

**LOWER DUWAMISH WATERWAY FISH AND CRAB DATA
REPORT**

FINAL

Prepared for

Lower Duwamish Waterway Group

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Prepared by:  Windward
environmental LLC

200 West Mercer Street, Suite 401 s Seattle, Washington s 98119

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Acronyms

ALS	ALS Environmental-Kelso
AOC	Administrative Order on Consent
ARI	Analytical Resources, Inc.
Axys	Axys Analytical Services, Ltd.
BHC	benzene hexachloride
Brooks Applied	Brooks Applied Labs
cPAH	carcinogenic polycyclic aromatic hydrocarbon
DDT	dichlorodiphenyltrichloroethane
DQO	data quality objective
ECD	electron capture detector
EPA	US Environmental Protection Agency
GC/MS	gas chromatography/mass spectrometry
HG-AFS	hydride generation-atomic fluorescence spectrometry
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectrometry
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
IsoLab	IsoLab at University of Washington
LDW	Lower Duwamish Waterway
PCB	polychlorinated biphenyl
PSEP	Puget Sound Estuary Program
QAPP	quality assurance project plan
RI	remedial investigation
RL	reporting limit
SIM	select ion monitoring
SVOC	semivolatile organic compound
TBT	tributyltin
TEQ	toxic equivalent

TTL	target tissue level
UCT-KED	universal cell technology-kinetic energy discrimination
Windward	Windward Environmental LLC
ww	wet weight

1 Introduction

This data report presents the results of baseline chemical analyses of fish and crab tissue samples collected from the Lower Duwamish Waterway (LDW) in August/September 2017. Baseline fish and crab tissue data were collected to address the third amendment to the Administrative Order on Consent (AOC) (EPA 2016). Data quality objectives (DQOs) are presented in the *Pre-Design Studies Work Plan* (Windward and Integral 2017), hereafter referred to as the Work Plan, and in the fish and crab tissue quality assurance project plan (QAPP) (Windward 2017). The QAPP includes details regarding project organization, sampling design, analytical methods, and data validation.

This report provides field catch results, QAPP deviations, and the results of chemical analyses and validation of fish and crab composite tissue samples.

The remainder of this data report is organized into the following sections:

- u Section 2 – Fish and Crab Tissue Sampling and Processing
- u Section 3 – Analytical Methods
- u Section 4 – Results of Chemical Analyses
- u Section 5 – References

The text is supported by the following appendices:

- u Appendix A – Data Tables (complete results for all samples)
- u Appendix B – Field Forms, Field Notes, and COCs
- u Appendix C – Compositing Plan and Tissue Preparation Notes from Axys
- u Appendix D – Laboratory Reports and Data Validation Report
- u Appendix E – IsoLab Report on Carbon and Nitrogen Stable Isotope Analyses

2 Fish and Crab Tissue Sampling and Processing

This section summarizes the collection and processing of fish and crab tissue samples. Additional details are described in the QAPP (Windward 2017). Section 2.1 describes the targeted species and collection reaches and subreaches, Section 2.2 presents the field collection methods, Section 2.3 presents the catch results, Section 2.4 describes the sample processing procedures, and Section 2.5 describes field deviations from the QAPP.

2.1 TARGETED SPECIES AND COLLECTION REACHES AND SUBREACHES

Fish and crab sampling took place over four days, from August 29, 2017, to September 1, 2017. One additional day of crab sampling occurred on September 5, 2017. As presented in Section 4.1.1 of the QAPP (Windward 2017), species targeted for collection were English sole (*Parophrys vetulus*),¹ shiner surfperch (*Cymatogaster aggregate*), and Dungeness crab (*Metacarcinus magister*).² Graceful crabs (*Metacarcinus gracilis*) were collected as an alternate species for Dungeness crabs, as necessary.³

Hereafter, target species refers to English sole, shiner surfperch, Dungeness crab, and graceful crab.

English sole and crab tissue samples were collected from two distinct sampling areas of the LDW (Reach 1 and Reach 2), as described in the QAPP (Windward 2017) (Map 2-1). The QAPP also describes how both reaches were divided into two subreaches (a and b) for the purpose of collecting shiner surfperch (Map 2-2), which during the remedial investigation (RI), showed more spatial variability in their tissue concentrations than did English sole and crabs.

2.2 COLLECTION METHODS

Fish and crabs were collected using a high-rise otter trawl. Crabs were also collected using crab traps. The rationale for the field collection procedures is described in detail in the QAPP (Windward 2017).

2.2.1 High-rise otter trawl

Trawling took place in the LDW for four days, from August 29, 2017, through September 1, 2017. All trawling was conducted using the research vessel *Kittiwake*,

¹ In the QAPP, starry flounder (*Platichthys stellatus*) was identified as an alternate species for English sole in the event that insufficient numbers of English sole were collected to meet target specimen numbers. Sufficient numbers of English sole were collected, so starry flounder was not needed as an alternate.

² Per the request of King County public health agencies, sand sole (*Psettichthys melanostictus*) were also retained when incidentally caught during trawling.

³ The target numbers of Dungeness crab were not available, so graceful crab was used as an alternate species for Dungeness crab, as specified in the QAPP.

captained by Charles Eaton (Bio-Marine Enterprises), per the specifications in the QAPP (Windward 2017). Trawls targeting shiner surfperch were conducted within subreaches rather than reaches. After the target number of shiner surfperch had been collected, all subsequent trawls were conducted throughout a reach. The numbers of trawls conducted in each reach/subreach are presented in Table 2-1, and trawling locations are shown on Map 2-3.

Table 2-1. Number of trawls conducted in each LDW sampling reach or subreach

Sampling Reach or Subreach ^a	Number of Trawls
R1	15^a
R1a	9
R1b	5
R2	21^b
R2a	11
R2b	3

^a Includes R1a trawls, R1b trawls, and one reach-wide trawl.

^b Includes R2a trawls, R2b trawls, and seven reach-wide trawls.

2.2.2 Crab traps

Crap traps were deployed in Reach 1 on August 31, 2017, and in Reach 2 from August 29, 2017, through September 1, 2017, and on September 5, 2017. All traps were Ladner© 30-in. rubber-wrapped stainless steel crab traps. Bait (i.e., squid and salmon carcass) was placed in a mesh bait bag and tied to the inside of the trap to prevent the bags from being opened and the contents consumed. Ten traps were dispersed throughout the sampling reaches at any one time. Trap deployment times typically ranged from approximately 2 to 4 hours, although some traps soaked overnight to ascertain if a longer soak time yielded better catch results. Crab trap locations are shown on Map 2-4.

2.3 CATCH RESULTS

A total of 483⁴ target fish and crab specimens were retained from 36 trawls and 63 crab trap deployments. Target numbers of fish and crabs specified in the QAPP (Windward 2017) were met or exceeded for all species in each reach or subreach, except for Dungeness crab in both reaches. The sampling of Dungeness crab did not yield the target number after numerous attempts; therefore, graceful crab were used as the designated alternate species per the QAPP. Catch results for all target fish and crab species collected and processed from each sampling reach of the LDW are presented in Table 2-2.

⁴ A total of 74 starry flounder were also retained as a potential alternate for English sole but not included in the total. Starry flounder were not analyzed because sufficient numbers of English sole were collected.

Table 2-2. Target and actual numbers of target species retained by reach

Species ^a	Size (cm)	Reach 1		Reach 2	
		Target	Actual	Target	Actual
English sole	≥ 20 ^b	60	60 ^c	60	70 ^e
Shiner surfperch	≥ 8	90 ^d	120 ^{d,e}	90 ^d	120 ^{d,e}
Graceful crab	≥ 9	42	56 ^e	42	48 ^e
Dungeness crab	≥ 9	30	1	30	8

- ^a In addition to the target species listed, starry flounder were collected as a potential alternate species for English sole, and sand sole were collected for archiving by King County public health agencies.
- ^b English sole measuring 17 to 20 cm in length were also collected for potential inclusion if insufficient English sole ≥ 20 cm in length were collected.
- ^c Two English sole from the 17- to 20-cm group (one 19.4 cm and one 19.9 cm) were included in the total for Reach 1.
- ^d Shiner surfperch were collected within four subreaches. Each reach contained two subreaches, each with a target of 45 individuals. Within each subreach, 60 shiner surfperch were collected.
- ^e English sole, shiner surfperch, and graceful crab specimens not composited were archived (see Section 2.4.3).

Non-target fish and crab species captured in the LDW were identified, recorded, and returned to the sampling reach where they had been collected. A total of 22 types of fish and 23 types of invertebrates were caught from the LDW and classified to the lowest taxonomic level practicable, including both target and non-target species. The numbers of each species caught using each collection method are presented in Table 2-3 for fish and in Table 2-4 for invertebrates.

Table 2-3. Numbers and types of fish species caught in the LDW using trawls and crab traps

Species	Scientific Name	Number of Specimens Caught ^a		
		Otter Trawl	Crab Trap	Total
Blacktip poacher	<i>Xeneretmus latifrons</i>	2	0	2
Buffalo sculpin	<i>Enophrys bison</i>	3	0	3
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	1	0	1
English sole	<i>Parophrys vetulus</i>	981	0	981
Pacific herring	<i>Clupea pallasii</i>	35	0	35
Longfin smelt	<i>Spirinchus thaleichthys</i>	452	0	452
Pacific cod	<i>Gadus macrocephalus</i>	334	0	334
Padded sculpin	<i>Artedius fenestralis</i>	1	0	1
Pile perch	<i>Rhacochilus vacca</i>	107	0	107
Prickly sculpin	<i>Cottus asper</i>	4	0	4
Rock sole	<i>Lepidopsetta bilineata</i>	88	0	88
Roughback sculpin	<i>Chitonotus pugetensis</i>	29	0	29

Species	Scientific Name	Number of Specimens Caught ^a		
		Otter Trawl	Crab Trap	Total
Sand sole	<i>Psettichthys melanostictus</i>	7	0	7
Scalyhead sculpin	<i>Artedius harringtoni</i>	1	0	1
Shad	<i>Alosa</i> sp.	1	0	1
Shiner surfperch	<i>Cymatogaster aggregata</i>	3,446	0	3,446
Smooth head sculpin	<i>Artedius lateralis</i>	4	0	4
Snake pricklyback	<i>Lumpenus sagitta</i>	11	0	11
Staghorn sculpin	<i>Leptocottus armatus</i>	379	0	379
Starry flounder	<i>Platichthys stellatus</i>	846	0	846
Striped sea perch	<i>Embiotoca lateralis</i>	2	0	2
Total		6,734	0	6,734

^a Number of specimens includes target species retained for compositing and archiving.
LDW – Lower Duwamish Waterway

Table 2-4. Number and types of invertebrate species caught in the LDW using trawls and crab traps

Species	Scientific Name	Number of Specimens Caught ^a		
		Otter Trawl	Crab Trap	Total
Anemone	<i>Monactis</i> sp.	76	0	76
Blackclawed crab	<i>Lophopanopeus bellus</i>	1	0	1
Cockle	<i>Clinocardium nuttallii</i> .	8	0	8
Decorator crab	<i>Oregonia gracilis</i>	58	0	58
Dock (coonstripe) shrimp	<i>Pandalus danae</i>	21	0	21
Dungeness crab	<i>Metacarcinus magister</i>	2	8	10 ^b
Giant California sea cucumber	<i>Parastichopus californicus</i>	1	0	1
Graceful crab	<i>Metacarcinus gracilis</i>	678	95	773
Hermit crab	Order: Decapoda	21	0	21
Kelp crab	<i>Pugettia productus</i>	10	0	10
Lyre crab	<i>Hyas lyratus</i>	33	0	33
Moon snail	<i>Euspira lewisii</i>	1	0	1
Nudibranch	Class: Gastropoda	7	0	7
Pygmy rock crab	<i>Glebocarcinus oregonensis</i>	3	0	3

Species	Scientific Name	Number of Specimens Caught ^a		
		Otter Trawl	Crab Trap	Total
Red rock crab	<i>Cancer productus</i>	10	19	29
Sea cucumber	Class: Holothuroidea	1	0	1
Sea pen	Class: Anthozoa	3	0	3
Sea star	Class: Asteroidea	2	0	2
Sea urchin	Order: Echinoidea	7	0	7
Shore crab	<i>Hemigrapsus oregonensis</i>	2	0	2
Shrimp	Order: Decapoda	845	0	845
Snail	Class: Gastropoda	151	0	151
Tunicate	Class: Ascidiacea	6	0	6
Total		1,947	122	2,069

^a Number of specimens includes target species retained for compositing and archiving.

^b One Dungeness crab specimen was below the target size and was released.

LDW – Lower Duwamish Waterway

2.4 SAMPLE PROCESSING, IDENTIFICATION, AND COMPOSITING

This section presents the procedures used to process, identify, and composite fish and crab tissue samples. The fish and crab QAPP (Windward 2017) contains additional detail regarding these methods.

2.4.1 Sample processing

Organisms captured in trawls and traps were placed in containers filled with site water and sorted by species. Non-target species were identified to the lowest practical taxonomic level, counted (or estimated if a species was present in large numbers), and released to the LDW as quickly as possible. Non-target species data were recorded on non-target species tally forms (Appendix B). Target species fish and crabs that did not meet size requirements were counted and returned to the LDW.⁵

Specimens of target fish and crab species that met size requirements were rinsed with site water and inspected to ensure that the skin or exoskeleton was undamaged and intact. Target species were killed following the methods outlined by the US Environmental Protection Agency (EPA) (2000).⁶

All target specimens were weighed and measured according to the QAPP (Windward 2017), either on the boat after collection or on the dock at the end of each sampling

⁵ English sole that were > 17 but < 20 cm in length were archived in case there were not sufficient fish ≥ 20 cm in length.

⁶ Prior to processing, retained crabs were killed by placing them on dry ice, small fish (i.e., shiner surfperch) were killed by placing them on wet ice, and large fish (i.e., English sole) were killed with a sharp blow to the head.

day. Fish were measured with a measuring board to determine total length to the nearest millimeter, then wrapped in aluminum foil and weighed to the nearest 0.5 g.⁷ In addition, the gender of each English sole was determined by examining the gonads.⁸ Crabs were measured with calipers to determine carapace width to the nearest millimeter, then wrapped in two layers of aluminum foil to prevent punctures and weighed to the nearest 0.5 g. All measurements were recorded on target species tally forms (Appendix B). A bagged label containing the project number, sampling personnel, date, time, and specimen identification (ID) was placed in the outer bag of each double-bagged specimen. All specimens were stored in coolers containing wet ice and delivered to Analytical Resources, Inc. (ARI). Tissue samples were stored frozen at ARI, organized into composite groups by Windward Environmental LLC (Windward) staff, and then transferred via courier to Axys Analytical Services, Ltd. (Axys) for homogenization.

All fish and crab tissue preparation—including the filleting of fish, dissection of crabs, and homogenization of tissues—was conducted by Axys following standard operating procedures. English sole were filleted (skin on), and the fillet and remainder (i.e., all tissue remaining after removal of fillet) were homogenized separately. Shiner surfperch were homogenized whole. Crabs were dissected, and the hepatopancreas and edible meat tissues⁹ were homogenized separately. Laboratory notes for tissue preparation are presented in Appendix C. Frozen subsamples of homogenized composite tissue samples were delivered via courier to the other analytical laboratories (ARI, Brooks Applied Labs [Brooks Applied], and IsoLab at University of Washington [IsoLab]). Frozen subsamples of homogenized composite tissue samples were shipped via FedEx to ALS Environmental-Kelso (ALS). The analytical methods used by each laboratory are listed in the QAPP and in Section 3.1 of this report.

2.4.2 Sample identification

Unique alphanumeric sample IDs were assigned to each individual target fish or crab specimen and recorded on the target species tally forms (Appendix B). Table 2-5 presents the ID scheme for individual fish and crab specimens.

⁷ The weight of each piece of foil was not measurable by the scales (i.e., too light to be tared) and was considered negligible.

⁸ English sole were sexed by examining the size and shape of the gonads. The gonads of the larger sole were easily visible when individual fish were held up to the sunlight. For smaller fish, it was usually necessary to internally examine the gonads by incising the abdomen with a clean scalpel blade.

⁹ Crab edible meat includes tissue from the upper body, legs, and claws.

Table 2-5. ID scheme for individual fish and crab specimens

Identifier	Description
LDW	identifies the project
17	identifies the year collected
R1, R1a, R1b, R2, R2a, R2b	identifies the sampling reach or subreach, if applicable
ES, SF, SS, SA, DC, or GC	identifies the species type (English sole, starry flounder, shiner surfperch, Pacific sand sole, Dungeness crab, or graceful crab, respectively)
Sequential number	identifies the order in which the specimen was captured in the sampling event from a given reach or subreach

ID – identification

LDW – Lower Duwamish Waterway

Thus, for example, the 16th English sole captured in reach 2 was identified as LDW17-R2-ES016. After individual fish and crab specimens had been combined to form composite samples, as discussed in Section 2.4.3, composite sample IDs were assigned as shown in Table 2-6.

Table 2-6. ID scheme for fish and crab composite tissue samples

Identifier	Description
LDW	identifies the project
17	identifies the year collected
R1, R1a, R1b, R2, R2a, R2b	identifies the sampling reach or subreach, if applicable
ES, SF, SS, DC, or GC	identifies the species type (English sole, starry flounder, shiner surfperch, Dungeness crab, or graceful crab, respectively)
WB, FL, RM, EM, or HP	identifies whole-body, skin-on fillet, remainder, edible meat, or hepatopancreas samples, respectively
comp	indicates the sample as a composite of individual specimens
sequential number	identifies the composite number for a specific species and sampling reach combination

ID – identification

LDW – Lower Duwamish Waterway

Thus, for example, the second composite sample of English sole fillets, which contained specimens from reach 1, was identified as LDW17-R1-ESFL-comp02.

2.4.3 Sample compositing

Fish and crab tissue samples were chemically analyzed as composite samples, which were created by homogenizing individual specimens together. The compositing plan (Appendix C) was developed with and approved by EPA. The numbers and types of composite samples created and chemically analyzed are presented in Table 2-7. Fish and crab composite samples were created using comparable specimen sizes from the same sampling reach or subreach, as possible.

Additional compositing details—including the ID, length, and weight of each target specimen included in the composite samples—are provided in the compositing plan (Appendix C). Most of the specimens retained for analysis were included in composite samples (Table 2-7). The remaining target specimens were archived individually (Table 2-8).

Table 2-7. Numbers of fish and crab composite tissue samples collected from the LDW

Species Name	Sample Type	No. of Individuals per Composite Sample	No. of Composite Tissue Samples by Reach			
			1	2	1 and 2	
English sole	fillet (skin on)	10	6	6	na	
	remainder	10	6	6	na	
Shiner surfperch	whole body	15	1a	1b	2a	2b
			3	3	3	3
Graceful crab	edible meat	7	6	6	na	
	hepatopancreas	14	3 ^a	3 ^a	na	
Dungeness crab	edible meat	3	0	2	1 ^b	
	hepatopancreas	3	0	2	1 ^b	

^a To obtain sufficient mass for analysis, each hepatopancreas composite contained tissue from the 14 crabs represented in the corresponding 2 edible meat composites.

^b This Dungeness crab composite sample included one specimen from Reach 1 and two specimens from Reach 2.

LDW – Lower Duwamish Waterway

na – not applicable

Table 2-8. Number of archived individual fish and crab specimens

Species	Sampling Reach/Subreach	No. of Individuals Archived ^a
English sole	R1	0
	R2	10
Starry flounder	R1	4
	R2	70
Shiner perch	R1a	15
	R1b	15
	R2a	15
	R2b	15
Graceful crab	R1	14
	R2	6
Dungeness crab	R1	0
	R2	0

^a Per the QAPP, archived specimens will be held frozen for up to one year from collection.

QAPP – quality assurance project plan

2.5 FIELD DEVIATIONS FROM THE QAPP

Field deviations from the QAPP (Windward 2017) included minor modifications to collection and processing methods. All deviations were approved by EPA. Specific deviations were:

- u Two English sole specimens from the 17–20-cm size class (one 19.4 cm and one 19.9 cm) were used for compositing to meet the target number of 60 English sole for R1 (see Appendix C).
- u In addition to the graceful crab composites, three composites of edible meat and three composites of hepatopancreas with three Dungeness crabs each were analyzed for dioxins/furans and polychlorinated biphenyl (PCB) congeners. One Dungeness crab composite contained specimens from R1 and R2, and the other two composites contained specimens from R2. See Appendix C for additional details.
- u The QAPP stated that crab trap deployments would not occur overnight due to the potential for trap loss; however, some traps were soaked overnight in an effort to collect more Dungeness crabs.

3 Analytical Methods

The methods and procedures used to prepare and chemically analyze the composite tissue samples are described briefly in this section and in detail in the QAPP (Windward 2017). This section also discusses laboratory deviations from the QAPP.

3.1 TISSUE ANALYTICAL METHODS

ARI performed PCB Aroclor, carcinogenic polycyclic aromatic hydrocarbon (cPAH), semivolatile organic compound (SVOC), vanadium, lipid, and percent solids analyses. Axys performed PCB congener and dioxin/furan analyses, Brooks Applied performed inorganic arsenic analyses, and ALS performed organochlorine pesticide analyses. IsoLab conducted carbon and nitrogen stable isotope analysis. Tissue samples were analyzed according to the methods presented in Table 3-1. Specific analytes analyzed in each tissue type are summarized in Table 3-2.

Table 3-1. Analytical methods for fish and crab tissue analyses

Analyte	Method	Reference	Laboratory
PCB Aroclors	GC/ECD	EPA 3350-C Mod EPA 8082A	ARI
PCB congeners	HRGC/HRMS	soxhlet extraction EPA 1668C	Axys
Inorganic arsenic	HG-AFS	EPA 1632	Brooks Applied
cPAHs	GC/MS	EPA 3350-C Mod EPA 8270D-SIM	ARI
Dioxins/furans	HRGC/HRMS	soxhlet extraction EPA 1613B	Axys
SVOCs	GC/MS	EPA 3350-C Mod EPA 8270D	ARI
TBT	GC/MS	EPA 3350-C Mod EPA 8270-SIM	ARI
Vanadium	ICP-MS	EPA 6020A UCT-KED	ARI
Organochlorine pesticides	GC/MS	EPA 3541 EPA 8270D/1699 Mod	ALS
Lipids	gravimetric extraction	Bligh and Dyer (mod)	ARI
Percent solids	drying oven	PSEP (1986)	ARI
Delta13C, delta15N	isotope ratio mass spectrometer	IsoLab (2017)	IsoLab

ALS – ALS Environmental-Kelso

ARI – Analytical Resources, Inc.

Axys – Axys Analytical Services Ltd.

Brooks Applied – Brooks Applied Labs

cPAH – carcinogenic polycyclic aromatic hydrocarbon

ECD – electron capture detector

EPA – US Environmental Protection Agency

GC/MS – gas chromatography/mass spectrometry

HG-AFS – hydride generation-atomic fluorescence spectrometry

HRGC/HRMS – high-resolution gas chromatography/high-resolution mass spectrometry

ICP-MS – inductively coupled plasma-mass spectrometry

IsoLab – IsoLab at University of Washington

PCB – polychlorinated biphenyl

PSEP – Puget Sound Estuary Program

SIM – select ion monitoring

SVOC – semivolatile organic compound

TBT – tributyltin

UCT-KED – universal cell technology-kinetic energy discrimination

Table 3-2. Chemical analyses of fish and crab tissue composites

Species	Tissue Type	Sampling Reach/ Subreach	Total No. of Composites	Number of Composites Analyzed									
				PCB Aroclors	PCB Congeners	Dioxins/ Furans	cPAHs	Inorganic Arsenic	Select SVOCs	TBT	Vanadium	Select Organochlorine Pesticides	Delta ¹³ C, Delta ¹⁵ N
English sole	fillet	R1	6	6	3	6	-	6	1	1	1	1	-
		R2	6	6	3	6	-	6	1	1	1	1	-
	remainder	R1	6	6	3	6	-	6	1	1	1	1	-
		R2	6	6	3	6	-	6	1	1	1	1	-
Shiner surfperch	whole body	R1a	3	3	2	3	-	3	-	-	-	1	-
		R1b	3	3	2	3	-	3	1	1	1	-	-
		R2a	3	3	2	3	-	3	1	1	1	-	-
		R2b	3	3	2	3	-	3	-	-	-	1	-
Graceful crab	edible meat	R1	6	6	4	6	6	6	2	-	2	-	6
		R2	6	6	4	6	6	6	-	2	-	2	6
	hepatopancreas	R1	3	3	2	3	3	3	1	-	1	-	-
		R2	3	3	2	3	3	3	-	1	-	1	-
Dungeness crab	edible meat	R2	2	-	2	2	-	-	-	-	-	-	2
		R1 and R2	1	-	1	1	-	-	-	-	-	-	1
	hepatopancreas	R2	2	-	2	2	-	-	-	-	-	-	-
		R1 and R2	1	-	1	1	-	-	-	-	-	-	-

cPAH – carcinogenic polycyclic aromatic hydrocarbon
 PCB – polychlorinated biphenyl

SVOC – semivolatile organic compound
 TBT – tributyltin

3.2 LABORATORY DEVIATIONS FROM THE QAPP

There were no laboratory deviations from the methods and procedures described in the QAPP (Windward 2017).

4 Results of Chemical Analyses

This section summarizes the results of the chemical analyses and data validation of fish and crab tissue composite samples. Data management practices—including methods used for calculations (e.g., concentrations of total PCBs and toxic equivalents [TEQs])—are presented in the Work Plan (Windward and Integral 2017).

English sole whole-body concentrations were calculated from the fillet and remainder concentrations. Crab whole-body concentrations were calculated from the edible meat and hepatopancreas concentrations. The equations for these calculations and the supporting data are presented in Appendix A1. In addition, the complete chemistry dataset is provided in Appendix A2. Laboratory reports and the data validation report are presented in Appendix D. Stable isotope data for crab tissue composites are presented in Section 5.

4.1 TISSUE CHEMISTRY RESULTS

This section summarizes fish and crab tissue chemistry and conventional parameters (i.e., total solids and lipids) data. The data evaluation report (Task 6 of the Work Plan) will contain analysis of the data, including comparison to TTLs. Results for each analyte are summarized by tissue type in Tables 4-1 through 4-8. Note that PCB Aroclors were detected in all samples, so additional PCB congener analyses were not necessary.

Table 4-1. PCBs tissue data summary

Sampling Reach/ Subreach	Analyte	Units	Detection Frequency		Detected Concentrations		
			Ratio	%	Min.	Max.	Mean
English sole (fillet)							
R1	total PCB Aroclors	µg/kg ww	6/6	100	275	442	341
	total PCB congeners	µg/kg ww	3/3	100	327.5 J	426.8 J	380.9
	PCB TEQ	ng/kg ww	3/3	100	2.74	3.23 J	3.01
R2	total PCB Aroclors	µg/kg ww	6/6	100	144.6	238 J	177
	total PCB congeners	µg/kg ww	3/3	100	130.9 J	348.2 J	258.0
	PCB TEQ	ng/kg ww	3/3	100	1.09 J	2.82 J	2.09
English sole (remainder)							
R1	total PCB Aroclors	µg/kg ww	6/6	100	813	1,308	1,150
	total PCB congeners	µg/kg ww	3/3	100	1,084 J	1,486 J	1,290
	PCB TEQ	ng/kg ww	3/3	100	8.83 J	9.71	9.29

Sampling Reach/ Subreach	Analyte	Units	Detection Frequency		Detected Concentrations		
			Ratio	%	Min.	Max.	Mean
R2	total PCB Aroclors	µg/kg ww	6/6	100	608	924	841
	total PCB congeners	µg/kg ww	3/3	100	722.6 J	865.0 J	787.0
	PCB TEQ	ng/kg ww	3/3	100	5.63 J	6.35 J	6.07
English sole (whole body [calculated])							
R1	total PCB Aroclors	µg/kg ww	6/6	100	634	1,034	890
	total PCB congeners	µg/kg ww	3/3	100	853.4 J	1,198 J	1,010
	PCB TEQ	ng/kg ww	3/3	100	6.97 J	7.90	7.34
R2	total PCB Aroclors	µg/kg ww	6/6	100	458	681	620
	total PCB congeners	µg/kg ww	3/3	100	530.4 J	643.8 J	605.8
	PCB TEQ	ng/kg ww	3/3	100	4.15 J	5.27 J	4.72
Shiner surfperch (whole body)							
R1a	total PCB Aroclors	µg/kg ww	3/3	100	393	488	439
	total PCB congeners	µg/kg ww	2/2	100	460.2 J	531.8 J	496.0
	PCB TEQ	ng/kg ww	2/2	100	5.10 J	6.44 J	5.77
R1b	total PCB Aroclors	µg/kg ww	3/3	100	319	415	370
	total PCB congeners	µg/kg ww	2/2	100	391.8 J	417.2 J	404.5
	PCB TEQ	ng/kg ww	2/2	100	4.47 J	5.32 J	4.90
R2a	total PCB Aroclors	µg/kg ww	3/3	100	493	515	504
	total PCB congeners	µg/kg ww	2/2	100	500.6 J	602.0 J	551.3
	PCB TEQ	ng/kg ww	2/2	100	5.76 J	5.98 J	5.87
R2b	total PCB Aroclors	µg/kg ww	3/3	100	308	323	316
	total PCB congeners	µg/kg ww	2/2	100	318.2 J	346.8 J	332.5
	PCB TEQ	ng/kg ww	2/2	100	3.40 J	3.85 J	3.63

Sampling Reach/ Subreach	Analyte	Units	Detection Frequency		Detected Concentrations		
			Ratio	%	Min.	Max.	Mean
Graceful crab (edible meat)							
R1	total PCB Aroclors	µg/kg ww	6/6	100	124.7 J	165 J	146
	total PCB congeners	µg/kg ww	4/4	100	110.0 J	156.1 J	143.0
	PCB TEQ	ng/kg ww	4/4	100	1.54	2.15 J	1.83
R2	total PCB Aroclors	µg/kg ww	6/6	100	61.1	117.0	84.5
	total PCB congeners	µg/kg ww	4/4	100	66.55 J	106.1 J	83.11
	PCB TEQ	ng/kg ww	4/4	100	0.586	1.60 J	1.10
Graceful crab (hepatopancreas)							
R1	total PCB Aroclors	µg/kg ww	3/3	100	632 J	1,050 J	867
	total PCB congeners	µg/kg ww	2/2	100	652.6 J	1,106 J	879.3
	PCB TEQ	ng/kg ww	2/2	100	11.2 J	16.6	13.9
R2	total PCB Aroclors	µg/kg ww	3/3	100	425	589 J	507
	total PCB congeners	µg/kg ww	2/2	100	489.5 J	628.5 J	559.0
	PCB TEQ	ng/kg ww	2/2	100	6.79	9.24	8.02
Graceful crab (whole body [calculated])							
R1	total PCB Aroclors	µg/kg ww	6/6	100	245 J	359 J	319
	total PCB congeners	µg/kg ww	4/4	100	239.3 J	356.7 J	301.9
	PCB TEQ	ng/kg ww	4/4	100	3.85 J	5.24 J	4.46
R2	total PCB Aroclors	µg/kg ww	6/6	100	147.3	224 J	192
	total PCB congeners	µg/kg ww	4/4	100	193.3 J	232.3 J	212.3
	PCB TEQ	ng/kg ww	4/4	100	2.76	3.27	2.97
Dungeness crab (edible meat)							
R1/2	total PCB congeners	µg/kg ww	1/1	100	195.5 J	195.5 J	na
	PCB TEQ	ng/kg ww	1/1	100	2.18 J	2.18 J	na
R2	total PCB congeners	µg/kg ww	2/2	100	52.91 J	119.9 J	86.41
	PCB TEQ	ng/kg ww	2/2	100	0.720	1.50 J	1.11

Sampling Reach/ Subreach	Analyte	Units	Detection Frequency		Detected Concentrations		
			Ratio	%	Min.	Max.	Mean
Dungeness crab (hepatopancreas)							
R1/2	total PCB congeners	µg/kg ww	1/1	100	1,616 J	1,616 J	na
	PCB TEQ	ng/kg ww	1/1	100	15.5	15.5	na
R2	total PCB congeners	µg/kg ww	2/2	100	812.9 J	918.0 J	865.0
	PCB TEQ	ng/kg ww	2/2	100	8.95	10.5	9.73
Dungeness crab (whole body [calculated])							
R1/2	total PCB congeners	µg/kg ww	1/1	100	595.3 J	595.3 J	na
	PCB TEQ	ng/kg ww	1/1	100	5.94 J	5.94 J	na
R2	total PCB congeners	µg/kg ww	2/2	100	336.3 J	336.5 J	336.4
	PCB TEQ	ng/kg ww	2/2	100	3.79	3.94 J	3.87

Note: PCB TEQ was considered a detect if at least one component was detected.

J – estimated concentration
na – not applicable

PCB – polychlorinated biphenyl
TEQ – toxic equivalent
ww – wet weight

Table 4-2. Dioxin/furan TEQ tissue data summary

Sampling Reach/Subreach	Detection Frequency		Dioxin/Furan TEQ (ng/kg ww)		
	Ratio	%	Min.	Max.	Mean
English sole (fillet)					
R1	6/6	100	0.378 J	0.597 J	0.507
R2	6/6	100	0.236 J	0.510 J	0.350
English sole (remainder)					
R1	6/6	100	1.71 J	2.01 J	1.84
R2	6/6	100	0.939 J	1.54 J	1.23
English sole (whole body [calculated])					
R1	6/6	100	1.27 J	1.50 J	1.41
R2	6/6	100	0.699 J	1.19 J	0.943
Shiner surfperch (whole body)					
R1a	3/3	100	0.702 J	1.51 J	1.16
R1b	3/3	100	0.725 J	1.06 J	0.889
R2a	3/3	100	0.744 J	1.21 J	1.00
R2b	3/3	100	0.613 J	0.903 J	0.756
Graceful crab (edible meat)					
R1	6/6	100	0.391 J	0.550 J	0.458
R2	6/6	100	0.267 J	0.500 J	0.355

Sampling Reach/Subreach	Detection Frequency		Dioxin/Furan TEQ (ng/kg ww)		
	Ratio	%	Min.	Max.	Mean
Graceful crab (hepatopancreas)					
R1	3/3	100	3.55 J	5.14 J	4.52
R2	3/3	100	2.66 J	3.09 J	2.83
Graceful crab (whole body [calculated])					
R1	6/6	100	1.15 J	1.73 J	1.44
R2	6/6	100	0.744 J	1.16 J	0.987
Dungeness crab (edible meat)					
R1/2	1/1	100	0.538 J	0.538 J	na
R2	2/2	100	0.271 J	0.458 J	0.365
Dungeness crab (hepatopancreas)					
R1/2	1/1	100	5.89 J	5.89 J	na
R2	2/2	100	3.43 J	3.61 J	3.52
Dungeness crab (whole body [calculated])					
R1/2	1/1	100	2.04 J	2.04 J	na
R2	2/2	100	1.32 J	1.45 J	1.39

Note: Dioxin/furan TEQ was considered a detect if at least one component was detected.

J – estimated concentration
na – not applicable

TEQ – toxic equivalent
ww – wet weight

Table 4-3. cPAH TEQ graceful crab tissue data summary

Sampling Reach	Detection Frequency		cPAH TEQ (µg/kg ww)			RL or Range of RLs for Non-detected Results
	Ratio	%	Min.	Max.	Mean	
Edible meat						
R1	0/6	0	nd	nd	nd	4.51–4.52
R2	0/6	0	nd	nd	nd	4.49–4.53
Hepatopancreas						
R1	0/3	0	nd	nd	nd	4.51–4.53
R2	0/3	0	nd	nd	nd	4.51–4.52
Whole body (calculated)						
R1	0/6	0	nd	nd	nd	4.51–4.53
R2	0/6	0	nd	nd	nd	4.49–4.53

cPAH – carcinogenic polycyclic aromatic hydrocarbon
nd – not detected
RL – reporting limit

TEQ – toxic equivalent
ww – wet weight

Table 4-4. Inorganic arsenic tissue data summary

Sampling Reach/ Subreach	Detection Frequency		Detected Results (mg/kg ww)			RL or Range of RLs for Non-detected Results
	Ratio	%	Min.	Max.	Mean	
English sole (fillet)						
R1	0/6	0	nd	nd	nd	0.010
R2	1/6	17	0.005 J	0.005 J	na	0.010
English sole (remainder)						
R1	6/6	100	0.056	0.119	0.085	na
R2	6/6	100	0.200	0.369	0.280	na
English sole (whole body [calculated])						
R1	6/6	100	0.042	0.085	0.059	na
R2	6/6	100	0.1 J	0.26	0.19	na
Shiner surfperch (whole body)						
R1a	3/3	100	0.028	0.046	0.037	na
R1b	3/3	100	0.067	0.076	0.071	na
R2a	3/3	100	0.029	0.040	0.034	na
R2b	3/3	100	0.030	0.058	0.043	na
Graceful crab (edible meat)						
R1	6/6	100	0.050	0.251	0.11	na
R2	6/6	100	0.031	0.126	0.086	na
Graceful crab (hepatopancreas)						
R1	3/3	100	0.127	0.160	0.144	na
R2	3/3	100	0.105	0.253	0.177	na
Graceful crab (whole body [calculated])						
R1	6/6	100	0.071	0.225	0.12	na
R2	6/6	100	0.070	0.158	0.11	na

J – estimated concentration
na – not applicable

nd – not detected
RL – reporting limit
ww – wet weight

Table 4-5. SVOCs tissue data summary

Analyte	Detection Frequency		Detected Concentration (µg/kg ww)			RL or Range of RLs for Non-detected Results
	Ratio	%	Min.	Max.	Mean	
English sole (fillet)						
Bis(2-ethylhexyl)phthalate	0/2	0	nd	nd	nd	49.6
Pentachlorophenol	0/2	0	nd	nd	nd	99.2

Analyte	Detection Frequency		Detected Concentration (µg/kg ww)			RL or Range of RLs for Non-detected Results
	Ratio	%	Min.	Max.	Mean	
Carbazole	0/2	0	nd	nd	nd	19.8
Hexachlorobenzene	0/2	0	nd	nd	nd	19.8
English sole (remainder)						
Bis(2-ethylhexyl)phthalate	2/2	100	496	498	497	na
Pentachlorophenol	2/2	100	99.2	99.6	99.4	na
Carbazole	2/2	100	19.8	19.9	19.9	na
Hexachlorobenzene	2/2	100	19.8	19.9	19.9	na
English sole (whole body [calculated])						
Bis(2-ethylhexyl)phthalate	2/2	100	340	341	341	na
Pentachlorophenol	2/2	100	82.9	82.9	82.9	na
Carbazole	2/2	100	16.6	16.6	16.6	na
Hexachlorobenzene	2/2	100	16.6	16.6	16.6	na
Shiner surfperch (whole body)						
Bis(2-ethylhexyl)phthalate	2/2	100	495	496	496	na
Pentachlorophenol	2/2	100	99.0	99.2	99.1	na
Carbazole	2/2	100	19.8	19.8	19.8	na
Hexachlorobenzene	2/2	100	19.8	19.8	19.8	na
Graceful crab (edible meat)						
Bis(2-ethylhexyl)phthalate	2/2	100	49.7	49.9	49.8	na
Pentachlorophenol	2/2	100	99.4	99.8	99.6	na
Carbazole	2/2	100	19.9	20.0	20.0	na
Hexachlorobenzene	2/2	100	19.9	20.0	20.0	na
Graceful crab (hepatopancreas)						
Bis(2-ethylhexyl)phthalate	1/1	100	149	149	na	na
Pentachlorophenol	1/1	100	99.3	99.3	na	na
Carbazole	1/1	100	19.9	19.9	na	na
Hexachlorobenzene	1/1	100	19.9	19.9	na	na
Graceful crab (whole body [calculated])						
Bis(2-ethylhexyl)phthalate	2/2	100	77.6	78.0	77.8	na
Pentachlorophenol	2/2	100	99.4	99.7	99.6	na
Carbazole	2/2	100	19.9	20.0	20.0	na
Hexachlorobenzene	2/2	100	19.9	20.0	20.0	na

na – not applicable
nd – not detected

RL – reporting limit
SVOC – semivolatile organic compound
ww – wet weight

Table 4-6. TBT and vanadium tissue data summary

Species	Units	Detection Frequency		Detected Results			RL or Range of RLs for Non-detected Results
		Ratio	%	Min.	Max.	Mean	
English sole (fillet)							
TBT	µg/kg ww	0/2	0	nd	nd	nd	3.84–3.85
Vanadium	mg/kg ww	2/2	100	0.0461	0.0480	0.0471	na
English sole (remainder)							
TBT	µg/kg ww	0/2	0	nd	nd	nd	3.82–3.84
Vanadium	mg/kg ww	2/2	100	0.461	0.518	0.490	na
English sole (whole body [calculated])							
TBT	µg/kg ww	0/2	0	nd	nd	nd	3.83–3.84
Vanadium	mg/kg ww	2/2	100	0.336	0.357	0.347	na
Shiner surfperch (whole body)							
TBT	µg/kg ww	2/2	100	8.44	12.1	10.3	na
Vanadium	mg/kg ww	2/2	100	0.761	0.821	0.791	na
Graceful crab (edible meat)							
TBT	µg/kg ww	0/2	0	nd	nd	nd	3.84–3.85
Vanadium	mg/kg ww	2/2	100	0.199	0.241	0.220	na
Graceful crab (hepatopancreas)							
TBT	µg/kg ww	0/1	0	nd	nd	nd	3.84
Vanadium	mg/kg ww	1/1	100	0.214	0.214	na	na
Graceful crab (whole body [calculated])							
TBT	µg/kg ww	0/2	0	nd	nd	nd	3.84–3.85
Vanadium	mg/kg ww	2/2	100	0.202	0.235	0.219	na

na – not applicable
 nd – not detected

RL – reporting limit
 TBT – tributyltin
 ww – wet weight

Table 4-7. Organochlorine pesticides tissue data summary

Chemical	Detection Frequency		Detected Concentration (µg/kg ww)			RL or Range of RLs for Non-detected Results
	Ratio	%	Min.	Max.	Mean	
English sole (fillet)						
Aldrin	0/2	0	nd	nd	nd	0.77–0.89
alpha-BHC	2/2	100	0.42 J	0.83 J	0.63	na
beta-BHC	0/2	0	nd	nd	nd	0.77–0.89
gamma-BHC	1/2	50	0.25 J	0.25 J	na	0.89

Chemical	Detection Frequency		Detected Concentration (µg/kg ww)			RL or Range of RLs for Non-detected Results
	Ratio	%	Min.	Max.	Mean	
Total chlordane	2/2	100	1.04 J	1.31 J	1.18	na
Total DDTs	2/2	100	3.0 J	6.3 J	4.7	na
Dieldrin	1/2	50	0.30 J	0.30 J	na	0.89
Heptachlor	2/2	100	0.14 J	0.20 J	0.17	na
Heptachlor epoxide	0/2	0	nd	nd	nd	0.77–0.89
English sole (remainder)						
Aldrin	0/2	0	nd	nd	nd	0.80–0.92
alpha-BHC	2/2	100	0.28 J	0.80 J	0.54	na
beta-BHC	0/2	0	nd	nd	nd	0.80–0.92
gamma-BHC	0/2	0	nd	nd	nd	0.80–0.92
Total chlordane	2/2	100	4.4 J	6.2 J	5.3	na
Total DDTs	2/2	100	14.1 J	19.9 J	17.0	na
Dieldrin	2/2	100	0.82 J	1.0	0.91	na
Heptachlor	2/2	100	0.10 J	0.20 J	0.15	na
Heptachlor epoxide	1/2	50	0.25 J	0.25 J	na	0.92
English sole (whole body [calc.])						
Aldrin	0/2	0	nd	nd	nd	0.79–0.91
alpha-BHC	2/2	100	0.49 J	0.68 J	0.59	na
beta-BHC	0/2	0	nd	nd	nd	0.79–0.91
gamma-BHC	1/2	50	0.35 J	0.35 J	na	0.91
Total chlordane	2/2	100	3.4 J	4.5 J	4.0	na
Total DDTs	2/2	100	11.3 J	15.4 J	13.4	na
Dieldrin	2/2	100	0.66 J	0.79	0.73	na
Heptachlor	2/2	100	0.11 J	0.20 J	0.16	na
Heptachlor epoxide	1/2	50	0.29 J	0.29 J	na	0.91
Shiner surfperch (whole body)						
Aldrin	0/2	0	nd	nd	nd	0.88–0.92
alpha-BHC	2/2	100	0.55 J	1.1 J	0.83	na
beta-BHC	0/2	0	nd	nd	nd	0.88–0.92
gamma-BHC	2/2	100	0.22 J	0.47 J	0.35	na
Total chlordane	2/2	100	1.27 J	2.26 J	1.77	na
Total DDTs	2/2	100	3.9 J	7.9 J	5.9	na
Dieldrin	0/2	0	nd	nd	nd	0.88–0.92
Heptachlor	2/2	100	0.25 J	0.27 J	0.26	na
Heptachlor epoxide	0/2	0	nd	nd	nd	0.88–0.92

Chemical	Detection Frequency		Detected Concentration (µg/kg ww)			RL or Range of RLs for Non-detected Results
	Ratio	%	Min.	Max.	Mean	
Graceful crab (edible meat)						
Aldrin	1/2	50	0.34 J	0.34 J	na	0.96
alpha-BHC	2/2	100	0.60 J	0.61 J	0.61	na
beta-BHC	0/2	0	nd	nd	nd	0.92–0.96
gamma-BHC	2/2	100	0.31 J	0.38 J	0.35	na
Total chlordane	1/2	50	0.11 J	0.11 J	na	2.3
Total DDTs	2/2	100	0.94 J	1.7 J	1.3	na
Dieldrin	0/2	0	nd	nd	nd	0.92–0.96
Heptachlor	2/2	100	0.24 J	0.25 J	0.25	na
Heptachlor epoxide	1/2	50	0.19 J	0.19 J	na	0.92
Graceful crab (hepatopancreas)						
Aldrin	0/1	0	nd	nd	nd	0.90
alpha-BHC	0/1	0	nd	nd	nd	0.90
beta-BHC	0/1	0	nd	nd	nd	0.90
gamma-BHC	0/1	0	nd	nd	nd	0.90
Total chlordane	1/1	100	0.46 J	0.46 J	na	na
Total DDTs	1/1	100	10.4	10.4	na	na
Dieldrin	0/1	0	nd	nd	nd	0.90
Heptachlor	1/1	100	0.18 J	0.18 J	na	na
Heptachlor epoxide	0/1	0	nd	nd	nd	0.90
Graceful crab (whole body [calc.])						
Aldrin	1/2	50	0.37 J	0.37 J	na	0.94
alpha-BHC	2/2	100	0.56 J	0.57 J	0.57	na
beta-BHC	0/2	0	nd	nd	nd	0.91–0.94
gamma-BHC	2/2	100	0.35 J	0.40 J	0.38	na
Total chlordane	2/2	100	0.20 J	0.46 J	0.33	na
Total DDTs	2/2	100	3.9 J	3.9 J	3.9	na
Dieldrin	0/2	0	nd	nd	nd	0.91–0.94
Heptachlor	2/2	100	0.22 J	0.23 J	0.23	na
Heptachlor epoxide	1/2	50	0.26 J	0.26 J	na	0.91

BHC – benzene hexachloride
DDT - dichlorodiphenyltrichloroethane
J – estimated concentration

na – not applicable
nd – not detected
RL – reporting limit
ww – wet weight

Table 4-8. Conventional parameters tissue data summary

Species	Detection Frequency		Result (%)		
	Ratio	%	Min.	Max.	Mean
English sole (fillet)					
Total solids	12/12	100	20.6	23.4	22.0
Lipid	12/12	100	1.2	3.0	2.3
English sole (remainder)					
Total solids	12/12	100	24.1	30.6	26.8
Lipid	12/12	100	5.2	10	7.0
English sole (whole body [calculated])					
Total solids	12/12	100	23.4	27.9	25.3
Lipid	12/12	100	4.0	7.7	5.4
Shiner surfperch (whole body)					
Total solids	12/12	100	25.9	27.7	26.7
Lipid	12/12	100	3.6	5.9	5.1
Graceful crab (edible meat)					
Total solids	12/12	100	10.9	18.3	15.8
Lipid	12/12	100	0.48	0.98	0.66
Graceful crab (hepatopancreas)					
Total solids	6/6	100	12.8	15.4	14.0
Lipid	6/6	100	1.9	2.9	2.4
Graceful crab (whole body [calculated])					
Total solids	12/12	100	11.3	17.5	15.3
Lipid	12/12	100	0.84	1.5	1.1
Dungeness crab (edible meat)					
Total solids	3/3	100	18.0	19.9	18.9
Lipid	3/3	100	0.75	1.4	1.1
Dungeness crab (hepatopancreas)					
Total solids	3/3	100	18.2	20.3	19.4
Lipid	3/3	100	5.0	6.6	5.6
Dungeness crab (whole body [calculated])					
Total solids	3/3	100	18.1	19.9	19.1
Lipid	3/3	100	2.4	2.7	2.5

4.2 DATA VALIDATION RESULTS

Independent data validation was performed on all results by Ecochem. Full validation was performed on a minimum of 10% of the data or a single sample delivery group, as specified in the QAPP (Windward 2017). A summary-level validation review was conducted on the remaining data.

All data were determined to be acceptable for use as qualified. No data were rejected. The data validation report includes detailed information regarding all data qualifiers and is presented in Appendix D.

5 Stable Isotope Results

This section presents the results of the carbon and nitrogen stable isotope analyses conducted on crab edible meat composite samples (Table 5-1). As specified in the QAPP, the stable isotope data provide additional information related to trophic level, and will be discussed in the data evaluation report. These data will not be validated, as there is no applicable EPA analytical method, and stable isotope analysis is not included as part of the national functional guidelines for data review. The laboratory followed its standard internal quality control procedures, including analyzing reference materials and determining precision and accuracy. IsoLab's report is included as Appendix E.

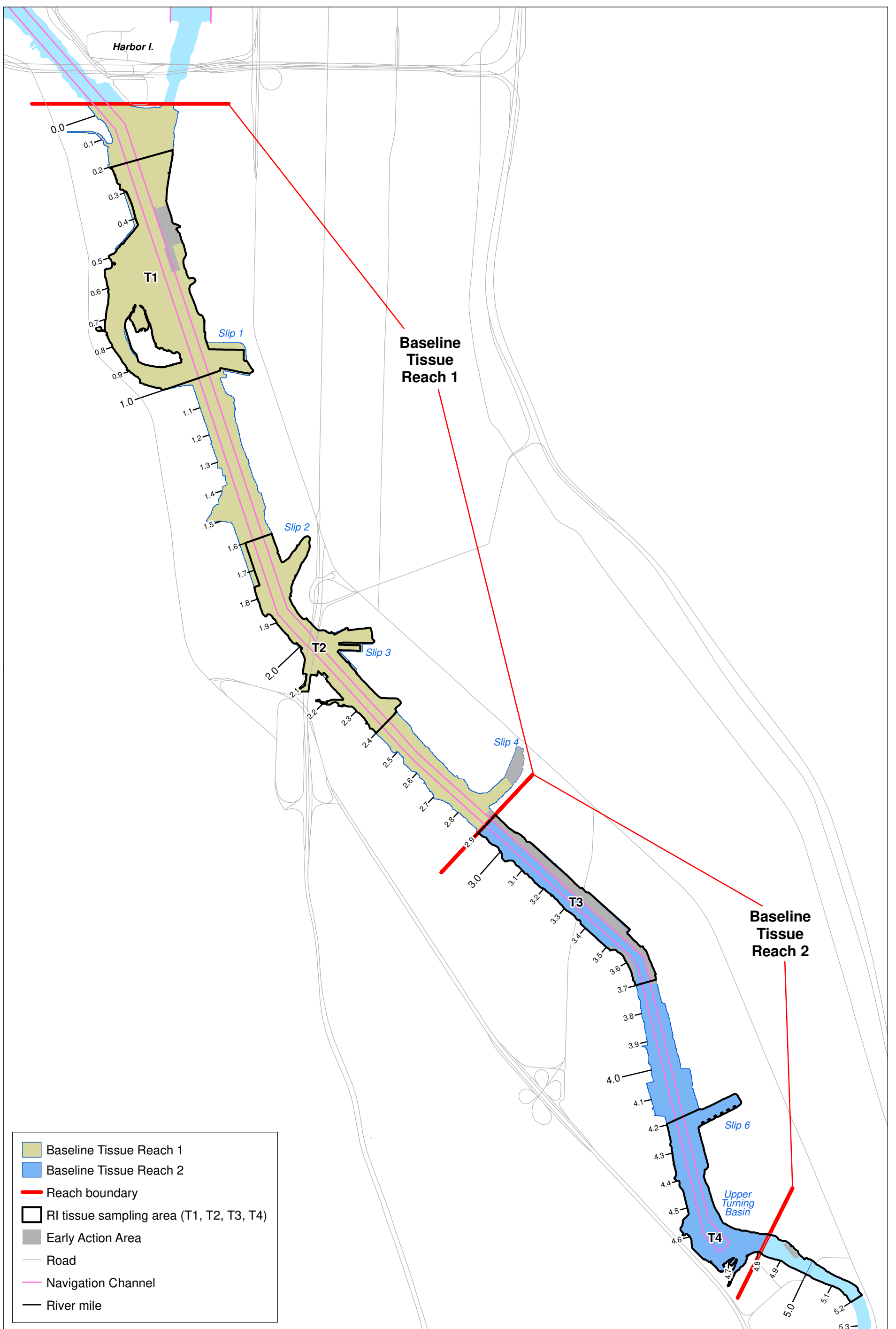
Table 5-1. Stable isotope data for crab tissue composites

Composite ID	Sampling Reach	delta ¹³ C	delta ¹⁵ N
Graceful crab (edible meat)			
LDW17-R1-GCEM-comp01	R1	-17.5092	12.2952
LDW17-R1-GCEM-comp02	R1	-17.3243	12.2025
LDW17-R1-GCEM-comp03	R1	-17.0254	13.0482
LDW17-R1-GCEM-comp04	R1	-17.8254	12.1188
LDW17-R1-GCEM-comp05	R1	-17.6059	12.39
LDW17-R1-GCEM-comp06	R1	-18.11	12.2287
LDW17-R2-GCEM-comp01	R2	-20.5097	12.5352
LDW17-R2-GCEM-comp02	R2	-17.9609	14.0819
LDW17-R2-GCEM-comp03	R2	-20.5724	12.9168
LDW17-R2-GCEM-comp04	R2	-20.9511	12.2894
LDW17-R2-GCEM-comp05	R2	-19.9012	12.3468
LDW17-R2-GCEM-comp06	R2	-20.9525	12.0331
Dungeness crab (edible meat)			
LDW17-DCEM-comp01	R2	-20.4519	12.5148
LDW17-DCEM-comp02	R2	-20.1781	12.7191
LDW17-DCEM-comp03	R1/2	-19.5078	13.1036

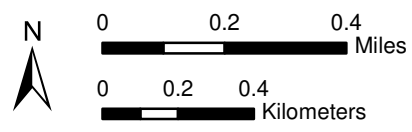
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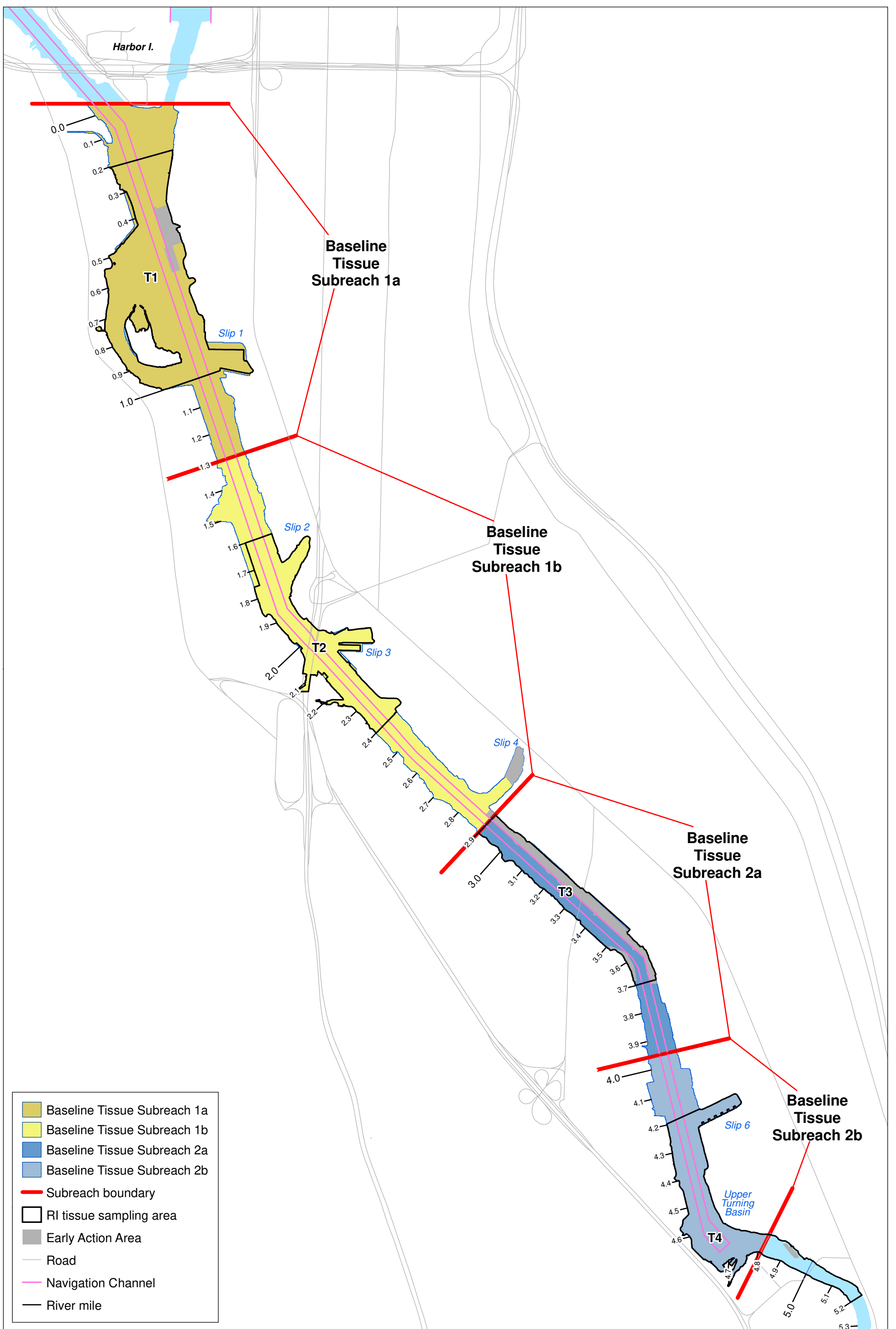
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Map 2-1. Sampling reaches for baseline English sole and crab tissue collection





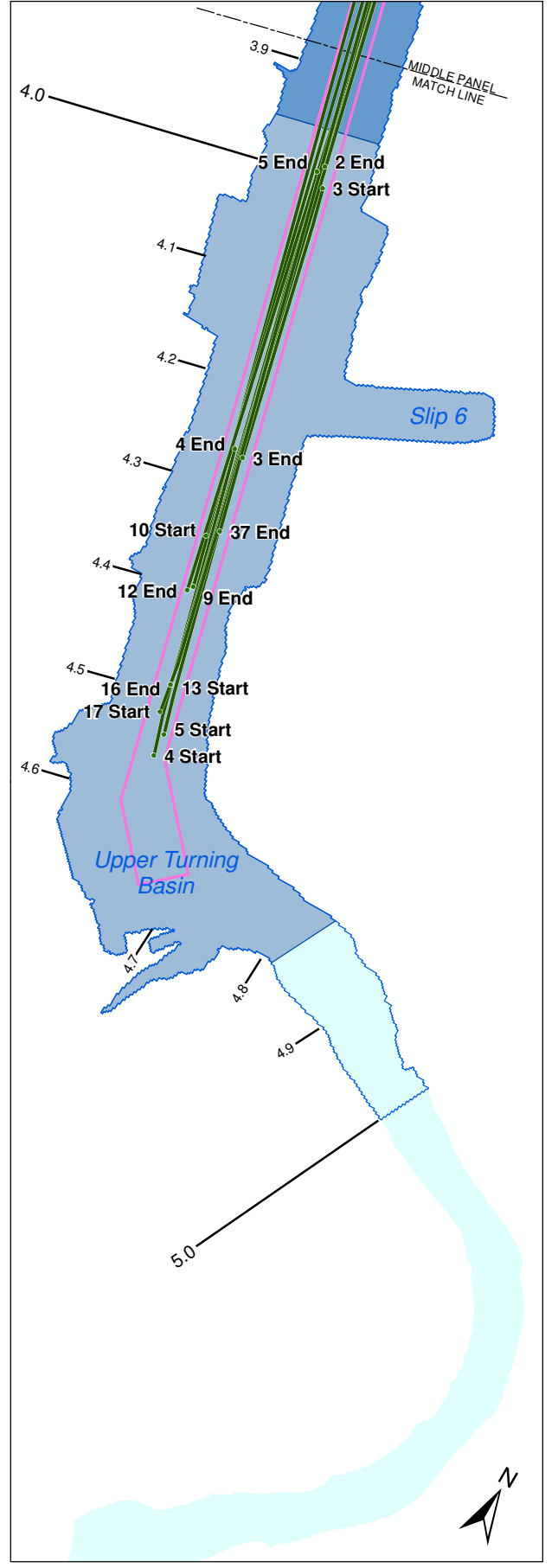
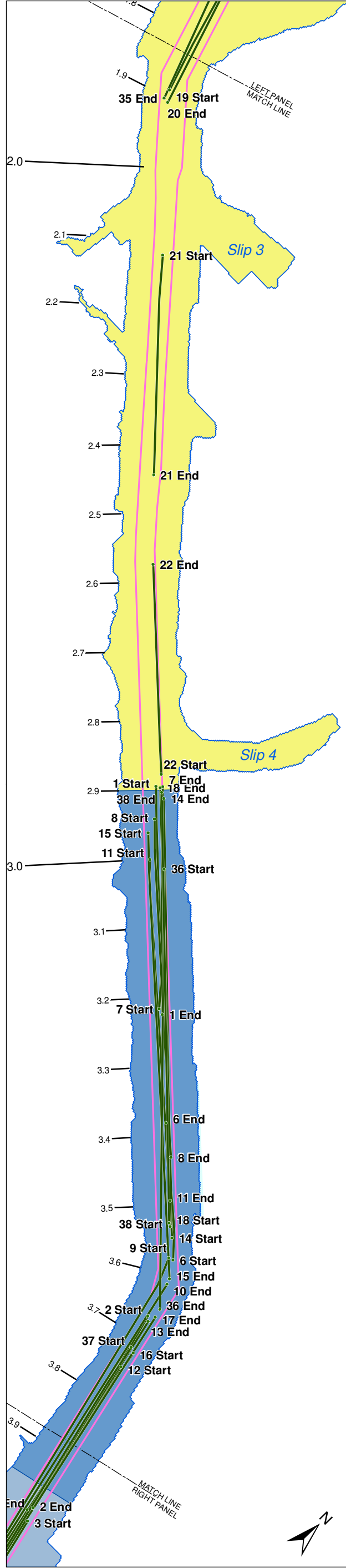
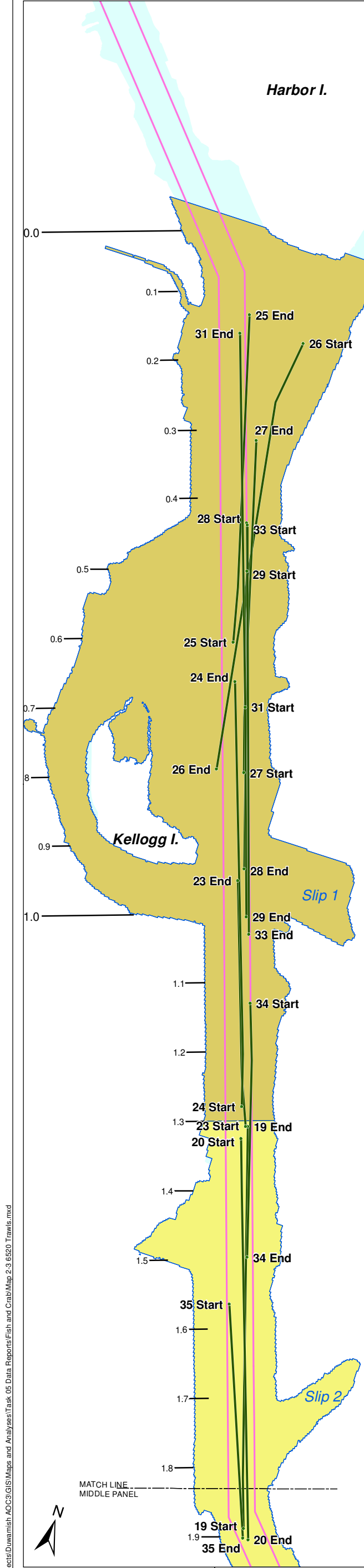
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Map 2-2. Sampling subreaches for baseline shiner surfperch tissue collection



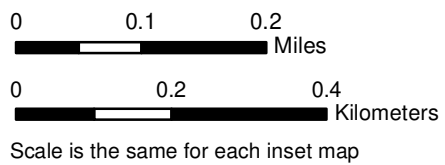
- Trawl
- Tissue sampling subreaches**
- Baseline Tissue Subreach 1a
- Baseline Tissue Subreach 1b
- Baseline Tissue Subreach 2a
- Baseline Tissue Subreach 2b
- LDW Superfund Boundary
- Navigation Channel
- River mile

Station Name	Status	River Mile	Station Name	Status	River Mile	Station Name	Status	River Mile
1	Start	2.9	13	Start	4.5	25	Start	0.6
	End	3.2		End	3.7		End	0.1
2	Start	3.7	14	Start	3.6	26	Start	0.2
	End	4.0		End	2.9		End	0.8
3	Start	4.0	15	Start	3.0	27	Start	0.8
	End	4.3		End	3.6		End	0.3
4	Start	4.6	16	Start	3.7	28	Start	0.4
	End	4.3		End	4.5		End	0.9
5	Start	4.5	17	Start	4.5	29	Start	0.5
	End	4.0		End	3.7		End	1.0
6	Start	3.6	18	Start	3.5	31	Start	0.7
	End	3.4		End	2.9		End	0.2
7	Start	3.2	19	Start	1.9	33	Start	0.4
	End	2.9		End	1.3		End	1.0
8	Start	2.9	20	Start	1.3	34	Start	1.1
	End	3.4		End	1.9		End	1.5
9	Start	3.6	21	Start	2.1	35	Start	1.6
	End	4.4		End	2.4		End	1.9
10	Start	4.3	22	Start	2.9	36	Start	3.0
	End	3.6		End	2.6		End	3.7
11	Start	3.0	23	Start	1.3	37	Start	3.7
	End	3.5		End	1.0		End	4.3
12	Start	3.8	24	Start	1.3	38	Start	3.5
	End	4.4		End	0.7		End	2.9

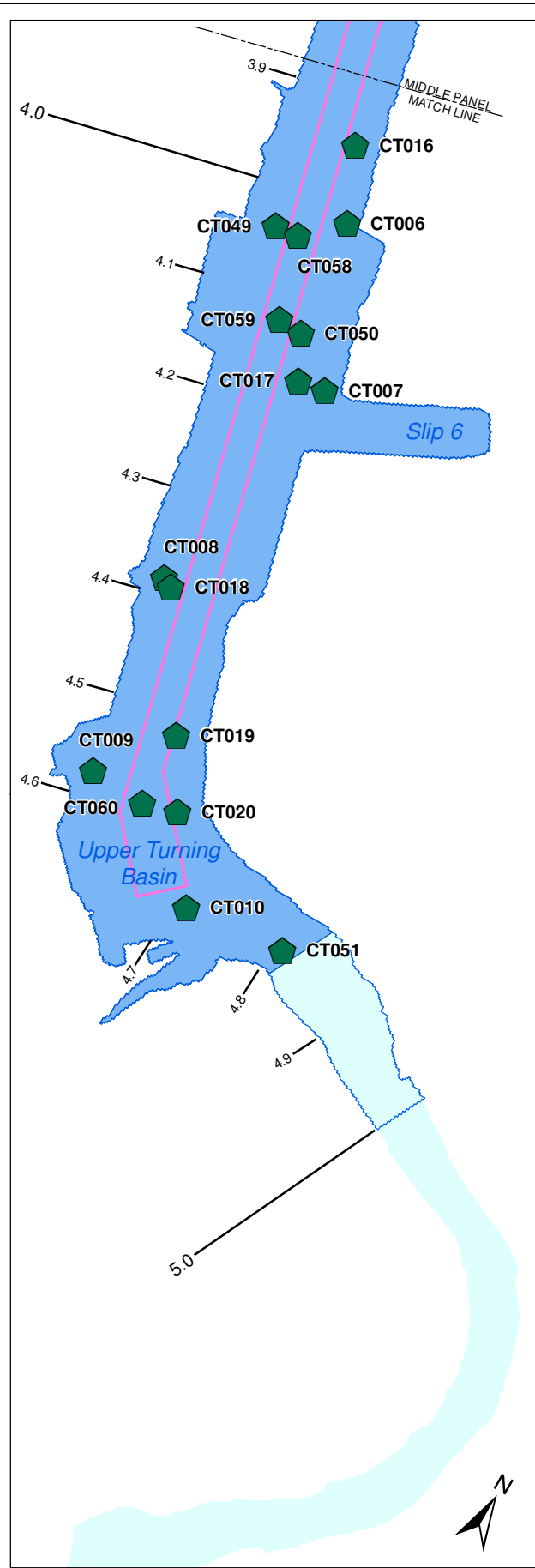
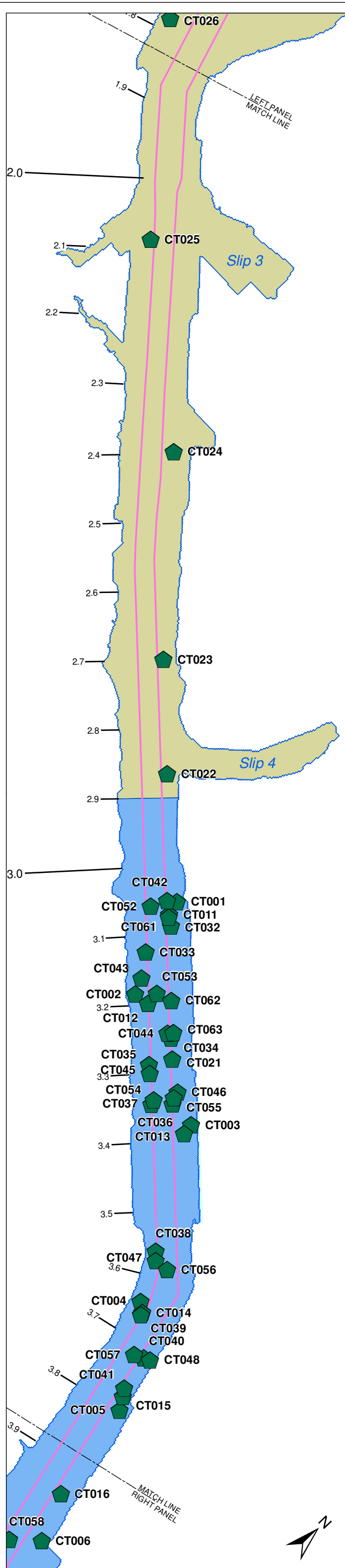
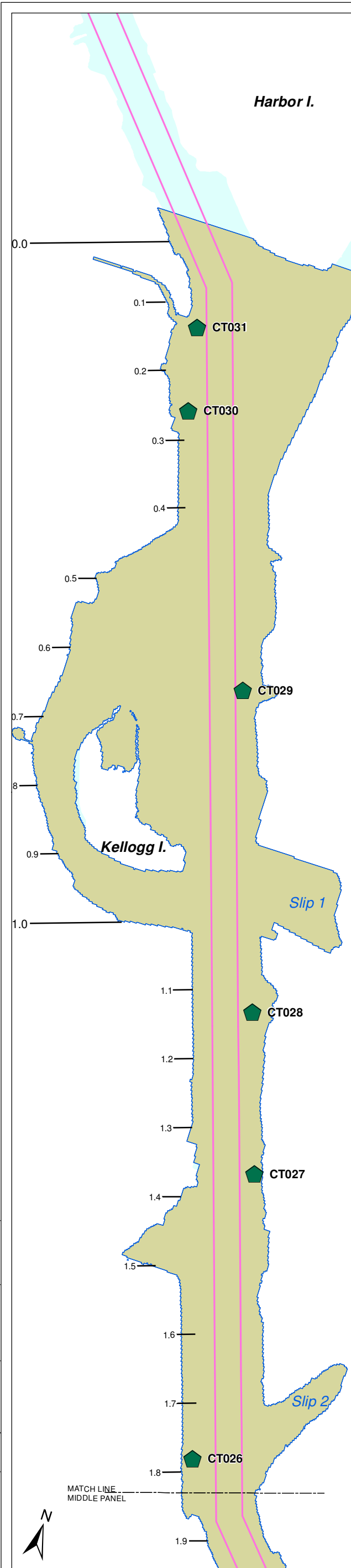
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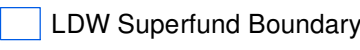
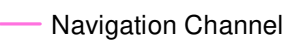



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Map 2-3 LDW trawl locations

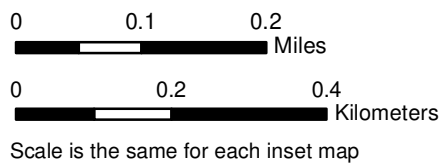


 Crab trap
Tissue sampling reaches
 Baseline Tissue Reach 1
 Baseline Tissue Reach 2
 LDW Superfund Boundary
 Navigation Channel
 River mile

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Map 2-4 LDW crab trap locations