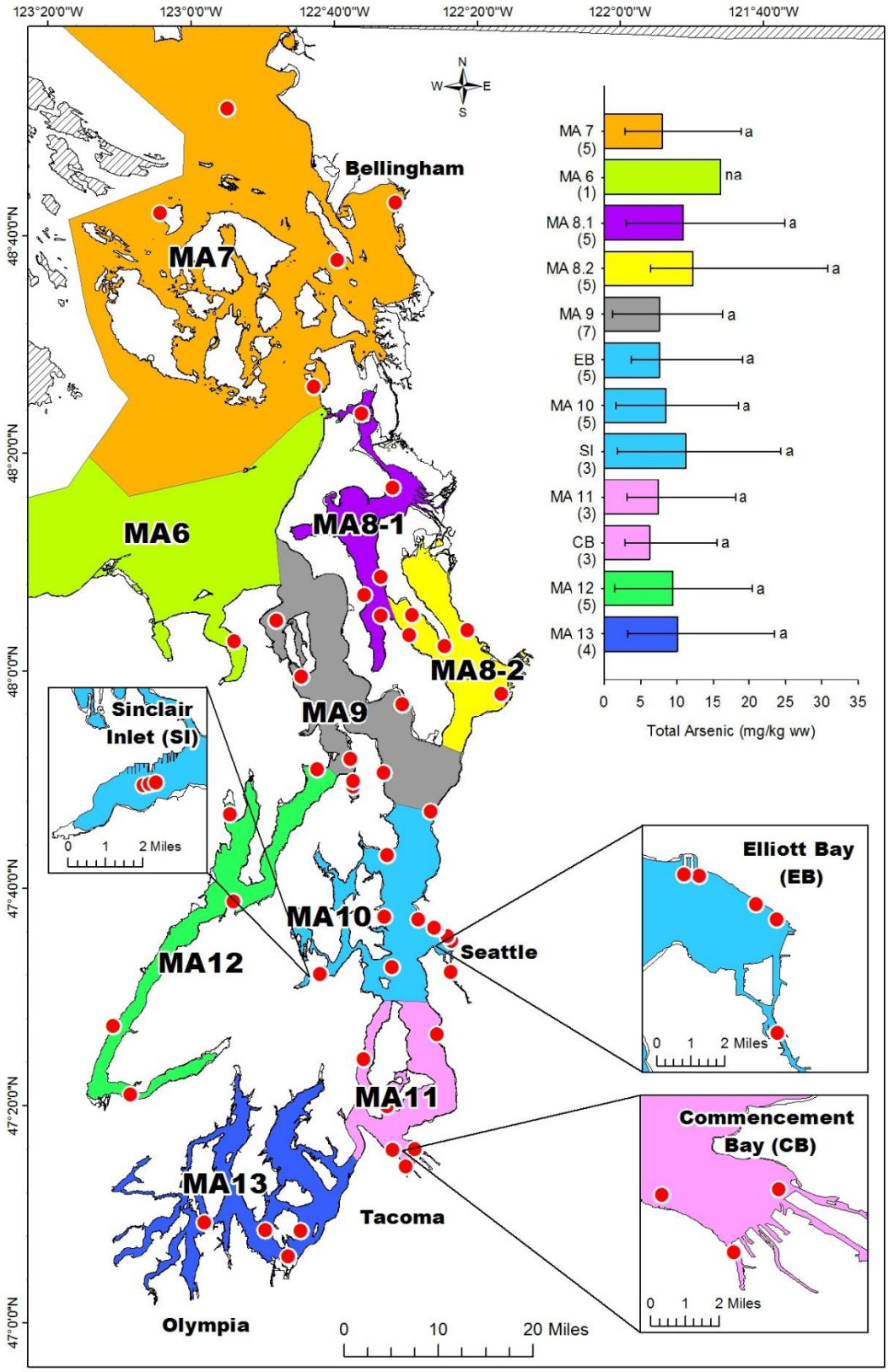

Figure 19. Geometric mean concentrations of total arsenic (mg/kg ww) in Dungeness crab muscle tissue ± 95% CI by WDFW Marine Area and three urban areas (EB = Elliott Bay, SI = Sinclair Inlet and CB = Commencement Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$, na = not analyzed) and sample size is in parentheses.

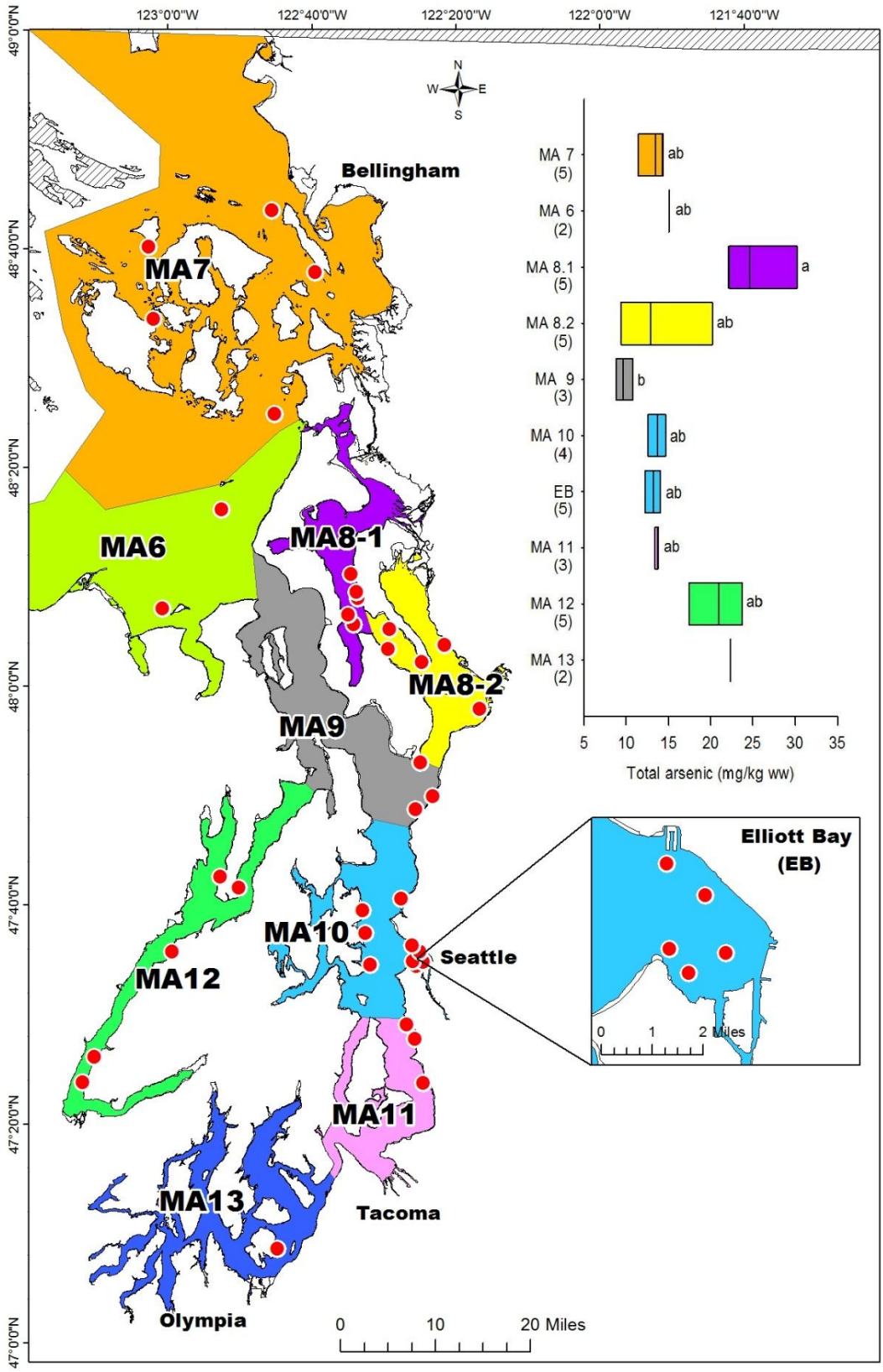

Figure 20. Median concentrations of total arsenic (mg/kg ww) in spot prawn muscle by WDFW Marine Area and one urban embayment (EB = Elliott Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Boxes with the same letter are not significantly different ($p > 0.05$) and sample size is in parentheses.

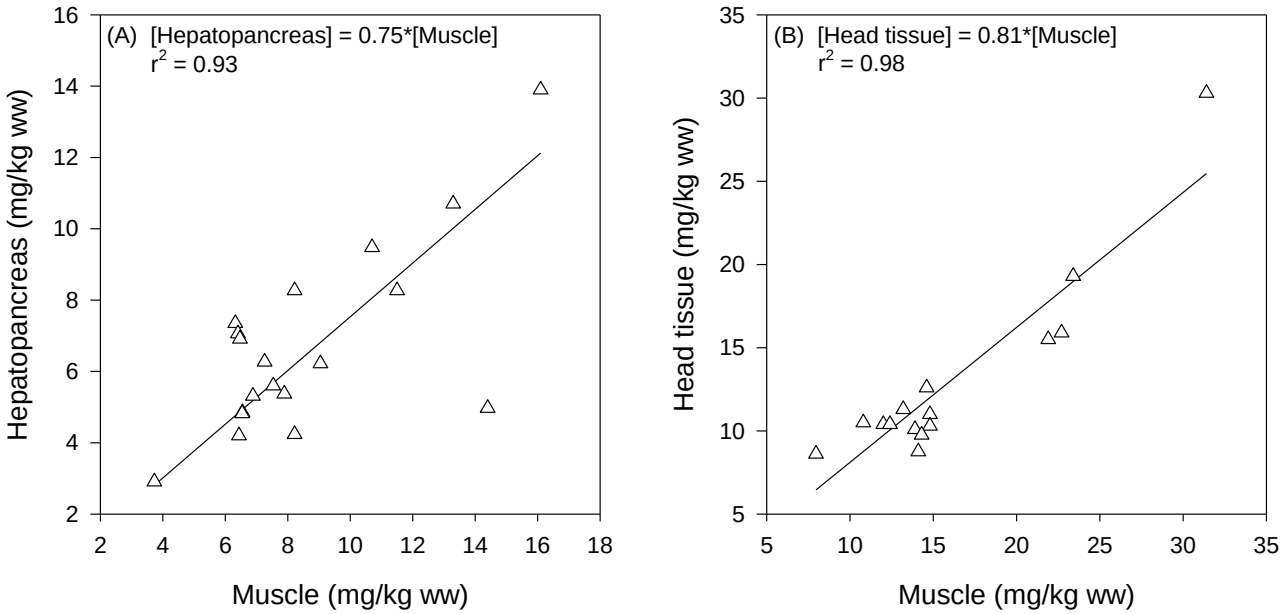

Figure 21. Regression results of arsenic (mg/kg ww) in (A) Dungeness crab muscle in relation to hepatopancreas and (B) spot prawn muscle in relation to head tissue

Cadmium

Cadmium was detected in 80.4 % of Dungeness crab muscle samples and 100% of spot prawn muscle samples (Table 15) and the non-detect samples for Dungeness crab varied across locations. Cadmium in Dungeness crab muscle ranged from 0.0019 mg/kg ww in Elliott Bay to 0.019 mg/kg ww in MA 11 (Table E1). Detected cadmium levels in spot prawn ranged from 0.013 mg/kg ww in MA 7 to 0.041 mg/kg ww in MA 12 (Table E2), which was two times higher than the maximum level in crabs.

The variability of cadmium in Dungeness crab muscle was explained by location (ANOVA, natural log-transformed, $F_{(10,50)} = 3.48$, $p = 0.002$; Table 16). Pairwise comparison found Dungeness crab from MA 11 had the highest level of cadmium, with a geometric mean of 0.0081 mg/kg ww, when compared to crab collected in areas with the lowest cadmium concentration, MA 8.1 and Sinclair Inlet, both at 0.0023 mg/kg ww (THSD, $p < 0.04$). There were no discernible patterns among the other seven MAs and two urban embayments (Figure 22).

The variability of cadmium in spot prawn muscle was also explained by location (ANOVA, $F_{(9,39)} = 3.88$, $p = 0.003$; Table 17). Prawn collected in MA 12 had the highest cadmium geometric mean concentration of 0.031 mg/kg ww when compared to prawn from MAs 11, 10, and 9 (descending order of cadmium levels) which ranged from 0.019 mg/kg ww in MA 11 to 0.016 mg/kg ww in MA 9 (THSD, $p < 0.04$). Cadmium concentrations in spot prawn did not vary widely across the areas and there was no noticeable pattern of contamination (Figure 23).

Cadmium in Dungeness crab muscle was positively correlated with cadmium in hepatopancreas (linear regression, log-transformed, $p = 0.004$, $r^2 = 0.387$; Table 18, Figure 24A) and cadmium in hepatopancreas was roughly 174 times greater than in muscle (Table E3). Cadmium in spot prawn muscle was also positively correlated with cadmium in head tissue (linear regression, $p < 0.001$, $r^2 = 0.936$; Table 19, Figure 24B) and cadmium in head tissue was roughly 44 times greater than in muscle (Table E4). In addition, the y-intercept of the spot prawn analysis was not significant and the regression equation was simplified as a result.

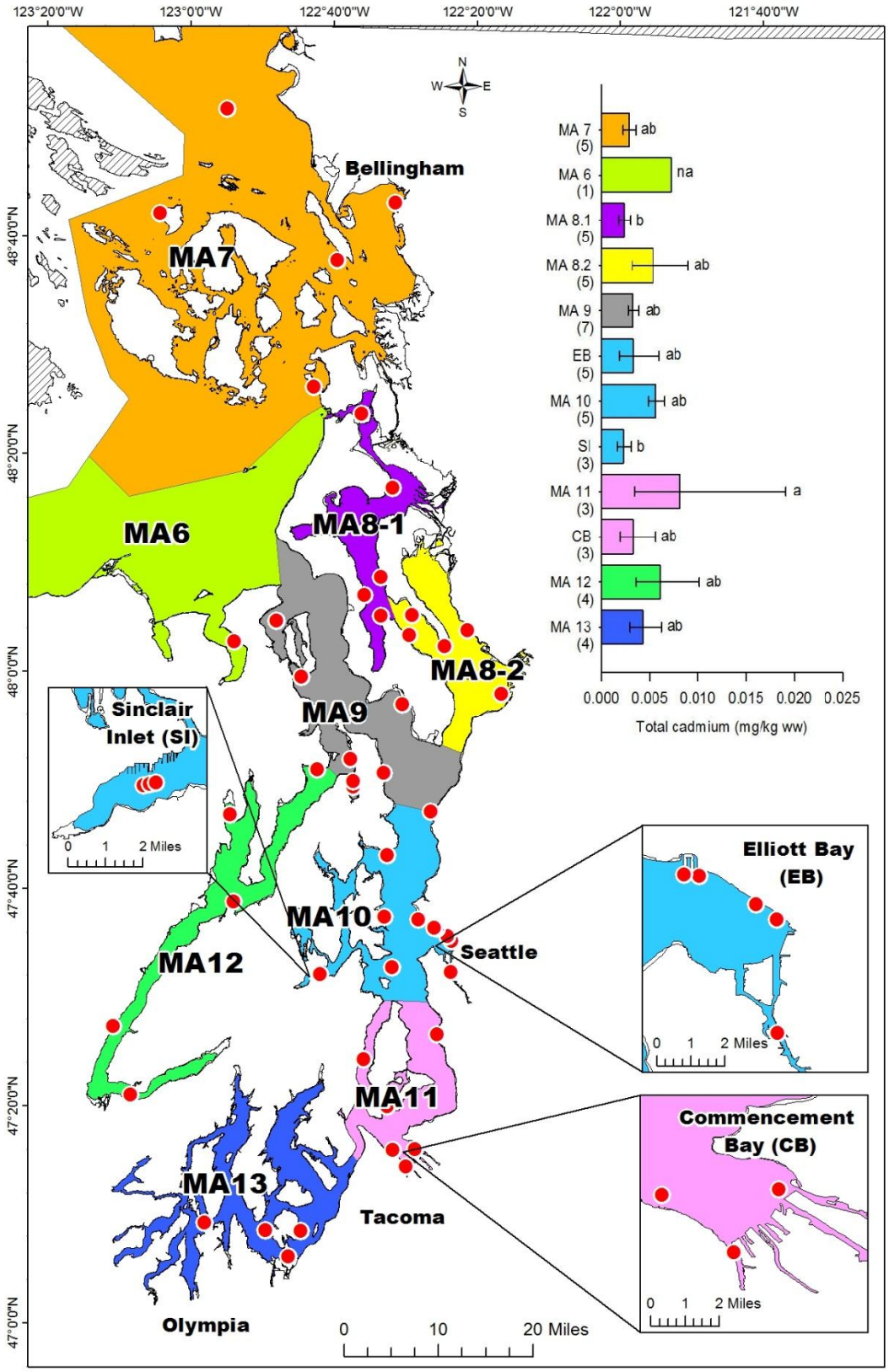

Figure 22. Geometric mean concentrations of total cadmium (mg/kg ww) in Dungeness crab muscle tissue ± 95% CI by WDFW Marine Area and three urban areas (EB = Elliott Bay, SI = Sinclair Inlet and CB = Commencement Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$, na = not analyzed) and sample size is in parentheses.

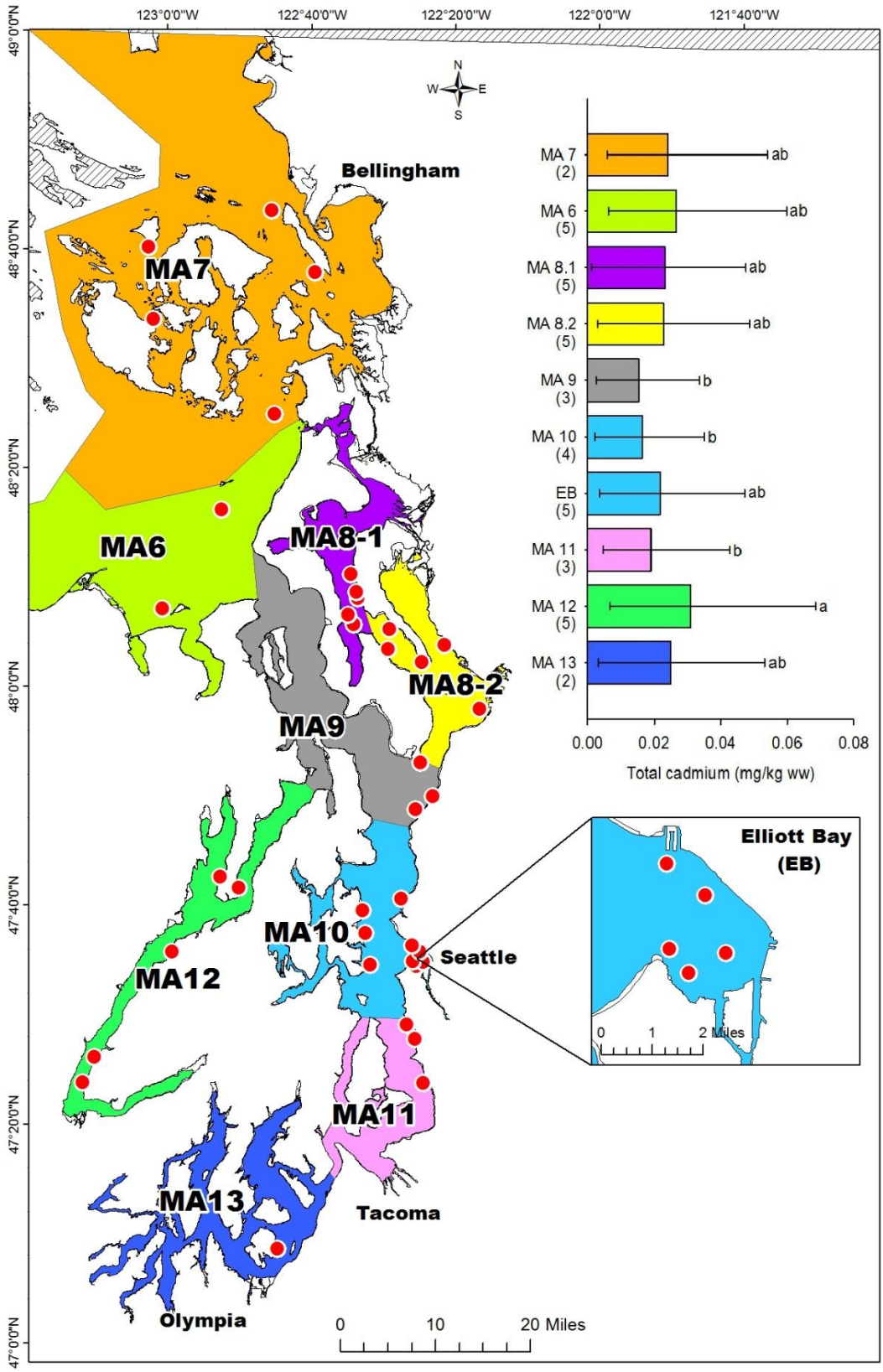

Figure 23. Geometric mean concentrations of total cadmium (mg/kg ww) in spot prawn muscle tissue ± 95% CI by WDFW Marine Area and one urban area (EB = Elliott Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$) and sample size is in parentheses.

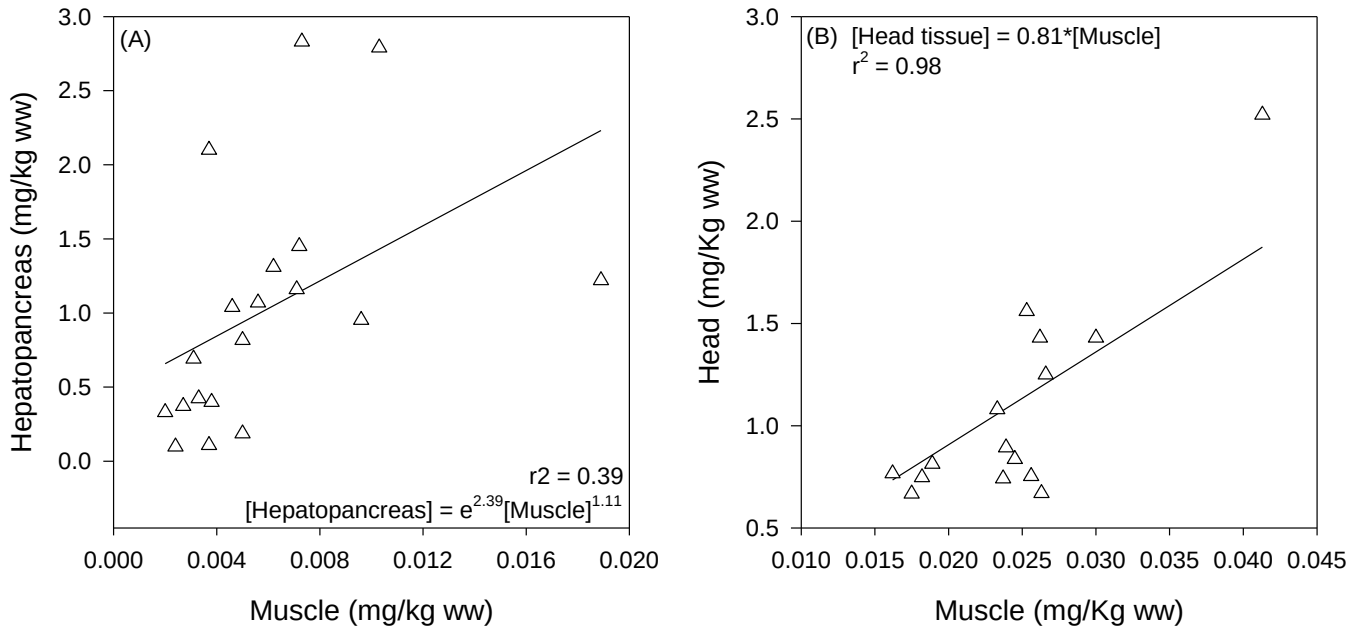

Figure 24. Regression results of cadmium (mg/kg ww) in (A) Dungeness crab muscle in relation to hepatopancreas and (B) spot prawn muscle in relation to head tissue

Copper

Copper was detected in all samples of Dungeness crab and spot prawn muscle (Table 15). In Dungeness crab muscle, copper ranged from 4.22 mg/kg ww in MA 7 to 13.2 mg/kg ww in MA 13 (Table E1). Copper levels in spot prawn were similar to crab with a range from 4.18 mg/kg ww in MA 8.2 to 12.4 mg/kg ww in MA 8.1 (Table E2).

Copper in Dungeness crab muscle did not vary significantly across locations (ANOVA, $F_{(10,50)} = 1.34$, $p = 0.245$; Table 16, Figure 25). However variability of copper in spot prawn muscle was explained by location (ANOVA, $F_{(9,39)} = 3.76$, $p = 0.003$; Table 17). Spot prawn collected in MA 8.1 had the highest geometric mean concentration of copper (9.9 mg/kg ww). Spot prawn collected in MA 8.1 were significantly higher than prawn with the four lowest concentrations from MAs 8.2, 10, 7 and 9 (descending order of concentration) with geometric mean copper concentrations ranging from 6.9 mg/kg ww in MA 8.2 to 6.1 mg/kg ww in MA 9 (THSD, $p < 0.04$). Spot prawn collected in Elliott Bay, MAs 12, 11, 6 and 13 were not significantly different from either MA 8.1 or the 4 areas with the lowest copper concentrations (Figure 26). Copper concentrations in spot prawn muscle were only slightly less than the concentrations reported in crab muscle.

Copper in Dungeness crab muscle was positively correlated with copper in the hepatopancreas (linear regression, $p < 0.001$, $r^2 = 0.836$; Table 18, Figure 27A) and copper in the hepatopancreas was roughly 2.5 times greater than in muscle (Table E3). The y-intercept was not significant and the regression equation was simplified as a result. These results give us the ability to predict copper in Dungeness crab hepatopancreas based on copper concentrations in their muscle. Conversely, no relationship was found between copper in spot prawn muscle and copper in head tissue (linear regression, $p = 0.73$, $r^2 = 0.010$; Table 19, Figure 27B) but copper in head tissue was roughly 8.5 times greater than in muscle (Table E4). Thus, the copper concentration in spot prawn muscle should not be used to predict copper concentrations in the head tissue.

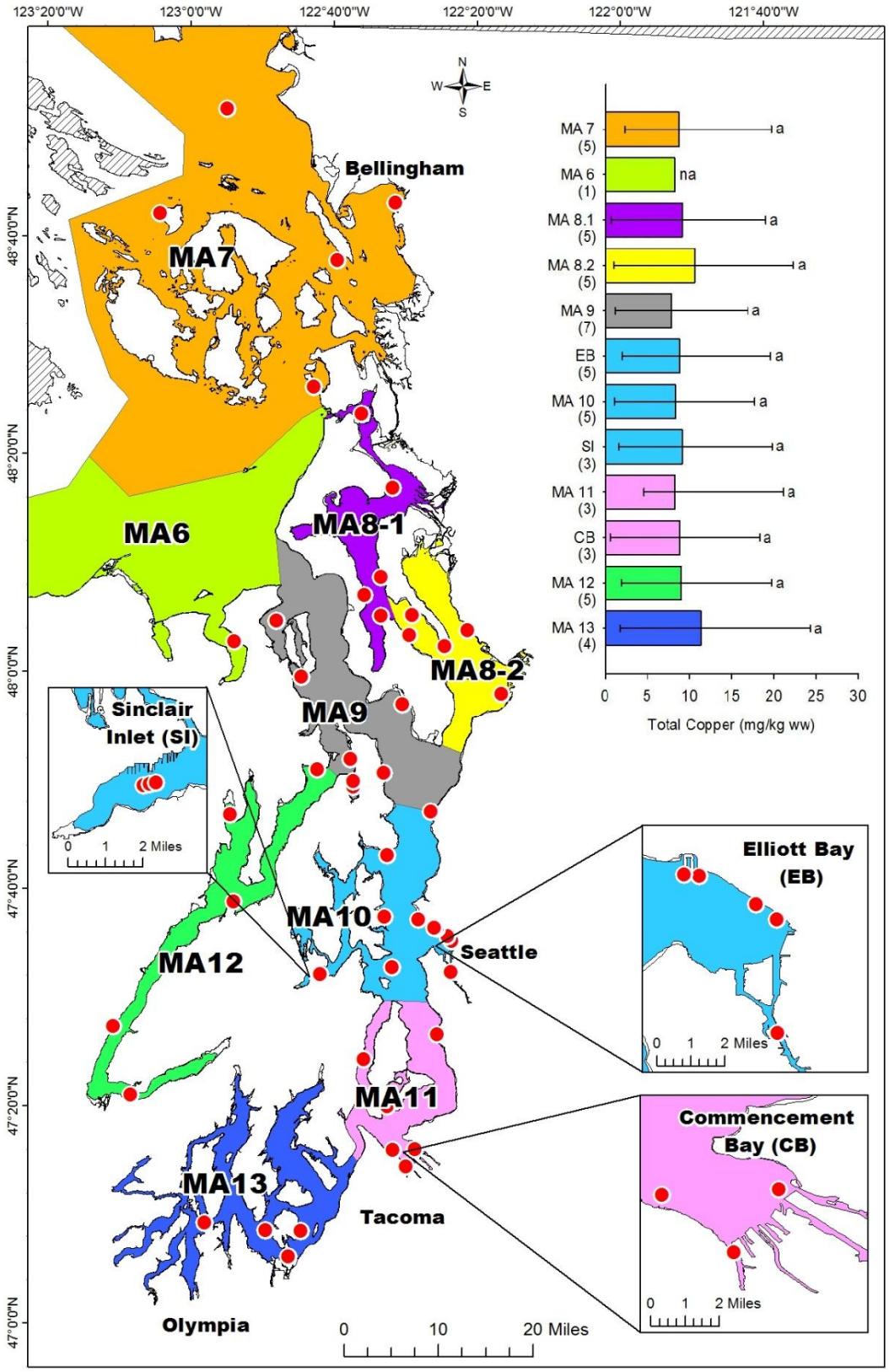

Figure 25. Geometric mean concentrations of total copper (mg/kg ww) in Dungeness crab muscle tissue ± 95% CI by WDFW Marine Area and three urban areas (EB = Elliott Bay, SI = Sinclair Inlet and CB = Commencement Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$, na = not analyzed) and sample size is in parentheses.

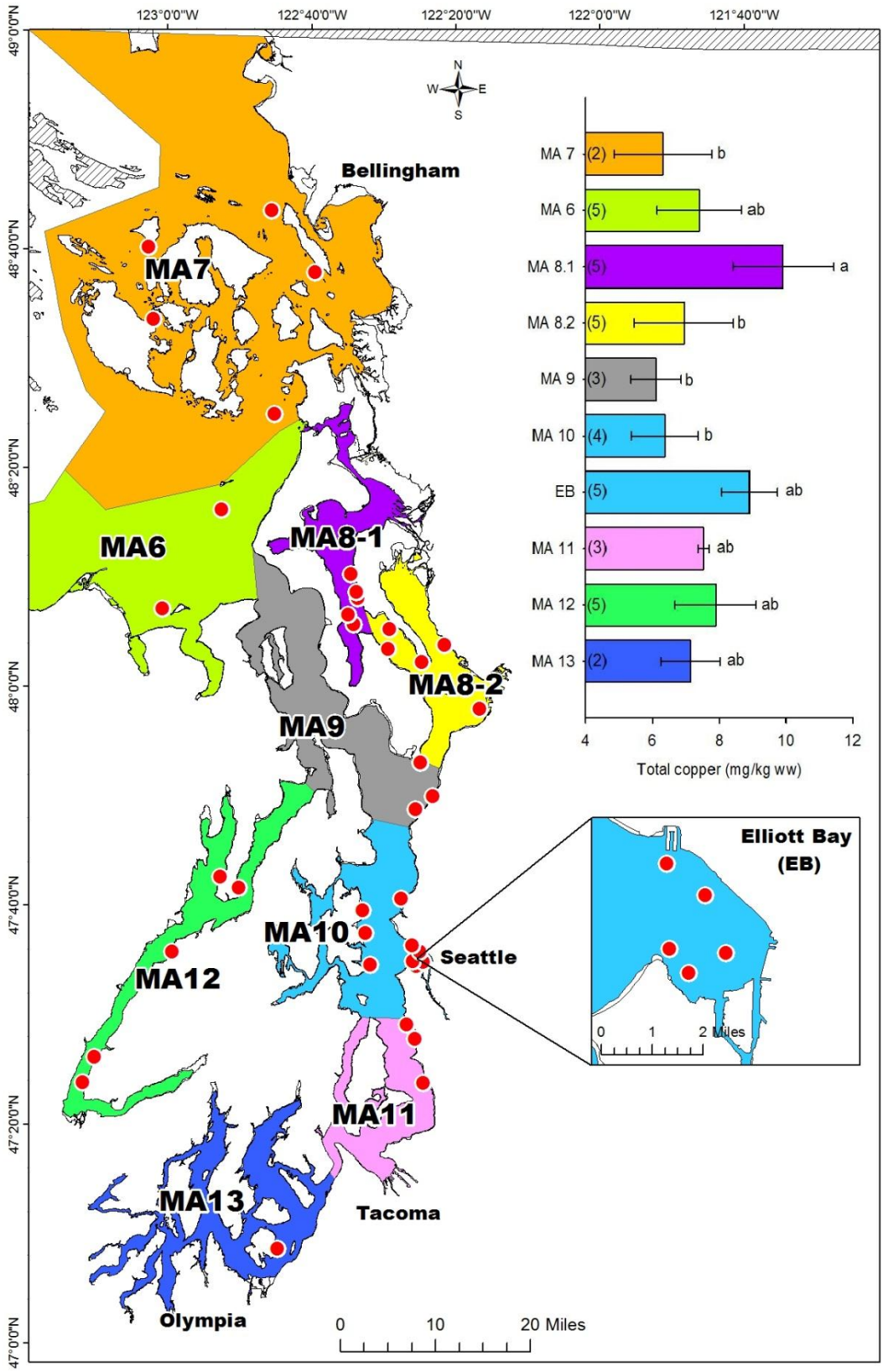

Figure 26. Geometric mean concentrations of total copper (mg/kg ww) in spot prawn muscle tissue ± 95% CI by WDFW Marine Area and one urban area (EB = Elliott Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$) and sample size is in parentheses.

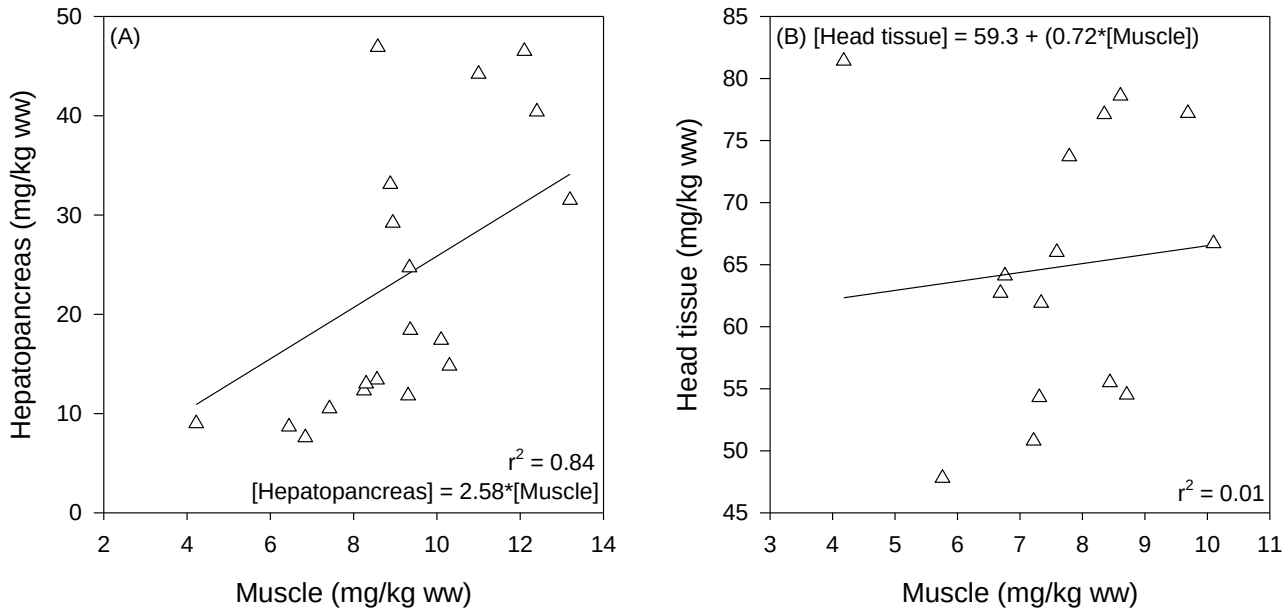

Figure 27. Regression results of copper (mg/kg ww) in (A) Dungeness crab muscle in relation to hepatopancreas and (B) spot prawn muscle in relation to head tissue

Lead

Lead was the least detected of all the metals analyzed. Only 39.2% of Dungeness crab muscle stations and 2.6% of spot prawn muscle stations had detected levels of lead (Table 15). In Dungeness crab muscle, lead was only detected in 9 of 12 locations and it ranged from 0.0038 mg/kg ww (MDL) in MA 8.2 to 0.023 mg/kg in Commencement Bay (Table E1). In spot prawn muscle, lead was only detected in one sample from Elliott Bay (ELLTBAY4_P91) at 0.0045 mg/kg ww (Table E2).

For Dungeness crab muscle, MA 10, Elliott Bay, and Sinclair Inlet reported all samples above the detection limits with crab collected in Elliott Bay having the highest mean lead concentration of 0.014 mg/kg ww. Commencement Bay had two out of three total crab samples above the detection limits and they had the same mean lead concentration as Elliott Bay. MAs 7, 8.2, 9, 11, and 13 all had one sample above the detection limit, but all those means just slightly higher than the MDL of 0.038 mg/kg ww (Table E1). ANOVA analyses were not performed on either data set due to the large number of non-detects.

Since lead was detected in all crab hepatopancreas and prawn head tissue samples, regression analyses were performed using the MDL value in place of a zero as the detection value. Initially, the crab tissues failed tests of variance and normality due to the Elliott Bay Pier 69 (ELLTBAY_P69) station which had hepatopancreas lead levels 2.5 times greater than the second highest value, thus it was declared an outlier and excluded from further analyses. Lead in Dungeness crab muscle was positively correlated with lead in the hepatopancreas (linear regression, $p < 0.001$, $r^2 = 0.632$; Table 18, Figure 28A) and lead in the hepatopancreas was roughly 12 times greater than in muscle (Table E3). Also, the y-intercept was not significant and the regression equation was simplified as a result. Since only 39.2% of the crab muscle stations had detected levels of lead and the remaining 60.8% had substituted MDL values more crab muscle samples should be analyzed to fill in the missing data. Although only 2.6% of the spot prawn muscle stations had detected values, lead in spot prawn muscle was positively correlated with lead in head tissue (linear regression, $p < 0.001$, $r^2 = 0.868$; Table 19, Figure 28B) and lead in the head tissue was roughly 18 times greater than in the muscle (Table E4). In addition, the y-intercept was not significant and the regression equation was simplified as a result. These results could be used to predict lead in both Dungeness crab hepatopancreas and spot prawn head tissue from lead concentrations in the muscle of either species, but it should be used with caution since it was generated using few detected values.

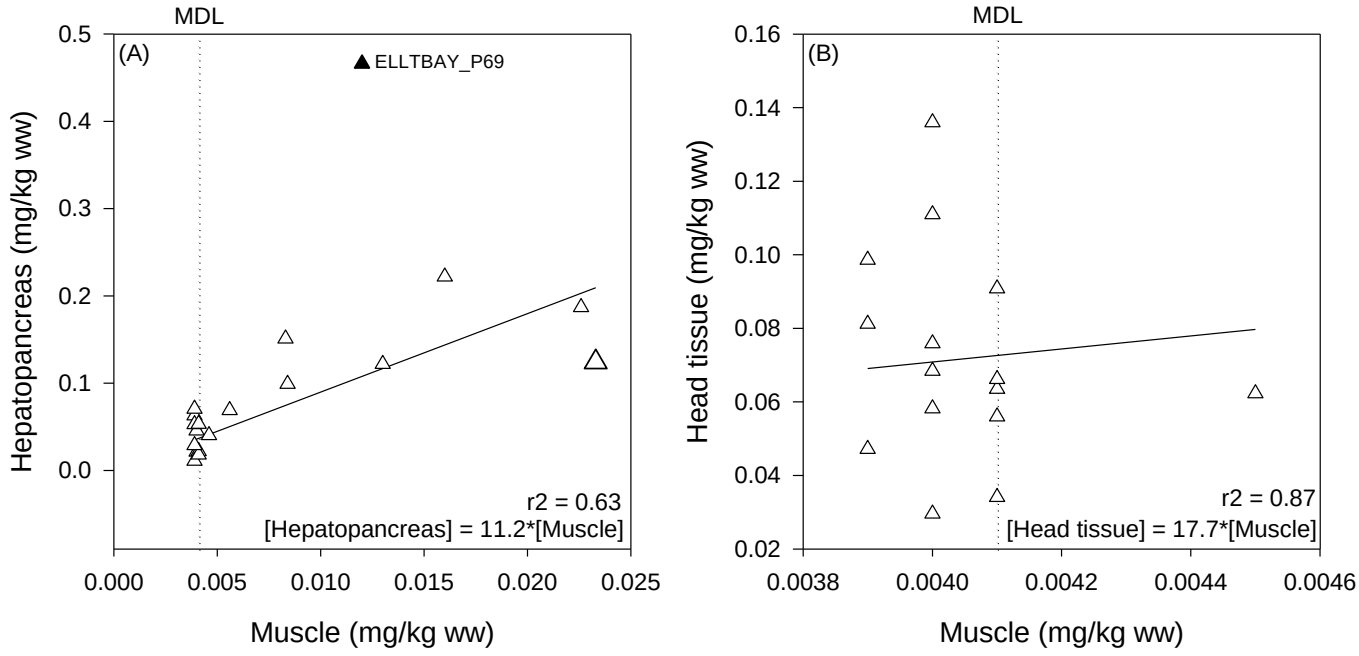

Figure 28. Regression results of lead (mg/kg ww) in (A) Dungeness crab muscle in relation to hepatopancreas and (B) spot prawn muscle in relation to head tissue. Any plot on or to the left of the MDL line are non-detects. ELLTBAY_P69 removed from the crab analysis as an outlier.

Zinc

Zinc was detected in all Dungeness crab and spot prawn muscle samples (Table 15). In Dungeness crab muscle, the range of zinc across all locations occurred also within MA 7, with a minimum of 26 mg/kg ww and a maximum of 61.2 mg/kg ww (Table E1). In spot prawn muscle, zinc ranged from 10.9 mg/kg ww in MA 9 to 14.2 mg/kg ww in MA 8.1 (Table E2).

Zinc concentrations in Dungeness crab muscle failed the parametric assumptions for ANOVA testing, therefore the non-parametric Kruskal-Wallis test was used to determine differences between locations. Zinc in Dungeness crab muscle did not vary significantly across all locations (Kruskal-Wallis, $p = 0.538$; Table 16, Figure 29).

The variability of zinc in spot prawn muscle was explained by location (ANOVA, $F_{(9,39)} = 5.95$, $p < 0.001$; Table 17). However, zinc in spot prawn only varied by 2.1 mg/kg ww across Puget Sound (Figure 30). Spot prawn from Marine Areas 13 and 8.1 both had the highest zinc concentration, with geometric means of 13.5 mg/kg ww. Spot prawn collected in Elliott Bay had the second highest zinc concentration (13.3 mg/kg ww) and was not significantly different from MA 13 or 8.1. Spot prawn from MAs 7 and 9 had the lowest zinc concentrations (11.7 and 11.4 mg/kg ww, respectively) and were significantly lower than MAs 13, 8.1 and Elliott Bay (THSD, $p < 0.003$).

Zinc in Dungeness crab muscle was positively correlated with zinc in the hepatopancreas (linear regression, $p < 0.001$, $r^2 = 0.974$; Table 18, Figure 31A) and zinc in muscle was roughly three times greater than in the hepatopancreas (Table E3). The y-intercept was not significant and was removed from the regression equation. Also, zinc in spot prawn muscle was positively correlated with zinc in head tissue (linear regression, $p < 0.001$, $r^2 = 0.989$; Table 19, Figure 31B) and zinc in head tissue was roughly two times greater than in muscle (Table E4). Similarly, the y-intercept was not significant and the regression equation was simplified. These results give us the ability to predict zinc concentrations in Dungeness crab hepatopancreas and spot prawn head tissue based on zinc found in the muscle of either species.

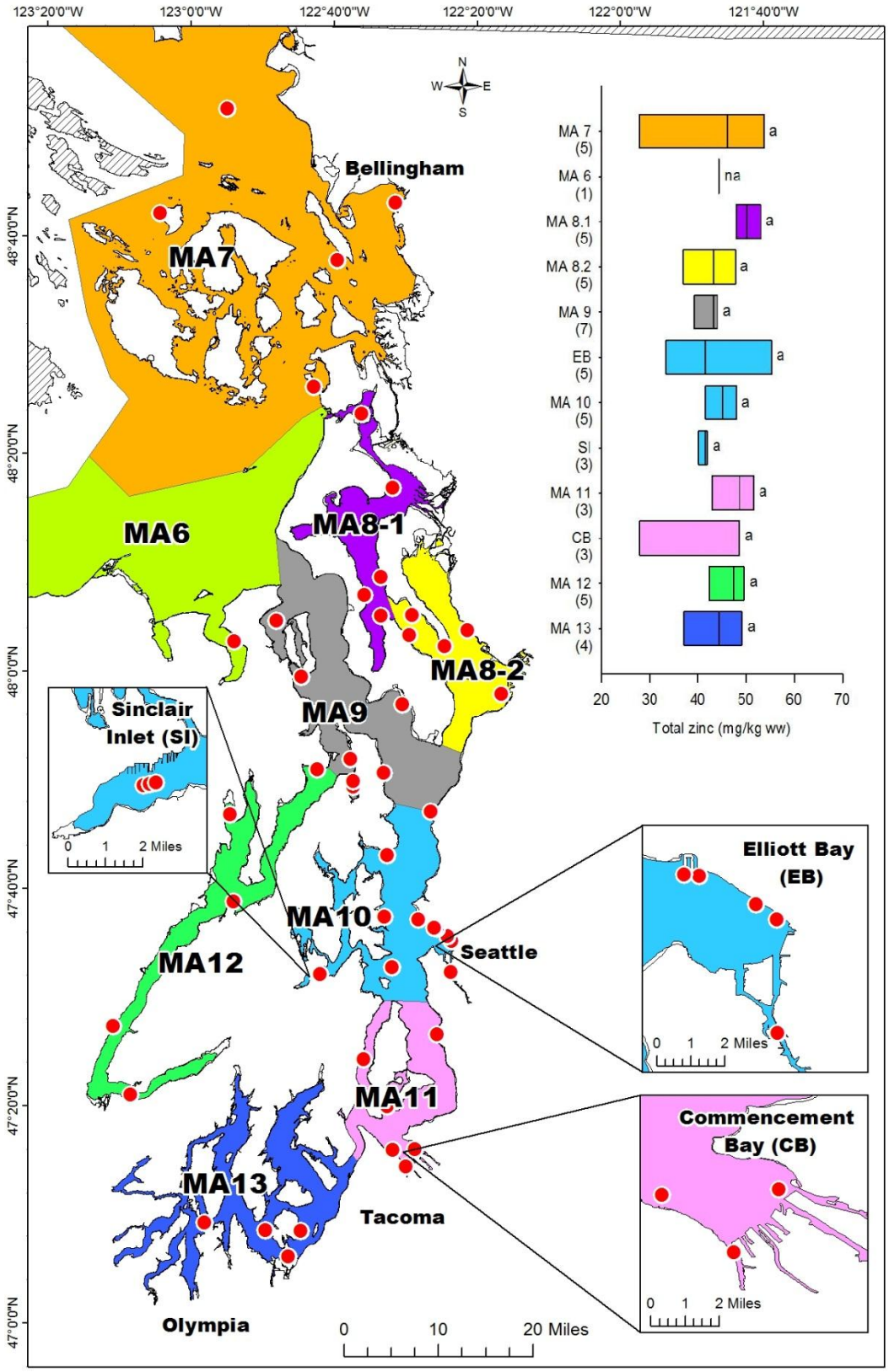

Figure 29. Median concentrations of total zinc (mg/kg ww) in Dungeness crab muscle by WDFW Marine Area and three urban embayments (EB = Elliott Bay, SI = Sinclair Inlet, CB = Commencement Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Boxes with the same letter are not significantly different ($p > 0.05$) and sample size is in parentheses.

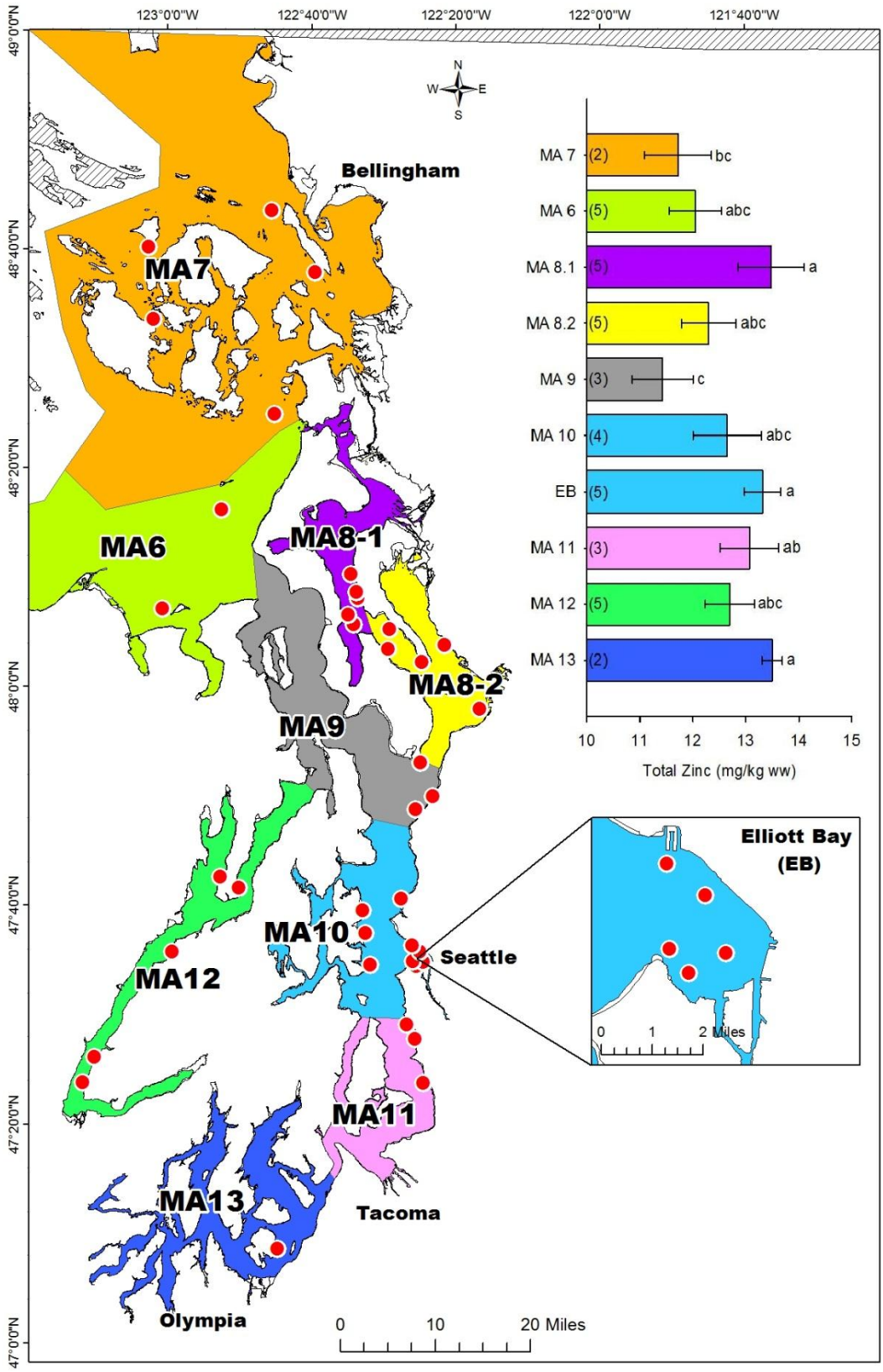

Figure 30. Geometric mean concentrations of total zinc (mg/kg ww) in spot prawn muscle tissue ± 95% CI by WDFW Marine Area and one urban area (EB = Elliott Bay) and the results of the pairwise comparison analysis. Red dots indicate sampling stations. Bars with the same letter are not significantly different ($p > 0.05$) and sample size is in parentheses.

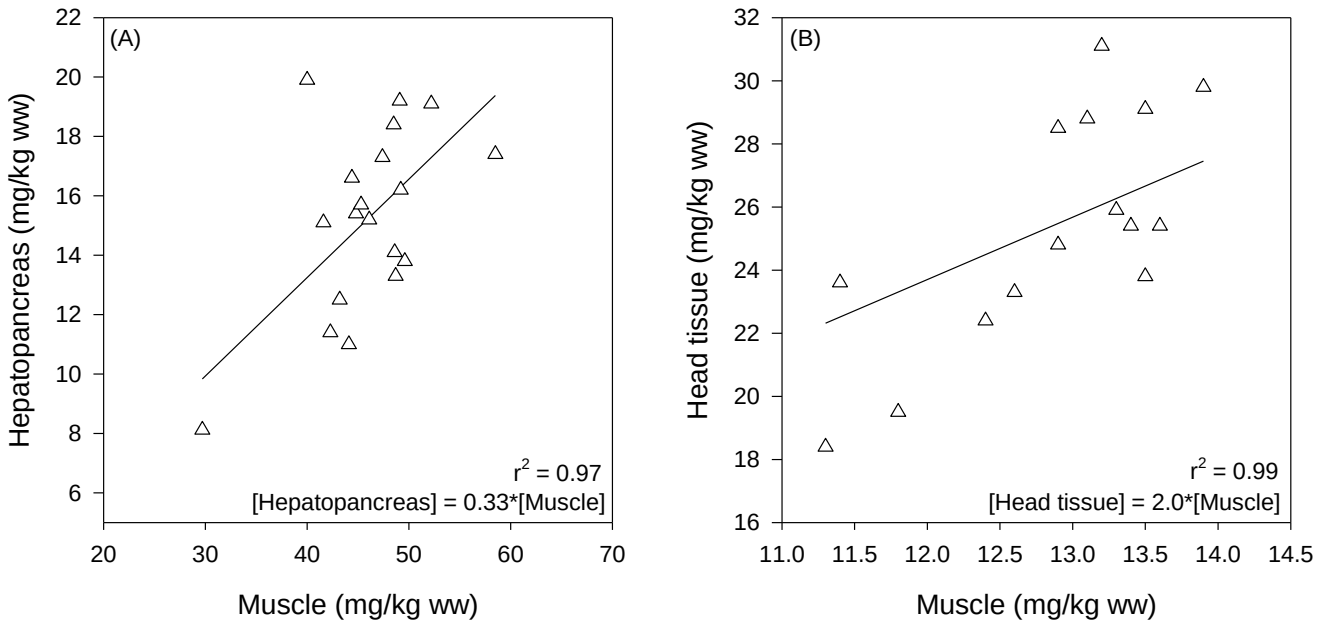

Figure 31. Regression results of zinc (mg/kg ww) in (A) Dungeness crab muscle in relation to hepatopancreas and (B) spot prawn muscle in relation to head tissue

DISCUSSION

Overview

We found most POPs and metal concentrations in both Dungeness crab and spot prawn muscle were relatively low, with the greatest concentrations of POPs found in highly urbanized areas. In addition, the concentration of all POPs and some metals were consistently higher in crab hepatopancreas or spot prawn head tissue compared to muscle tissue. In muscle tissue only one POP, eTPCBs, was consistently above 5 ng/g ww in many samples. The greatest concentrations of PCBs (or any other POPs), were observed in Elliott Bay, Sinclair Inlet and Commencement Bay. In contrast to PCBs, the mean Σ_{11}PBDEs, Σ_6DDTs and Σ_{37}PAHs were below 3 ng/g ww in muscle tissue for both species, from all locations. In addition, hexachlorobenzene and hexachlorocyclohexanes were rarely detected in muscle tissue from either species in any location and Σ_8Chlordanes concentrations were below 1 ng/g in muscle from both species in all locations.

PCBs

Polychlorinated biphenyls were the most abundant POP reported in both Dungeness crab and spot prawn muscle tissue across all the areas analyzed in Puget Sound. The greatest concentrations were observed in the most contaminated urban embayments and generally followed spatial patterns reported for PCBs in English sole (*Parophrys vetulus*), a benthic flatfish (West et al. 2001). Greatest mean eTPCB concentrations in crab muscle were from the urban locations, Elliott Bay, Commencement Bay, and Sinclair Inlet, at 119, 29 and 27 ng/g ww, respectively. PCBs were uniformly low (mean of less than 7 ng/g ww) across all non-urban Marine Areas with the exception of MA 10, which exhibited a mean eTPCB of 18 ng/g ww. This intermediate MA 10 value resulted from including crab from the Four-mile Rock station (Station 34, Figure 1) in MA 10, rather than including them in the urban sub-division of Elliott Bay. The Four-mile Rock station is located near the northwestern margin of Elliott Bay, just outside the line used to demarcate the bay, and it clearly exhibited PCB characteristics similar to samples from Elliott Bay (eTPCB of 55 ng/g ww). The maximum eTPCB from all other non-urban MA 10 locations was 12 ng/g ww. Ylitalo et al. (1999) reported total PCB concentrations in Dungeness crab muscle in similar ranges: Elliott Bay, 120 ng/g ww; Commencement Bay, 43 ng/g ww; Nisqually Reach (in MA 13), 8.6 ng/g ww; and Useless Bay (in MA 9); 5.7 ng/g ww.

Spot prawn were only sampled from one of the three urban locations in this study; Elliott Bay. This species typically inhabits waters deeper than are found in Sinclair Inlet and Commencement Bay. PCBs were seven times higher in crab muscle than prawn muscle in Elliott Bay, yet PCB concentration was roughly equivalent between the two species in all other non-urban Marine Areas, where the mean concentration of muscle eTPCB was 10 ng/g ww or lower (both species). Differences in the species' PCB concentrations in Elliott Bay probably resulted from the different sampling locations within the bay; most crab samples were taken from the Duwamish River and the shallow nearshore waters along the Seattle Waterfront (Stations 27, 30 and 31 in Figure 1). These are PSEMP index-site sampling locations where English sole have consistently exhibited high PCB residues as well (West et al. 2001). Conversely, Elliott Bay spot prawn were taken in deeper waters from along the southwestern shoreline, where PCBs among English sole have been consistently low (West et al. 2001), and in deeper waters of the central or northern bay.

PBDEs

PBDE patterns in crab and prawns were similar to those reported by PSEMP for English sole. English sole from non-urban sites exhibited Σ_{11}PBDE muscle concentrations less than 3 ng/g ww, while fish from urban monitoring sites, such as Elliott Bay, ranged from 0.6 to 20 ng/g ww (WDFW unpublished data). Similarly, Dungeness crab muscle from Elliott Bay and Commencement Bay had significantly higher concentrations of Σ_{11}PBDE than crab from many other non-urban locations. However, relative to English sole Σ_{11}PBDE concentrations in muscle tissue of both species from all locations was low; maximum concentrations were 7.3 and 2.8 ng/g ww in crab muscle from the two urban bays (Commencement and Elliott Bays), while samples from all the other locations had Σ_1PBDE concentrations of less than 2 ng/g wet ww for crab and less than 1 ng/g ww for spot prawn muscle.

DDTs and other Chlorinated POPs

DDTs were detected in most crab muscle samples but were only detected in one prawn muscle sample. The spatial pattern of DDT distribution in crab muscle was similar to PBDEs; concentrations were low overall (maximum values less than 5 ng/g ww, and mean values less than 3 ng/g ww), and Σ_6DDTs were greatest in crab from Elliott Bay and Commencement Bay.

PAHs

As with the chlorinated POP compounds, PAHs were uniformly low (mean Σ_{37}PAHs less than 3 ng/g ww) in muscle tissue of both crab and spot prawn from all locations. Similar to the chlorinated POPs, PAHs were higher in crab and spot prawn muscle from the urban locations. It is likely that the higher concentration of PAHs in crab relative to prawn in Elliott Bay was the result of small spatial-scale differences in catch locations (see PCBs above).

Metals

Unlike POPs all the metals we measured in this study occur naturally in seawater, so we expect to find them in some form in all tissue samples. Of the six metals measured in Dungeness crab muscle only concentrations of mercury and lead appeared to be related to urban habitats (mercury in Elliott Bay and Sinclair Inlet, lead in Elliott Bay). Lead was rarely detected in spot prawn muscle and mercury was variable and low (< 0.05 ng/g ww) across all spot prawn locations. Although low overall, the greatest concentrations of mercury in spot prawn were found in the northernmost Marine Areas (MA 8.2, 8.1, 6, and 7). These mercury and lead results are generally consistent with concentrations and geographic patterns found in English sole muscle tissue (West et al. 2001).

Concentrations of arsenic, cadmium, zinc and copper were characterized by high variability among species and across Marine Areas. There appeared to be no relationship between these metals and urban locations, suggesting that either (1) exposure to these metals across Marine Areas is also highly variable (and possibly unrelated to human activities), or (2) these species can metabolically regulate metals, with the result that metals do not accumulate in muscle tissue.

Comparison of Contaminants in Muscle with Other Tissues

Dungeness crab hepatopancreas and spot prawn head tissues had as much as 36 times higher concentrations of POPs, on average, than their corresponding muscle tissues (Tables C1 through C8). The higher POPs concentrations found in the hepatopancreas and head are most likely related to the high lipid content (Hellou, et al. 1997) and the detoxification function of that organ. Our findings are in agreement with Ylitalo et al. (1999), who also observed a positive correlation between PCBs in hepatopancreas and muscle tissue from Dungeness crab, American lobster, and blue crab, with much greater concentrations of PCBs in hepatopancreas relative to the muscle.

Some metals were found at higher concentrations in the hepatopancreas and head tissue than in muscle. For Dungeness crab, cadmium, copper and lead were found in higher concentrations in the hepatopancreas relative to the muscle, while mercury, arsenic and zinc were found at lower concentrations in the hepatopancreas compared to the muscle. For spot prawn, cadmium, copper, lead and zinc were found at higher concentrations in the head tissue relative to their muscle, while mercury and arsenic were found at lower concentrations in the head tissue compared to the muscle.

Some useful predictive models were generated by comparing hepatopancreas (crab) or head (spot prawn) tissues with muscle tissue. Overall, positive slope coefficients from most linear regressions were significant, indicating preferential accumulation of the contaminants in the hepatopancreas and head, however variability in the

regression relationships increased with contaminant concentration. Log-transformation of contaminant concentrations for both tissues and both species were required to ensure homoscedasticity and normality of the data, but confidence of predicted values decreased with increasing tissue concentration.

Comparison to Other Studies

Ylitalo et al. (1999) examined various aquatic species in a 1993-1994 study, including Puget Sound Dungeness crab collected from multiple sites along both the Atlantic and Pacific coasts of the U.S. They determined that species from urban areas had higher body burdens of PCBs than species from non-urban sites. In their study Ylitalo et al. examined Dungeness crab muscle and hepatopancreas collected from four locations within Puget Sound, locations where we also collected crab for our study. Although separated by approximately 19 years, the PCB concentrations in muscle tissue of Dungeness crabs collected from urban areas of the Puget Sound in both studies was similar; mean concentration measured by Ylitalo et al. in 1999 in Elliott Bay and Commencement Bay were 156 ng/g ww and 56 ng/g ww respectively, while we measured 55-180 ng/g ww and 13-54 ng/g ww, respectively, in 2012. However, mean concentration of PCBs in muscle from crab collected by Ylitalo et al. in non-urban areas, specifically the Nisqually Reach and Useless Bay, were approximately two-and-a-half to five times higher than levels seen in non-urban areas for this study. In crab hepatopancreas, both studies reported highest PCB levels in Elliott Bay, however PCB concentrations in crab hepatopancreas from Elliott Bay in 1999 were 5.2 times higher than those collected in Elliott Bay in 2012 for this study (Ylitalo et al. 1999). However, POPs in the hepatopancreas were highly variable in both studies, especially at the high end of the concentration ranges, which may account for some of the disparity between the two studies.

Two British Columbian studies, conducted along the Pacific Oceanic coast and within the Strait of Georgia, observed distribution of PBDEs in Dungeness crab similar to this study – crab collected near urban areas and areas close to pulp/paper mills contained higher concentrations of PBDEs in the hepatopancreas compared to crab collected at non-urban, "pristine" sites (Ikonomou et al. 2002, Ikonomou et al. 2006). For the 2002 study, PBDEs in hepatopancreas from crab collected over a two year period from 1993-1995 ranged from 0.62 ng/g at the (pristine) reference site in Gardener, BC to 52.2 ng/g in Sechelt, BC (an urban site) (Ikonomou et al. 2002). Their PBDE values were reported on a lipid basis; we adjusted them to wet weight for comparison with our study, using lipid percentages reported in their study. PBDEs in crab hepatopancreas from our study ranged from 3.9 ng/g wet wt. in MA 8.1 (non-urban) to 200 ng/g in Commencement Bay (an urbanized bay), approximately four times higher than the highest concentration reported in British Columbia. In addition, we note that the lowest concentration of PBDEs in hepatopancreas from our MA 8.1 was roughly six times higher than the PBDEs in the hepatopancreas of the crabs collected at the pristine reference site in Gardener, BC, located north of Vancouver Island along the central coast of British Columbia (Ikonomou et al. 2002).

SUMMARY & CONCLUSIONS

The primary objective of this study was to evaluate the geographic extent and magnitude of toxic chemical contaminants in Dungeness crab (*Metacarcinus magister*) and spot prawn (*Pandalus platyceros*) throughout Puget Sound. This one-time 2011-2012 synoptic survey is the first broad scale, Puget Sound wide assessment of contaminants in these two crustaceans, both of which are important ecologically and economically to this region. Samples were collected either directly from test fisheries or from areas where people harvest for these species. Two hundred forty and 777 adult Dungeness crab and spot prawn with characteristics defined by rules for legal harvest were used in the study. Sampling was focused on muscle tissue but also included hepatopancreas for Dungeness crab, and head (thorax and abdomen, including hepatopancreas) tissue for spot prawn. Enough hepatopancreas and head tissues were sampled to generate regression models that could allow for the prediction of contaminant concentrations in these tissues from muscle tissue. This study will also provide contaminant data to the Washington Department of Health (DOH) for their human health risk assessment of these two edible species.

The most important conclusions from this study are:

- Overall, PCBs were the most abundant POPs in both Dungeness crab and spot prawn, followed by PAHs, PBDEs and DDTs in crab, and PAHs and DDTs in spot prawn. PBDEs were rarely detected in spot prawn.
- Highest POP concentrations for both species were observed in urban areas such as Elliott Bay, Sinclair Inlet, and Commencement Bay compared to the less urban areas of Puget Sound (Marine Areas 6, 7, 9, and 12).
- Mercury is the only metal that showed a strong (positive) correlation with urban areas, and only in Dungeness crab; arsenic, copper, and zinc in both species, and mercury in spot prawn were distributed more equally across all MAs and urban areas.
- With the exception of a few metals, contaminant concentrations in the hepatopancreas of Dungeness crab and head tissue of spot prawn were consistently higher (as much as 36 times higher) than the concentrations reported in the corresponding muscle for each species. The strength of the regression models to predict analyte concentrations in hepatopancreas or head from muscle tissue varied widely. In most cases variability in the relationship between the two increased as analyte concentration increased, lowering confidence in predictions for those scenarios.

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APPENDIX A: SAMPLE INFORMATION

Table A1. Dungeness crab muscle samples submitted for chemical analysis. Bolded stations were composited but not chemically analyzed due to budget constraints. Location number refers to Marine Area and urban embayments are represented by their initials (SI = Sinclair Inlet, EB = Elliott Bay, CB = Commencement Bay). Two additional aliquots were made from each station for possible future analysis and are being stored in a freezer; Aliquot C for high resolution PCB/Dioxin analysis and Aliquot D were saved as PSEMP archive samples.

Map Number	Station ID	Location	Number of specimens	Fish IDs	Aliquot A Samples Delivered to NOAA (task order 12CrabMuscle)	Submitted for analysis 12/5/12	Aliquot B Samples Delivered to KCEL (task order 12CrabMuscleKCEL)	Submitted for analysis 12/26/12
1	DISCOBAY_TU	6	5	127001-7005	12DB_TU-DCM01A	yes	12DB_TU-DCM01B	yes
2	VENDOVI	7	5	117038-7042	11VD-DCM01A	yes	11VD-DCM01B	yes
3	WALDRONISL_N	7	5	127011-7015	12WALD_N-DCM01A	yes	12WALD_N-DCM01B	yes
4	BHMHARBR	7	5	127016-7020	12BH-DCM01A	yes	12BH-DCM01B	yes
5	STRTGEOR[a]	7	5	127006-7010	12SG-DCM01A	yes	12SG-DCM01B	yes
6	ALLANISL_S	7	4	127021-7024	12ALNIS_S-DCM01A	yes	12ALNIS_S-DCM01B	yes
7	BABYISLAND	8.1	5	127051-7055	12BBY-DCM01A	yes	12BBY-DCM01B	yes
8	**GREENBANK**	**8.1**	**5**	**127046-7050**	**12GBNK-DCM01A**	**no**	**12GBNK-DCM01B**	**no**
9	NORTHBLUFF_N	8.1	5	127041-7045	12NBL_N-DCM01A	yes	12NBL_N-DCM01B	yes
10	CAMANOCITY_S	8.1	5	127036-7040	12CCS-DCM01A	yes	12CCS-DCM01B	yes
11	STRAWBERRYPT	8.1	5	127031-7035	12STRPT-DCM01A	yes	12STRPT-DCM01B	yes
12	SKAGITIS	8.1	5	127026-7030	12SKIS-DCM01A	yes	12SKIS-DCM01B	yes
13	PTGARDNR	8.2	5	117002-7006	11PG-DCM01A	yes	11PG-DCM01B	yes
14	CAMANOHEAD	8.2	5	127061-7065	12CH-DCM01A	yes	12CH-DCM01B	yes
15	LANGLEY_N	8.2	5	127056-7060	12LYN-DCM01A	yes	12LYN-DCM01B	yes
16	PTSUSAN	8.2	3	127066-7068	12PS-DCM01A	yes	12PS-DCM01B	yes
17	MABANA_N	8.2	5	127257-7261	12MB_N-DCM01A	yes	12MB_N-DCM01B	yes
18	**LOWELLPOINT**	**8.2**	**5**	**127252-7256**	**12LPT-DCM01A**	**no**	**12LPT-DCM01B**	**no**
19	PTGAMBLE_3	9	5	127267-7271	12PTGB3-DCM01A	yes	12PTGB3-DCM01B	yes
20	PTGAMBLE_1	9	5	127262-7266	12PTGB1-DCM01A	yes	12PTGB1-DCM01B	yes
21	EGLON	9	5	127126-7030	12ELN-DCM01A	yes	12ELN-DCM01B	yes
22	PTGAMBLE_N	9	5	127121-7025	12PTGB_N-DCM01A	yes	12PTGB_N-DCM01B	yes
23	USELESSBAY_M	9	5	127106-7010	12UB_M-DCM01A	yes	12UB_M-DCM01B	yes
24	OAKBAY	9	5	127101-7005	12OAKB-DCM01A	yes	12OAKB-DCM01B	yes
25	PTTWNSND_GC	9	5	127081-7085	12PT_GC-DCM01A	yes	12PT_GC-DCM01B	yes
26	SCLINLET	SI	5	116987-6991	11SI-DCM01A	yes	11SI-DCM01B	yes
26	SCLINLET	SI	5	116992-6996	11SI-DCM02A	yes	11SI-DCM02B	yes
26	SCLINLET	SI	5	116997-7001	11SI-DCM03A	yes	11SI-DCM03B	yes
27	DUWAMISH	EB	5	117056-7060	11DU-DCM01A	yes	11DU-DCM01B	yes
28	BLAKEISLAND_N	10	5	127176-7180	12BLK_N-DCM01A	yes	12BLK_N-DCM01B	yes

Continued.

Table A1 (continued). Dungeness crab muscle samples submitted for chemical analysis. Bolded stations were composited but not chemically analyzed due to budget constraints. Location number refers to Marine Area and urban embayments are represented by their initials (SI = Sinclair Inlet, EB = Elliott Bay, CB = Commencement Bay). Two additional aliquots were made from each station for possible future analysis and are being stored in a freezer; Aliquot C for high resolution PCB/Dioxin and Aliquot D were saved as PSEMP archive samples.

Map Number	Station ID	Location	Number of specimens	Fish IDs	Aliquot A Samples Delivered to NOAA (task order 12CrabMuscle)	Submitted for analysis 12/5/12	Aliquot B Samples Delivered to KCEL (task order 12CrabMuscleKCEL)	Submitted for analysis 12/26/12
29	**ALKIPOINT_S**	**10**	**5**	**127171-7175**	**12AKP_S-DCM01A**	**no**	**12AKP_S-DCM01B**	**no**
30	ELLTBAY	EB	3	117063-7065	11EB-DCM01A	**yes**	11EB-DCM01B	**yes**
31	ELLTBAY_P69	EB	4	127166-7169	12EB_P69-DCM01A	**yes**	12EB_P69-DCM01B	**yes**
32	ELLTBAY4_P89	EB	4	127161-7164	12EB4_P89-DCM01A	**yes**	12EB4_P89-DCM01B	**yes**
33	ELLTBAY4_P91SH	EB	4	127156-7159	12EB4-P91SH-DCM01A	**yes**	12EB4-P91SH-DCM01B	**yes**
34	4MILEROCK	10	5	127151-7155	124M-DCM01A	**yes**	124M-DCM01B	**yes**
35	YEOMALT_SH	10	5	127146-7150	12YEO_SH-DCM01A	**yes**	12YEO_SH-DCM01B	**yes**
36	PTMADISN_IND	10	5	127141-7145	12PM_IND-DCM01A	**yes**	12PM_IND-DCM01B	**yes**
37	**KINGSTON**	**10**	**5**	**127136-7140**	**12KG-DCM01A**	**no**	**12KG-DCM01B**	**no**
38	EDMONDS	10	5	127131-7135	12ED-DCM01A	**yes**	12ED-DCM01B	**yes**
39	COMMBAY	CB	5	116969-6973	11CB-DCM01A	**yes**	11CB-DCM01B	**yes**
40	COMMBAY4_DEEP	CB	4	127196-7199	12CB4_DEEP-DCM01A	**yes**	12CB4_DEEP-DCM01B	**yes**
41	COMMBAY_P23	CB	3	127201-7203	12CB_P23-DCM01A	**yes**	12CB_P23-DCM01B	**yes**
42	QTRMASTR	11	5	127191-7195	12QM-DCM01A	**yes**	12QM-DCM01B	**yes**
43	OLALLA	11	5	127186-7190	12OL-DCM01A	**yes**	12OL-DCM01B	**yes**
44	3TREEPOINT	11	5	127181-7185	12TT-DCM01A	**yes**	12TT-DCM01B	**yes**
45	HDCANAL_TA	12	5	127236-7240	12HC_TA-DCM01A	**yes**	12HC_TA-DCM01B	**yes**
46	LILLIWAUP	12	5	127231-7235	12LW-DCM01A	**yes**	12LW-DCM01B	**yes**
47	SCENICBEACH	12	5	127221-7225	12SC-DCM01A	**yes**	12SC-DCM01B	**yes**
48	QUILCENE	12	5	127216-7220	12QB-DCM01A	**yes**	12QB-DCM01B	**yes**
49	**HDCANAL**	**12**	**5**	**117020-7024**	**11HC-DCM01A**	**no**	**11HC-DCM01B**	**no**
50	SQUAMISHHRBR	12	5	127206-7210	12SUH-DCM01A	**yes**	12SUH-DCM01B	**yes**
51	NISQUALY_FLATS_GC	13	5	127241-7245	12NQ_FLGC-DCM01A	**yes**	12NQ_FLGC-DCM01B	**yes**
52	TREBLEPOINT	13	3	127246-7248	12TRP-DCM01A	**yes**	12TRP-DCM01B	**yes**
53	NISQUALY	13	5	116951-6955	11NQ-DCM01A	**yes**	11NQ-DCM01B	**yes**
54	BRISCOPOINT	13	3	127249-7251	12BRP-DCM01A	**yes**	12BRP-DCM01B	**yes**

[a]All specimens in composite were noted as being soft-shelled

Table A2. Spot prawn muscle samples submitted for chemical analysis. Bolded stations were composited but not chemically analyzed due to budget constraints. Location number refers to Marine Area and the urban embayment is represented by its initials (EB = Elliott Bay). An additional aliquot was made from each station (Aliquot C) when possible and saved as an archive sample.

Map Number	Station ID	Location	Number of specimens	Fish IDs	Aliquot A Samples Delivered to NOAA (task order 12ShrimpMuscle)	Submitted for analysis 12/5/12	Aliquot B Samples Delivered to KCEL (task order 12ShrimpMuscleKCEL)	Submitted for analysis 12/26/12
1	PROTECTIONISL	6	20	126181-6200	12PRO-SPM01A	**yes**	12PRO-SPM01B	**yes**
2	PARTRIDGEBANK_N	6	20	126221-6240	12PBN-SPM01A	**yes**	12PBN-SPM01B	**yes**
3	LAWSONREEF_N	7	20	126361-6380	12LRN-SPM01A	**yes**	12LRN-SPM01B	**yes**
4	POINTCAUTION	7	20	126301-6320	12PTC-SPM01A	**yes**	12PTC-SPM01B	**yes**
5	VENDOVI	7	20	118001-8020	11VD-SPM01A	**yes**	11VD-SPM01B	**yes**
6	POINTDISNEY	7	19	126341-6359	12PTD-SPM01A	**yes**	12PTD-SPM01B	**yes**
7	FERNPOINT	7	20	126261-6280	12FPT-SPM01A	**yes**	12FPT-SPM01B	**yes**
8	BABYISLAND	8.1	20	126441-6460	12BBY-SPM01A	**yes**	12BBY-SPM01B	**yes**
9	NORTHBLUFF	8.1	20	126401-6420	12NBL-SPM01A	**yes**	12NBL-SPM01B	**yes**
10	**NORTHBLUFF_N**	**8.1**	**20**	**126481-6500**	**12NBL_N-SPM01A**	**no**	**12NBL_N-SPM01B**	**no**
11	CAMABEACH	8.1	20	126381-6400	12CMB-SPM01A	**yes**	12CMB-SPM01B	**yes**
12	CAMANOCITY_S	8.1	20	126461-6480	12CCS-SPM01A	**yes**	12CCS-SPM01B	**yes**
13	ONAMAC	8.1	20	126421-6440	12ON-SPM01A	**yes**	12ON-SPM01B	**yes**
14	PTGARDNR	8.2	20	118101-8120	11PG-SPM01A	**yes**	11PG-SPM01B	**yes**
15	CAMANOHEAD	8.2	20	126541-6560	12CH-SPM01A	**yes**	12CH-SPM01B	**yes**
16	LANGLEY_N	8.2	20	126561-6580	12LYN-SPM01A	**yes**	12LYN-SPM01B	**yes**
17	PTSUSAN	8.2	20	126581-6600	12PS-SPM01A	**yes**	12PS-SPM01B	**yes**
18	MABANA_N	8.2	20	126521-6540	12MB_N-SPM01A	**yes**	12MB_N-SPM01B	**yes**
19	**LOWELLPOINT**	**8.2**	**20**	**126501-6520**	**12LPT-SPM01A**	**no**	**12LPT-SPM01B**	**no**
20	EDMONDS_N	9	20	125741-5760	12EDN-SPM01A	**yes**	12EDN-SPM01B	**yes**
21	BROWNBAY	9	20	125701-5720	12BRB-SPM01A	**yes**	12BRB-SPM01B	**yes**
22	POSSEPT	9	20	125781-5800	12PP-SPM01A	**yes**	12PP-SPM01B	**yes**
23	BLAKLYRK	10	20	125821-5840	12BR-SPM01A	**yes**	12BR-SPM01B	**yes**
24	ELLTBAY_SW	EB	20	126701-6720	12EB_SW-SPM01A	**yes**	12EB_SW-SPM01B	**yes**
25	ELLTBAY_PSSDA	EB	20	126741-6760	12EB_PSSDA-SPM01A	**yes**	12EB_PSSDA-SPM01B	**yes**
26	DUWAMISHHEAD	EB	20	126681-6700	12DH-SPM01A	**yes**	12DH-SPM01B	**yes**
27	ELLTBAY_P71DEEP	EB	20	126761-6780	12EB_P71DP-SPM01A	**yes**	12EB_P71DP-SPM01B	**yes**
28	**ELLTBAY4_P90DEEP**	EB	**20**	126721-6740	**12EB4_P90DP-SPM01A**	**no**	**12EB4_P90DP-SPM01B**	**no**
29	ELLTBAY4_P91	EB	19	126781-6799	12EB4_P91-SPM01A	**yes**	12EB4_P91-SPM01B	**yes**

Continued.

Table A2 (continued). Spot prawn muscle samples submitted for chemical analysis. Bolded stations were composited but not chemically analyzed due to budget constraints. Location number refers to Marine Area and the urban embayment is represented by its initials (EB = Elliott Bay). An additional aliquot was made from each station (Aliquot C) when possible and saved as an archive sample.

Map Number	Station ID	Location	Number of specimens	Fish IDs	Aliquot A Samples Delivered to NOAA (task order 12ShrimpMuscle)	Submitted for analysis 12/5/12	Aliquot B Samples Delivered to KCEL (task order 12ShrimpMuscleKCEL)	Submitted for analysis 12/26/12
30	YEOMALT	10	20	125901-5920	12YEO-SPM01A	**yes**	12YEO-SPM01B	**yes**
31	SKIFFPT_N	10	20	125861-5880	12SKPN-SPM01A	**yes**	12SKPN-SPM01B	**yes**
32	MEADOWPOINT	10	20	126601-6620	12MP-SPM01A	**yes**	12MP-SPM01B	**yes**
33	DESMOINES_N	11	20	125981-6000	12DMN-SPM01A	**yes**	12DMN-SPM01B	**yes**
34	SEAHURST	11	20	126021-6040	12SR-SPM01A	**yes**	12SR-SPM01B	**yes**
35	BRACEPT_S	11	20	125941-5960	12BRPS-SPM01A	**yes**	12BRPS-SPM01B	**yes**
36	HDCANAL_MUS	12	20	126061-6080	12HCMUS-SPM01A	**yes**	12HCMUS-SPM01B	**yes**
37	DEWATTO_S	12	20	126621-6640	12DES-SPM01A	**yes**	12DES-SPM01B	**yes**
38	HDCANAL_NEL	12	20	126101-6120	12HCNEL-SPM01A	**yes**	12HCNEL-SPM01B	**yes**
39	**PLEASANTHARBOR**	**12**	**17**	**126661-6677**	**12PH-SPM01A**	**no**	**12PH-SPM01B**	**no**
40	HAZELPOINT_N	12	20	126641-6660	12HAZN-SPM01A	**yes**	12HAZN-SPM01B	**yes**
41	HDCANAL_ZEL	12	20	126141-6160	12HCZEL-SPM01A	**yes**	12HCZEL-SPM01B	**yes**
42	NISQUALY	13	20	118201-8220	11NQ-SPM01A	**yes**	11NQ-SPM01B	**yes**
42	NISQUALY	13	20	118221-8240	11NQ-SPM02A	**yes**	11NQ-SPM02B	**yes**

Table A3. Dungeness crab station descriptions and locations. Location number refers to Marine Area and urban embayments are represented by their initials (SI = Sinclair Inlet, EB = Elliott Bay, CB = Commencement Bay).

Map Number	Station ID	Location	Basin	Collection Effort ID	Effort Date	Latitude	Longitude	Station Location Coordinate Calculation Method	Gear Type
1	DISCOBAY_TU	6	Strait of Juan de Fuca	12DB_TU-S1	6/28/12	48.05517	-122.85640	GPS - Single Point	Crab Pot
2	ALLANISL_S	7	Strait of Juan de Fuca	12SJST1-H77	5/29/12	48.44963	-122.69114	GPS - Start End Average	Bottom Trawl
3	VENDOVI	7	San Juan Islands	11VD-H08	4/28/11	48.64479	-122.64410	GPS Start End Average - multiple efforts	Bottom Trawl
4	WALDRONISL_N	7	San Juan Islands	12WALD_N-S1A,B,C,D,E	6/26/12	48.70788	-123.05804	GPS- Average from multiple efforts	Crab Pots
5	BHMHARBR	7	North Sound	12BH-S1A,B,C,D,E	6/27/12	48.73466	-122.51459	GPS- Average from multiple efforts	Crab Pots
6	STRTGEOR	7	Strait of Georgia	12GBNU2-H40	5/15/12	48.87209	-122.90997	GPS - Start End Average	Bottom Trawl
7	BABYISLAND	8.1	North Sound	12BBY-S2	6/12/12	48.10128	-122.52367	GPS - Single Point	Crab Pot
8	GREENBANK	8.1	North Sound	12GBNK-S1	6/1/12	48.11079	-122.55334	GPS - Single Point	Crab Pot
9	NORTHBLUFF_N	8.1	North Sound	12NBL_N-S2	6/12/12	48.13230	-122.56152	GPS - Single Point	Crab Pot
10	CAMANOCITY_S	8.1	North Sound	12CCS-S2	6/12/12	48.15995	-122.52547	GPS - Single Point	Crab Pot
11	STRAWBERRYPT	8.1	North Sound	12STRPT-S1	6/1/12	48.29723	-122.50386	GPS - Single Point	Crab Pot
12	SKAGITIS	8.1	North Sound	12SKIS-S1	6/1/12	48.41035	-122.57871	GPS - Single Point	Crab Pot
13	PTGARDNR	8.2	North Sound	11PG-H05(A-B)	4/25/11	47.98529	-122.24391	GPS Start End Average - multiple efforts	Bottom Trawl
14	CAMANOHEAD	8.2	North Sound	12CH-S2	6/6/12	48.05698	-122.37582	GPS - Single Point	Crab Pot
15	LANGLEY_N	8.2	North Sound	12LYN-S2	6/12/12	48.07237	-122.45727	GPS - Single Point	Crab Pot
16	PTSUSAN	8.2	North Sound	12PS-S2	6/14/12	48.08162	-122.32363	GPS - Single Point	Crab Pot
17	MABANA_N	8.2	North Sound	12MB_N-WINU H31,H32	5/10/12	48.10347	-122.45214	GPS - average	Bottom Trawl
18	LOWELLPOINT	8.2	North Sound	12LPT-WINV H29	5/10/12	48.11338	-122.49547	GPS - average	Bottom Trawl
19	PTGAMBLE_3	9	North Sound	12PG3-S1	8/13/12	47.83803	-122.57556	GPS - Single Point	Crab Pot
20	PTGAMBLE_1	9	North Sound	12PG1-S1	8/13/12	47.84600	-122.57628	GPS - Single Point	Crab Pot
21	EGLON	9	North Sound	12ELN-S1A,B,C	5/23/12	47.86038	-122.50792	GPS- Average from multiple efforts	Crab Pots
22	PTGAMBLE_N	9	North Sound	12PTGB_N-S1	6/2/12	47.88007	-122.58368	GPS - Single Point	Crab Pot
23	USELESSBAY_M	9	North Sound	12UB_M-S1	6/13/12	47.96605	-122.46863	GPS - Single Point	Crab Pot
24	OAKBAY	9	North Sound	12OAKB-S1	6/13/12	48.00403	-122.70168	GPS - Single Point	Crab Pot
25	PTTWNSND_GC	9	North Sound	12PT_GC-S1	6/14/12	48.08912	-122.76245	GPS - Single Point	Crab Pot
26	SCLINLET	SI	Central Sound	11SI-H04(A-C)	4/20/11	47.54814	-122.64353	GPS Start End Average - multiple efforts	Bottom Trawl
27	DUWAMISH	EB	Central Sound	11DU-H09(A-C)	5/16/12	47.55740	-122.34402	GPS Start End Average - multiple efforts	Bottom Trawl

Continued.

Table A3 (continued). Dungeness crab station descriptions and location. Location number refers to Marine Area and urban embayments are represented by their initials (SI = Sinclair Inlet, EB = Elliott Bay, CB = Commencement Bay).

Map Number	Station ID	Location	Basin	Effort ID	Effort Date	Latitude	Longitude	Station Location Coordinate Calculation Method	Gear Type
28	BLAKEISLAND_N	10	Central Sound	12CSMV1-H81, 2-H82	5/30/12	47.56217	-122.47695	GPS Start End Average - multiple efforts	Bottom Trawl
29	ALKIPOINT_S	10	Central Sound	12AKP_S-S01A,B	5/22/12	47.56768	-122.41206	GPS- Average from multiple efforts	Crab Pots
30	ELLTBAY	EB	Central Sound	11EB-H10	5/17/12	47.60541	-122.34414	GPS Start End Average - multiple efforts	Bottom Trawl
31	ELLTBAY_P69	EB	Central Sound	12EB_P69-S1	6/29/12	47.61194	-122.35306	Estimated	Crab Pot
32	ELLTBAY4_P89	EB	Central Sound	12EB4_P89-S1	7/12/12	47.62398	-122.37687	GPS - Single Point	Crab Pot
33	ELLTBAY4_P91SH	EB	Central Sound	12EB4_P91SH-S1	6/29/12	47.62444	-122.38333	GPS - Single Point	Crab Pot
34	4MILEROCK	10	Central Sound	124M-S1A,B,C	5/22/12	47.63703	-122.42081	GPS- Average from multiple efforts	Crab Pots
35	YEOMALT_SH	10	Central Sound	12YEO_SH-S1A,B	5/22/12	47.64000	-122.49717	GPS- Average from multiple efforts	Crab Pots
36	PTMADISN_IND	10	Central Sound	12PM_IND-S1A,B,C	5/23/12	47.73392	-122.49447	GPS- Average from multiple efforts	Crab Pots
37	KINGSTON	10	Central Sound	12KG-S1A,B,C	5/23/12	47.78600	-122.48762	GPS- Average from multiple efforts	Crab Pots
38	EDMONDS	10	Central Sound	12ED-S1A,B,C	5/23/12	47.80297	-122.39833	GPS- Average from multiple efforts	Crab Pots
39	COMMBAY	CB	Central Sound	11CB-H02(A-E)	4/19/11	47.25767	-122.43543	GPS Start End Average - multiple efforts	Bottom Trawl
40	COMMBAY4_DEEP	CB	Central Sound	12CSSU01-H13	5/3/12	47.28175	-122.46606	GPS - Start End Average	Bottom Trawl
41	COMMBAY_P23	CB	Central Sound	12CB_P23-S1	5/25/12	47.28428	-122.41645	GPS - Single Point	Crab Pot
42	QTRMASTR	11	Central Sound	12QM-S1	5/25/12	47.34857	-122.48082	GPS - Single Point	Crab Pot
43	OLALLA	11	Central Sound	12OL-S1A,B,C	5/22/12	47.42058	-122.53609	GPS- Average from multiple efforts	Crab Pots
44	3TREEPOINT	11	Central Sound	12TT-S1A,B,C	5/22/12	47.46066	-122.37141	GPS- Average from multiple efforts	Crab Pots
45	HDCANAL_TA	12	Hood Canal	12HCST02-H22	5/8/12	47.35595	-123.05986	GPS - Start End Average	Bottom Trawl
46	LILLIWAUP	12	Hood Canal	12LW-S1	6/1/12	47.45938	-123.10405	GPS - Single Point	Crab Pot
47	SCENICBEACH	12	Hood Canal	12SC-S1	5/31/12	47.65610	-122.84040	GPS - Single Point	Crab Pot
48	QUILCENE	12	Hood Canal	12QB-S1	6/1/12	47.79040	-122.85520	GPS - Single Point	Crab Pot
49	HDCANAL	12	Hood Canal	11HC-H06	4/26/11	47.83437	-122.64420	GPS Start End Average - multiple efforts	Bottom Trawl
50	SQUAMISHHRBR	12	Hood Canal	12SUH-S1	6/2/12	47.86232	-122.65945	GPS - Single Point	Crab Pot
51	NISQUALY_FLATS_GC	13	South Sound	12NQ_FLGC-S1	7/11/12	47.11448	-122.69442	GPS - Single Point	Crab Pot
52	TREBLEPOINT	13	South Sound	12TRP-S1	7/12/12	47.15338	-122.74805	GPS - Single Point	Crab Pot
53	NISQUALY	13	South Sound	11NQ-H01	4/18/11	47.15453	-122.66850	GPS - Start End Average	Bottom Trawl
54	BRISCOPOINT	13	South Sound	12BRP-S1A,B,C	7/11/12	47.16241	-122.88489	GPS- Average from multiple efforts	Crab Pots

Table A4. Spot prawn station descriptions and locations. Location number refers to Marine Area and the urban embayment is represented by its initials (EB = Elliott Bay).

Map Number	Station ID	Location	Basin	Effort ID	Effort Date	Latitude	Longitude	Station Location Coordinate Calculation Method	Gear Type
1	PROTECTIONISL	6	Strait of Juan de Fuca	12JEET1-H69	5/23/12	48.12535	-122.97075	GPS - Start End Average	Bottom Trawl
2	PARTRIDGEBANK_N	6	Strait of Juan de Fuca	12JEEU1-H71	5/24/12	48.27955	-122.84215	GPS - Start End Average	Bottom Trawl
3	LAWSONREEF_N	7	Strait of Juan de Fuca	12SJSU1-H75	5/29/12	48.42709	-122.72835	GPS - Start End Average	Bottom Trawl
4	POINTCAUTION	7	San Juan Islands	12SJSV1-H53	5/17/12	48.56646	-123.01249	GPS - Start End Average	Bottom Trawl
5	VENDOVI	7	San Juan Islands	11VD-H08	4/28/11	48.64479	-122.64410	GPS Start End Average - multiple efforts	Bottom Trawl
6	POINTDISNEY	7	San Juan Islands	12SJNV2-H52	5/17/12	48.67545	-123.02743	GPS - Start End Average	Bottom Trawl
7	FERNPOINT	7	Strait of Georgia	12GBSU1-H47	5/16/12	48.73699	-122.74786	GPS - Start End Average	Bottom Trawl
8	BABYISLAND	8.1	North Sound	12BBY-S1	6/12/12	48.10930	-122.53403	GPS - Single Point	Prawn Pot
9	NORTHBLUFF	8.1	North Sound	12NBL-S1	5/29/12	48.12418	-122.54700	GPS - Single Point	Prawn Pot
10	NORTHBLUFF_N	8.1	North Sound	12NBL_N-S1	6/12/12	48.13402	-122.55437	GPS - Single Point	Prawn Pot
11	CAMABEACH	8.1	North Sound	12CMB-S1	5/29/12	48.14995	-122.52643	GPS - Single Point	Prawn Pot
12	CAMANOCITY_S	8.1	North Sound	12CCS-S1	6/12/12	48.15932	-122.52988	GPS - Single Point	Prawn Pot
13	ONAMAC	8.1	North Sound	12ON-S1	5/29/12	48.18593	-122.54310	GPS - Single Point	Prawn Pot
14	PTGARDNR	8.2	North Sound	11PG-H05(A-B)	4/25/11	47.98529	-122.24391	GPS Start End Average - multiple efforts	Bottom Trawl
15	CAMANOHEAD	8.2	North Sound	12CH-S1	6/11/12	48.05428	-122.37762	GPS - Single Point	Prawn Pot
16	LANGLEY_N	8.2	North Sound	12LYN-S1	6/12/12	48.07325	-122.45450	GPS - Single Point	Prawn Pot
17	PTSUSAN	8.2	North Sound	12PS-S1	6/14/12	48.08118	-122.32690	GPS - Single Point	Prawn Pot
18	MABANA_N	8.2	North Sound	12WINU1-H31,H32	5/10/12	48.10347	-122.45214	GPS - Start End Average	Bottom Trawl
19	LOWELLPOINT	8.2	North Sound	12WINV1-H29	5/10/12	48.11338	-122.49547	GPS - Start End Average	Bottom Trawl
20	EDMONDS_N	9	Central Sound	12EDN-S01	3/22/12	47.83025	-122.38410	GPS - Single Point	Prawn Pot
21	BROWNBAY	9	Central Sound	12BRB-S01	3/22/12	47.85108	-122.34510	GPS - Single Point	Prawn Pot

Continued.

Table A4 (continued). Spot prawn station descriptions and locations. Location number refers to Marine Area and the urban embayment is represented by its initials (EB = Elliott Bay).

Map Number	Station ID	Location	Basin	Effort ID	Effort Date	Latitude	Longitude	Station Location Coordinate Calculation Method	Gear Type
22	POSSEPT	9	North Sound	12PP-S01	3/22/12	47.90123	-122.37453	GPS - Single Point	Prawn Pot
23	BLAKLYRK	10	Central Sound	12BR-S01	3/22/12	47.59152	-122.47678	GPS - Single Point	Prawn Pot
24	ELLTBAY_SW	EB	Central Sound	12EB_SW-S1	6/21/12	47.59157	-122.37298	GPS - Single Point	Prawn Pot
25	ELLTBAY_PSSDA	EB	Central Sound	12EB_PSSDA-S1	6/28/12	47.59740	-122.35782	GPS - Single Point	Prawn Pot
26	DUWAMISHHEAD	EB	Central Sound	12DH-S1	6/21/12	47.59828	-122.38137	GPS - Single Point	Prawn Pot
27	ELLTBAY_P71DEEP	EB	Central Sound	12EB_P71DP-S1	7/12/12	47.61372	-122.36680	GPS - Single Point	Prawn Pot
28	ELLTBAY4_P90DEEP	EB	Central Sound	12EB4_P90DP-S1	6/21/12	47.62022	-122.37953	GPS - Single Point	Prawn Pot
29	ELLTBAY4_P91	EB	Central Sound	12EB4_P91-S1	6/29/12	47.62250	-122.38333	Estimated from map - Single Point	Prawn Pot
30	YEOMALT	10	Central Sound	12YEO-S01	3/22/12	47.63935	-122.48995	GPS - Single Point	Prawn Pot
31	SKIFFPT_N	10	Central Sound	12SKPN-S01	3/22/12	47.67430	-122.49740	GPS - Single Point	Prawn Pot
32	MEADOWPOINT	10	Central Sound	12CSMT1-H15	5/7/12	47.69312	-122.41202	GPS - Start End Average	Bottom Trawl
33	DESMOINES_N	11	Central Sound	12DMN-S01	3/21/12	47.41327	-122.35208	GPS - Single Point	Prawn Pot
34	SEAHURST	11	Central Sound	12SR-S01	3/21/12	47.47953	-122.37227	GPS - Single Point	Prawn Pot
35	BRACEPT_S	11	Central Sound	12BRPS-S01	3/21/12	47.50208	-122.39217	GPS - Single Point	Prawn Pot
36	HDCANAL_MUS	12	Hood Canal	12HCMUS-S01	4/4/12	47.39957	-123.11628	GPS - Single Point	Prawn Pot
37	DEWATTO_S	12	Hood Canal	12DES-S1	6/15/12	47.43840	-123.09124	GPS - Single Point	Prawn Pot
38	HDCANAL_NEL	12	Hood Canal	12HCNEL-S01	4/6/12	47.60265	-122.92460	GPS - Single Point	Prawn Pot
39	PLEASANTHARBOR	12	Hood Canal	12PH-S1	6/15/12	47.62552	-122.90186	GPS - Single Point	Prawn Pot
40	HAZELPOINT_N	12	Hood Canal	12HAZN-S1	6/15/12	47.70389	-122.77889	GPS - Single Point	Prawn Pot
41	HDCANAL_ZEL	12	Hood Canal	12HCZEL-S01	4/5/12	47.71943	-122.82048	GPS - Single Point	Prawn Pot
42	NISQUALY	13	South Sound	11NQ-H01	4/18/11	47.15453	-122.66850	GPS - Start End Average	Bottom Trawl

Table A5. Dungeness crab collection efforts and contact information. Location number refers to Marine Area and urban embayments are represented by their initials (SI = Sinclair Inlet, EB = Elliott Bay, CB = Commencement Bay).

Map #	Station ID	Location	Collection Effort	Collection Contact	Phone Number	Email Address
1	DISCOBAY_TU	6	Tribal_SubsistenceCrab_Jamestown S'Kallam _2012	Kelly Toy	(360) 681-4641	ktoy@jamestowntribe.org
2	ALLANISL_S	7	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext314	Robert.Pacunski@dfw.wa.gov
3	VENDOVI	7	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov
4	WALDRONISL_N	7	Tribal_TestFisheryCrab_Lummi_2012	Ben Starkhouse	(360) 312-2300	bens@lummi-nsn.gov
5	BHMHARBR	7	Tribal_TestFisheryCrab_Lummi_2012	Ben Starkhouse	(360) 312-2300	bens@lummi-nsn.gov
6	STRTGEOR	7	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext314	Robert.Pacunski@dfw.wa.gov
7	BABYISLAND	8.1	Tribal_TestFisheryCrab_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
8	GREENBANK	8.1	Tribal_TestFisheryCrab_Swinomish_2012	Jim Gibson	(360) 466-7283	jgibson@skagitcoop.org
9	NORTHBLUFF_N	8.1	Tribal_TestFisheryCrab_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
10	CAMANOCITY_S	8.1	Tribal_TestFisheryCrab_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
11	STRAWBERRYPT	8.1	Tribal_TestFisheryCrab_Swinomish_2012	Jim Gibson	(360) 466-7283	jgibson@skagitcoop.org
12	SKAGITIS	8.1	Tribal_TestFisheryCrab_Swinomish_2012	Jim Gibson	(360) 466-7283	jgibson@skagitcoop.org
13	PTGARDNR	8.2	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov
14	CAMANOHEAD	8.2	Tribal_TestFisheryCrab_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
15	LANGLEY_N	8.2	Tribal_TestFisheryCrab_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
16	PTSUSAN	8.2	Tribal_TestFisheryCrab_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
17	MABANA_N	8.2	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext314	Robert.Pacunski@dfw.wa.gov
18	LOWELLPOINT	8.2	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext314	Robert.Pacunski@dfw.wa.gov
19	PTGAMBLE_3	9	Tribal_TestFisheryCrab_PortGamble S'Kallam _2012	Rory O'Rourke	(360) 297-6289	rorourke@pgst.nsn.us
20	PTGAMBLE_1	9	Tribal_TestFisheryCrab_PortGamble S'Kallam _2013	Rory O'Rourke	(360) 297-6289	rorourke@pgst.nsn.us
21	EGLON	9	WDFW_TestFisheryCrab_2012	Don Velasquez	(425) 775-1311 ext112	Don.Velasquez@dfw.wa.gov
22	PTGAMBLE_N	9	WDFW_TestFisheryCrab_2012	Brian Mclaughlin	(360) 586-1498 ext218	Brian.Mclaughlin@dfw.wa.gov
23	USELESSBAY_M	9	Tribal_TestFisheryCrab_Jamestown S'Kallam _2012	Kelly Toy	(360) 681-4641	ktoy@jamestowntribe.org
24	OAKBAY	9	WDFW_TestFisheryCrab_2012	Brian Mclaughlin	(360) 586-1498 ext218	Brian.Mclaughlin@dfw.wa.gov
25	PTTWNSND_GC	9	WDFW_TestFisheryCrab_2012	Brian Mclaughlin	(360) 586-1498 ext218	Brian.Mclaughlin@dfw.wa.gov
26	SCLINLET	SI	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov
27	DUWAMISH	EB	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov
28	BLAKEISLAND_N	10	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext314	Robert.Pacunski@dfw.wa.gov
29	ALKIPOINT_S	10	WDFW_TestFisheryCrab_2012	Don Velasquez	(425) 775-1311 ext112	Don.Velasquez@dfw.wa.gov
30	ELLTBAY	EB	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov

Continued.

Table A5 (continued). Dungeness crab collection efforts and contact information. Location number refers to Marine Area and urban embayments are represented by their initials (SI = Sinclair Inlet, EB = Elliott Bay, CB = Commencement Bay).

Map #	Station ID	Location	Collection Effort	Collection Contact	Phone Number	Email Address
31	ELLTBAY_P69	EB	Tribal_TestFisheryCrab_Suquamish_2012	Paul Williams	(360) 434-7432	pwilliams@suquamish.nsn.us
32	ELLTBAY4_P89	EB	Tribal_TestFisheryCrab_Muckleshoot_2012	Andy Dalton	(253) 876-3131	Andy.Dalton@muckleshoot.nsn.us
33	ELLTBAY4_P91SH	EB	Tribal_TestFisheryCrab_Suquamish_2012	Paul Williams	(360) 434-7432	pwilliams@suquamish.nsn.us
34	4MILEROCK	10	WDFW_TestFisheryCrab_2012	Don Velasquez	(425) 775-1311 ext112	Don.Velasquez@dfw.wa.gov
35	YEOMALT_SH	10	WDFW_TestFisheryCrab_2012	Don Velasquez	(425) 775-1311 ext112	Don.Velasquez@dfw.wa.gov
36	PTMADISN_IND	10	WDFW_TestFisheryCrab_2012	Don Velasquez	(425) 775-1311 ext112	Don.Velasquez@dfw.wa.gov
37	KINGSTON	10	WDFW_TestFisheryCrab_2012	Don Velasquez	(425) 775-1311 ext112	Don.Velasquez@dfw.wa.gov
38	EDMONDS	10	WDFW_TestFisheryCrab_2012	Don Velasquez	(425) 775-1311 ext112	Don.Velasquez@dfw.wa.gov
39	COMMBAY	CB	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov
40	COMMBAY4_DEEP	CB	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext314	Robert.Pacunski@dfw.wa.gov
41	COMMBAY_P23	CB	Tribal_TestFisheryCrab_Puyallup_2012	David Winfrey	(253) 573-7933	david.winfrey@puyalluptribe.com
42	QTRMASTR	11	Tribal_TestFisheryCrab_Puyallup_2012	David Winfrey	(253) 573-7933	david.winfrey@puyalluptribe.com
43	OLALLA	11	WDFW_TestFisheryCrab_2012	Don Velasquez	(425) 775-1311 ext112	Don.Velasquez@dfw.wa.gov
44	3TREEPOINT	11	WDFW_TestFisheryCrab_2012	Don Velasquez	(425) 775-1311 ext112	Don.Velasquez@dfw.wa.gov
45	HDCANAL_TA	12	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext314	Robert.Pacunski@dfw.wa.gov
46	LILLIWAUP	12	WDFW_TestFisheryCrab_2012	Brian Mclaughlin	(360) 586-1498 ext218	Brian.Mclaughlin@dfw.wa.gov
47	SCENICBEACH	12	WDFW_TestFisheryCrab_2012	Brian Mclaughlin	(360) 586-1498 ext218	Brian.Mclaughlin@dfw.wa.gov
48	QUILCENE	12	WDFW_TestFisheryCrab_2012	Brian Mclaughlin	(360) 586-1498 ext218	Brian.Mclaughlin@dfw.wa.gov
49	HDCANAL	12	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov
50	SQUAMISHHRBR	12	WDFW_TestFisheryCrab_2012	Brian Mclaughlin	(360) 586-1498 ext218	Brian.Mclaughlin@dfw.wa.gov
51	NISQUALY_FLATS_GC	13	PSEMP_Crab2012	Laurie Niewolny	(360) 902-2687	Laurie.Niewolny@dfw.wa.gov
52	TREBLEPOINT	13	PSEMP_Crab2012	Laurie Niewolny	(360) 902-2687	Laurie.Niewolny@dfw.wa.gov
53	NISQUALY	13	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov
54	BRISCOPOINT	13	PSEMP_Crab2012	Laurie Niewolny	(360) 902-2687	Laurie.Niewolny@dfw.wa.gov

Table A6. Spot prawn collection efforts and contact information. Location number refers to Marine Area and the urban embayment is represented by its initials (EB = Elliott Bay).

Map Number	Station ID	Location	Collection Effort	Collection Contact	Phone Number	Email Address
1	PROTECTIONISL	6	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext. 314	Robert.Pacunski@dfw.wa.gov
2	PARTRIDGEBANK_N	6	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext. 314	Robert.Pacunski@dfw.wa.gov
3	LAWSONREEF_N	7	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext. 314	Robert.Pacunski@dfw.wa.gov
4	POINTCAUTION	7	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext. 314	Robert.Pacunski@dfw.wa.gov
5	VENDOVI	7	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov
6	POINTDISNEY	7	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext. 314	Robert.Pacunski@dfw.wa.gov
7	FERNPOINT	7	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext. 314	Robert.Pacunski@dfw.wa.gov
8	BABYISLAND	8.1	Tribal_TestFisheryShrimp_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
9	NORTHBLUFF	8.1	Tribal_TestFisheryShrimp_Swinomish_2012	Jim Gibson	(360) 466-7283	jgibson@skagitcoop.org
10	NORTHBLUFF_N	8.1	Tribal_TestFisheryShrimp_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
11	CAMABEACH	8.1	Tribal_TestFisheryShrimp_Swinomish_2012	Jim Gibson	(360) 466-7283	jgibson@skagitcoop.org
12	CAMANOCITY_S	8.1	Tribal_TestFisheryShrimp_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
13	ONAMAC	8.1	Tribal_TestFisheryShrimp_Swinomish_2012	Jim Gibson	(360) 466-7283	jgibson@skagitcoop.org
14	PTGARDNR	8.2	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov
15	CAMANOHEAD	8.2	Tribal_TestFisheryShrimp_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
16	LANGLEY_N	8.2	Tribal_TestFisheryShrimp_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
17	PTSUSAN	8.2	Tribal_TestFisheryShrimp_Tulalip_2012	Cathy Stanley	(360) 716-4628	cstanley@tulaliptribes-nsn.gov
18	MABANA_N	8.2	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext. 314	Robert.Pacunski@dfw.wa.gov
19	LOWELLPOINT	8.2	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext. 314	Robert.Pacunski@dfw.wa.gov
20	EDMONDS_N	9	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
21	BROWNBAY	9	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
22	POSSEPT	9	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
23	BLAKLYRK	10	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
24	ELLTBAY_SW	EB	Tribal_TestFisheryShrimp_Muckleshoot_2012	Andy Dalton	(253) 876-3131	Andy.Dalton@muckleshoot.nsn.us
25	ELLTBAY_PSSDA	EB	Tribal_TestFisheryShrimp_Muckleshoot_2012	Andy Dalton	(253) 876-3131	Andy.Dalton@muckleshoot.nsn.us
26	DUWAMISHHEAD	EB	Tribal_TestFisheryShrimp_Muckleshoot_2012	Andy Dalton	(253) 876-3131	Andy.Dalton@muckleshoot.nsn.us
27	ELLTBAY_P71DEEP	EB	Tribal_TestFisheryShrimp_Muckleshoot_2012	Andy Dalton	(253) 876-3131	Andy.Dalton@muckleshoot.nsn.us
28	ELLTBAY4_P90DEEP	EB	Tribal_TestFisheryShrimp_Muckleshoot_2012	Andy Dalton	(253) 876-3131	Andy.Dalton@muckleshoot.nsn.us
29	ELLTBAY4_P91	EB	Tribal_TestFisheryShrimp_Suquamish_2012	Paul Williams	(360) 434-7432	pwilliams@suquamish.nsn.us
30	YEOMALT	10	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov

Continued.

Table A6 (continued). Spot prawn collection efforts and contact information. Location number refers to Marine Area and the urban embayment is represented by its initials (EB = Elliott Bay).

Map Number	Station ID	Location	Collection Effort	Collection Contact	Phone Number	Email Address
31	SKIFFPT_N	10	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
32	MEADOWPOINT	10	WDFW GroundfishTrawl2012	Robert Pacunski	(425) 775-1311 ext. 314	Robert.Pacunski@dfw.wa.gov
33	DESMOINES_N	11	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
34	SEAHURST	11	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
35	BRACEPT_S	11	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
36	HDCANAL_MUS	12	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
37	DEWATTO_S	12	Tribal_SubsistenceFisheryShrimp_Skokomish_2012	Margaret Homerding	(360) 877-5213	mhomerding@skokomish.org
38	HDCANAL_NEL	12	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
39	PLEASANTHARBOR	12	Tribal_SubsistenceFisheryShrimp_Skokomish_2012	Margaret Homerding	(360) 877-5213	mhomerding@skokomish.org
40	HAZELPOINT_N	12	Tribal_SubsistenceFisheryShrimp_Skokomish_2012	Margaret Homerding	(360) 877-5213	mhomerding@skokomish.org
41	HDCANAL_ZEL	12	WDFW_TestFisheryShrimp_2012	Mark O'Toole	(360) 466-4345 Ext 241	Mark.OToole@dfw.wa.gov
42	NISQUALY	13	PSEMP_EnglishSoleTrawl2011	James West	(360) 902-2842	James.West@dfw.wa.gov

Table A7. Dungeness crab hepatopancreas samples submitted for chemical analysis. Location number refers to Marine Area and urban embayments are represented by their initials (EB = Elliott Bay, CB = Commencement Bay). Two additional aliquots were made from each station for possible future analysis and are being stored in a freezer; Aliquot C for high resolution PCB/Dioxin analysis and Aliquot D were saved as PSEMP archive samples.

Map Number	Station ID	Location	Number of specimens	Fish IDs	Aliquot A Samples Delivered to NOAA (task order 12CrabHepato)	Submitted for analysis 12/5/12	Aliquot B Samples Delivered to KCEL (task order 12CrabHepatoKCEL)	Submitted for analysis 12/26/12
1	DISCOBAY_TU	6	5	127001-7005	12DB_TU-DCHP01A	**yes**	12DB_TU-DCHP01B	**yes**
4	BHMHARBR	7	5	127016-7020	12BH-DCHP01A	**yes**	12BH-DCHP01B	**yes**
5	STRTGEOR	7	5	127006-7010	12SG-DCHP01A	**yes**	12SG-DCHP01B	**yes**
12	SKAGITIS	8.1	5	127026-7030	12SKIS-DCHP01A	**yes**	12SKIS-DCHP01B	**yes**
16	PTSUSAN[a]	8.2	3	127066-7068	12PS-DCHP01A	**yes**	12PT-DCHP01B	**yes**
19	PTGAMBLE_3	9	5	127267-7271	12PTGB3-DCHP01A	**yes**	12PTGB3-DCHP01B	**yes**
20	PTGAMBLE_1	9	5	127262-7266	12PTGB1-DCHP01A	**yes**	12PTGB1-DCHP01B	**yes**
31	ELLTBAY_P69	EB	4	127166-7169	12EB_P69-DCHP01A	**yes**	12EB_P69-DCHP01B	**yes**
32	ELLTBAY4_P89	EB	4	127161-7164	12EB4_P89-DCHP01A	**yes**	12EB4_P89-DCHP01B	**yes**
33	ELLTBAY4_P91SH	EB	4	127156-7159	12EB4-P91SH-DCHP01A	**yes**	12EB4-P91SH-DCHP01B	**yes**
34	4MILEROCK	10	5	127151-7155	124M-DCHP01A	**yes**	124M-DCHP01B	**yes**
35	YEOMALT_SH	10	5	127146-7150	12YEO_SH-DCHP01A	**yes**	12YEO_SH-DCHP01B	**yes**
38	EDMONDS	10	5	127131-7135	12ED-DCHP01A	**yes**	12ED-DCHP01B	**yes**
40	COMMBAY4_DEEP	CB	4	127196-7199	12CB4_DEEP-DCHP01A	**yes**	12CB4_DEEP-DCHP01B	**yes**
41	COMMBAY_P23	CB	3	127201-7203	12CB_P23-DCHP01A	**yes**	12CB_P23-DCHP01B	**yes**
42	QTRMASTR	11	5	127191-7195	12QM-DCHP01A	**yes**	12QM-DCHP01B	**yes**
47	SCENICBEACH	12	5	127221-7225	12SC-DCHP01A	**yes**	12SC-DCHP01B	**yes**
51	NISQUALY_FLATS_GC	13	5	127241-7245	12NQ_FLGC-DCHP01A	**yes**	12NQ_FLGC-DCHP01B	**yes**
54	BRISCOPOINT[a]	13	3	127249-7251	12BRP-DCHP01A	**yes**	12BRP-DCHP01B	**yes**

[a]An archive sample was unable to be made due to a limited tissue amount

Table A8. Spot prawn head tissue samples submitted for chemical analysis. Location number refers to Marine Area and the urban embayment is represented by its initials (EB = Elliott Bay). No archive samples were made due to limited tissue amounts.

Map Number	Station ID	Location	Number of specimens	Fish IDs	Aliquot A Samples Delivered to NOAA (task order 12ShrimpHead)	Submitted for analysis 12/5/12	Aliquot B Samples Delivered to KCEL (task order 12ShrimpHeadKCEL)	Submitted for analysis 12/26/12
2	PARTRIDGEBANK_N	6	20	126221-6240	12PBN-SPHD01A	**yes**	12PBN-SPHD01B	**yes**
4	POINTCAUTION	7	20	126301-6320	12PTC-SPHD01A	**yes**	12PTC-SPHD01B	**yes**
7	FERNPOINT	7	20	126261-6280	12FPT-SPHD01A	**yes**	12FPT-SPHD01B	**yes**
8	BABYISLAND	8.1	20	126441-6460	12BBY-SPHD01A	**yes**	12BBY-SPHD01B	**yes**
14	PTGARDNR	8.2	20	118101-8120	11PG-SPHD01A	**yes**	11PG-SPHD01B	**yes**
17	PTSUSAN	8.2	20	126581-6600	12PS-SPHD01A	**yes**	12PS-SPHD01B	**yes**
24	ELLTBAY_SW	EB	20	126701-6720	12EB_SW-SPHD01A	**yes**	12EB_SW-SPHD01B	**yes**
25	ELLTBAY_PSSDA	EB	20	126741-6760	12EB_PSSDA-SPHD01A	**yes**	12EB_PSSDA-SPHD01B	**yes**
26	DUWAMISHHEAD	EB	20	126681-6700	12DH-SPHD01A	**yes**	12DH-SPHD01B	**yes**
27	ELLTBAY_P71DEEP	EB	20	126761-6780	12EB_P71DP-SPHD01A	**yes**	12EB_P71DP-SPHD01B	**yes**
28	ELLTBAY4_P90DEEP	EB	20	126721-6740	12EB4_P90DP-SPHD01A	**yes**	12EB4_P90DP-SPHD01B	**yes**
29	ELLTBAY4_P91	EB	19	126781-6799	12EB4_P91-SPHD01A	**yes**	12EB4_P91-SPHD01B	**yes**
32	MEADOWPOINT	10	20	126601-6620	12MP-SPHD01A	**yes**	12MP-SPHD01B	**yes**
40	HAZELPOINT_N	12	20	126641-6660	12HAZN-SPHD01A	**yes**	12HAZN-SPHD01B	**yes**
42	NISQUALY	13	20	118201-8220	11NQ-SPHD01A	**yes**	11NQ-SPHD01B	**yes**
42	NISQUALY	13	20	118221-8240	11NQ-SPHD02A	**yes**	11NQ-SPHD02B	**yes**

APPENDIX B: MATERIALS AND METHODS DETAILS

Chemistry Sample Creation (Tissue Composites)

Prior to sample preparation, all work surfaces were cleaned and covered with aluminum foil and all stainless steel lab instruments were cleaned as follows; 1) hand washed with warm soapy water (Terg-A-Zyme®), 2) rinsed three times with tap water, 3) rinsed once with deionized water, 4) solvent-rinsed with isopropyl alcohol. Cleaned instruments were left to dry on aluminum foil. All specimens were rinsed with tap and deionized water and allowed to dry prior to sample preparation to remove large debris and sediment. Pre-cleaned I-Chem™ Series 200 jars (various sizes) were used to store all the composites described below.

Dungeness Crab Sample Preparation

After removing from the freezer, the sex of each crab was verified by inspection of the telson width and the shell hardness was verified. The carapace width of each crab was measured to the nearest millimeter from inside the last anterolateral spine using calipers and the total weight was measured to the nearest 10th of a gram (0.1 g) using a bench scale (Figure B1). Unfortunately, total weight was not recorded for the crabs collected during the 2011 English sole survey because at that time standard catch processing procedure for crab was to remove the claws and legs and store them separately from the body. After measurements were taken, the claws and first two walking legs were removed from the body and the body and remaining legs were placed into labeled Ziploc bags and stored in the -20° C freezer until the hepatopancreas could be resected.

For muscle resection, the claws and legs were cracked open using a cleaver and a mallet. Approximately 40 g of muscle tissue was removed, using stainless steel tools, and placed in a clean 8-ounce composite jar (Figure B2). This was repeated until tissue from a maximum of five crabs had been removed. The composite sample was then ground to a homogenous mixture using a Bamix® hand mixer with cleaned cutting blades. Twenty-five gram aliquots were removed and redistributed into an additional four labeled jars for analyses of the following chemical groups; a) organics, b) metals, c) dioxins[1], as well as an archive. A total of 56 muscle composite samples were created by combining a maximum of five crabs and a minimum of three crabs per station (Table A1). Three composite samples were created from a single station in Sinclair Inlet because broader station coverage within the bay was not possible. The following five station composites contained fewer than five crabs; ELLTBAY (three crabs), COMMBAY4_DEEP (four crabs), COMMBAY_P23 (three crabs), TREBLEPOINT (three crabs) and BRISCOPOINT (three crabs). Upon resection, it was observed and noted that all crabs from STRTGEOR were soft-shelled. All jars were stored in a -20° C freezer until transferred to the analytical lab for chemical analysis.

The hepatopancreas is a brown/orange lobed organ located throughout the entire body cavity of a crab. For hepatopancreas resection, whole crab bodies were removed from the freezer the night before processing and stored in a 5° C cold room to slowly thaw. The hepatopancreas was collected, using a pre-cleaned spatula, while the crab was still partially frozen to avoid significant mixing of body fluids or loss of tissue, because parts of the hepatopancreas tended to liquefy when completely thawed. To gain access to the body cavity the partially thawed crab was placed upside down with its carapace against the lab table while each set of five legs were held by hand, then one side of the crab was pushed down and rotated forward (towards the eyes), which effectively broke off one set of legs and half of the attached abdomen. Once this was accomplished the other set of legs and attached abdomen could be easily removed. This opening method exposed the entire hepatopancreas, which could then be removed using forceps. Composite samples of five crabs were made with individuals from a total of 19 stations (Table A7). The locations selected for hepatopancreas sampling were chosen in order to represent an expected low to high chemical concentration gradient. All samples were stored in labeled jars in a -20° C freezer until transferred to the analytical lab for chemical analysis (Figure B2).

[1] Dioxins were not analyzed in this study. Jars will be held in archive.

Figure B1. Five partially frozen Dungeness crab (left) and carapace width measurement using calipers (right)

Figure B2. Dungeness crab muscle resection; removal of the legs (top left), cutting into each leg section (top right) and scraping the muscle out of the leg into a pre-labeled I-Chem™ jar (middle left). The result was four jars of composite samples (middle right). The bottom two images show a crab's hepatopancreas after the carapace was removed (images captured from a YouTube video: http://www.youtube.com/watch?v=rPFLZT5ZD2k)

Spot Prawn Sample Preparation

Spot prawns were removed from the freezer, rinsed with tap water and deionized water, and allowed to dry on paper towels. Carapace length, measured from behind the eye stalk to the beginning of the abdomen, was recorded to the nearest tenth of a millimeter (0.1 mm) using electronic calipers and a total animal weight was measured to the nearest 10^{th} of a gram (0.1 g) using a bench scale (Figure B3).

Muscle samples were removed by separating the tail from the head/thorax. The tail section was split along its dorsal surface with scissors and the tissue was removed with forceps (Figure B4). Each muscle sample was weighed individually prior to addition to the composite jar. This process was repeated until a maximum of 20 muscle samples were accumulated in the jar. The composite was then ground to a homogeneous mixture using a Bamix® hand mixer. Aliquots were placed in clean composite jars as follows; 50g for organic contaminant analysis, 20g for metal analysis, and the remaining tissue was saved as an archive sample. Spot prawn muscle composite samples were prepared from 42 stations. However, two replicate composites were made from the NISQUALLY station spot prawns, resulting in a total of 43 muscle samples for chemistry analysis (Appendix A, **Error! Reference source not found.**). Station composites contained 20 prawn specimens with the exception of POINTDISNEY (19 prawns), LOWELLPOINT (18 prawns), ELLTBAY4_91 (19 prawns), DEWATTO_S (19 prawns), and PLEASANTHARBOR (17 prawns).

The spot prawn head tissue samples were collected after separating the tail section from the thorax. All head and thorax tissue were scraped from the carapace as follows; 1) the curved edge of a spatula was inserted into the ventral surface of the thorax cavity posterior to the walking legs, 2) the spatula was scraped along each side of the thorax to release the tissue, 3) the gills were cut using scissors and 4) the entire contents of the thorax, except the legs, carapace and any errant shell fragments, were placed into a clean composite jar (Figure B4). The weight of each individual thorax tissue sample was recorded. After 20 samples had been added to the jar, the tissue composite was ground to a homogeneous mixture using a Bamix® hand mixer and then redistributed in the following aliquots; 50g for organic contaminant analysis, 20g for metals analysis, and any remaining tissue was saved as an archive sample. Samples were labeled and stored in a -20°C freezer until transferred to the analytical lab. A total of 16 stations were selected for head/thorax tissue sampling in order to represent a low to high chemical concentration gradient (Table A8). Upon resection, it was observed and noted that one prawn from PROTECTIONISL had a soft shell.

Figure B3. Partially frozen spot prawn prior to resection (left); measuring of carapace length using calipers (right)

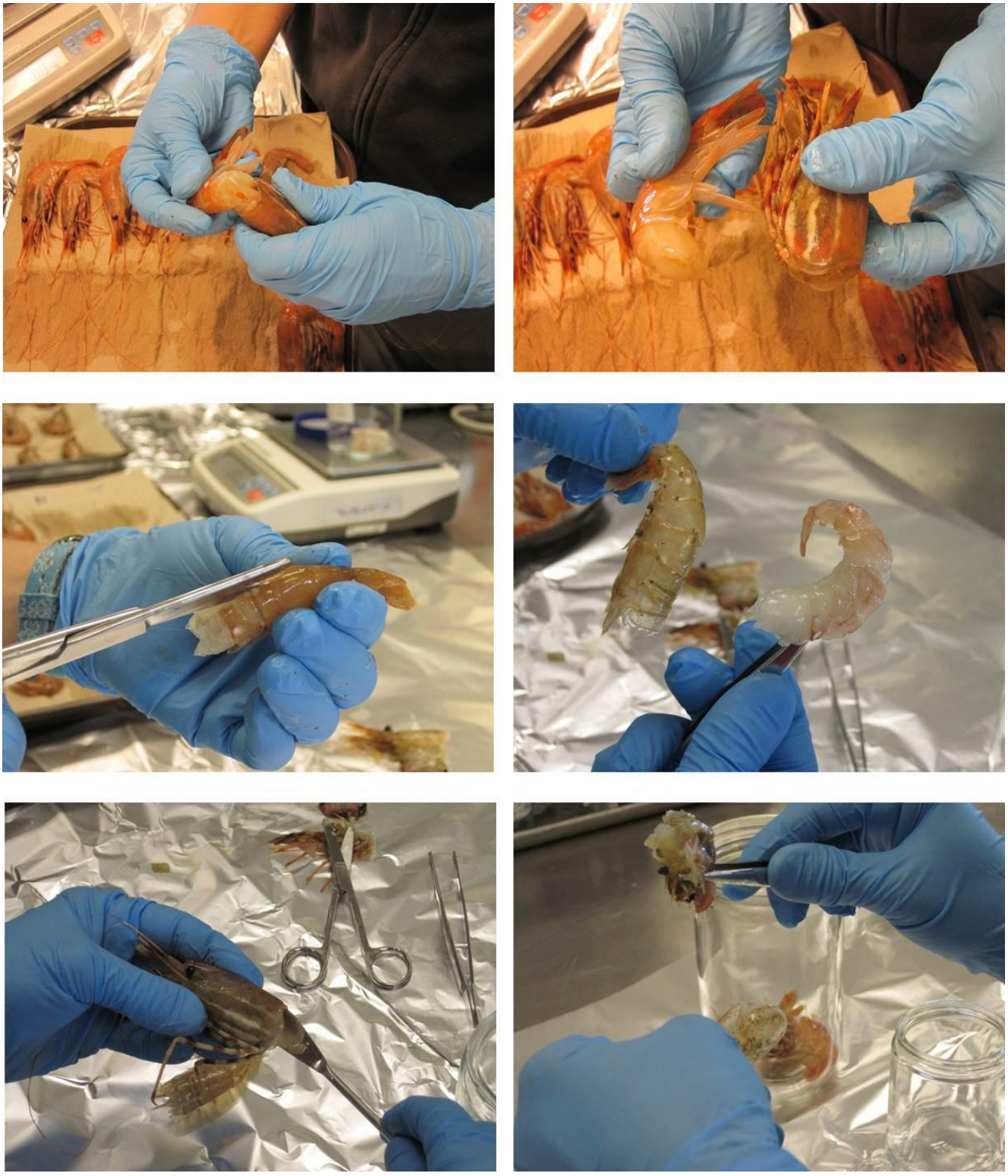

Figure B4. Spot prawn tissue resection began with separating the carapace from the tail (top left) to make two separate pieces (top right). The muscle was removed by splitting the tail section (center left) and removing the muscle using forceps (center right). A spatula was then used to scrape the inside of the carapace (bottom left) which released the head tissue that was subsequently removed and placed into an I-Chem™ jar (bottom right).

Laboratory Analysis

All samples were delivered frozen to analytical laboratories and thawed samples were stirred prior to extraction to ensure they were adequately homogenized. Four extra spot prawn sites and five Dungeness crab sites were composited but not analyzed for contaminants (Table A1, Table A2, Table A7, and Table A8). All samples met QAQC criteria

Four matrices, 1) Dungeness crab, 2) spot prawn muscle tissue, 3) Dungeness crab hepatopancreas, and 4) spot prawn head/thorax tissue were analyzed for polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), organo-chlorinated pesticides (OCPs) and polycyclic aromatic hydrocarbons (PAHs) at the National Oceanic and Atmospheric Association's (NOAA) Northwest Fisheries Science Center (NWFSC). After homogenization, all samples were analyzed for these persistent organic pollutants (POPs) using accelerated solvent extraction and gas chromatography/mass spectrometry according to Sloan et al. (2004). In brief, this method comprises three steps; 1) accelerated solvent extraction (ASE) of tissue using methylene chloride, 2) cleanup of the methylene chloride extract by silica/aluminum columns and size-exclusion high-performance liquid chromatography (SEC HPLC), and 3) quantitation of chlorinated hydrocarbons (CHs) and aromatic hydrocarbons (AHs) using gas chromatography/mass spectrometry (GC/MS) with selected-ion-monitoring (SIM). Extraction by ASE methods provided an extraction that was used for AH, CH recovery and gravimetric lipid evaluation. Alterations to the typical GC/MS methods were included in order to stabilize the instrument and improve accuracy, specifically chemical ionization filaments (used to increase source temperature) employed a cool on-column injection system in the GC, a guard column before the analytical column, and point-to-point calibration to improve data fit over the full range of GC/MS calibration standards (Sloan et al. 2004).

Two methods were used to analyze the tissue matrices for mercury, cadmium, arsenic, copper, lead and zinc. Mercury was analyzed via automated cold vapor atomic absorption spectrometry following King County Environmental Laboratory's (KCEL) Standard Operating Procedure (SOP) 604v6. This SOP incorporates elements of the following Environmental Protection Agency's (EPA) methods; 245.1 revision 3, SW-846 7470, 7471B and PSEP 1997. Arsenic, cadmium, copper, zinc and lead were analyzed via Thermo Elemental X Series II CCT (Collision Cell Technology) Inductively Coupled Plasma Mass Spectrometry (ICP-MA), following KCEL SOP 624v2. This SOP incorporates elements of EPA methods; 200.8 revision 5.4, SW-846 6020A February 2007, ILMO5.3 Exhibit D part B, and PSEP 1997. Total solids were analyzed using KCEL SOP 307v3 to facilitate reporting metals data in both dry and wet weight concentrations.

Stable Isotope Analysis

The stable isotopes of carbon and nitrogen were measured to calculate the isotopic ratios of ^{13}C to^{12}C as $\delta^{13}C$, and of ^{15}N to^{14}N, as $\delta\ ^{15}N$, relative to standardized isotopic ratios. We used $\delta^{15}N$ as an estimator of trophic level, *sensu* Hobson (1999) and Post et al. (2007). We used $\delta^{13}C$ in crab and prawn tissues as an independent estimator of the gradient from oceanic to estuarine conditions within Puget Sound ($\delta^{13}C$ increases from oceanic to estuarine conditions; see Hobson 1999, West et al. 2011).

Stable isotope ratios were calculated using carbon and nitrogen isotopes measured from tissue subsamples taken from the same jars used for analysis of chemical contaminants. Wet samples were desiccated in a vacuum freeze dryer. Freeze-dried subsamples were then powdered in a SPEX 5100 ball mill (Metuchen, N. J) and then weighed into 5x9 mm tin capsules. Stable isotope ratios for the powdered samples were determined using a Costech ECS 4010 elemental analyzer (Valencia, CA) coupled to a Thermo Electron Delta Plus stable isotope ratio mass spectrometer (Bremen, Germany). Stable isotope values were expressed in δ notation as parts-per-thousand (‰) as defined by the following expression:

$$\delta Z = [(R_{sample}/R_{standard})\text{-}1]\text{x}1000,$$

where Z represents ^{15}N or ^{13}C, R_{sample} is the ratio $^{15}N/^{14}N$ or $^{13}C/^{12}C$ for samples, and $R_{standard}$ is the ratio $^{15}N/^{14}N$ or $^{13}C/^{12}C$ for the corresponding standards. The lab used two standards each for N and C to define the line used to convert the mass spectrometer signal to sample $\delta^{15}N$ and $\delta^{13}C$ values, respectively. Precision for isotope analysis was $\leq \pm 0.3‰$ for $\delta^{15}N$ and $\leq \pm 0.2‰$ for $\delta^{13}C$. All nitrogen values were referenced to atmospheric nitrogen ($\delta^{15}N$ for atmospheric N is 0‰ exactly) and carbon values were referenced to Vienna Pee Dee Belemnite, also known as NBS 19 [($\delta^{13}C$ of NBS 19 ≡ 1.95‰ (Coplen et al., 2006).

$\delta^{13}C$ values were corrected for variable lipid content (rather than pre-extracting lipids from samples) using a correction for aquatic animals proposed by (Post et al., 2007), presented as "delta delta C" from his Equation 3:

$$\Delta\delta C^{13} = -3.32 + 0.99 * C:N,$$

Where C:N is the ratio of carbon to nitrogen by weight in the sample. For simplicity this adjusted $\delta^{13}C$ is hereafter referred to as $\delta^{13}C$.

Data Quality

There were no analytical issues that compromised data quality or the ability to analyze data. Minor deviations from the study plan (see Deviations from the QAPP, below) likely had a trivial effect on our interpretations.

Deviations from the QAPP

1. QAPP states "All crab and shrimp samples will be taken from late March through July."- Crab samples from PTGAMBLE_1 and PTGAMBLE_3 were collected on 8/13/2012. The original collection window was identified to mimic the sport fishery, and to avoid molting seasons. These August collections were still within the normal fishing season, and all crab from these sites were hard-shelled, reducing possible impacts from this deviation.

2. QAPP states we would only collect legal size crab (carapace width of 158.75mm or 6.25 inches) – we collected some that were smaller than that. The range was 150-239 mm CW. 1 crab was 150mm, 1 crab was 156mm, and 2 were 158mm. The minimum size for this study was based on WDFW fishery regulations. The 8.75mm to 0.75 mm difference in these few crab are trivial deviations.

3. QAPP states that we would only collect hard-shelled crab – all the crab collected from the Strait of Georgia were noted as having somewhat soft-shells. Although this condition would not represent the fishery, its effect on contaminant levels is unknown. The Strait of Georgia contaminant results were not unusual in any way, and so this deviation was not highlighted in the Results or Discussion.

APPENDIX C: POPS AND METALS RAW DATA FOR ALL SAMPLES ANALYZED

Table C1. POPs concentrations (ng/g wet weight) in Dungeness crab muscle from crab collected in nine Marine Areas and three urban embayments (SI = Sinclair Inlet, EB = Elliott Bay, and CB = Commencement Bay) of Puget Sound (Location). Concentrations with a "<" represent non-detected values that are below or equal to the limit of quantitation (LOQ). The maximum LOQ is reported for summed analytes.

Location	Station Name	Sample ID	Gravimetric Lipids (%)	HCB	$\sum_8$CHLDs	$\sum_6$DDTs	$\sum_3$HCHs	Total PCBs	$\sum_{11}$PBDEs	Total PAHs
6	DISCOBAY_TU	12DB_TU-DCM01B	0.36	-0.33	< 0.33	0.47	< 0.33	1.9	< 0.34	< 0.49
7	VENDOVI	11VD-DCM01B	0.30	-0.18	< 0.18	0.25	< 0.18	1.9	0.21	0.6
7	WALDRONISL_N	12WALD_N-DCM01B	0.18	-0.20	< 0.20	0.24	< 0.20	3.8	< 0.20	< 0.35
7	BHMHARBR	12BH-DCM01B	0.23	-0.26	< 0.26	0.45	< 0.26	3.8	< 0.26	1.8
7	STRTGEOR	12SG-DCM01B	0.17	-0.21	< 0.21	< 0.21	< 0.21	1.5	< 0.21	2.0
7	ALLANISL_S	12ALNIS_S-DCM01B	0.39	-0.22	< 0.22	0.29	< 0.22	5.7	< 0.22	0.70
8.1	BABYISLAND	12BBY-DCM01B	0.24	-0.26	< 0.26	0.28	< 0.26	4.4	< 0.26	< 0.36
8.1	NORTHBLUFF_N	12NBL_N-DCM01B	0.29	-0.32	< 0.32	< 0.32	< 0.32	3.6	< 0.32	< 0.55
8.1	CAMANOCITY_S	12CCS-DCM01B	0.27	-0.23	< 0.23	< 0.23	< 0.23	4.8	< 0.23	< 0.48
8.1	STRAWBERRYPT	12STRPT-DCM01B	0.21	-0.28	< 0.28	0.35	< 0.28	3.6	< 0.28	< 0.57
8.1	SKAGITIS	12SKIS-DCM01B	0.10	-0.23	< 0.23	0.27	< 0.23	1.2	< 0.23	< 0.38
8.2	PTGARDNR	11PG-DCM01B	0.24	-0.22	< 0.22	0.53	< 0.22	6.3	0.75	< 0.42
8.2	CAMANOHEAD	12CH-DCM01B	0.18	-0.19	< 0.19	0.27	< 0.19	2	0.22	0.27
8.2	LANGLEY_N	12LYN-DCM01B	0.24	-0.20	< 0.20	0.45	< 0.20	4	0.23	< 0.37
8.2	PTSUSAN	12PS-DCM01B	0.27	-0.26	< 0.26	0.49	< 0.26	6.5	0.81	< 0.33
8.2	MABANA_N	12MB_N-DCM01B	0.19	-0.23	< 0.23	0.66	< 0.23	8.8	0.7	0.32
9	PTGAMBLE_3	12PTGB3-DCM01B	0.17	-0.25	< 0.25	0.72	0.34	5.5	< 0.25	0.34
9	PTGAMBLE_1	12PTGB1-DCM01B	0.22	-0.20	< 0.20	0.26	0.49	2.1	< 0.21	0.30
9	EGLON	12ELN-DCM01B	0.19	-0.28	< 0.28	< 0.29	< 0.28	2	< 0.29	< 0.54
9	PTGAMBLE_N	12PTGB_N-DCM01B	0.27	-0.21	< 0.21	0.48	0.73	3.7	0.22	< 0.43
9	USELESSBAY_M	12UB_M-DCM01B	0.15	-0.26	< 0.26	< 0.26	0.31	1.5	< 0.26	< 0.41
9	OAKBAY	12OAKB-DCM01B	0.18	-0.23	< 0.23	0.28	< 0.23	2	< 0.23	< 0.52
9	PTTWNSND_GC	12PT_GC-DCM01B	0.26	-0.27	< 0.27	0.35	< 0.27	2.5	< 0.27	< 0.35
10	BLAKEISLAND_N	12BLK_N-DCM01B	0.33	-0.27	< 0.27	0.74	0.28	9.8	1.2	0.33
10	YEOMALT_SH	12YEO_SH-DCM01B	0.21	-0.21	< 0.21	0.33	0.46	4.1	0.48	< 0.38
10	PTMADISON_IND	12PM_IND-DCM01B	0.23	-0.20	< 0.20	1	0.77	12	1.1	0.29
10	EDMONDS	12ED-DCM01B	0.26	-0.16	0.19	0.64	0.16	11	0.66	0.57
10	4MILEROCK	124M-DCM01B	0.24	-0.19	0.61	1.6	0.29	55	1.5	0.28
SI	SCLINLET	11SI-DCM01B	0.49	-0.24	< 0.24	0.72	0.42	25	0.97	1.45
SI	SCLINLET	11SI-DCM02B	0.40	-0.26	< 0.26	0.74	< 0.26	28	1.0	0.73
SI	SCLINLET	11SI-DCM03B	0.49	-0.27	< 0.27	0.66	< 0.27	28	0.94	0.41

Continued.

Table C1 (continued). POPs concentrations (ng/g wet weight) in Dungeness crab muscle from crab collected in nine Marine Areas and three urban embayments (SI = Sinclair Inlet, EB = Elliott Bay, and CB = Commencement Bay) of Puget Sound (Location). Concentrations with a "<" represent non-detected values that are below or equal to the limit of quantitation (LOQ). The maximum LOQ is reported for the summed analytes.

Location	Station Name	Sample ID	Gravimetric Lipids (%)	HCB	$\sum_8$CHLDs	$\sum_6$DDTs	$\sum_3$HCHs	Total PCBs	$\sum_{11}$PBDEs	Total PAHs
EB	DUWAMISH	11DU-DCM01B	0.20	-0.31	0.67	1.9	< 0.31	110	2.1	2.76
EB	ELLTBAY	11EB-DCM01B	0.26	-0.27	0.87	2.6	< 0.27	180	1.7	0.96
EB	ELLTBAY_P69	12EB_P69-DCM01B	0.21	-0.20	< 0.20	1.1	< 0.20	55	1.8	1.44
EB	ELLTBAY4_P89	12EB4_P89-DCM01B	0.35	-0.53	1.2	4.8	< 0.53	160	2.8	3.22
EB	ELLTBAY4_P91SH	12EB4-P91SH-DCM01B	0.21	-0.17	0.82	1.9	< 0.17	91	2.5	4.01
11	QTRMASTR	12QM-DCM01B	0.16	-0.23	< 0.23	0.51	1.8	6	0.79	0.62
11	OLLALA	12OL-DCM01B	0.30	-0.20	< 0.20	0.63	1.7	7.3	1.1	0.35
11	3TREEPOINT	12TT-DCM01B	0.23	-0.27	< 0.27	0.36	0.35	2.2	1.1	0.36
CB	COMMBAY	11CB-DCM01B	0.19	-0.37	< 0.37	0.75	< 0.37	20	1.4	5.98
CB	COMMBAY4_DEEP	12CB4_DEEP-DCM01B	0.29	-0.22	0.25	0.76	< 0.22	13	2.2	< 0.31
CB	COMMBAY_P23	12CB_P23-DCM01B	0.31	0.23	1.8	3.6	< 0.15	54	7.3	0.52
12	HDCANAL_TA	12HC_TA-DCM01B	0.22	-0.24	< 0.24	< 0.24	< 0.24	1	< 0.24	0.32
12	LILLIWAUP	12LW-DCM01B	0.26	-0.29	< 0.29	0.52	< 0.29	2.5	< 0.29	< 0.44
12	SCENICBEACH	12SC-DCM01B	0.26	-0.21	< 0.21	0.48	< 0.21	2.8	< 0.21	< 0.41
12	QUILCENE	12QB-DCM01B	0.32	-0.25	< 0.25	0.32	< 0.25	2.5	< 0.25	< 0.42
12	SQUAMISHHRBR	12SUH-DCM01B	0.21	-0.36	< 0.36	0.48	< 0.36	2.6	< 0.36	1.52
13	NISQUALY_FLATS_GC	12NQ_FLGC-DCM01B	0.30	-0.24	< 0.24	0.5	0.83	7.9	0.68	1.15
13	TREBLEPOINT	12TRP-DCM01B	0.11	-0.39	< 0.39	< 0.39	< 0.39	2.2	< 0.39	0.43
13	NISQUALY	11NQ-DCM01B	0.33	-0.28	< 0.28	0.32	0.53	4.2	0.33	0.32
13	BRISCOPOINT	12BRP-DCM01B	0.35	-0.36	< 0.36	0.71	1.1	9.9	< 0.36	1.9

Table C2. POPs concentrations (ng/g wet weight) in Dungeness crab hepatopancreas from crab collected in nine Marine Areas and two urban embayments (EB = Elliott Bay and CB = Commencement Bay) of Puget Sound (Location). Concentrations with a "<" represent non-detected values that are below or equal to the limit of quantitation (LOQ). The maximum LOQ is reported for the summed analytes.

Location	Station Name	Sample ID	Gravimetric Lipid (%)	HCB	$\sum_8$CHLDs	$\sum_6$DDTs	$\sum_3$HCHs	Total PCBs	$\sum_{11}$PBDEs	Total PAHs
6	DISCOBAY_TU	12DB_TU-DCHP01B	3.27	0.87	1.4	8.6	3.1	52	4.4	1.71
7	BHMHARBR	12BH-DCHP01B	6.56	1.8	3.8	30	2.2	87	15	12.2
7	STRTGEOR	12SG-DCHP01B	4.39	1.4	2.4	15	2.1	52	8.8	2.17
8.1	SKAGITIS	12SKIS-DCHP01B	4.15	1.1	1.3	11	1.4	49	3.9	< 0.50
8.2	PTSUSAN	12PTS-DCHP01B	7.86	3.4	6.4	21	2	210	26	7.44
9	PTGAMBLE_3	12PTGB3-DCHP01B	7.38	2.1	1.9	11	7.4	100	5	2.84
9	PTGAMBLE_1	12PTGB1-DCHP01B	6.88	2	1.7	11	11	110	7.1	2.74
10	EDMONDS	12ED-DCHP01B	4.46	1.2	4.1	23	2.8	280	20	5.99
10	4MILEROCK	124M-DCHP01B	4.41	1.6	9.3	56	7.1	1300	47	16.7
10	YEOMALT_SH	12YEO_SH-DCHP01B	6.27	1.8	3.5	14	7.1	190	17	4.30
EB	ELLTBAY_P69	12EB_P69-DCHP01B	2.26	1.4	11	69	2.3	2200	51	40.7
EB	ELLTBAY4_P89	12EB4_P89-DCHP01B	3.56	1.6	8.5	44	1.6	1600	64	48.9
EB	ELLTBAY4_P91SH	12EB4-P91SH-DCHP01B	6.15	1.6	13	44	2.9	1400	48	67.5
11	QTRMASTR	12QM-DCHP01B	3.62	1.7	2.8	11	19	120	14	1.97
CB	COMMBAY4_DEEP	12CB4_DEEP-DCHP01B	6.43	2.3	10	29	4.5	370	62	12.3
CB	COMMBAY_P23	12CB_P23-DCHP01B	6.53	4	33	140	3.3	1400	200	14.4
12	SCENICBEACH	12SC-DCHP01B	6.12	1.8	4.2	27	2.7	110	10	0.91
13	NISQUALY_FLATS_GC	12NQ_FLGC-DCHP01B	5.68	1.6	3.7	15	9.7	190	16	2.54
13	BRISCOPOINT	12BRP-DCHP01B	3.99	1.3	3	13	8.6	190	10	2.91

Table C3. POPs concentrations (ng/g wet weight) in spot prawn muscle from prawn collected in nine Marine Areas and one urban embayment (EB = Elliott Bay) of Puget Sound (Location). Concentrations with a "<" represent non-detected values that are below or equal to the limit of quantitation (LOQ). The maximum LOQ is reported for the summed analytes.

Location	Station Name	Sample ID	Gravimetric Lipids (%)	HCB	$\sum_8$CHLDs	$\sum_6$DDTs	$\sum_3$HCHs	Total PCBs	$\sum_{11}$PBDEs	Total PAHs
6	PROTECTIONISL	12PRO-SPM01B	0.56	-0.14	< 0.14	< 0.14	< 0.14	1	< 0.14	0.53
6	PARTRIDGEBANK_N	12PBN-SPM01B	0.39	-0.15	< 0.15	< 0.15	< 0.15	1.6	0.17	0.56
7	LAWSONREEF_N	12LRN-SPM01B	0.52	-0.14	< 0.14	< 0.14	< 0.14	0.85	< 0.14	1.06
7	POINTCAUTION	12PTC-SPM01B	0.42	-0.18	< 0.18	< 0.18	< 0.18	1.4	0.19	0.63
7	VENDOVI	11VD-SPM01B	0.59	-0.11	< 0.11	< 0.11	< 0.11	1.4	0.11	2.3
7	POINTDISNEY	12PTD-SPM01B	0.55	-0.11	< 0.11	< 0.11	< 0.11	0.96	< 0.11	0.35
7	FERNPOINT	12FPT-SPM01B	0.37	-0.11	< 0.11	< 0.11	< 0.11	2.1	0.17	0.65
8.1	BABYISLAND	12BBY-SPM01B	0.78	-0.13	< 0.13	< 0.13	< 0.13	3.5	0.16	1.13
8.1	NORTHBLUFF	12NBL-SPM01B	0.70	-0.14	< 0.14	< 0.14	< 0.14	2.9	< 0.14	0.68
8.1	CAMABEACH	12CMB-SPM01B	0.67	-0.14	< 0.14	< 0.14	< 0.14	3	< 0.14	0.66
8.1	CAMANOCITY_S	12CCS-SPM01B	0.35	-0.16	< 0.16	< 0.16	< 0.16	2.8	0.21	0.93
8.1	ONAMAC	12ON-SPM01B	0.78	-0.16	< 0.16	< 0.16	< 0.16	3.2	< 0.16	0.55
8.2	PTGARDNR	11PG-SPM01B	0.69	-0.12	< 0.12	< 0.12	< 0.12	8	0.52	0.94
8.2	CAMANOHEAD	12CH-SPM01B	0.29	-0.18	< 0.18	< 0.18	< 0.18	2.8	0.47	0.3
8.2	LANGLEY_N	12LYN-SPM01B	0.46	-0.20	< 0.20	< 0.20	< 0.20	4.5	0.21	0.62
8.2	PTSUSAN	12PS-SPM01B	0.29	-0.13	< 0.13	< 0.14	< 0.13	3.8	0.42	0.77
8.2	MABANA_N	12MB_N-SPM01B	0.42	-0.16	< 0.16	< 0.16	< 0.16	3.1	0.37	0.82
9	EDMONDS_N	12EDN-SPM01B	0.27	-0.28	< 0.28	< 0.28	< 0.28	6.1	0.39	0.67
9	BROWNBAY	12BRB-SPM01B	0.36	-0.23	< 0.23	< 0.23	< 0.23	12	0.47	0.96
9	POSSEPT	12PP-SPM01B	0.33	-0.22	< 0.22	0.24	< 0.22	12	0.68	0.73
10	BLAKLYRK	12BR-SPM01B	0.31	-0.31	< 0.31	< 0.32	< 0.31	9.4	0.32	0.38
10	YEOMALT	12YEO-SPM01B	0.61	-0.32	< 0.32	< 0.32	< 0.32	7.4	0.46	0.71
10	SKIFFPT_N	12SKPN-SPM01B	0.40	-0.26	< 0.26	< 0.27	< 0.26	8.1	0.45	0.6
10	MEADOWPOINT	12MP-SPM01B	1.32	-0.24	< 0.24	< 0.24	< 0.24	5.3	0.33	1.23
EB	ELLTBAY_SW	12EB_SW-SPM01B	0.62	-0.30	< 0.30	< 0.30	< 0.30	27	0.32	1.16
EB	ELLTBAY_PSSDA	12EB_PSSDA-SPM01B	0.59	-0.25	< 0.25	< 0.25	< 0.25	17	< 0.25	1.04
EB	DUWAMISHHEAD	12DH-SPM01B	0.61	-0.31	< 0.31	< 0.31	< 0.31	16	< 0.31	1.2
EB	ELLTBAY_P71DEEP	12EB_P71DP-SPM01B	0.63	-0.30	< 0.30	< 0.30	< 0.30	17	< 0.30	1.04
EB	ELLTBAY4_P91	12EB4_P91-SPM01B	0.79	-0.19	< 0.19	< 0.19	< 0.19	14	< 0.19	3.72
11	DESMOINES_N	12DMN-SPM01B	0.37	-0.32	< 0.32	< 0.32	< 0.32	6.6	0.43	0.78
11	SEAHURST	12SR-SPM01B	0.59	-0.35	< 0.35	< 0.35	< 0.35	7	8.2	0.74
11	BRACEPT_S	12BRPS-SPM01B	0.46	-0.27	< 0.27	< 0.27	< 0.27	7.3	< 0.27	0.96

Continued.

Table C3 (continued). POPs concentrations (ng/g wet weight) in spot prawn muscle from prawn collected in nine Marine Areas and one urban embayment (EB = Elliott Bay) of Puget Sound (Location). Concentrations with a "<" represent non-detected values that are below or equal to the limit of quantitation (LOQ). The maximum LOQ is reported for the summed analytes.

Location	Station Name	Sample ID	Gravimetric Lipids (%)	HCB	$\sum_8$CHLDs	$\sum_6$DDTs	$\sum_3$HCHs	Total PCBs	$\sum_{11}$PBDEs	Total PAHs
12	HDCANAL_MUS	12HCMUS-SPM01B	0.32	-0.44	< 0.44	< 0.44	< 0.44	2.2	< 0.44	< 0.39
12	DEWATTO_S	12DES-SPM01B	0.85	-0.13	< 0.13	< 0.13	< 0.13	1.2	< 0.13	0.72
12	HDCANAL_NEL	12HCNEL-SPM01B	0.64	-0.13	< 0.13	< 0.13	< 0.13	2.1	< 0.13	0.90
12	HAZELPOINT_N	12HAZN-SPM01B	0.57	-0.23	< 0.23	< 0.23	< 0.23	1	< 0.23	0.66
12	HDCANAL_ZEL	12HCZEL-SPM01B	0.67	-0.13	< 0.13	< 0.14	< 0.13	2.3	< 0.14	0.76
13	NISQUALY	11NQ-SPM01B	0.39	-0.20	< 0.20	< 0.20	< 0.20	4.5	0.49	2.58
13	NISQUALY	11NQ-SPM02B	0.33	-0.22	< 0.22	< 0.22	< 0.22	2.8	< 0.22	1.5

Table C4. POPs concentrations (ng/g wet weight) in spot prawn head tissue from prawn collected in nine Marine Areas and one urban embayment (EB = Elliott Bay) of Puget Sound (Location). Concentrations with a "<" represent non-detected values that are below or equal to the limit of quantitation (LOQ). The maximum LOQ is reported for the summed analytes.

Location	Station Name	Sample ID	Gravimetric Lipids (%)	HCB	$\sum_8$CHLDs	$\sum_6$DDTs	$\sum_3$HCHs	Total PCBs	$\sum_{11}$PBDEs	Total PAHs
6	PARTRIDGEBANK_N	12PBN-SPHD01B	3.25	-0.16	0	0.21	0.22	24	0.99	6.57
7	POINTCAUTION	12PTC-SPHD01B	4.27	-0.25	0	0.72	0.25	10	0.87	2.66
7	FERNPOINT	12FPT-SPHD01B	2.88	-0.19	0	0.25	0	14	1.7	1.89
8.1	BABYISLAND	12BBY-SPHD01B	7.38	0.44	0.35	2	0.73	80	4.9	3.63
8.2	PTGARDNR	11PG-SPHD01B	7.27	0.48	2.3	3	0.87	160	18	7.98
8.2	PTSUSAN	12PS-SPHD01B	11.31	0.74	2.2	4.6	1.2	180	16	5.22
10	MEADOWPOINT	12MP-SPHD01B	6.18	0.39	1.4	1.7	0.68	160	19	22.75
EB	ELLTBAY_SW	12EB_SW-SPHD01B	9.61	0.36	1.6	3	0.8	690	17	23.76
EB	ELLTBAY_PSSDA	12EB_PSSDA-SPHD01B	9.37	0.38	1.3	2.5	0.89	570	11	17.089
EB	DUWAMISHHEAD	12DH-SPHD01B	9.73	0.41	1.5	2.4	0.93	500	13	27.8
EB	ELLTBAY_P71DEEP	12EB_P71DP-SPHD01B	11.48	0.61	2	3.2	1.3	690	15	32.2
EB	ELLTBAY4_P91	12EB4_P91-SPHD01B	9.67	0.44	1.6	3	0.97	520	15	16.9
12	HAZELPOINT_N	12HAZN-SPHD01B	7.20	0.36	0.41	0.85	0.75	29	2.2	2.25
13	NISQUALY	11NQ-SPHD01B	8.99	0.39	1.2	1.3	1	160	10	12.07
13	NISQUALY	11NQ-SPHD02B	8.88	0.42	1.2	1.5	1	150	10	8.81

Table C5. Metal concentrations (mg/kg wet weight) in Dungeness crab muscle from crab collected in nine Marine Areas and three urban embayments (SI = Sinclair Inlet, EB = Elliott Bay, and CB = Commencement Bay) of Puget Sound (Location). Negative concentrations represent non-detected values that are equal to or below the method detection limit (MDL).

Location	Station Name	Sample ID	Total Solids (%)	Total Mercury	Total Arsenic	Total Cadmium	Total Copper	Total Lead	Total Zinc
6	DISCOBAY_TU	12DB_TU-DCM01B	18.5	0.0719	16.1	0.0072	8.25	-0.0039	44.4
7	VENDOVI	11VD-DCM01B	15.5	0.0462	7.01	-0.0020	9.62	-0.0041	26
7	WALDRONISL_N	12WALD_N-DCM01B	21.8	0.045	11.5	0.0037	8.84	0.0059	61.2
7	BHMHARBR	12BH-DCM01B	18.2	0.0442	6.32	0.0024	4.22	-0.0040	46.1
7	STRTGEOR	12SG-DCM01B	11.6	0.0191	3.73	0.0037	10.1	-0.0040	29.7
7	ALLANISL_S	12ALNIS_S-DCM01B	19.4	0.0539	11.2	0.0029	10.8	-0.0040	46.5
8.1	BABYISLAND	12BBY-DCM01B	20.3	0.0467	14.6	0.0022	9.99	-0.0038	46.2
8.1	NORTHBLUFF_N	12NBL_N-DCM01B	19.6	0.0464	13.5	0.0039	9.8	-0.0040	51.2
8.1	CAMANOCITY_S	12CCS-DCM01B	19.8	0.0351	8.27	-0.0020	8.26	-0.0040	54.9
8.1	STRAWBERRYPT	12STRPT-DCM01B	19.6	0.0547	11.7	-0.0020	8.25	-0.0040	50.2
8.1	SKAGITIS	12SKIS-DCM01B	19.2	0.0563	6.41	-0.0020	9.31	-0.0041	49.6
8.2	PTGARDNR	11PG-DCM01B	19	0.0536	5.47	-0.0020	8.92	-0.0040	32.8
8.2	CAMANOHEAD	12CH-DCM01B	18.7	0.0516	8.67	0.0057	10.6	-0.0040	50.7
8.2	LANGLEY_N	12LYN-DCM01B	16.7	0.0412	20.5	0.0072	10.5	-0.0040	41.1
8.2	PTSUSAN	12PS-DCM01B	20.1	0.0609	6.55	0.0056	11	-0.0039	44.8
8.2	MABANA_N	12MB_N-DCM01B	16.2	0.0455	19.8	0.0095	12.2	0.0052	43.2
9	PTGAMBLE_3	12PTGB3-DCM01B	17.5	0.0383	7.54	0.0033	7.42	-0.0041	42.3
9	PTGAMBLE_1	12PTGB1-DCM01B	19.2	0.0295	6.89	0.0027	6.84	0.0046	44.1
9	EGLON	12ELN-DCM01B	16.7	0.032	5.94	0.0032	7.56	-0.0040	38.5
9	PTGAMBLE_N	12PTGB_N-DCM01B	19.7	0.0419	8.34	0.0043	8.48	-0.0041	43.2
9	USELESSBAY_M	12UB_M-DCM01B	14.5	0.0433	8.98	0.0042	6.85	-0.0041	39.2
9	OAKBAY	12OAKB-DCM01B	17.5	0.0298	5.89	0.0022	6.48	-0.0040	43.7
9	PTTWNSND_GC	12PT_GC-DCM01B	19.8	0.0395	9.83	0.0035	11.2	-0.0039	52.6
10	BLAKEISLAND_N	12BLK_N-DCM01B	20.7	0.0997	11.4	0.0051	9.36	0.0068	50.6
10	YEOMALT_SH	12YEO_SH-DCM01B	18	0.0428	8.22	0.0073	6.45	0.0056	40
10	PTMADISON_IND	12PM_IND-DCM01B	18.1	0.0679	8.27	0.005	7.87	0.0051	45.1
10	EDMONDS	12ED-DCM01B	19.1	0.0625	6.44	0.005	8.56	0.0084	45.3
10	4MILEROCK	124M-DCM01B	17.7	0.065	7.89	0.0062	9.36	0.013	43.2
SI	SCLINLET	11SI-DCM01B	21.7	0.22	13.1	0.0031	9.15	0.012	40.2
SI	SCLINLET	11SI-DCM02B	21.8	0.247	10.3	-0.0019	7.65	0.012	41.9
SI	SCLINLET	11SI-DCM03B	22.1	0.165	10.4	-0.0020	10.5	0.012	41.5

Continued.

Table C5 (continued). Metal concentrations (mg/kg wet weight) in Dungeness crab muscle from crab collected in 9 Marine Areas and 3 urban embayments (SI = Sinclair Inlet, EB = Elliott Bay, and CB = Commencement Bay) of Puget Sound (Location). Negative concentrations represent non-detected values that are equal to or below the method detection limit (MDL).

Location	Station Name	Sample ID	Total Solids (%)	Total Mercury	Total Arsenic	Total Cadmium	Total Copper	Total Lead	Total Zinc
EB	DUWAMISH	11DU-DCM01B	18.7	0.103	3.73	-0.0019	6.1	0.0088	35.7
EB	ELLTBAY	11EB-DCM01B	16.9	0.0827	4.62	-0.0019	8.07	0.01	31
EB	ELLTBAY_P69	12EB_P69-DCM01B	17.2	0.0659	6.47	0.0031	8.58	0.012	41.6
EB	ELLTBAY4_P89	12EB4_P89-DCM01B	17.9	0.189	14.4	0.0096	8.88	0.0233	52.2
EB	ELLTBAY4_P91SH	12EB4-P91SH-DCM01B	21.3	0.1	9.05	0.0038	12.4	0.016	58.5
11	QTRMASTR	12QM-DCM01B	19.1	0.0907	6.54	0.0189	8.3	0.0083	48.6
11	OLLALA	12OL-DCM01B	20.7	0.0717	10.6	0.0065	12.3	-0.0040	51.6
11	3TREEPOINT	12TT-DCM01B	18.4	0.0294	5.16	0.0044	4.26	-0.0041	42.9
CB	COMMBAY	11CB-DCM01B	15	0.0348	3.44	-0.0020	8.25	0.014	27.9
CB	COMMBAY4_DEEP	12CB4_DEEP-DCM01B	19.9	0.045	7.26	0.0037	8.94	0.0226	48.5
CB	COMMBAY_P23	12CB_P23-DCM01B	20.2	0.159	8.22	0.005	9.34	-0.0039	48.7
12	HDCANAL_TA	12HC_TA-DCM01B	17.8	0.0296	7.49	0.0086	11.9	-0.0040	43.1
12	LILLIWAUP	12LW-DCM01B	18.2	0.0629	9.92	0.009	8.54	-0.0040	41.6
12	SCENICBEACH	12SC-DCM01B	19.1	0.0483	11.5	0.0103	10.3	-0.0039	47.4
12	QUILCENE	12QB-DCM01B	20.9	0.0575	10.4	0.0029	7.06	-0.0040	51.4
12	SQUAMISHHRBR	12SUH-DCM01B	19	0.0491	8.16	0.0036	6.92	-0.0040	47.7
13	NISQUALY_FLATS_GC	12NQ_FLGC-DCM01B	19.1	0.0598	10.7	0.0071	13.2	-0.0041	49.2
13	TREBLEPOINT	12TRP-DCM01B	15.5	0.0297	5.5	0.0034	10.9	0.0039	36.2
13	NISQUALY	11NQ-DCM01B	22.6	0.0626	11	0.003	9.06	-0.0039	39.9
13	BRISCOPOINT	12BRP-DCM01B	20.5	0.0789	13.3	0.0046	12.1	-0.0039	49.1

Table C6. Metal concentrations (mg/kg wet weight) in Dungeness crab hepatopancreas from crab collected in nine Marine Areas and two urban embayments (EB = Elliott Bay, and CB = Commencement Bay) of Puget Sound (Location).

Location	Station Name	Sample ID	Total Solids (%)	Total Mercury	Total Arsenic	Total Cadmium	Total Copper	Total Lead	Total Zinc
6	DISCOBAY_TU	12DB_TU-DCHP01B	15.5	0.055	13.9	1.45	12.3	0.063	16.6
7	BHMHARBR	12BH-DCHP01B	17.5	0.029	7.35	0.0978	8.99	0.0457	15.2
7	STRTGEOR	12SG-DCHP01B	11.4	0.0238	2.91	0.108	17.4	0.0215	8.12
8.1	SKAGITIS	12SKIS-DCHP01B	17.5	0.0442	7.06	0.33	11.8	0.0221	13.8
8.2	PTSUSAN	12PTS-DCHP01B	19.2	0.0446	4.85	1.07	44.2	0.0529	15.4
9	PTGAMBLE_3	12PTGB3-DCHP01B	17.5	0.0234	5.6	0.424	10.5	0.0532	11.4
9	PTGAMBLE_1	12PTGB1-DCHP01B	18.5	0.0224	5.31	0.372	7.58	0.0403	11
10	EDMONDS	12ED-DCHP01B	15.7	0.0452	4.2	0.817	13.4	0.099	15.7
10	4MILEROCK	124M-DCHP01B	14.6	0.0513	5.37	1.31	18.4	0.122	12.5
10	YEOMALT_SH	12YEO_SH-DCHP01B	19.4	0.0546	8.27	2.83	8.66	0.0691	19.9
EB	ELLTBAY_P69	12EB_P69-DCHP01B	12.2	0.127	6.91	0.691	46.9	0.466	15.1
EB	ELLTBAY4_P89	12EB4_P89-DCHP01B	14.3	0.0874	4.97	0.952	33.1	0.124	19.1
EB	ELLTBAY4_P91SH	12EB4-P91SH-DCHP01B	18.9	0.0485	6.22	0.399	40.4	0.222	17.4
11	QTRMASTR	12QM-DCHP01B	14	0.0684	4.82	1.22	13	0.151	14.1
CB	COMMBAY4_DEEP	12CB4_DEEP-DCHP01B	18.6	0.0344	6.27	2.1	29.2	0.187	18.4
CB	COMMBAY_P23	12CB_P23-DCHP01B	16.4	0.0688	4.24	0.187	24.7	0.0706	13.3
12	SCENICBEACH	12SC-DCHP01B	19.9	0.0348	8.27	2.79	14.8	0.011	17.3
13	NISQUALY_FLATS_GC	12NQ_FLGC-DCHP01B	19.6	0.0485	9.48	1.16	31.5	0.018	16.2
13	BRISCOPOINT	12BRP-DCHP01B	17.9	0.0399	10.7	1.04	46.5	0.0289	19.2

Table C7. Metal concentrations (mg/kg wet weight) in spot prawn muscle from prawn collected in nine Marine Areas and one urban embayment (EB = Elliott Bay) of Puget Sound (Location). Negative concentrations represent non-detected values that are equal to or below the method detection limit (MDL).

Location	Station Name	Sample ID	Total Solids (%)	Total Mercury	Total Arsenic	Total Cadmium	Total Copper	Total Lead	Total Zinc
6	PROTECTIONISL	12PRO-SPM01B	23.3	0.0593	15.3	0.0235	8.05	-0.0039	12.3
6	PARTRIDGEBANK_N	12PBN-SPM01B	21.8	0.103	14.8	0.03	6.76	-0.0041	11.8
7	LAWSONREEF_N	12LRN-SPM01B	23.2	0.112	12.7	0.0306	8.62	-0.0041	12.4
7	POINTCAUTION	12PTC-SPM01B	22.4	0.0698	14.6	0.0262	7.31	-0.0041	12.6
7	VENDOVI	11VD-SPM01B	21.6	0.0518	10.1	0.0127	4.3	-0.0041	11.3
7	POINTDISNEY	12PTD-SPM01B	21.3	0.0715	13.5	0.0256	5.59	-0.0040	11
7	FERNPOINT	12FPT-SPM01B	20.8	0.0516	14.1	0.0253	5.76	-0.0041	11.3
8.1	BABYISLAND	12BBY-SPM01B	22	0.0962	31.4	0.0239	8.44	-0.0040	12.9
8.1	NORTHBLUFF	12NBL-SPM01B	23.7	0.0902	29	0.0245	12.4	-0.0039	14.2
8.1	CAMABEACH	12CMB-SPM01B	24.9	0.0864	24.6	0.0237	11	-0.0039	14.2
8.1	CAMANOCITY_S	12CCS-SPM01B	22.4	0.0844	23.1	0.0225	8.62	-0.0039	12.7
8.1	ONAMAC	12ON-SPM01B	23.4	0.0708	21.2	0.0215	9.12	-0.0040	13.4
8.2	PTGARDNR	11PG-SPM01B	20.7	0.054	7.96	0.0175	4.18	-0.0040	11.4
8.2	CAMANOHEAD	12CH-SPM01B	22.4	0.063	12.9	0.0241	7.31	-0.0040	12.7
8.2	LANGLEY_N	12LYN-SPM01B	22.6	0.106	24.4	0.0248	8.82	-0.0039	12.9
8.2	PTSUSAN	12PS-SPM01B	21.7	0.115	10.8	0.0263	7.22	-0.0041	12.4
8.2	MABANA_N	12MB_N-SPM01B	22.4	0.0595	16	0.0214	7.19	-0.0040	12.1
9	EDMONDS_N	12EDN-SPM01B	21.3	0.0495	10.7	0.0174	6.22	-0.0040	11.5
9	BROWNBAY	12BRB-SPM01B	22	0.0455	8.8	0.0161	6.7	-0.0040	11.9
9	POSSEPT	12PP-SPM01B	21.9	0.0373	9.61	0.0129	5.4	-0.0039	10.9
10	BLAKLYRK	12BR-SPM01B	20.6	0.0426	13.4	0.0171	5.34	-0.0039	11.9
10	YEOMALT	12YEO-SPM01B	21.4	0.0472	14	0.0174	5.69	-0.0041	12.6
10	SKIFFPT_N	12SKPN-SPM01B	22.7	0.041	12.3	0.0133	7.15	-0.0040	12.6
10	MEADOWPOINT	12MP-SPM01B	22.2	0.0475	14.8	0.0182	7.34	-0.0040	13.5
EB	ELLTBAY_SW	12EB_SW-SPM01B	22.5	0.0638	13.2	0.0245	8.61	-0.0040	13.1
EB	ELLTBAY_PSSDA	12EB_PSSDA-SPM01B	22.2	0.0563	12	0.0256	7.79	-0.0040	12.9
EB	DUWAMISHHEAD	12DH-SPM01B	23.2	0.0373	12.4	0.0189	10.1	-0.0041	13.5
EB	ELLTBAY_P71DEEP	12EB_P71DP-SPM01B	22.6	0.0514	13.9	0.0237	8.35	-0.0040	13.2
EB	ELLTBAY4_P91	12EB4_P91-SPM01B	22.4	0.0442	14.3	0.0162	9.69	0.0045	13.9
11	DESMOINES_N	12DMN-SPM01B	22.4	0.0476	13.4	0.0172	7.37	-0.0040	13.3
11	SEAHURST	12SR-SPM01B	22.6	0.0409	13.8	0.016	7.62	-0.0041	12.5
11	BRACEPT_S	12BRPS-SPM01B	21.4	0.0397	13.7	0.0238	7.63	-0.0040	13.4

Continued.

Table C7 (continued). Metal concentrations (mg/kg wet weight) in spot prawn muscle from prawn collected in nine Marine Areas and one urban embayment (EB = Elliott Bay) of Puget Sound (Location). Negative concentrations represent non-detected values that are equal to or below the method detection limit (MDL).

Location	Station Name	Sample ID	Total Solids (%)	Total Mercury	Total Arsenic	Total Cadmium	Total Copper	Total Lead	Total Zinc
12	HDCANAL_MUS	12HCMUS-SPM01B	21.5	0.0266	17.4	0.0237	6.87	-0.0041	12.5
12	DEWATTO_S	12DES-SPM01B	21.3	0.0348	21	0.0232	9.92	-0.0039	13.2
12	HDCANAL_NEL	12HCNEL-SPM01B	20.8	0.0494	24	0.0344	7.11	-0.0039	12.1
12	HAZELPOINT_N	12HAZN-SPM01B	21.6	0.0349	23.4	0.0413	8.71	-0.0039	13.3
12	HDCANAL_ZEL	12HCZEL-SPM01B	21	0.0419	17.5	0.0318	6.84	-0.0040	12.4
13	NISQUALY	11NQ-SPM01B	22.3	0.0575	21.9	0.0266	7.59	-0.0039	13.6
13	NISQUALY	11NQ-SPM02B	22.6	0.0606	22.7	0.0233	6.69	-0.0039	13.4

Table C8. Metal concentrations (mg/kg wet weight) in spot prawn head tissue from prawn collected in seven Marine Areas and one urban embayment (EB = Elliott Bay) in Puget Sound (Location).

Location	Station Name	Sample ID	Total Solids (%)	Total Mercury	Total Arsenic	Total Cadmium	Total Copper	Total Lead	Total Zinc
6	PARTRIDGEBANK_N	12PBN-SPHD01B	20.8	0.0426	11	1.43	64.1	0.0635	19.5
7	POINTCAUTION	12PTC-SPHD01B	22.1	0.0346	12.6	1.43	54.3	0.0341	23.3
7	FERNPOINT	12FPT-SPHD01B	18.6	0.0322	8.76	1.56	47.8	0.0662	18.4
8.1	BABYISLAND	12BBY-SPHD01B	26	0.0429	30.3	0.893	55.5	0.0296	24.8
8.2	PTGARDNR	11PG-SPHD01B	23.8	0.0351	8.62	0.667	81.4	0.0582	23.6
8.2	PTSUSAN	12PS-SPHD01B	28.7	0.0491	10.5	0.67	50.8	0.056	22.4
10	MEADOWPOINT	12MP-SPHD01B	23.4	0.0312	10.3	0.747	61.9	0.0759	23.8
EB	ELLTBAY_SW	12EB_SW-SPHD01B	29.9	0.0360	11.3	0.836	78.6	0.111	28.8
EB	ELLTBAY_PSSDA	12EB_PSSDA-SPHD01B	30	0.0271	10.4	0.753	73.7	0.0684	28.5
EB	DUWAMISHHEAD	12DH-SPHD01B	30.5	0.0257	10.4	0.813	66.7	0.0908	29.1
EB	ELLTBAY_P71DEEP	12EB_P71DP-SPHD01B	33.8	0.0292	10.1	0.741	77.1	0.136	31.1
EB	ELLTBAY4_P90DEEP	12EB4_P90DP-SPHD01B	32.2	0.0349	9.62	0.72	78.7	0.104	29.1
EB	ELLTBAY4_P91	12EB4_P91-SPHD01B	30.4	0.0310	9.76	0.766	77.2	0.0623	29.8
12	HAZELPOINT_N	12HAZN-SPHD01B	27.4	0.0247	19.3	2.52	54.5	0.0472	25.9
13	NISQUALY	11NQ-SPHD01B	27	0.0392	15.5	1.25	66	0.0812	25.4
13	NISQUALY	11NQ-SPHD02B	27.3	0.0410	15.9	1.08	62.7	0.0986	25.4

APPENDIX D: POPS SUMMARY DATA FROM DUNGENESS CRAB AND SPOT PRAWN TISSUES

Table D1. Summary of POPs (ng/g wet weight) and mean lipids (%) in Dungeness crab hepatopancreas by location. The number of samples analyzed is reported in parentheses beneath each location (EB = Elliott Bay, CB = Commencement Bay). nc = not calculated

		MA 6	MA 7	MA 8.1	MA 8.2	MA 9	MA 10	EB	MA 11	CB	MA 12	MA 13
		(1)	(2)	(1)	(1)	(2)	(3)	(3)	(1)	(2)	(1)	(2)
Lipids (%)	mean	3.27	5.47	4.15	7.86	7.13	5.05	3.99	3.62	6.48	6.12	4.83
eTPCBs	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	52	52	49	210	100	190	1400	120	370	110	190
	maximum	52	87	49	210	110	1300	2200	120	1400	110	190
	mean	nc	70	nc	nc	105	590	1733	nc	885	nc	190
$\sum_{11}$PBDEs	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	4.4	8.8	3.9	26	5	17	48	14	62	10	10
	maximum	4.4	15	3.9	26	7.1	47	64	14	200	10	16
	mean	nc	12	nc	nc	6.1	28	54	nc	131	nc	13
$\sum_{6}$DDTs	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	8.6	15	11	21	11	14	44	11	29	27	13
	maximum	8.6	30	11	21	11	56	69	11	140	27	15
	mean	nc	23	nc	nc	11	31	52	nc	85	nc	14
$\sum_{8}$Chlds	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	1.4	2.4	1.3	6.4	1.7	3.5	8.5	2.8	10	4.2	3.0
	maximum	1.4	3.8	1.3	6.4	1.9	9.3	13	2.8	33	4.2	3.7
	mean	nc	3.1	nc	nc	1.8	5.6	11	nc	22	nc	3.4
$\sum_{3}$HCHs	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	3.1	2.1	1.4	2.0	7.4	2.8	1.6	19	3.3	2.7	8.6
	maximum	3.1	2.2	1.4	2.0	11	7.1	2.9	19	4.5	2.7	9.7
	mean	nc	2.2	nc	nc	9.2	5.7	2.3	nc	3.9	nc	9.2
HCB	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	0.87	1.4	1.1	3.4	2	1.2	1.4	1.7	2.3	1.8	1.3
	maximum	0.87	1.8	1.1	3.4	2.1	1.8	1.6	1.7	4.0	1.8	1.6
	mean	nc	1.6	nc	nc	2.1	1.5	1.5	nc	3.2	nc	1.5

Continued.

Table D1 (continued). Summary of POPs (ng/g wet weight) and mean lipids (%) in Dungeness crab hepatopancreas by location. The number of samples analyzed is reported in parentheses beneath each location (EB = Elliott Bay, CB = Commencement Bay). nc = not calculated

		MA 6	MA 7	MA 8.1	MA 8.2	MA 9	MA 10	EB	MA 11	CB	MA 12	MA 13
	n analyzed	(1)	(2)	(1)	(1)	(2)	(3)	(3)	(1)	(2)	(1)	(2)
$\sum_{37}$PAHs	n detects	1	2	0	1	2	3	3	1	2	1	2
	minimum	1.7	2.2	0.50	7.4	2.7	4.3	41	2.0	12	0.91	2.5
	maximum	1.7	12	0.50	7.4	2.8	17	68	2.0	14	0.91	2.9
	mean	nc	7.2	nc	nc	2.8	9.0	52	nc	13	nc	2.73

Table D2. Summary of POPs (ng/g wet weight) and mean lipids (%) in spot prawn heads by location. The number of samples analyzed is reported in parentheses beneath each location (EB = Elliott Bay). nc = not calculated

		MA 6	MA 7	MA 8.1	MA 8.2	MA 10	EB[a]	MA 12	MA 13
		(1)	(2)	(1)	(2)	(1)	(6)	(1)	(2)
Lipids (%)	mean	3.25	3.58	7.38	9.29	6.18	10.0	7.20	8.93
eTPCBs	n detects	1	2	1	2	1	6	1	2
	minimum	24	10	80	160	160	500	29	150
	maximum	24	14	80	180	160	690	29	160
	mean	nc	12	nc	170	nc	603	nc	155
$\sum_{11}$PBDEs	n detects	1	2	1	2	1	6	1	2
	minimum	0.99	0.87	4.9	16	19	11	2.20	10
	maximum	0.99	1.7	4.9	18	19	18	2.20	10
	mean	nc	1.3	nc	17	nc	15	nc	10
$\sum_{6}$DDTs	n detects	1	2	1	2	1	6	1	2
	minimum	0.21	0.25	2	3.0	1.7	2.4	0.85	1.3
	maximum	0.21	0.72	2	4.6	1.7	3.8	0.85	1.5
	mean	nc	0.49	nc	3.8	nc	3.0	nc	1.4
$\sum_{8}$Chlds	n detects	0	0	1	2	1	6	1	2
	minimum	0.16	0.19	0.35	2.2	1.4	1.3	0.41	1.2
	maximum	0.16	0.25	0.35	2.3	1.4	2.1	0.41	1.2
	mean	nc	0.22	nc	2.3	nc	1.7	nc	1.2
$\sum_{3}$HCHs	n detects	1	1	1	2	1	6	1	2
	minimum	0.22	0.19	0.73	0.87	0.68	0.80	0.75	1.0
	maximum	0.22	0.25	0.73	1.2	0.68	1.3	0.75	1.0
	mean	nc	0.22	nc	1.0	nc	0.98	nc	1
HCB	n detects	0	0	1	2	1	6	1	2
	minimum	0.16	0.19	0.44	0.48	0.39	0.36	0.36	0.39
	maximum	0.16	0.25	0.44	0.74	0.39	0.61	0.36	0.42
	mean	nc	0.22	nc	0.61	nc	0.45	nc	0.41
$\sum_{37}$PAHs	n detects	1	2	1	2	1	6	1	2
	minimum	6.57	1.89	3.6	5.22	22.8	16.9	2.25	8.8
	maximum	6.57	2.66	3.6	7.98	22.8	32.2	2.25	12.1
	mean	nc	2.3	nc	6.60	nc	23.4	nc	10.4

[a]Includes a station (ELLBAY4_P90DEEP) that does not have corresponding muscle data

Table D3. Summary of POP concentrations (ng/g wet wet) data in Dungeness crab muscle from 12 Puget Sound locations comprising nine WDFW Marine Areas and three urban embayments (EB = Elliott Bay, SI = Sinclair Inlet, CB = Commencement Bay). The number of samples analyzed is reported in parentheses beneath each Marine or urban area. In cases where all analytes for a summed group were less than the limit of quantitation (LOQ), the summation value used was the highest reported LOQ for any analyte for the location. nc = not calculated

		MA 6	MA 7	MA 8.1	MA 8.2	MA 9	MA 10	EB	SI	MA 11	CB	MA 12	MA 13
		(1)	(5)	(5)	(5)	(7)	(5)	(5)	(3)	(3)	(3)	(5)	(4)
eTPCBs	n detects	1	5	5	5	7	5	5	3	3	3	5	4
	minimum	1.9	1.5	1.2	2.0	1.5	4.1	55	25	2.2	13	1.0	2.2
	maximum	1.9	5.7	4.8	8.8	5.5	55	180	28	7.3	54	2.8	9.9
	mean	nc	3.3	3.5	5.5	2.8	18	119	27	5.2	29	2.3	6.1
	geo. mean	nc	3.0	3.2	4.9	2.5	12	110	27	4.6	24	2.1	5.2
	10^{th} pctle.	nc	1.7	2.2	2.8	1.8	6.4	69	26	3.0	14	1.6	2.8
	median	nc	3.8	3.6	6.3	2.1	11	110	28	6.0	20	2.5	6.1
	90^{th} pctle.	nc	4.9	4.6	7.9	4.4	38	172	28	7.0	47	2.7	9.3
$\sum_{11}$PBDEs	n detects	0	1	0	5	1	5	5	3	3	3	0	2
	minimum	0.34	0.20	0.23	0.22	0.21	0.48	1.7	0.94	0.79	1.4	0.21	0.33
	maximum	0.34	0.26	0.32	0.81	0.29	1.5	2.8	1.0	1.1	7.3	0.36	0.68
	mean	nc	0.22	0.26	0.54	0.25	0.99	2.2	0.97	1.0	3.6	0.27	0.44
	geo. mean	nc	0.22	0.26	0.46	0.25	0.91	2.1	0.97	0.99	2.8	0.27	0.42
	10^{th} pctle.	nc	0.20	0.23	0.22	0.22	0.55	1.7	0.95	0.85	1.6	0.22	0.34
	median	nc	0.21	0.26	0.70	0.25	1.1	2.1	0.97	1.1	2.2	0.27	0.38
	90^{th} pctle.	nc	0.24	0.30	0.79	0.28	1.4	2.7	0.99	1.1	6.3	0.33	0.59
$\sum_{6}$DDTs	n detects	1	4	3	5	5	5	5	3	3	3	4	3
	minimum	0.47	0.21	0.23	0.27	0.26	0.33	1.1	0.66	0.36	0.75	0.24	0.32
	maximum	0.47	0.45	0.35	0.66	0.72	1.6	4.8	0.74	0.63	3.6	0.52	0.71
	mean	nc	0.29	0.29	0.48	0.38	0.86	2.5	0.71	0.50	1.7	0.41	0.48
	geo. mean	nc	0.28	0.29	0.46	0.35	0.76	2.2	0.71	0.49	1.3	0.39	0.46
	10^{th} pctle.	nc	0.22	0.25	0.34	0.26	0.45	1.4	0.67	0.39	0.75	0.27	0.34
	median	nc	0.25	0.28	0.49	0.29	0.74	1.9	0.72	0.51	0.76	0.48	0.45
	90^{th} pctle.	nc	0.39	0.34	0.61	0.58	1.4	3.9	0.74	0.61	3.0	0.50	0.65

Continued.

Table D3 (continued). Summary of POP concentrations (ng/g wet weight) data in Dungeness crab muscle from 12 Puget sound locations comprising nine WDFW Marine Areas and three urban embayments (EB = Elliott Bay, SI = Sinclair Inlet, CB = Commencement Bay). The number of samples analyzed is reported in parentheses beneath each Marine or urban area. In cases where all analytes for a summed group were less than the limit of quantitation (LOQ), the summation value used was the highest reported LOQ for any analyte for the location. nc = not calculated

		MA 6 (1)	MA 7 (5)	MA 8.1 (5)	MA 8.2 (5)	MA 9 (7)	MA 10 (5)	EB (5)	SI (3)	MA 11 (3)	CB (3)	MA 12 (5)	MA 13 (4)
$\sum_8$Chlordanes	n detects	0	0	0	0	0	2	4	0	0	2	0	0
	minimum	0.33	0.18	0.23	0.19	0.20	0.19	0.2	0.24	0.20	0.25	0.21	0.24
	maximum	0.33	0.26	0.32	0.26	0.28	0.61	1.2	0.27	0.27	1.80	0.36	0.39
	mean	nc	0.21	0.26	0.22	0.24	0.30	0.75	0.26	0.23	0.81	0.27	0.32
	geo. mean	nc	0.21	0.26	0.22	0.24	0.30	0.75	0.26	0.23	0.81	0.27	0.32
	10^{th} pctle.	nc	0.19	0.23	0.19	0.21	0.19	0.39	0.24	0.21	0.27	0.22	0.25
	median	nc	0.21	0.26	0.22	0.25	0.21	0.82	0.26	0.23	0.37	0.27	0.32
	90^{th} pctle.	nc	0.24	0.30	0.25	0.27	0.47	1.1	0.27	0.26	1.5	0.33	0.38
$\sum_3$HCHs	n detects	0	0	0	0	4	5	1	0	3	0	0	3
	minimum	0.33	0.18	0.23	0.19	0.23	0.16	0.17	0.26	0.35	0.15	0.21	0.39
	maximum	0.33	0.26	0.32	0.26	0.73	0.77	0.53	0.42	1.8	0.37	0.36	1.1
	mean	nc	0.21	0.26	0.22	0.38	0.39	0.30	0.32	1.3	0.25	0.27	0.71
	geo. mean	nc	0.21	0.26	0.22	0.35	0.34	0.27	0.31	1.0	0.23	0.27	0.66
	10^{th} pctle.	nc	0.19	0.23	0.19	0.25	0.21	0.18	0.26	0.62	0.16	0.22	0.43
	median	nc	0.21	0.26	0.22	0.31	0.29	0.27	0.27	1.7	0.22	0.27	0.68
	90^{th} pctle.	nc	0.24	0.30	0.25	0.59	0.65	0.44	0.39	1.8	0.34	0.33	1.0
Hexachlorobenzene	n detects	0	0	0	0	0	0	0	0	0	1	0	0
	minimum	0.33	0.18	0.23	0.19	0.20	0.16	0.17	0.24	0.20	0.22	0.21	0.24
	maximum	0.33	0.26	0.32	0.26	0.28	0.27	0.53	0.27	0.27	0.37	0.36	0.39
	mean	nc	0.21	0.26	0.22	0.24	0.21	0.30	0.26	0.23	0.27	0.27	0.32
	geo. mean	nc	0.21	0.26	0.22	0.24	0.21	0.30	0.26	0.23	0.27	0.27	0.32
	10^{th} pctle.	nc	0.19	0.23	0.19	0.21	0.17	0.18	0.24	0.21	0.22	0.22	0.25
	median	nc	0.21	0.26	0.22	0.25	0.21	0.27	0.26	0.23	0.23	0.27	0.32
	90^{th} pctle.	nc	0.24	0.30	0.25	0.27	0.25	0.44	0.27	0.26	0.34	0.33	0.38

Continued.

Table D3 (continued). Summary of POP concentrations (ng/g wet weight) data in Dungeness crab muscle from 12 Puget sound locations comprising nine WDFW Marine Areas and three urban embayments (EB = Elliott Bay, SI = Sinclair Inlet, CB = Commencement Bay). The number of samples analyzed is reported in parentheses beneath each Marine or urban area. In cases where all analytes for a summed group were less than the limit of quantitation (LOQ), the summation value used was the highest reported LOQ for any analyte for the location. nc = not calculated

		MA 6 (1)	MA 7 (5)	MA 8.1 (5)	MA 8.2 (5)	MA 9 (7)	MA 10 (5)	EB (5)	SI (3)	MA 11 (3)	CB (3)	MA 12 (5)	MA 13 (4)
$\sum_{37}$PAHs	n detects	0	4	0	2	2	4	5	3	3	2	2	4
	minimum	0.49	0.35	0.36	0.27	0.30	0.28	0.96	0.41	0.35	0.31	0.32	0.32
	maximum	0.49	2.0	0.57	0.42	0.54	0.57	4.0	1.5	0.62	6.0	1.5	1.9
	mean	nc	1.1	0.47	0.34	0.41	0.37	2.5	0.86	0.44	2.3	0.62	0.95
	geo. mean	nc	0.88	0.46	0.34	0.40	0.36	2.2	0.76	0.43	0.99	0.52	0.74
	10^{th} pctle.	nc	0.45	0.37	0.29	0.32	0.28	1.2	0.47	0.35	0.35	0.36	0.35
	median	nc	0.70	0.48	0.33	0.41	0.33	2.8	0.73	0.36	0.52	0.42	0.79
	90^{th} pctle.	nc	1.9	0.56	0.40	0.53	0.49	3.7	1.3	0.57	4.9	1.1	1.7

Table D4. Summary of POP concentrations (ng/g wet weight) data in spot prawn muscle from 10 Puget Sound locations comprising nine WDFW Marine Areas and one urban embayment (EB = Elliott Bay). The number of samples analyzed is reported in parentheses beneath each Marine or urban area. In cases where all analytes for a summed group were less than the limit of quantitation (LOQ), the summation value used was the highest reported LOQ for any analyte for the location.

		MA 6 (2)	MA 7 (5)	MA 8.1 (5)	MA 8.2 (5)	MA 9 (3)	MA 10 (4)	EB (5)	MA 11 (3)	MA 12 (5)	MA 13 (2)
eTPCBs	n detects	2	5	5	5	3	4	5	3	5	2
	minimum	1.0	0.85	2.8	2.8	6.1	5.3	14	6.6	1.0	2.8
	maximum	1.6	2.1	3.5	8.0	12	9.4	27	7.3	2.3	4.5
	mean	1.3	1.3	3.1	4.4	10	7.6	18	7.0	1.8	3.7
	geo. mean	1.3	1.3	3.1	4.1	9.6	7.4	18	7.0	1.7	3.6
	10^{th} pctle.	1.1	0.89	2.8	2.9	7.3	5.9	15	6.7	1.1	3.0
	median	1.3	1.4	3.0	3.8	12	7.8	17	7.0	2.1	3.7
	90^{th} pctle.	1.5	1.8	3.4	6.6	12	9.0	23	7.2	2.3	4.3
$\sum_{11}$PBDEs	n detects	1	3	2	5	3	4	1	1[a]	0	1
	minimum	0.14	0.11	0.14	0.21	0.39	0.32	0.19	0.27	0.13	0.22
	maximum	0.17	0.19	0.21	0.52	0.68	0.46	0.32	0.43	0.44	0.49
	mean	0.16	0.14	0.16	0.40	0.51	0.39	0.27	0.35	0.21	0.36
	geo. mean	0.15	0.14	0.16	0.38	0.50	0.38	0.27	0.34	0.19	0.33
	10^{th} pctle.	0.14	0.11	0.14	0.27	0.41	0.32	0.21	0.29	0.13	0.25
	median	0.16	0.14	0.16	0.42	0.47	0.39	0.30	0.35	0.14	0.36
	90^{th} pctle.	0.17	0.18	0.19	0.50	0.64	0.46	0.32	0.41	0.36	0.46
$\sum_{6}$DDTs	n detects	0	0	0	0	1	0	0	0	0	0
	minimum	0.14	0.11	0.13	0.12	0.23	0.24	0.19	0.27	0.13	0.20
	maximum	0.15	0.18	0.16	0.20	0.28	0.32	0.31	0.35	0.44	0.22
	mean	0.15	0.13	0.15	0.16	0.25	0.29	0.27	0.31	0.21	0.21
	geo. mean	0.15	0.13	0.15	0.16	0.25	0.29	0.27	0.31	0.21	0.21
	10^{th} pctle.	0.14	0.11	0.13	0.13	0.23	0.25	0.21	0.28	0.13	0.20
	median	0.15	0.11	0.14	0.16	0.24	0.30	0.30	0.32	0.14	0.21
	90^{th} pctle.	0.15	0.16	0.16	0.19	0.27	0.32	0.31	0.34	0.36	0.22

[a] SEAHURST station, was determined to be an outlier and removed from further PBDE analyses

Continued.

Table D4 (continued). Summary of POP concentrations (ng/g wet weight) data in spot prawn muscle from 10 Puget sound locations comprising nine WDFW Marine Areas and one urban embayment (EB = Elliott Bay). The number of samples analyzed is reported in parentheses beneath each Marine or urban area. In cases where all analytes for a summed group were less than the limit of quantitation (LOQ), the summation value used was the highest reported LOQ for any analyte for the location.

		MA 6 (2)	MA 7 (5)	MA 8.1 (5)	MA 8.2 (5)	MA 9 (3)	MA 10 (4)	EB (5)	MA 11 (3)	MA 12 (5)	MA 13 (2)
$\sum_8$Chlordanes	n detects	0	0	0	0	0	0	0	0	0	0
	minimum	0.14	0.11	0.13	0.12	0.22	0.24	0.19	0.27	0.13	0.20
	maximum	0.15	0.18	0.16	0.20	0.28	0.32	0.31	0.35	0.44	0.22
	mean	0.15	0.13	0.15	0.16	0.24	0.28	0.27	0.31	0.21	0.21
	geo. mean	0.15	0.13	0.15	0.16	0.24	0.28	0.27	0.31	0.21	0.21
	10^{th} pctle.	0.14	0.11	0.13	0.12	0.22	0.25	0.21	0.28	0.13	0.20
	median	0.15	0.11	0.14	0.16	0.23	0.29	0.30	0.32	0.13	0.21
	90^{th} pctle.	0.15	0.16	0.16	0.19	0.27	0.32	0.31	0.34	0.36	0.22
$\sum_3$HCHs	n detects	0	0	0	0	0	0	0	0	0	0
	minimum	0.14	0.11	0.13	0.12	0.22	0.24	0.19	0.27	0.13	0.20
	maximum	0.15	0.18	0.16	0.20	0.28	0.32	0.31	0.35	0.44	0.22
	mean	0.15	0.13	0.15	0.16	0.24	0.28	0.27	0.31	0.21	0.21
	geo. mean	0.15	0.13	0.15	0.16	0.24	0.28	0.27	0.31	0.21	0.21
	10^{th} pctle.	0.14	0.11	0.13	0.12	0.22	0.25	0.21	0.28	0.13	0.20
	median	0.15	0.11	0.14	0.16	0.23	0.29	0.30	0.32	0.13	0.21
	90^{th} pctle.	0.15	0.16	0.16	0.19	0.27	0.32	0.31	0.34	0.36	0.22
Hexachlorobenzene	n detects	0	0	0	0	0	0	0	0	0	0
	minimum	0.14	0.11	0.13	0.12	0.22	0.24	0.19	0.27	0.13	0.20
	maximum	0.15	0.18	0.16	0.20	0.28	0.32	0.31	0.35	0.44	0.22
	mean	0.15	0.13	0.15	0.16	0.24	0.28	0.27	0.31	0.21	0.21
	geo. mean	0.15	0.13	0.15	0.16	0.24	0.28	0.27	0.31	0.21	0.21
	10^{th} pctle.	0.14	0.11	0.13	0.12	0.22	0.25	0.21	0.28	0.13	0.20
	median	0.15	0.11	0.14	0.16	0.23	0.29	0.30	0.32	0.13	0.21
	90^{th} pctle.	0.15	0.16	0.16	0.19	0.27	0.32	0.31	0.34	0.36	0.22

Continued.

Table D4 (continued). Summary of POP concentrations (ng/g wet weight) data in spot prawn muscle from 10 Puget Sound locations comprising nine WDFW Marine Areas and one urban embayment (EB = Elliott Bay). The number of samples analyzed is reported in parentheses beneath each Marine or urban area. In cases where all analytes for a summed group were less than the limit of quantitation (LOQ), the summation value used was the highest reported LOQ for any analyte for the location.

		MA 6 (2)	MA 7 (5)	MA 8.1 (5)	MA 8.2 (5)	MA 9 (3)	MA 10 (4)	EB (5)	MA 11 (3)	MA 12 (5)	MA 13 (2)
$\sum_{37}$PAHs	n detects	2	5	5	5	3	4	5	3	4	2
	minimum	0.53	0.35	0.55	0.30	0.67	0.38	1.0	0.74	0.39	1.5
	maximum	0.56	2.3	1.1	0.94	0.96	1.2	3.7	0.96	0.90	2.6
	mean	0.55	1.0	0.79	0.69	0.79	0.73	1.6	0.83	0.69	2.0
	geo. mean	0.54	0.81	0.76	0.64	0.78	0.67	1.4	0.82	0.66	2.0
	10^{th} pctle.	0.53	0.46	0.59	0.43	0.68	0.45	1.0	0.75	0.50	1.6
	median	0.55	0.65	0.68	0.77	0.73	0.66	1.2	0.78	0.72	2.0
	90^{th} pctle.	0.56	1.8	1.1	0.89	0.91	1.1	2.7	0.92	0.84	2.5

APPENDIX E: METALS SUMMARY DATA FROM DUNGENESS CRAB AND SPOT PRAWN TISSUES

Table E1. Summary of metal concentrations (mg/kg wet weight) data in Dungeness crab muscle from nine WDFW Marine Areas and three urban embayments (EB = Elliott Bay, SI = Sinclair Inlet, CB = Commencement Bay). The number of samples analyzed is reported in parentheses beneath each location. Method detection limit (MDL) values were used when reported values were deemed below detection limits, nc = not calculated

		MA 6 (1)	MA 7 (5)	MA 8.1 (5)	MA 8.2 (5)	MA 9 (7)	MA 10 (5)	EB (5)	SI (3)	MA 11 (3)	CB (3)	MA 12 (5)	MA 13 (4)
Mercury	n detects	1	5	5	5	7	5	5	3	3	3	5	4
	minimum	0.072	0.018	0.035	0.041	0.030	0.043	0.066	0.17	0.029	0.035	0.030	0.030
	maximum	0.072	0.054	0.056	0.061	0.043	0.10	0.19	0.25	0.091	0.16	0.063	0.079
	mean	nc	0.042	0.048	0.051	0.036	0.068	0.11	0.21	0.064	0.080	0.049	0.058
	geo. mean	nc	0.039	0.047	0.050	0.036	0.065	0.10	0.21	0.058	0.063	0.048	0.054
	10^{th} pctle.	nc	0.029	0.040	0.043	0.030	0.051	0.073	0.18	0.038	0.037	0.037	0.039
	median	nc	0.045	0.047	0.052	0.038	0.065	0.10	0.22	0.072	0.045	0.049	0.061
	90^{th} pctle.	nc	0.051	0.056	0.058	0.042	0.087	0.15	0.24	0.087	0.14	0.061	0.074
Arsenic	n detects	1	5	5	5	7	5	5	3	3	3	5	4
	minimum	16.1	3.73	6.41	5.47	5.89	6.44	3.73	10.3	5.16	3.44	7.49	5.50
	maximum	16.1	11.5	14.6	20.5	9.83	11.4	14.4	13.1	10.6	8.22	11.5	13.3
	mean	nc	7.95	10.9	12.2	7.63	8.44	7.65	11.3	7.43	6.31	9.49	10.1
	geo. mean	nc	7.95	10.9	12.2	7.63	8.44	7.65	11.3	7.43	6.31	9.49	10.1
	10^{th} pctle.	nc	4.77	7.15	5.90	5.92	7.02	4.09	10.3	5.44	4.20	7.76	7.06
	median	nc	7.01	11.7	8.67	7.54	8.22	6.47	10.4	6.54	7.26	9.92	10.9
	90^{th} pctle.	nc	11.4	14.2	20.2	9.32	10.1	12.3	12.6	9.79	8.03	11.1	12.6
Cadmium	n detects	1	4	2	4	7	5	3	1	3	2	5	4
	minimum	0.0072	0.002	0.0020	0.0020	0.0022	0.0050	0.0019	0.0019	0.0044	0.002	0.0029	0.0030
	maximum	0.0072	0.0037	0.0039	0.0095	0.0043	0.0073	0.0096	0.0031	0.019	0.0050	0.010	0.0071
	mean	nc	0.0029	0.0024	0.0060	0.0033	0.0057	0.0041	0.0023	0.010	0.0036	0.0069	0.0045
	geo. mean	nc	0.0029	0.0023	0.0053	0.0033	0.0057	0.0033	0.0023	0.0081	0.0033	0.0061	0.0043
	10^{th} pctle.	nc	0.0022	0.0020	0.0034	0.0025	0.0050	0.0019	0.0019	0.0048	0.0023	0.0032	0.0031
	median	nc	0.0029	0.0020	0.0057	0.0033	0.0051	0.0031	0.0020	0.0070	0.0037	0.0086	0.0040
	90^{th} pctle.	nc	0.0037	0.0032	0.0086	0.0042	0.0069	0.0073	0.00288	0.016	0.0047	0.0098	0.0064

Continued.

Table E1 (continued). Summary of metal concentrations (mg/kg wet weight) data in Dungeness crab muscle from nine WDFW Marine Areas and three urban embayments (EB = Elliott Bay, SI = Sinclair Inlet, CB = Commencement Bay). The number of samples analyzed is reported in parentheses beneath each location. Method detection limit (MDL) values were used when reported values were deemed below detectable limits, nc = not calculated

		MA 6 (1)	MA 7 (5)	MA 8.1 (5)	MA 8.2 (5)	MA 9 (7)	MA 10 (5)	EB (5)	SI (3)	MA 11 (3)	CB (3)	MA 12 (5)	MA 13 (4)
Copper	n detects	1	5	5	5	7	5	5	3	3	3	5	4
	minimum	8.25	4.22	8.25	8.92	6.48	6.45	6.10	7.65	4.26	8.25	6.92	9.06
	maximum	8.25	10.8	9.99	12.2	11.2	9.36	12.4	10.5	12.3	9.34	11.9	13.2
	mean	nc	8.72	9.12	10.6	7.83	8.32	8.81	9.10	8.29	8.84	8.94	11.3
	geo. mean	nc	8.72	9.12	10.6	7.833	8.32	8.81	9.10	8.29	8.84	8.94	11.3
	10^{th} pctle.	nc	6.07	8.25	9.55	6.70	7.02	6.89	7.95	5.07	8.39	6.98	9.61
	median	nc	9.62	9.31	10.6	7.42	8.56	8.58	9.15	8.30	8.94	8.54	11.5
	90^{th} pctle.	nc	10.5	9.91	11.7	9.57	9.36	11.0	10.2	11.5	9.26	11.3	12.9
Lead	n detects	0	1	0	1	1	5	5	3	1	2	0	1
	minimum	0.0039	0.0040	0.0038	0.0039	0.0039	0.0051	0.0088	0.012	0.004	0.0039	0.0039	0.0039
	maximum	0.0039	0.0059	0.0041	0.0052	0.0046	0.013	0.023	0.012	0.0083	0.023	0.0040	0.0041
	mean	nc	0.0044	0.0040	0.0042	0.0041	0.0078	0.014	0.012	0.005	0.014	0.0040	0.0040
	geo. mean	nc	0.0044	0.0040	0.0042	0.0041	0.0078	0.014	0.012	0.0055	0.014	0.0040	0.0040
	10^{th} pctle.	nc	0.0040	0.0039	0.0039	0.0040	0.0053	0.0093	0.012	0.0040	0.0059	0.0039	0.0039
	median	nc	0.0040	0.0040	0.0040	0.0041	0.0068	0.012	0.012	0.004	0.014	0.0040	0.0039
	90^{th} pctle.	nc	0.00518	0.0041	0.0047	0.0043	0.011	0.020	0.012	0.0075	0.021	0.0040	0.0040
Zinc	n detects	1	5	5	5	7	5	5	3	3	3	5	4
	minimum	44	26	46	33	39	40	31	40	42.9	27.9	42	36
	maximum	44	61	55	51	53	51	59	42	51.6	48.7	51	49
	mean	nc	42	50	43	43	45	44	41	47.7	41.7	46	44
	geo. mean	nc	42	50	43	43	45	44	41	48	42	46	44
	10^{th} pctle.	nc	27	48	36	39	41	33	40	44.0	32.0	42	37
	median	nc	46	50	43	43	45	42	42	48.6	48.5	47	45
	90^{th} pctle.	nc	55	53	48	48	48	56	42	51.0	48.7	50	49

Table E2. Summary of metal concentrations (mg/kg wet weight) data in spot prawn muscle from nine WDFW Marine Areas and one urban embayment (EB = Elliott Bay). The number of samples analyzed is reported in parentheses beneath each location. Method detection limit (MDL) values were used when reported values were deemed below detectable limits.

		MA 6 (2)	MA 7 (5)	MA 8.1 (5)	MA 8.2 (5)	MA 9 (3)	MA 10 (4)	EB (5)	MA 11 (3)	MA 12 (5)	MA 13 (2)
Mercury	n detects	2	5	5	5	3	4	5	3	5	2
	minimum	0.059	0.052	0.071	0.054	0.037	0.041	0.037	0.040	0.027	0.058
	maximum	0.10	0.11	0.096	0.12	0.050	0.048	0.064	0.048	0.049	0.061
	mean	0.081	0.071	0.086	0.080	0.044	0.045	0.051	0.043	0.038	0.059
	geo. mean	0.078	0.068	0.085	0.076	0.044	0.044	0.050	0.043	0.037	0.059
	10^{th} pctle.	0.064	0.052	0.076	0.056	0.039	0.041	0.040	0.040	0.030	0.058
	median	0.081	0.070	0.086	0.063	0.046	0.045	0.051	0.041	0.035	0.059
	90^{th} pctle.	0.099	0.096	0.094	0.11	0.049	0.047	0.061	0.046	0.046	0.060
Arsenic	n detects	2	5	5	5	3	4	5	3	5	2
	minimum	15	10	21	8.0	8.8	12	12	13	17	22
	maximum	15	10	31	24	11	15	14	14	24	23
	mean	15	13	26	14	9.7	14	13	14	21	22
	geo. mean	15	13	26	14	10	14	13	14	21	22
	10^{th} pctle.	15	11	22	9.1	9.0	13	12	13	17	22
	median	15	14	25	13	9.6	14	13	14	21	22
	90^{th} pctle.	15	14	30	21	10	15	14	14	24	23
Cadmium	n detects	2	5	5	5	3	4	5	3	5	2
	minimum	0.024	0.013	0.022	0.018	0.013	0.013	0.016	0.016	0.023	0.023
	maximum	0.030	0.031	0.025	0.026	0.017	0.018	0.026	0.024	0.041	0.027
	mean	0.027	0.024	0.023	0.023	0.015	0.017	0.022	0.019	0.031	0.025
	geo. mean	0.027	0.024	0.023	0.023	0.016	0.017	0.022	0.019	0.031	0.025
	10^{th} pctle.	0.024	0.018	0.022	0.019	0.014	0.014	0.017	0.016	0.023	0.024
	median	0.027	0.026	0.024	0.024	0.016	0.017	0.024	0.017	0.032	0.025
	90^{th} pctle.	0.029	0.029	0.024	0.026	0.017	0.018	0.025	0.022	0.039	0.026

Continued.

Table E2 (continued). Summary of metal concentrations (mg/kg wet weight) data in spot prawn muscle from nine WDFW Marine Areas and one urban embayment (EB = Elliott Bay). The number of samples analyzed is reported in parentheses beneath each location. Method detection limit (MDL) values were used when reported values were deemed below detectable limits.

		MA 6 (2)	MA 7 (5)	MA 8.1 (5)	MA 8.2 (5)	MA 9 (3)	MA 10 (4)	EB (5)	MA 11 (3)	MA 12 (5)	MA 13 (2)
Copper	n detects	2	5	5	5	3	4	5	3	5	2
	minimum	6.8	4.3	8.4	4.2	5.4	5.3	7.8	7.4	6.8	6.7
	maximum	8.1	8.6	12	8.8	6.7	7.3	10	7.6	9.9	7.6
	mean	7.4	6.3	9.9	6.9	6.1	6.4	8.9	7.5	7.9	7.1
	geo. mean	7.4	6.3	9.9	6.9	6.1	6.4	8.9	7.5	7.9	7.1
	10^{th} pctle.	6.9	4.8	8.5	5.4	5.6	5.4	8.0	7.4	6.9	6.8
	median	7.4	5.8	9.1	7.2	6.2	6.4	8.6	7.6	7.1	7.1
	90^{th} pctle.	7.9	8.1	12	8.2	6.6	7.3	9.9	7.6	9.4	7.5
Lead	n detects	0	0	0	0	0	0	1	0	0	0
	minimum	0.0039	0.0040	0.0039	0.0039	0.0039	0.0039	0.0040	0.0040	0.0039	0.0039
	maximum	0.0041	0.0041	0.0040	0.0041	0.0040	0.0041	0.0045	0.0041	0.0041	0.0039
	mean	0.0040	0.0041	0.0039	0.0040	0.0040	0.0040	0.0041	0.0040	0.0040	0.0039
	geo. mean	0.0040	0.0041	0.0039	0.0040	0.0040	0.0040	0.0041	0.0040	0.0040	0.0039
	10^{th} pctle.	0.0039	0.0040	0.0039	0.0039	0.0039	0.0039	0.0040	0.0040	0.0039	0.0039
	median	0.0040	0.0041	0.0039	0.0040	0.0040	0.0040	0.0040	0.0040	0.0039	0.0039
	90^{th} pctle.	0.0041	0.0041	0.0040	0.0041	0.0040	0.0041	0.0043	0.0041	0.0041	0.0039
Zinc	n detects	2	5	5	5	3	4	5	3	5	2
	minimum	12	11	13	11	11	12	13	13	12	13
	maximum	12	13	14	13	12	14	14	13	13	14
	mean	12	12	13	12	11	13	13	13	13	14
	geo. mean	12.1	11.7	13.5	12.3	11.4	12.7	13.3	13.1	12.7	13.5
	10^{th} pctle.	12	11	13	12	11	12	13	13	12	13
	median	12	11	13	12	12	13	13	13	13	14
	90^{th} pctle.	12	13	14	13	12	13	14	13	13	14

Table E3. Summary of metals (mg/kg wet weigh) and mean total solids (%) in Dungeness crab hepatopancreas by location. The number of samples analyzed is reported in parentheses beneath each Marine Area or urban embayment (EB = Elliott Bay, CB = Commencement Bay), nc = not calculated.

		MA (1)	MA (2)	MA (1)	MA (1)	MA (2)	MA (3)	EB (3)	MA11 (1)	CB (2)	MA (1)	MA (2)
Solids (%)	mean	15.5	14.5	17.5	19.2	18.0	16.6	15.1	14.0	17.5	19.9	18.8
Mercury	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	0.055	0.024	0.044	0.04	0.022	0.045	0.04	0.068	0.034	0.035	0.040
	maximum	0.055	0.029	0.044	0.04	0.023	0.055	0.13	0.068	0.069	0.035	0.049
	mean	nc	0.026	nc	nc	0.023	0.050	0.08	nc	0.052	nc	0.044
Arsenic	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	14	2.9	7.1	4.9	5.3	4.2	5.0	4.8	4.2	8.3	9.5
	maximum	14	7.4	7.1	4.9	5.6	8.3	6.9	4.8	6.3	8.3	11
	mean	nc	5.1	nc	nc	5.5	5.9	6.0	nc	5.3	nc	10
Cadmium	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	1.5	0.098	0.33	1.1	0.37	0.82	0.40	1.2	0.19	2.8	1.0
	maximum	1.5	0.11	0.33	1.1	0.42	2.8	0.95	1.2	2.1	2.8	1.2
	mean	nc	0.10	nc	nc	0.40	1.7	0.68	nc	1.1	nc	1.1
Copper	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	12	9.0	12	44	7.6	8.7	33	13	25	15	32
	maximum	12	17	12	44	11	18	47	13	29	15	47
	mean	nc	13	nc	nc	9.0	13	40	nc	27	nc	39
Lead	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	0.063	0.022	0.022	0.053	0.040	0.069	0.12	0.15	0.071	0.011	0.018
	maximum	0.063	0.046	0.022	0.053	0.053	0.12	0.47	0.15	0.19	0.011	0.029
	mean	nc	0.034	nc	nc	0.047	0.10	0.27	nc	0.13	nc	0.023
Zinc	n detects	1	2	1	1	2	3	3	1	2	1	2
	minimum	17	8.1	13.8	15.4	11	13	15	14	13	17.3	16
	maximum	17	15	13.8	15.4	11	20	19	14	18	17.3	19
	mean	nc	12	nc	nc	11.2	16	17	nc	16	nc	18

Table E4. Summary of metals (mg/kg wet weight) and mean total solids (%) in spot prawn head tissue by location. The number of samples analyzed is reported in parentheses beneath each Marine Area or urban embayment (EB = Elliott Bay), nc = not calculated.

		MA 6 (1)	MA 7 (2)	MA 8.1 (1)	MA 8.2 (2)	MA 10 (1)	EB[a] (6)	MA 12 (1)	MA 13 (2)
Solids (%)	mean	20.8	20.4	26.0	26.3	23.4	31.1	27.4	27.2
Mercury	n detects	1	2	1	2	1	6	1	2
	minimum	0.043	0.032	0.043	0.035	0.031	0.026	0.025	0.039
	maximum	0.043	0.035	0.043	0.049	0.031	0.036	0.025	0.041
	mean	nc	0.033	nc	0.042	nc	0.031	nc	0.040
Arsenic	n detects	1	2	1	2	1	6	1	2
	minimum	11	8.8	30	8.6	10	9.6	19	16
	maximum	11	13	30	11	10	11	19	16
	mean	nc	11	nc	9.6	nc	10	nc	16
Cadmium	n detects	1	2	1	2	1	6	1	2
	minimum	1.4	1.4	0.89	0.67	0.75	0.72	2.5	1.1
	maximum	1.4	1.6	0.89	0.67	0.75	0.84	2.5	1.3
	mean	nc	1.5	nc	0.67	nc	0.77	nc	1.2
Copper	n detects	1	2	1	2	1	6	1	2
	minimum	64	48	56	51	62	67	55	63
	maximum	64	54	56	81	62	79	55	66
	mean	nc	51	nc	66	nc	75	nc	64
Lead	n detects	1	2	1	2	1	6	1	2
	minimum	0.064	0.034	0.030	0.056	0.076	0.062	0.047	0.081
	maximum	0.064	0.066	0.030	0.058	0.076	0.14	0.047	0.099
	mean	nc	0.050	nc	0.057	nc	0.095	nc	0.090
Zinc	n detects	1	2	1	2	1	6	1	2
	minimum	20	18	25	22	24	29	26	25
	maximum	20	23	25	24	24	31	26	25
	mean	nc	21	nc	23	nc	29	nc	25

[a]Includes a station (ELLBAY4_P90DEEP) that does not have corresponding muscle data.